# MONETARY FORESTRY ACCOUNTING INCLUDING ENVIRONMENTAL GOODS AND SERVICES [1]

**B. Kriström [1], K. Skånberg [2]**

[1] Department of Forest Economics
SLU
901 83 Umeå, Sweden

[2] Swedish National Institute of Economic Research. Stockholm. Sweden

bengt@kristrom.net

## SUMMARY

There is substantial current interest in expanding accounting systems, such that they include services appropriated from the ecological systems. Much of this activity has focused upon forest resources; there are currently more than 100 «green» forest accounting studies, covering many different countries. This paper provides a view of some theoretical and empirical issues on «green» forest accounting. It discusses some issues in calculating «true» income from forests, as well as the measurement problems that arise when valuing non-priced services. It also reviews recent efforts at EUROSTAT and includes a detailed illustration of a comprehensive official Swedish application on «green» forest accounting. The paper concludes by arguing that future work on green forest accounting should be directed towards tying together theory and practice to a even larger extent than what is currently the case.

**KEY WORDS:** Expanded Forestry Accounts
Environmental Accounting
EUROSTAT proposal
Sweden

## INTRODUCTION

There is substantial current interest in expanding national accounting systems, such that they include services appropriated from the ecological systems. Forests are among the resources that have received the most interest. A recent review by Vincent & Hartwick (1997) reviews more than 100 such applications. Efforts by international organizations, such as the FAO and IUFRO, by means of conferences, solicited papers on forest accounting (e.g. FAO and the Vincent & Hartwick report) etc., underline the impor-

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[1] This paper draws heavily in certain sections on a recent survey by Kriström (2001).

tance attached to expanded forest accounts. More generally, concerns about ecological and environmental functions of forest manifest itself within international discussions and agreements (such as ITTA, TFAP, Agenda 21 and others).

It is clear that conventional economic accounts can only shed light on a subset of the many ways in which forest contribute to human welfare. This is because conventional accounts are essentially restricted to goods and services that pass through markets. But there are aspects of forests that contribute to human welfare, yet do not pass conventional markets, such as certain recreation activities. In addition, there are religious and cultural uses of forests that serve to enhance human welfare, although the value of such services are not (and perhaps should not!) be registered in any economic account.

Furthermore, forest soil and species are part of the biogeochemical cycles, fulfilling several ecological functions, such as promoting biodiversity and fostering other ecosystems and, therefore, other economic sectors. Conventional economic accounts indirectly include some of these services, but certainly not all.

Sometimes the non-market values of forests can be substantial. In his survey, Pearce (1999, p. 13) reports the value of carbon fixation in tropical forests to be somewhere between 600 and 4400 USD per ha and year. At the same time, there is no guarantee that non-market values exceed market values. The same survey shows the value of watershed protection functions in tropical forests to be about 30 USD per ha and year, which is «far from enough to justify conservation on economic grounds», Pearce (1999, p. 13).

In summary, expanded forest accounts are potentially useful for a number of reasons:

we gain knowledge about the economic and ecological interactions in the forestry sector and in society at large,

«correct», or at least more accurate, values in monetary terms (accounting prices) of forest goods and services are estimated, which is important for management decisions, environmental and economic policy,

one can show how to extend the accounting practices of the System of National Accounts, in this case by introducing non-timber values of forests, thereby getting more complete production and stock accounts.

The literature on expanded forest accounting is still in a formative stage and there are many theoretical and practical issues that remain to be discussed. This paper adds to this discussion and provides a detailed example of the kind of information collated in a comprehensive forest account. The plan of the paper is as follows. Section 2 of the paper focuses on a number of conceptual issues that arises when contemplating the «true value» of our forest resources. We then discuss a number of empirical problems related to green forest accounting in section 3. They circle, for the most part, on the nettlesome issue of measuring the value of non-marketed forest goods and services, e.g. the value of carbon sequestration and the value of preserving old-growth forests. The rest of the paper discusses empirical applications. Section 4 discuss some European experiences on forest accounting, in particular the EUROSTAT suggestions, while section 5 details a Swedish application. We present estimates of forest values including: (i) timber values, (ii) non-wood goods (iii) production capacity (iv) services (recreation, protection of soils & noise, carbon sequestration), (v) biodiversity and (vi) chemical imbalance costs (acidification). It should be noted that our application is unique in terms of the data availability, not only because it provide time series in some cases, it is also quite comprehensive regarding the scope. The paper concludes with suggestions for further work, which should focus on how to improve the links between theory and empirical work. Herein lies a great challenge, not only for current efforts within organizations such as the Eurostat and the UN, but also for those economists and natural scientists that co-operate in shaping forect accounts into even more powerful tools.

## GREEN ACCOUNTING AND FORESTS

Forest accounting at the national level conventionally focus on those goods and services that pass the market. Thus, the net contribution to the national product from the forest sector is equal to the sum of value added (wages plus gross profits) in this sector. The sum of value added across all sectors in the economy is equal to the gross domestic product, GDP. This value is the most important statistic that emerges out of the national accounts. While GDP is not an accurate indicator of a nation's well-being, a growing GDP is often correlated with welfare gains. Thus, an increasing GDP is often associated with improved health, better educational systems and infrastructure, and so on and so forth. While policy-makers, politicians and others are often rightfully critized for an unbalanced focus on GDP, it is a fact that GDP-increases transforms into a betterment of life for at least some people. Yet, GDP-increases driven by an increased use of renewable natural resources, let us say, increased cuttings of forests could easily give a biased, and incorrect, picture of a countrys' ability to prosper over the long run. All the more so in resource-dependent countries.

The origins of integrated environmental and economic accounting can be traced back to the beginning of the 1970s. Nordhaus & Tobin (1973) provided a calculation of an adjusted national product, called Measure of Economic Welfare (MEW). Their paper came out in a time when the net benefits of the «consumption society» had been debated for about decade. Nordhaus and Tobin reclassified certain items of expenditure; imputed values for services of consumer capital and leisure and household work and made a correction for the «disamenities of urbanization». Official attempts were subsequently undertaken in Norway and the Netherlands. International initiatives, such as the Brundtland Commission on Sustainable Development and the Rio-Conference 1992, were important in shaping the United Nations draft handbook on System of Environmental and Economic Accounting (SEEA), which is the most comprehensive current proposal on expanded green accounting. See e.g. the review by Heal & Kriström (2001) for additional discussions about the development of this literature.

The draft manual of the SEEA, the UNs system, contains detailed example of how forest accounts should be compiled. Conventional NDP in forestry is proposed to be reduced by (p. 108): «the value of depletion, i.e. that part of the value of removals or losses of non-cultivated standing timber (and other of the forest's non-cultivated biological assets) due to logging, harvesting, hunting and clearance of forests, which exceeds the sustainable use..» and «the value of decrease in the market value of land due to degradation resulting from forestry, logging or other forest-related activities and deforestation (clearance of forest land)». There is a substantial risk of double-counting if this approach is followed, a risk that is duly noted in the Draft Manual (p 114).

There is also a quite substantial theoretical literature on green accounting. It should be noted that the SEEA, and many other implementations of green accounting in practice, are not based on proposals that have been advanced in the theoretical literature. This is also true for some of the literature on green forest accounting, more on this below. There is, it would seem, a gap between theory and application. For example, while the SEEA definition of adjusted NDP in forestry seems sensible, it is not clear what objectives it is based on. To some extent, this arises from different points of views regarding the fundamental objectives of measurement. Theorists often takes it for granted that one should seek a measure that serves as an index of an underlying welfare change (or index of sustainability), while official proposals are based on broader objectives (not necessarily linked to an underlying theoretical maximazation model). What should the objectives of expanded (forest) accounts be? To this issue we now turn.

**On the objectives of expanded forest accounting**

There are several reasonable objectives that could be used as basis for devising expanded (forest) accounting system. One reasonable objective is to focus on sustainability. Many proposals exist on sustainability indeces, that one way or another signals whether a particular development path is sustainable or not. There are other useful objectives; the SEEA seems to have several objectives, since the system is based on a modular structure, in which one can add-on progressively more complex measurements.

When it comes to forestry, it is natural to first discuss whether or not one should try to value non-marketed services in a monetary metric, or limit the system to accounting in physical terms. In some sense, this distinction is imaginary, because physical accounts are needed for the construction of monetary accounts. Nevertheless, an objective of a forest accounting system could be to trace the stocks and the relevant flows throughout the economy over time and space.

In a physical account, the in- and outgoing stock over the accounting period is recorded, and the flows are then traced throughout the economy. Physical information is useful for many purposes and it finesses the difficulties encountered when trying to put monetary values on non-marketed goods. Experience shows that physical accounts for forests are quite inexpensive to compile, as country studies from e.g. the Nordic countries suggest; much of the necessary biological data are often easily available.

Converting physical flows into a monetary metric opens the scope for comparing the value of different alternatives. The difficulties of this transformation has in some cases meant that certain countries have chosen not to construct monetary account for non-market services and goods. The argument is simply that currently available empirical methods are unsophisticated, or at least, do not allow estimates to any reasonable degree of precision. Nevertheless, as noted, many countries and organizations have pressed forward and include non-market values in expanded accounts.

Yet, even if we managed to put a monetary value on, say, the value of biodiversity and carbon sequestration services, we need to able to interpret the sum of those monetary values. What should be avoided is to simply collect numbers on whatever non-priced forest services there might be, and then sum the numbers. The well-known Costanza *et al.* (1997) study illustrates the problem with such an approach. The authors' made an attempt to put a value of all ecosystem services on earth. They identified 17 ecosystem services, ranging from «regulation of atmospheric chemical composition» to «cultural» services. A value was estimated for all categories for a number of biomes, including tropical and temperate/boreal forests. The total yearly value of ecosystem services from forests is claimed to be about USD 969 per ha. This suggest that forest ecosystem contribute about 12 % of the total value of the world's ecosystem, according to the authors'.

However, from an economics perspective, the value of all ecosystems in the world is infinite, because without them human life cannot exist as we know it. The error in Costanza *et al.* (1997) is basically one of not making the objectives of measurement clear. Economic value does not exist in the abstract. The total economic value of a good is obtained by calculating the utility difference between having and not having the good. Consequently, the total economic value of all ecosystems must be infinite, because the utility loss is infinite. Whether or not human life is possible without forests is debatable, but the important point is that knowing the global value of all forest ecosystems in the world does not help very much when making difficult decisions about trade-offs. It is hard to imagine any policy-relevant scenario where the complete destruction of all forests in the world is a viable option. Furthermore, even if such a value could be found, virtually no conclusion can be drawn from a value per hectare of forest so calculated. Expanded forest accounts must be founded on a sound theoretical base, such that the measurements made can be interpreted within the realms of an existing economic theory.

For the most part, the theoretical literature on expanded accounts focus on the measurement of (changes in) human welfare, or human well-being. The concept of welfare is narrowly defined in the economics literature, and it is easiest to think of it here as simply an index (defined over goods and services etc. that affect the quality of life).

There are two ways of assessing changes in (aggregate) well-being (Dasgupta *et al.*, 1995). One would be to measure the value of changes in the constituents of well-being (utility and freedoms), and the other would be to measure the value of the alterations in the commodity determinants of well-being (goods and services that are inputs in the production of well-being). The former procedure measures the value of alterations in various «outputs», and the latter evaluates the aggregate value of changes in the «inputs» of the production of well-being. It can be shown that there exists a set of shadow (or accounting) prices of goods and services that can be used to obtain an index of welfare change. If a small investment project, valued at the appropriate shadow prices, improves the index (over a short time-interval) they also increase aggregate well-being.

What is important, and surprising, is that this index is the (net) national product, properly modified to include all non-market goods and services. See Dasgupta, Kriström & Mäler (1995) for an extensive discussion of this fact. Heal & Kriström (2001) show that (national) wealth measures, rather than national product, have some theoretical advantages and the wealth-measures boil down to focussing on changes of all underlying welfare-relevant stocks. They seem to work for a broader class of underlying models, allowing inter alia for different kinds of discounting structures.

An advantage of focussing on aggregate well-being and using some basic principles of economic theory is that the resulting system is not plagued by double-counting errors. As pointed out in the extensive review of Hartwick & Vincent (1997) and in Vincent (1999), several current proposals on forest accounting are plagued by potential double-counting errors. For example, if a forest is damaged by emissions from abroad (or from another sector), this damage will be reflected in the profits that one can make from the forest. Similarly, if another sector benefits from certain forest functions, such as hindering erosion, the value of such services are already reflected in the value added of the receiving sector. Thus, while it could be of significant interest to pin down the specific services rendered by forests to other sectors, these values are to some extent already reflected in the national product. Carefully constructed accounts avoids this kind of double-counting at the aggregate level.

While space precludes a longer and more detailed discussion of the objectives of expanded forest accounts, perhaps the most important lesson to be drawn is that the measurement objectives must be made clear. This is simply another way of answering the question of what it is one wants to measure. Measuring the extra-market values of forests is a necessary, but not a sufficient condition for obtaining a more effective information system. We need to have a framework that adds these monetary values consistently.

## MEASURING FOREST VALUES [2]

The development of techniques to measure the value of non-market goods has been rapidly expanding over the past 30 years. There are now literally thousands of applications of various techniques to value environmental quality improvements in monetary terms. Of those, the so-called direct methods of valuation are the most popular. They focus the individual's subjective valuation of a certain resource change, using carefully constructed questionnaires or interviews. The contingent valuation method (CVM) is the most popular among the direct methods. For a recent survey of the contingent valuation method, see Bateman & Willis (1998).

The CVM, and related direct methods such as conjoint analysis, are currently the only techniques that allow us to estimate non-use values. Such values arise when an individual perceive utility from preserving a forest, let us say, but do not plan to visit it (or «use» the forest more or less directly). Direct methods are subject to the basic weakness that the respondent is answering a hypothetical question.

It is sometimes possible to use observed market-behavior to infer willingness to pay for environmental quality improvements. The travel cost method is based on the assumption that the price of enjoying the services of a site depends on the distance to the site, time costs and other costs related to the visit. The individual indirectly reveals his willingness to pay for the services of the site by paying the travel costs. By analyzing data on the proportion of visitors from a given number of points (these points are typically defined by the counties surrounding the sites), one obtains a picture of the demand for the site. The approach has been substantially generalized, since it was first proposed by Harold Hotelling in 1947.

By construction, the travel cost method can only shed light on values related to expenditures on marketed goods. It is unable to capture passive use values. The practical problems are many. For example, it is not clear how the time costs of a trip should be approximated (a priori it is even hard to tell whether the time costs are negative or positive, because the traveler might enjoy the scenery on the way to the site). Furthermore, the trip may have multiple objectives, so that there is a joint-cost problem. It is also difficult to define and incorporate substitute sites into the empirical analysis. See Smith (1996, chapter 4-15) for extensive discussion of the travel cost method and Wibe (1994) for applications related to recreational benefits of forests.

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[2] This section follows Kriström (2001) closely.

The hedonic pricing method focuses on property values and how amenity benefits may be mapped into those. Tyrväinen (1999) examines the relation between property values and urban forestry benefits in Joensuu (a town in eastern Finland with about 49,000 inhabitants.). Tyrväinen (1999, p. 328) finds that a 100 metre increase in distance to «wooded recreational areas» reduces «apartment price» by FIM 42 (about USD 6) per squaremeter.

The hedonic method assumes that the market under scrutiny is working well, such that the market prices give the correct signals. Second, it has to be assumed that the agents on the housing market have perfect information about the extra-market good.

The avoidance cost is based on the idea of calculating the cost of restoring the environment to a predefined quality level. Examples include: the cost of using less hazardous chemical products, the costs of purifying emissions and the costs for liming a lake. Greig and Devonshire (1981) estimated the amount of money the households would have to spend to keep water quality constant, arguing that this would be a measure of the benefits of retaining tree cover to avoid the increase in salinity of the water.

The weakness of the avoidance cost method is that it does not necessarily measure what economists are ultimately interested in, i.e. welfare changes. Suppose we use the avoidance cost method to estimate the noise damage due to an airport construction. We could estimate the cost of installing particular windows that would reduce indoor noise. Clearly, such costs do not include the welfare loss associated with a change of the noise level outdoors. In addition, people may well prefer to have the window open. The essential weakness of any method that focuses on the cost side is that costs do not necessarily measure the total welfare loss. The main advantage of the avoidance cost method is that it is often inexpensive to use.

An approach here called «the politically determined willingness to pay» presumes that there is a politically determined environmental goal for a particular environmental problem. The annual costs of achieving the goal can be used as an approximation of what the public would be willing to pay to reach it. Unfortunately, explicitly formulated environmental goals do not always exist. If they do exist, we often observe that they change over time. When aspiration levels change dramatically upwards, the index of well-being will be reduced, while in the short run environmental quality may not change at all. This makes a time series all the more difficult to interpret. A peculiar artefact of this approach is that the conventional net national product and its «green» counterpart will be equal in a country with no environmental policy; if there are no goals, there can be no cost of reaching them.

An often used approach in the valuation literature is based on opportunity costs. For example, given an estimate of the area of forests that need to be set aside to sustain a given level of biodiversity, the opportunity costs of the «lost» lumber can easily be calculated, see Hultkrantz (1991) for an example. This method does not necessarily provide a good estimate of the underlying welfare change. Suppose that we did use the opportunity costs of «lost» lumber as a value of biodiversity. There is no guarantee that the current market price of timber times the area saved gives a good estimate of the value of preserving biodiversity.

## SOME EXPERIENCE OF FORESTRY ACCOUNTING

As noted above, there is now a substantial literature expanded forest accounts. For recent country-studies from Brazil, India and South Africa, see Da Motta, Seroa and Do Amaral, (2000), Haripriya (2000) and Hassan (2000) respectively. Hultkrantz (1991), Eliasson (1994), and Hoffren (1997) present Swedish and Finnish forest accounts. They describe the value of the harvested timber production, the net growth of the timber stock, the production of game, mushroom and berries and some qualitative changes of the forest natural capital such as acidification.

Eurostat (Office for Official Publications of the European Communities, Luxembourg) has worked with expanded accounts for more than a decade. A task force on forestry accounting was created in 1995 to construct a (European) framework for Integrated Environmental and Economic Accounting for Forests (IEEAF). The work has contributed to the implementation of the European System of Accounts (ESA 1995), the implementation of Economic Accounts for Forestry, as well as the ongoing revision of the SEEA. For a detailed description of the treatment of forestry in the SEEA compared to the SNA, see FAO (1998, section 2.4).

Eurostat describes the system in three reports. The terminology and the classifications are meant to be compatible with the System of National Accounts (SNA). Thus, forest products are classified as by ESA-functions; forest products result in primary income from the use of an asset. The objective of the accounts is to consistently link the flow accounts to the forest balance sheet, in physical and monetary terms.

Member countries are free to choose the monetary valuation methods best suited for valuing their forests, as long as the methods complies with ESA-principles. Actual real estate transaction data are recommended for the valuation of forest; thus, this gives the market value of a particular estate. The present value method is recommended for valuation of standing timber.

Differences in values found between countries may be related to the use of different valuation methods (and not only country specific biological and economic factors). Non-ESA functions of forests, i.e. values provided by forests which can not be classified as primary income or connected to tradeable assets, have up to recently only been discussed qualitatively.

Following the Eurostat guidelines, many European countries have produced standard forestry accounts containing ESA-goods during the last couple of years. In the Eurostat forestry related publications and the protocols of meetings of Eurostat:s task force on forestry accounting, completed and planned studies of the value of non-ESA goods and services of forests are also presented. Statistics Sweden and the Swedish National Institute of Economic Research have just completed a test application of tables for non-ESA functions of forest in both physical and monetary terms (presented in parts below). Statistics Finland is starting a project on statistics for non-timber and non-ESA functions of forests. The project will be based on existing data, statistics and studies, focusing on carbon storage including carbon storage in wood products, valuation of protected forests and biodiversity accounts. Where possible, time series for the years 1990 to 2000 will be provided. There will also be an evaluation of future data needs and possibilities for regular compilation of physical and monetary statistics in this area.

In Austria and Germany researchers have just started a project called «Non-timber Functions of Forests, Monetary Values and Carbon Balances for Austria and Germany».

The objectives are to elaborate a set of physical accounts and prepare operational guidelines for periodical updates of the accounts. The project also includes a feasibility study for monetary valuation. Monetary accounts for carbon binding in Austrian forests will be provided and a review of CVM studies on the value of non-marketed environmental goods and services in German speaking countries (Austria, Germany, Switzerland), will be presented. A study on the recreation value of the forests covering Germany as a whole has recently been completed and a study on the value of biodiversity protection in Germany's forests is underway. In France projects on the value of recreational activities in forests, the consequences of the storms in 1999 on these values, and work on carbon balances for forests and wood products, are initiated. Spanish researchers have presented local forest accounts including recreational values and carbon sink values.

## MONETARY FOREST ACCOUNTS FOR TIMBER AND OTHER FOREST RELATED GOODS AND SERVICES FOR SWEDEN 1987-1999

Timber production, the production of non-wood products, the provision of ecological services, and net changes in capital stocks related to timber and non-wood goods production are discussed in the original report. Monetary values are based on yearly physical data, using domestic 1999 prices and c sonverted into Euro according to the exchange rate at the beginning of year 2000; SEK/Euro 8,50.

**Table 1**

**Summary of the Contents of the Forestry Accounts; describing how the values relate to the SNA-system and the valuation methods used**

| Section | Comprises | SNA | Valuation |
|---|---|---|---|
| **5.1** | Timber | SNA in forestry sector | market prices |
| **5.2** | Non wood goods | mostly SNA | mostly market prices |
| **5.3** | non-wood prod. Capacity | non-SNA | expert estimates |
| **5.4** | Forest services (recreation, etc) | non-SNA | Various |
| **5.5** | Qualitative changes (biodiversity | non-SNA | avoidance/restoration cost |

### Timber values

The output of the Swedish forestry sector can be found in the national accounts. The value added of the forest sector is its revenue minus all inputs from other sectors. Since1993, the GDP-measure calculated within SNA incorporates net changes in the standing timber stock. Thus, forests stocks are treated in much the same ways as real capital assets in the post-1993 SNA. Positive net changes in a real capital stock come about, of course, as a result of investments in buildings, machines or any other real capital stock.

If forests were not cut, the resulting natural growth should in principle be added to national product, reflecting the added possibilities of increased future consumption.

Net growth of the Swedish timber stock has been positive in the last decade and therefore contributes to GDP-growth. The simplest method to value the net growth (change) is to multiply the net growth figure by the stumpage value. In principle, net changes of any stock should be valued at its shadow price, which in this case can be shown to be price less marginal cost. Vincent (1999) and Kriström (2002) presents the underlying theory and the reasoning leading to this conclusion. Vincent & Hartwick (1997) provides a practical way of making this calculation (the difficulty is that marginal costs are difficult to estimate precisely).

In this paper, however, we use the simple approximation of stumpage price directly.Taking account of the growing timber stock in 1999, approximately Euro Mill. 600 can be added to the contribution of the forestry sector to the Swedish GDP, see Table 2.

**Table 2**

**Value of Swedish Timber Production**

| | 1987 | 1991 | 1993 | 1995 | 1997 | 1999 |
|---|---|---|---|---|---|---|
| **Harvested timber: Mill. $m^3$sk** [3] | 60.5 | 61.5 | 64.5 | 75 | 72 | 70 |
| **Nominal timber price index** [4] | 90 | 100 | 84 | 110 | 103 | 101 |
| **Swedish GDP-deflator** [5] | 74 | 100 | 104 | 110 | 113 | 118 |
| **Mill. of Euros** | 2,050 | 2,080 | 2,180 | 2,540 | 2,430 | 2,370 |
| **Net growth of timber stock: Mill. $m^3$** | 27 | 35 | 31 | 21 | 25 | 27 |
| **Nominal Stumpage price index** [6] | 89 | 100 | 86 | 132 | 123 | 115 |
| **Mill. of Euros** | 600 | 780 | 690 | 470 | 560 | 600 |
| **Total: Mill. of Euros** | 2,650 | 2,860 | 2,870 | 3,010 | 2,990 | 2,970 |

The annual timber production of Swedish forests have increased somewhat between 1987-1999. Because all stock-increase figures are calculated from moving yearly averages, it is difficult to determine the outcome in any given year. Climatic factors, such as temperature and rainfall might also temporarily change production, even if the underlying production capacity is the same.

[3] Forest cubic meters (standing volumes).

[4] Nominal price index for all timber: the base year is 1991, when the price was SEK 295/$m^3$ (=Euro 36).

[5] By using the GDP-deflator and the nominal price-indices for different goods, it is possible to convert the results to any year's relative prices and price levels.

[6] Nominal stumpage price index (standing timber): the base year is 1991, when the price was SEK 171/$m^3$ (=Euro 18,5).

## Values of non-wood forest products

It has been increasingly recognized that non-wood forest products is of importance in several dimensions. These includes beneficial impacts on employment, foreign exchange and the environment. As an example, FAO (1993, p. 35) claims that the collection and processing of the tendu leaf provides part-time employment for up to half a million women in India. The economic importance of non-wood forest products varies across countries. In Sweden in particular and developed countries in general, the economic importance is small and perhaps even negligible overall. Yet, for some households and in some sectors, non-wood forest products are very important, even in Sweden (e.g. the importance of lichen for the reindeer sector).

The yearly yield of berries, mushrooms and game and lichen will be valued in this Section. Changes in the forest ecosystem's capacity to produce berries and lichen will be analysed below.

Twenty five percent of all berries and mushrooms picked in Sweden are sold on commercial markets. Approximately three (3) percent of the berries and mushrooms produced are picked, and this value enters the forest accounts. The rest of the berries and mushrooms will be considered to be inputs into the forest ecosystem's food-web, «producing» game and re-circulating nutrients. Concerning game-hunting, the number of bagged elks and deer would be higher if the forests were used primarily to breed game, but the browsing costs from large game stocks are high and hunting quotas are set partly to offset these negative browsing effects.

Because some hunters and berry and mushroom-pickers sell their products, market prices for these goods are available. Time series of market prices for berries, mushrooms and game meat have been used to value all volumes picked and hunted.

The market value of non-wood goods produced by forests are directly comparable to the value added of forestry sector, because it includes compensation for labour and capital involved in picking and hunting activities.

Lichens, the main winter forage for reindeer, grow on the ground and on old trees. In Northern Sweden, the Sami people have a historical right to feed reindeer with lichen. There is no market price on lichen. From time to time, substitutes (e.g. hay) must be used, e.g. during hard winters or when the reindeer-stock is too large compared to the lichen supply. Production of lichen is forecasted from forest (age) data (Wilhelmsson, 1989). When the reindeer population exceeds 200.000 individuals, as has been case within the studied time-period, demand exceeds supply. A reindeer consumes about 1,25 kg of lichen a day, which means that the 70.000 tons of lichen forage produced in 1999 represented 56 Mill. days of reindeer feeding. The cost of a substitute (hay), to feed the remaining reindeer is approximately Euro 1½ a day per reindeer in 1999: Thus, the annual lichen production has a value of Euro Mill. 84.

## Valuing the production capacity of non-wood forest goods

The forest ecosystem's capacity to produce berries and mushrooms is affected by natural climate variations. However, factors such as forest management, acidification, eutrophication and overgrazing may also affect the ecosystem's production capacity of

**Table 3**

**Values of Non-Wood Goods Produced by the Swedish Forest Ecosystem**

| | 1987 | 1991 | 1993 | 1995 | 1997 | 1999 |
|---|---|---|---|---|---|---|
| **Berries: Mill. kg (50 % of liter value): Volume** | 41 | 35 | 33 | 30 | 27 | 26 |
| **Nominal price index of berries** [7] | 75 | 100 | 94 | 137 | 88 | 88 |
| **Value Mill. of Euros** | 68 | 59 | 55 | 50 | 43 | 41 |
| **Mushrooms: Mill. kg (20 % of liter-value): Volume** | 5.6 | 5.2 | 4.8 | 4.8 | 5 | 5 |
| **Nominal price index of mushrooms** [8] | 47 | 100 | 60 | 79 | 38 | 35 |
| **Value Mill. of Euros** | 20 | 18 | 16 | 16 | 17 | 17 |
| **Game: 1000 ton** | 18.4 | 20.4 | 17.3 | 15.4 | 15.3 | 16.4 |
| **Nominal price index of game meat** | 103 | 100 | 88 | 142 | 149 | 137 |
| **Value Mill. of Euros (in SNA)** | 93 | 103 | 87 | 78 | 77 | 83 |
| **Lichen: Reindeer feeding days, Mill.** | 64 | 62 | 60,5 | 59 | 57,5 | 56 |
| **Value Mill. of Euros (in SNA*** [9]**)** | 96 | 93 | 91 | 89 | 86 | 84 |
| **Total Value of Non-Wood Goods: Mill. of Euros** | 277 | 273 | 249 | 233 | 223 | 225 |

non-wood products. The value of such changes of the forest's natural capital and production capacity should be registered in the monetary forest accounts.

Acidification and eutrophication, especially in the southern parts of Sweden, have an impact on the forest ecosystem's capacity to produce berries. Other species are better suited for the currently more acid and nitrogen-saturated soil conditions. Productivity is also lost, because denser forests absorb light. Currently, more than 95 % of the annual production of berries and mushrooms is left in the forests. If it is assumed that the berries remaining in the forest, approximately 400 Mill. kilograms annually, are as valuable as the ones picked, the berry production capacity, and how it changes over time, can be approximately calculated.

The annual land rent of the berries picked (25-40 Mill. kg, average 1987-99), was Euro Mill. 17. If the remaining 400 Million kilograms of berries are assumed to possess the same value –certainly a very optimistic and unrealistic assumption– then the total annual flow of berries, picked by humans, grazed by other animals or recirculated as nutrients, has a value of Euro Mill. 34. Using a discount rate, comparable to the projected long

[7] The price of berries comes from foreign trade statistics. Prices of lingon-, blue- and raspberries follow more or less the same pattern between the years (price/kg do not differ between the different berries). Cloudberries cost twice as much. Base year of the index is 1991 (=100), when lingon- and blueberries cost SEK 16/kg (=Euro 2). 1kg of berries is approximately 2 liters.

[8] The price of mushrooms comes from the foreign trade statistics. Prices of the most valuable species, like chantarelles, can be twice the price of ordinary species. The base year of the index is 1991, when the price of ordinary species was SEK 58kr/kg (=Euro 7). It is assumed that half of the mushrooms picked are chantarelle-like species. 1 kg of mushrooms is assumed to be approximately the same as 5 liters.

[9] Indirectly, the value enters GDP as reindeer meat (as agricultural production), but as lichen is grazed/browsed free of charge, the forestry sector does not get credited for the input it provides.

term GDP-growth, of 2 %, the capitalized value of the forest ecosystem's berry production capacity is Euro Mill. 1700.

According to some researchers, the forest ecosystem's annual capacity to produce berries has decreased by 10-15 % since 1980, i.e. by 0,5-1 % annually. Consequently, the value of the forest ecosystem's capacity to produce berries has eroded by approximately Euro Mill. 13 annually.

As noted, lichen is overgrazed by reindeer at the present. The northern Swedish forest ecosystem's capacity to produce lichen decreases by 1 % a year according to the Wilhelmsson (1989) study. The forest ecosystem's capacity to produce lichen is estimated to have a stock value of Euro Bill. 4.5, using the same calculation method as for the berries above. Thus, the value of the 1 % annual decrease of the lichen production capacity is Euro Mill. 45.

**Table 4**

**Estimated Annual Changes 1987-1999 for Berry, Lichens and Mushroom Natural Capital**

| | Value of capital stock Mill. of Euros | Annual change % | Mill. of Euros |
|---|---|---|---|
| **Berries** | 1,700 | –0.75 | –13 |
| **Lichen** | 4,500 | –1 | –45 |
| **Mushrooms** [10] | 500 | 0 | 0 |
| **Total** | 6,700 | | –58 |

## The value of services provided by forest ecosystems

Recreation, biodiversity, protection of soils, noise protection and carbon sequestration are perhaps the most important non-priced services that forests provide. We discuss these in turn.

### The value of forest recreation

Wibe (1994) surveyed a large number of studies from various countries on the value of forest recreation. He found an average value of about USD 20 for a recreation day in the forest. This estimate seems high, although later studies have buttressed his findings. For example, according to Nordhaus & Kokkelenberg (1999, p. 135), USDA has estimated that of the total $9 billion value of forest goods and service in 1993, production of minerals and timber and grazing range services accounts for about 20 %, while recreational and wildlife services provided 80 %.

[10] Using the same calculation method as for berries and mushroom (Euro Mill.10/0,02=500).

Several recreational activities take place in Swedish forest ecosystems. Berry picking and game hunting are mainly recreational, even though they contribute to private consumption. The total number of visits to Swedish forests is approximately Mill. 373 a year. The purpose of the forest visits, around 60 visits per person and year, was analysed in a study by Statistics Sweden (1995, published 1999). 40 % of the visits were done walking or skiing, while running/jogging, studying flora/fauna, picking berries/mushrooms and hiking represented 10-15 % of the visits respectively.

The value of forest recreation proper is often found to be larger than the meat-value of game, for example. Thus, hunters seem to place much higher value on the recreational aspects of the hunt, as compared to the meat-value of game.

The value of the forest related activities has been analysed in Jämttjärn (1996), using several Swedish valuation studies from the 1980s and early 1990s. The mean value of a forest visit was found to be Euro 6. Using that value and the Swedish visiting frequencies, the annual forest recreation value per person in Sweden is calculated to be Euro 360 Mill.

This value could possibly be interpreted as the entrance fees collected, if all Swedish forests were fenced. Because we are primarily interested in marginal values, not total values, this is quite likely to be an overestimate. A market price is a marginal value, showing how market participants (buyers and sellers) value an additional unit of a good. The market price of water is typically low for this very reason, while the total value of water is high (perhaps infinite). When markets do not exists, the corresponding price of interest is called a shadow price (and the shadow price of a marketed good is the market price in equilibrium).

We simply note the important distinction between marginal and total values here. It is a distinction that cuts through all of the literature on green accounting. Note, for example, that a contingent valuation study typically gives the total, not the marginal, value of a good or a service. Hence, the value of Euro 6 for a recreation day is the total value of recreation in a forest for one day, and is larger than the marginal value.

With the exception of hunting, forest recreational activities have been found to give similar values, according to Jämttjärn (1996). Recreational services provided by forest ecosystems, hunting excluded, is therefore assigned a total annual value of Euro Bill. 2,2. Hunting is valued at Euro 22/day in Jämttjärn (1996). This value is based on several CV-studies (about a third can be ascribed to the meat-value). The total WTP sums up to Euro Mill. almost 250, of which Euro Mill. 78 can be ascribed to meat value, and the remaining Euro Mill. 170 to recreation. The same issue arises here, in that we would ideally like to have marginal rather than total values.

**Table 5**

**Recreational Values of Forest Visits**

| Activity | Mill. Visits | Value/day Euro | Total value Mill. Euros |
|---|---|---|---|
| **Hunting** | 11 | 15 | 170 |
| **A visit to the forest** | 362 | 15 | 170 |
| **Total** | 373 | | 2,370 |

**Valuing the forest ecosystem's capacity to provide protection of soils and noise**

Forests prevent nearby agricultural soils from eroding, by decreasing the wind factor and surface water run off. Soil erosion in Swedish agriculture is low by international standards. Some 0,06 % of the Swedish soils, measured as agricultural production losses, are lost every year due to erosion (Hasund 1986). Hypothetically, the erosion damage could be twice as high, without the protection from surrounding forests. On this reckoning, the soil protecting function has an annual value of approximately Euro Mill. 5 in Sweden (Skånberg 2001). The value of this protection activity is, however, already reflected in the value added in the agricultural sector. So, from the perspective of the economy, the value of this protection activity is already reflected in the national product.

Forests also protect urban areas from noise. There are no studies on this value, however. The social costs of noise in general has been estimated at Euro Mill. 300 a year (Johansson 1995 and Hansson 1994). Noise is mostly an urban problem, but the median distance a Swede lives from the nearest forest area is 300 meters, according to Hörnsten (2000). It seems likely that forests near residential areas protects from some noise. We have no data to support our calculations in this respect, but guesstimate the protection at 5 %,; that service could be worth Euro Mill. 15 a year.

**Table 6**

**Value of the Forest Ecosystem's Capacity to Prevent Soil Erosion and Noise**

| Protective function | Value: Euro Mill. Per year |
|---|---|
| **Protect agricultural soils** | 5 |
| **Reduce noise** | 15 |
| **Avoid avalanches, landslides, floods** | low in Sweden, potentially high elsewhere |
| **To improve air quality** | Not studied |
| **As a component of real estate prices** | Not studied |
| **Total** | 20 (potentially higher) |

**Valuing the forest ecosystem's capacity to sequester carbon**

The forest ecosystem's capacity to act as a carbon sink is a service that in the near future might be directly rewarded in the market, as a consequence of the Kyoto-protocol. Thus, it might be possible to trade carbon sequestration services on a carbon permit market in the future. There are many problems yet to be resolved before such a scheme could be implemented, including measurement problems, both from a natural science and economic point of view. Yet, the net social value of carbon sequestration services is positive, but not accounted for in the standard forest accounts.

We present here a pragmatic effort to value carbon sequestration services in Swedish forests. In principle, what is needed is the shadow value of one unit of carbon stored. This value is very difficult to estimate. The uncertainty is reflected e.g. in the second IPCC assessment report, where a value in the interval of 5-125 USD per ton carbon is reported.

To reflect this uncertainty, several different approaches to value carbon sequestration give substantially different values. The alternative to sequester carbon in forests (letting a tree stand) is to harvest. Thus, foregone forestry net revenue is a possible valuation of carbon sequestration. The value of the increase in the Swedish timber stock was Euro Mill. 600 in 1999. The current Swedish carbon tax reflects a social value, or a shadow price, of carbon emissions. The Swedish carbon tax is Euro 42/ton carbon dioxide, i.e. Euro 155/ton carbon. The carbon sequestered by forests in 1999 was estimated to be 5,2 Mill. metric tons. The value of the forest ecosystem's capacity to sequester carbon using the carbon tax to price the service is therefore about Euro Mill. 775. Nordhaus (1994) showed in his DICE-model that the productivity of primary sectors in the US would be affected negatively by climate change. By extrapolating projected American damage caused by future climate change, Nordhaus discusses possible effects on all global economies. The carbon-value presented by Nordhaus is Euro 8 per ton carbon emitted. In the Swedish monetary forest accounts, the carbon tax valuation will be used.

## Valuing qualitative changes of the Swedish forest ecosystem

The Swedish forest ecosystems change over time for many reasons. The forestry sector still has a negative influence on biodiversity, despite many improvements in the last decades. The chemical status of the forest soils has also changed, due to acidification and contamination. We discuss valuation of these components of the expanded forest accounts in turn.

### Valuing (risk) of biodiversity loss

The Swedish forest ecosystem is not rich in species in comparison to other forest ecosystems around the world. The reasons are to be found in climate factors, especially the fact that ice covered Scandinavia 10.000 years ago. While it takes time to build biodiversity, the loss of biodiversity can be very rapid. Perrings (1994) discusses the value of (an ecosystem's) biodiversity in terms of providing life support, not only for the ecosystem itself, but also for surrounding ecosystems and society. Loss of biodiversity increases the risk for disturbances in the ecosystems.

The cost of biodiversity loss will be estimated as the cost of reaching environmental targets set by political consensus or ecological expertise. These costs include: government outlays to buy, manage and restore land, and incomes foregone by forest owners. This procedure is marred by the fact that costs do not necessarily provide a good approximation of the value of a service or good to consumers. What is needed is information on preferences, but this is lacking.

Experts consider that a handful of tree species (4 % of total tree species) some 40 plants (2 %), 200 lichen and macrofungi (5 %), 10 mammals (15 %), 18 birds (7 %) and 450 insects (1.5 %) are threatened. The politically determined target is to protect the equivalent of 7 % of Swedish forests (SCR 2000:52). By already having set aside some 3.3 % of the forest area, Swedish forestry foregoes income. The cost to the forestry sector of setting aside another 3.7 % is calculated here. This valuation method was used in Hultkrantz (1991) and Eliasson (1994).

The cost of protecting biodiversity so calculated is Euro Mill. 230 in 1987, and Euro Mill. 200 in 1991. The annual cost of protecting another 3.7 % of forest land, focussing sensitive and valuable biotopes would cost the government Euro Mill. 90 annually. The forest companies would lose Euro Mill. 70 annually in revenue, as their harvesting volumes would decrease (SCR 2000:52).

**Table 8**

**Value of (the Risk for) Biodiversity Loss in Swedish Forests: Mill. of Euros**

| | 1987 | 1991 | 1993 | 1995 | 1997 | 1999 |
|---|---|---|---|---|---|---|
| **Cost of meeting biodiversity targets** | 230 | 200 | 190 | 180 | 170 | 160 |

**Valuing changes in the chemical balance of Swedish forest soils**

In large areas of Sweden, the deposition of acidifying substances is considered by some natural scientists to be above the critical load, i.e. the amount the ecosystem can sustain over time without being negatively affected. The pH-level of (water in the) soils might affect the base cat-ion stock in the soil, which in turn could impair the future possible timber growth, at least according to certain scientists in soil chemistry. This hypothesis is based on mathematical models and experiments on young plants in laboratories. Field studies have not shown any major effects on timber growth from acidification, see the survey by Binkley and Högberg (1997). Natural scientists do not fully agree on when and how (much) acidification affects timber productivity.

Below, two different valuation methods to determine the cost of chemical imbalances in forest soils will be presented:

Model simulations based on soil chemistry and biological plant experiment results, combined with geographical information system data on acid deposition, weathering velocity, soil chemistry, forest areas, and timber growth. Projections of when and how much timber growth will be affected in different areas of Sweden provide annual estimates of how many cubic meters of timber are lost due to acidification in different years. These foregone incomes can be traced back to the acid deposition and the chemical imbalances caused in certain years.

Liming costs to restore the chemical balance to pre-industrial levels. The more acid deposition exceeds the critical load in a certain year, the larger part of the total liming cost will be assigned to that year. The costs rise in proportion to how much the chemical quality (base cat-ion/aluminium ratio) was eroded a certain year.

The acidification process spans over decades, even centuries, which makes it necessary to use a model to answer questions about how much each year's emissions of acid substances might affect the final acidification outcome. A modelling approach allows for different assumptions on future actions to reduce emissions. Such an exercise, based on results from soil chemistry research (Sverdrup and Warfvinge, 1994), has been performed at the Swedish National Institute of Economic Research (Skånberg, 1994). According to the simulations, the Swedish forest owners will lose Euro Bill. 15 during the 21st century, due to soil acidification, even if the international agreements on reducing acidifying emissions are implemented. The cost of impaired timber productivity in acidified areas will rise from low annual figures in the late 1990s to a maximum of Euro Mill. 300 annually, during the next decades. However, the acid deposition, and hence the chemical changes in the soil, peaked in the 1970s.

The total future productivity loss due to the chemical imbalances caused by substances emitted and deposited in 1993 is valued at Euro Mill. 110. The model can track production of timber in Swedish forests to the deposition of acid rain and the lack of re-circulating nutrients in the forestry sector in that year. In 1997 the cost is estimated to be Euro Mill. 100, due to the somewhat lower acid deposition that year.

Dickson (2000) estimates the total cost of liming the chemical status of forest soils back to pre-industrial levels to be Euro Bill. 12. To compensate for the upcoming acid deposition in future decades, until critical loads are not exceeded anywhere in the Swedish ecosystem, would cost another Euro Bill. 3. Ideally, the liming should take place every year in proportion to how much the critical loads were surpassed.

The cost caused by acidification in the model is of the same magnitude as the liming cost. Because the costs should be proportional to the excess over the critical load, according to both methods, these two valuation methods produce identical results. The liming costs will be used in the monetary Swedish forest accounts, as the model results have not yet been confirmed by empirical forest data.

**Table 9**

**Value of Quality Degradation of the Chemical Properties of Swedish Forest Soils: Mill. of Euros**

| | 1987 | 1991 | 1993 | 1995 | 1997 | 1999 |
|---|---|---|---|---|---|---|
| **Soil chemistry model results** | 125 | 115 | 110 | 105 | 100 | 95 |
| **Liming costs to restore base cation ratios** | 125 | 115 | 110 | 105 | 100 | 95 |

## CONCLUSIONS

This paper discusses a number of issues related to expanded forest accounting, and illustrates by means of a comprehensive application from Sweden how such accounts can be estimated. We have noted that green forest accounting is still in a formative stage, as evidenced by the fact that different principles and estimation methods are used. Furthermore, official manuals, such as the one by EUROSTAT, offers individual countries degrees of freedom regarding estimation methods. A focus of future work should be a better integration of theory and practice. This avoids the risk for double-counting that plagues several current studies, according to Vincent & Hartwick's (1997) review. In addition, it helps focusing on the important question of making the objectives of expanded forest accounts clear. In some countries expanded forest accounts will be mainly useful as a database for further analysis of the interactions between forests, the ecosystem ad the economic system. In other countries, expanded forest accounts could play a prominent role in displaying the «true» welfare gains related to forest policy. Whatever the final use, it is only accounts based on a judicious application of sound theory and empirics that will be really useful in the long-run.

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## RESUMEN

### Contabilidad forestal incluyendo bienes y servicios ambientales

En la actualidad existe sustancial interés en expandir los sistemas de contabilidad de forma tal que se incluyen servicios apropiados de los sistemas ecológicos. Muchas de las actividades desarrolladas se han centrado alrededor de los recursos forestales; actualmente existen más de 100 estudios de contabilidad forestal «verde» en diferentes países del mundo. Este artículo provee una visión de aspectos teóricos y empíricos de la contabilidad forestal «verde». En este se discute el cálculo de la renta «real» del bosque, así como los problemas de medición generados al valorar servicios sin precio de mercado. También se revisan los esfuerzos recientes de la Oficina Estadística de la Unión Europea (Eurostat) y se incluye una presentación detallada de las aplicaciones oficiales de la contabilidad forestal «verde» en Suecia. Este artículo concluye argumentando que los trabajos futuros de contabilidad forestal «verde» deberían dirigirse a través de la integración de la teoría y la práctica hacia un alcance mayor al que tiene la actual propuesta de Eurostat.



**PALABRAS CLAVE:** Contabilidad forestal ampliada
Bienes y servicios ambientales
Propuesta de Suecia


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