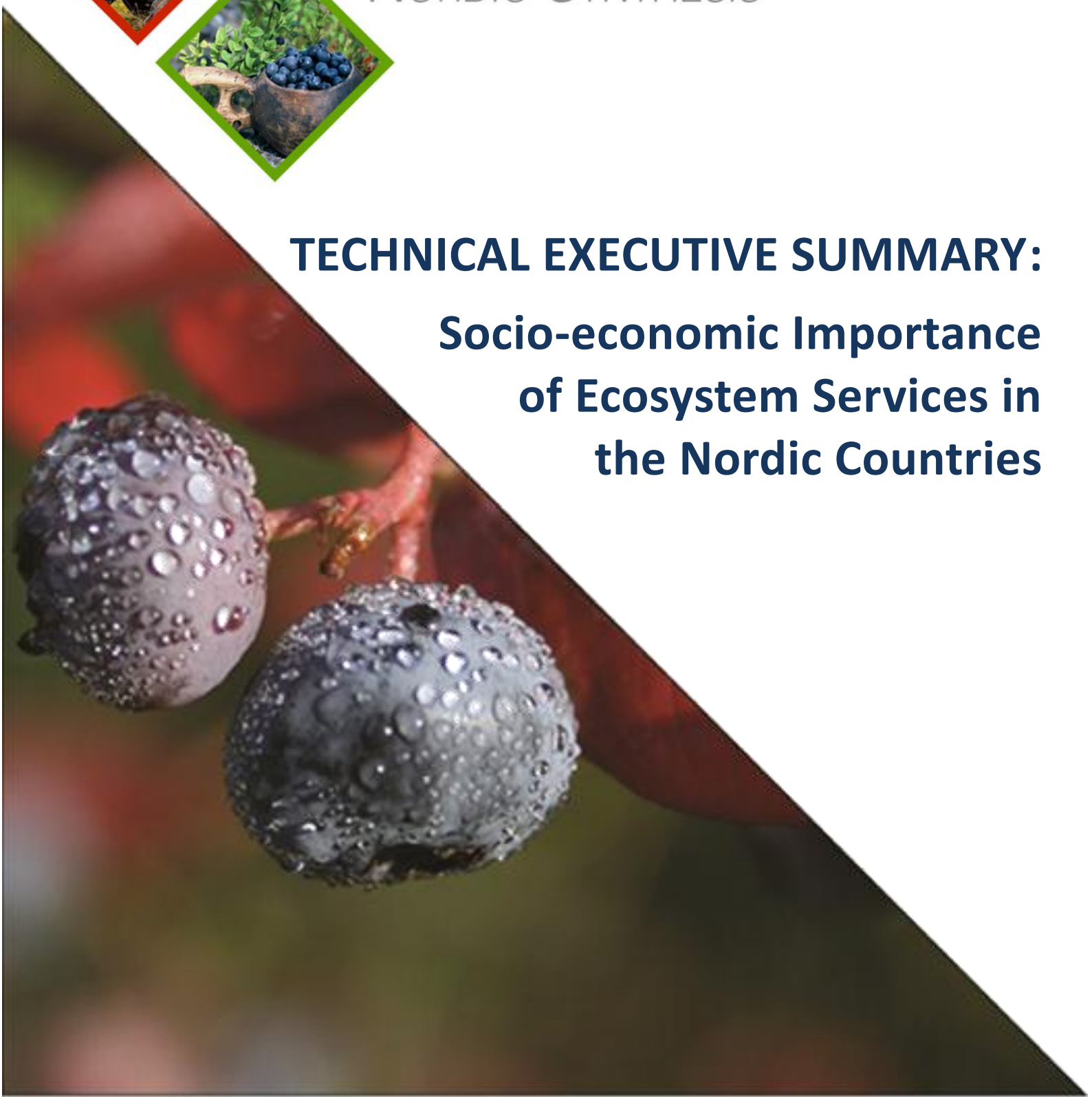
THE ECONOMICS OF ECOSYSTEMS & BIODIVERSITY
NORDIC SYNTHESIS

TECHNICAL EXECUTIVE SUMMARY:

Socio-economic Importance of Ecosystem Services in the Nordic Countries



Synthesis in the context of The Economics of Ecosystems and Biodiversity (TEEB)

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The synthesis of the Socio-economic Importance of Ecosystem Services in the Nordic Countries (TEEB Nordic) has been developed by the Institute for European Environmental Policy (IEEP) and Finnish Environment Institute (SYKE) with contributions and support from a range of Nordic experts. The study has been carried out in the context of The Economics of Ecosystems and Biodiversity (TEEB) (www.teebweb.org) and funded by the Nordic Council of Ministers in the context of the Finnish Presidency 2011 (www.norden.org).

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Full report:

Kettunen, M., Vihervaara, P., Kinnunen, S., D'Amato, D., Badura, T., Argimon, M. and ten Brink, P. (2013) Socio-economic importance of ecosystem services in the Nordic Countries – Synthesis in the context of The Economics of Ecosystems and Biodiversity (TEEB), Nordic Council of Ministers, Copenhagen

Background and context

Nature - while considered to be intrinsically valuable - provides a range of benefits (ecosystem services), that fuel the global economy and underpin human and societal well-being. For example, healthy natural systems regulate our climate, pollinate our crops, prevent soil erosion and protect against natural hazards. They also help to meet our energy needs and offer opportunities for recreation, cultural inspiration and spiritual fulfilment. Nature also underpins our economies, with economic sectors such as agriculture, fisheries, forestry, tourism, pharmaceuticals, and food and beverage sectors directly depending on biodiversity and ecosystem services. In addition, a range of other sectors, including health and security, depend indirectly on nature. However, many of the benefits provided by nature – and the associated economic values – are not recognised by the markets and remain unacknowledged in decision-making by a range of stakeholders including politicians, administrators, businesses, communities and individuals. In other words, nature is almost invisible in the political and individual choices we make, resulting in us steadily drawing down our natural capital.

The Economics of Ecosystems and Biodiversity (TEEB)

A major international undertaking called 'The Economics of Ecosystems and Biodiversity' (TEEB)[1] was initiated by the Environment Ministers of G8+5[2] countries in 2007. The objective of TEEB was to draw attention to the global economic benefits of nature and to highlight the growing costs of biodiversity loss and ecosystem degradation while highlighting opportunities arising from sustainable management, restoration and other appropriate conservation responses. The ultimate aim was to draw together expertise from the fields of science, economics and policy to enable concrete actions for raising awareness about the "true" value of nature and integrating these insights into decision-making processes at all levels.

Since the launch of the TEEB in 2010 several high level policy commitments have been made to integrate the value of nature into decision-making processes at global, national and local levels. For example, both the Strategic Plan for Biodiversity 2011-2020 to implement the UN Convention on Biological Diversity (CBD) and the EU Biodiversity Strategy to 2020 urge countries to assess the socio-economic value of ecosystem services and integrate these values into national accounting and reporting systems. The fundamental role of nature's capital - ecosystems, genetic resources and species - in maintaining human well-being is also gaining more ground in the context of broader sustainable development, e.g. as agreed in the UN Conference on Sustainable Development (Rio+20) in June 2012. Nature underlines the very functioning of our socio-economic systems, creates a range of business opportunities and provides cost-effective solutions for different sectors. The recognition that natural capital is fundamental for our well-

[1] www.teebweb.org

[2] The Group of Eight + Five (G8+5) an international group that consists of the leaders of the heads of government from the G8 nations (Canada, France, Germany, Italy, Japan, Russia, the United Kingdom, and the United States), plus the heads of government of the five leading emerging economies (Brazil, China, India, Mexico, and South Africa).

being and should be appreciated for its many values suggests that sustainable use, protection and restoration of nature should form a foundation for a green economy, i.e. an economy that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities.

Synthesis of the socio-economic importance of ecosystem services in the Nordic countries - TEEB Nordic

Several Nordic countries and stakeholders have taken a stance in increasing the knowledge base on the value of nature and integrating these insights into policies and decision-making. In 2011, following in the footsteps of the global initiative, the Nordic Council of Ministers (NCM) and the NCM Finnish Presidency decided to initiate a TEEB inspired synthesis in the Nordic context (TEEB Nordic). The aim of this synthesis was to bring together existing information on the socio-economic role and significance of biodiversity and ecosystem services for the Nordic countries (i.e. Denmark, Finland, Iceland, Norway and Sweden).

This stand-alone executive summary document presents the key outcomes of the Nordic synthesis. Based on the existing information available, the TEEB Nordic identified the range of ecosystem services maintained by healthy, well-functioning ecosystems and synthesised existing information on the present status, trends and socio-economic importance of these services. Finally, the study explored key opportunities and priorities for future policy action to integrate the true value of nature into decision-making processes, including possible areas for Nordic cooperation. An overarching aim of TEEB Nordic was also to complement the global TEEB initiative with interesting insights and concrete evidence from the Nordic countries. For this purpose six stand-alone case studies were developed together with relevant Nordic experts. In addition, a range of illustrative case examples were identified and documented.

Finally, it is to be noted that TEEB Nordic has been an independent synthesis, separate from the national ecosystem assessment currently taking place in or being initiated by the individual Nordic countries. It is hoped that TEEB Nordic will provide a useful source of information for these national in-depth assessments.

Socio-economic importance and value of Nordic ecosystem services

The results of TEEB Nordic reveal that, while in many ways similar to the global level, the range of benefits provided by ecosystem services in the Nordic countries exhibits some characteristics distinct to the region. While provisioning services provided by agriculture, forestry and fisheries still remain essential in the Nordic countries, a number of other regionally important ecosystem services can also be identified. These include reindeer herding (especially in the north), wood-based bioenergy, non-timber forest products such as berries, mushrooms and game, and recreation and tourism. In addition, there seem to be a range of existing and novel possibilities related to different bio-innovations (so called “bioeconomy”). Given the area coverage of forests in the region, it is not surprising that mitigation of climate changes (i.e. carbon storage and sequestration) is among one of the most significant – or at least most frequently

discussed - regulating services provided by Nordic ecosystems. In addition, the importance of water purification, as seen with the eutrophication of the Baltic Sea, and pollination are often highlighted.

In terms of information available, existing biophysical data on the capacity (status and trends) of Nordic ecosystems to provide services consists mainly of information on stocks, flows or indirect socio-economic proxies (i.e. the use and/or demand of service). With the exception of provisioning services, most of the information available is based on individual case studies with very little data available at national and regional level. Available data on the socio-economic value of Nordic ecosystem services consists mainly of information on the quantity and market value of stocks. In addition, a range of studies could be found that reflect the appreciation and public value of ecosystem services (i.e. people's willingness to pay for the improvement of services), including water purification and recreation. Important concrete information gaps include, for example, lack of estimates reflecting broader cultural and landscape values, lack of data on nature's role in maintaining health, and lack of information on the indirect employment impacts of nature. In terms of ecosystems, there seems to be considerable gaps related to marine ecosystem services (beyond fisheries). With the exception of provisioning services, most of the information available is based on individual case studies with very little data available at national and regional level. Also, surprisingly few estimates were found assessing the costs of service foregone or costs of replacing the service. Finally, no national or regional assessment focusing on the socio-economic role of the ecosystem processes and functions supporting the maintenance of services could be identified.

Insights related to the value of some key ecosystem services are provided below. More comprehensive overview of the Nordic ecosystem services and their socio-economic importance (e.g. detailed references for sources of information) are available in the main report of the study.

Marine and freshwater fisheries and recreational fishing

Fishing in the Nordic countries is important both as an industry and as a hobby, leading to a high demand for sustainable management of fisheries resources. Professional fishing happens mainly on marine areas but freshwaters are popular amongst recreational fishermen. While the numbers of professional fishermen are fairly low across the Nordic region, the fisheries industry is of high national and/or regional importance. For example, in Greenland and Iceland (and the Faroe Islands) fisheries and fish production make the single most significant economic contribution to the welfare of societies. In terms of size of catches, Norway is the biggest fish producer of the Nordic countries (Table 1 below).

Fishing is a very popular recreational hobby in Nordic countries, and there are over six million recreational fishermen (European Anglers Alliance 2002). In Finland, Sweden and Norway, 44%, 30% and 50% of the population, respectively, reported having engaged in some kind of fishing activity in

the past year. The size of catch by recreational fishermen in Finland was 48 million kg in 1998 and 79 million kg in Sweden in 1995. In Sweden, the net value of recreational fishing has been estimated at almost 79.5 million EUR, exceeding the value of commercial fishing. (Sievänen and Neuvonen 2010, Statistics Sweden 2012b and 2012c, Statistics Norway 2012, Toivonen et al. 2000, Garpe 2008).

Table 1: Socio-economic importance and value of marine fishing in the Nordic countries

	Greenland	Iceland	Norway	Denmark	Sweden	Finland
Number of professional fishermen (incl. part time)	3,752	4,500 man years	12,280	2,088	1,600	2,195
Reference year	2004	2005	2 010	2008	2012	2010
Source	Statistics Greenland 2012	Icelandic Fisheries 2012 /Statistic Iceland 2012	Statistics Norway 2012	Statistics Denmark 2012	Havs och vatten myndigheten 2012	RKTL 2012
Size of catch (tonnes)	225,413	1,063,467	2,288,623	1,066,428	159,968	122,078
Value of the catch (mil of nat. currency)	Not available	132,979.2 mil ISK (~ 837 mil EUR)[1]	15,883.6 mil NOK (~2,105 mil EUR)[1]	3,435.5 mil DKK (~462 mil EUR)[1]	970.8 mil SEK (~110 mil EUR)[1]	26.5 mil EUR
Reference year	2005	2010	2011	2010	2011	2010
Source	Statistics Greenland 2012	Statistics Iceland 2012	Statistics Norway 2012	The Danish Directorate of Fisheries 2011	Statistics Sweden 2012b, 2012c	RKTL 2012

[1] Based on based on exchange rate in 2012

Reindeer herding

Although the worldwide commercial production of reindeer meat is relatively small it is still a very significant source of income in Finland, Norway and Sweden. In north Finland, Norway and Sweden, i.e. Nordic areas where reindeer herding remains a common source of livelihood, approximately 6,500 Sami people work as reindeer herders (Table 2 below). Reindeer husbandry continues to be a great importance in the Sami region because the shipping, trading and processing of its products provide numerous jobs. Although the main business related to reindeer herding is meat production, reindeer herding is supported by policy action also because of its cultural importance, which goes beyond being merely a source of income. As a supplement to their income, reindeer herders also engage with several other sources of livelihood such as hunting, production of decorative items and tourism. Degrading of pastures due to overgrazing is one of the biggest challenges for reindeer herding in the future. In addition, competing land use with forestry and natural predators might affect numbers.

Table 2: Socio-economic importance of reindeer herding in Finland, Sweden and Norway Source: Jernsletten and Klokov (2002)

Country	Herders	Reindeers (No)	Size land (m2)	Organisation	Monopoly	Value of production (mil EUR)[1]		
						2004	2005	2006
Finland	5,600 Sami and non-Sami	186,000 [2]	114,000 (33%)	57 reindeer herding cooperatives	No	>10	>10	13
Sweden	3,500 Sami; 1000 non-Sami	227,000 [2]	160,000 (34%)	51 Sami villages	Yes	<5	<5	7
Norway	2,936 Sami	165,000 [2]	140,000 (40%)	80 reindeer herding districts	Yes	<10	<10	<10

[1] Based on 2.5 – 2.8 (FI), 1.5 – 2.0 (SE) and 2.0 – 2.3 (NO) million kg / year production of meat in 2004-2006
[2] Data from 2000 in Finland, from 1998 in Sweden and 2001 in Norway

Non-timber forest products: berries and game

While there are no on-going annual statistics on the amounts of **berries and mushrooms** picked and/or marketed across the Nordic countries, a number of individual studies from Finland and Sweden provide some estimates (Table 3 below). In general, the Nordic forests produce several tonnes of wild berries annually with only a small fraction of them being used, most at the household level. The socio-economic importance of **hunting** in the Nordic countries is a combination of revenue-providing activity, household subsistence value, and cultural and recreational significance.

Table 3: Quantities and values of berries and mushrooms picked for markets in 2005 in Finland, Norway and Sweden. Source: Turtiainen and Nuutinen (2011).

Country	Berries		Mushrooms	
	Quantity (tonnes / year)	Value (mil EUR)[2]	Quantity (tonnes / year)	Value (mil EUR)[2]
Finland	12,027	11.862	426	1.019
Sweden	13,790	32.435[1]	Not available	Not available
Norway	350	0.524	500	1.873

[1] Value for mushrooms and berries together
[2] Based on the source, the estimated values for NO and FI are based on collector's price whereas in Swedish the value is based on "… weather conditions and newspaper information".

Around one million Nordic people go hunting every year – almost 5% of the total Nordic populatin. Estimates for the value of game meat were obtained from Finland, Sweden and Norway ranging between 44 – 125 million EUR (Table 4 below). In terms of the national economy, game plays the most significant role in Greenland where hunting and whaling remain an important parts of people's livelihoods. In particular, hunting is of high socio-economic importance to local communities in terms of cultural identity and it also remains an important means of supplying households with preferred meat.

Table 4: Socio-economic significance of hunting in the Nordic countries

Country	**Finland**	**Sweden**	**Norway**	**Denmark**	**Iceland**	**Greenland**
Hunters (with licence)	311,000	263,000	195,500	171,119	12,227	6,539
Large mammals	Eurasian elk 68,423	Eurasian elk 80,974	Eurasian elk 36,400	Roe deer 128,200	Reindeer 1,229	Reindeer 15,092
Bears	179	181	3	NA	NA	Polarbear 124
Other species	Mallard 265,400 Wood pigeon 232,100 Black grouse 170,000	Roe deer 119,000 Mallard 91,500 Wood pigeon 71,000	Willow grouse 127,850 Wood pigeon 56,900 Red deer 39,100	Pheasant 721,400 Mallard 485,400 Wood pigeon 299,500	Rock ptarrigan 68,831 Greylag goose 45,828 Puffin 33,074	Guillemot 84,412 Harp seal 84,223 Ringed seal 71,260
Ref. year	2010	2007-2008	2010-2011	2010-2011	2010	2007-2009
Source	RKTL 2012	Naturvårdverket 2012, Statistics Sweden 2009	Statistics Norway 2012	Asferg (2011)	Heiðarsson et al. 2010, Statistics Iceland 2012	Statistics Greenland 2012
Value of game meat	83 mil EUR	1,119 mil SEK (~125 mil EUR)	44 mil EUR	NA	NA	NA
Ref. year	2010	2005-2006	2001			
Source	RKTL 2012	Mattsson et al. 2008	Lunnan et al. 2005			

Regulating services: climate regulation, water purification and pollination

While more research on status of and trends in Nordic **carbon storage and sequestration** is required, some estimates already exist for the monetary value of carbon sequestration and storage. In Finland Matero et al (2007) estimated the value of carbon sequestration of Finnish forest trees to be 1 876 million EUR, and the value of change in mineral soil carbon stock to be 136 million EUR. In Sweden Gren and Svensson (2004) calculated the annual carbon sequestering value of Swedish forest to be between 29-46 billion SEK (2001 SEK) (~3.3 – ~5.2 billion EUR) based on the estimated consumption value of 11-18 billion SEK (~1.2 – ~2 billion EUR) and investment value of 18-28 billion SEK (~2 – ~3.2 billion EUR) (See the main report for further details).

While estimates are available for the global economic importance and value of **pollination**, no such overall estimates yet exist for the Nordic countries. A recent study from Finland, however, assessed that the value of honeybee pollination service of selected crops would be around 18 million EUR and that of wild berries (bilberries and lingonberries) would be around 3.9 million EUR (Lehtonen 2012). In addition to pollination of commercial crops, there are numerous home gardens in Nordic countries. An estimated value of pollination (by honeybees) in home gardens was 39 million EUR in Finland (Yläoutinen 1994, cited in Lehtonen 2012). In Denmark the value of the general insect pollination service was calculated to be worth 421 to 690 million DKK (~56.6 to ~92.8 million EUR) a year (Axelsen et al. 2011). In Sweden the value of honeybee pollination service was calculated to be 189-325 million SEK (~21.5- ~37 million EUR) (Rahbek Pedersen 2009a). When considering these values it must be noted that insect pollination of greenhouse crops is often provided by commercial pollinators.

Finally, in the Nordic countries many studies have been carried out to reveal the public appreciation of cleaner surface waters. A summary of these is provided in Table below. In general, these studies can be used as proxy indicators for the value of water purification for the general public (i.e. water purification as a public good). These studies are mainly based on willingness to pay (WTP) studies and do not, therefore, reflect market values or real economic gains.

Table 5: Examples of the estimated values for ecosystem's ability to improve water quality (public good)

References	Study area	Method	Estimated impact on recreational services
Appelblad, 2001	Sweden, River Byske	WTP for a day fishing license in the River Byske	WTP under unimproved environmental conditions: 89 SEK (~10 EUR); WTP under improved conditions: 142 SEK (~16 EUR); Consumer surplus: SEK 18 (~2 EUR) / day in 1996
Sandstöm, 1996	Sweden, Laholm Bay and entire Swedish coast	Recreation benefits from hypothetical 50% reduction of the nutrient load	Consumer surplus: 12 - 32 million SEK (~1.3 – ~3.6 million EUR) / year for the only Laholm Bay; Consumer surplus: 240 - 540 million SEK (~27.3 – ~61.6 million EUR) / year for the entire Swedish coast
Soutukorva, 2001	Sweden, Stockholm archipelago, Stockholm and Uppsala	Recreational benefits from a hypothetical 1-metre improvement in water clarity, 30% reduction of the nutrient concentrations	Consumer surplus 59 - 93 million SEK (~6.7 – ~10.6 million EUR) in 1998 and 70- 110 million SEK (~8 – ~12.5 million EUR) in 1999.
Söderqvist et al, 2000	Sweden, Stockholm archipelago, Stockholm and Uppsala	WTP (higher prices of tap water and agricultural products) for 1-metre improvement in water clarity	500 - 850 million SEK (~57 – ~97 million EUR) / year in 1999
Kosenius, A-K, 2010	Finland, Gulf of Finland	WTP for three nutrient reduction scenarios of different intensities in the Gulf of Finland	28,475 – 53,884 million EUR (total)
Atkins and Burdon 2006	Denmark, Randers Fjord in Arhus County	WTP for hypothetical improvement to obtain good water quality in the fjord	12.02 EUR / month / person over 10 years, totalling 5.5 million EUR a month over 10 years
Eggert and Olsson 2002	Sweden, south-west Swedish coast	WTP for preferred water quality improvements (for biodiversity bathing and fishing)	Mean average WTP from 1,400 SEK (2002 SEK) (~159 EUR) / person for avoiding reduction in biodiversity to 600 SEK (2002 SEK) (~68 EUR) / person for improving biodiversity levels. Extrapolating the results over the whole Swedish population leads to an aggregate estimate of 400 - 700 million SEK (~45.6 – ~80 million EUR) for either improving the cod stock or avoiding deterioration of marine biodiversity.
Vesterinen et al. 2010	Finland, inland and coastal waters	Recreational benefits from a hypothetical 1-metre reduction/improvement in water clarity	Swimming benefits loss under impoverished environmental conditions: 31-92 million EUR / year; fishing benefits loss: 38 - 113 million EUR / year. Swimmers consumer surplus under improved environmental conditions: 29–87 million EUR / year; fishers consumer surplus 43 - 129 million EUR / year.

Recreation and tourism

Recreation activities in nature, i.e. outdoor recreation related to everyday life that people do near their home, are extremely popular in Nordic countries. For example, an average adult Finn does some kind of outdoor activity on average 170 times a year (i.e. around three times a week, with 1/3 of people doing such activity daily) (Sievänen and Neuvonen 2010). In Sweden, 36-56% of people reportedly use forests for walking at least 20 times a year (Romild et al. 2011). In Norway, hiking in forests or mountains is practised more than twice a month by almost half of the population (i.e. around 2.4 million people) (Statistics Norway 2012). Finally, in Denmark approximately 70% of Danes visited green areas several times a week, with parks and other open natural areas being the most popular green areas, followed by beaches (Schipperijn et al. 2010). Outdoor life can have significant impacts on regional and national economies. In Sweden, the value added from outdoor life expenditure was calculated to be 34,331 million SEK (~3,918 million EUR) and altogether spending on outdoor life would result in 75,637 job opportunities (Fredman et al. 2010).

Nature tourism, i.e. overnight trips with activities related to nature, is considered to be one of the fastest growing sectors of international tourism. For example in Lapland, Finland nature tourism is already the most important sector contributing the regional economy (Tyrväinen, 2006, cited in Bell 2007). No statistics specifically related to nature tourism are available for the Nordic counties. However, given the role nature plays in attracting tourism to the Nordic countries, general information on tourism can be used to indicate the socio-economic role of nature in supporting tourism. Yearly some 100 million nights are spent in different tourist accommodation establishments in Nordic countries by domestic or foreign tourists. In addition, nature is mentioned most often as a main attraction of holiday houses and there are perhaps more holiday homes per capita in Nordic countries than anywhere else in the world (1.5 million in total) (Müller 2007). Approximately 50% of Nordic people have access to holiday house and in Finland the figure is over 60% (Sievänen and Neuvonen 2010). Foreigners (including Nordic visitors to other Nordic countries) spend some 15 million nights at holiday houses.

Bioeconomy and bio-innovations

There is increasing interest from Nordic and Arctic countries in researching biotechnological application based on Nordic and Arctic genetic resources. Norway has the most developed and promising marine biotechnology sector focused on Arctic genetic resources.

Furthermore, a number of Nordic plant compounds are currently used by the pharmaceutical industry, e.g. cardiotonic compounds from lily of the valley (*Convallaria majalis* L.) and foxglove (*Digitalis purpurea* L.) and endurance increasing compounds from roseroot (*Rhodiola rosea* L.) (Fabricant and Farnsworth 2001) (Box 1 below). Altogether 134 Nordic plant species have been identified that have medicinal or aromatic properties and that are of

current socio-economic interest and that grow wild in the Nordic and Baltic region (Asdal et al. 2006). Recent examples of scientific screening of Nordic plants include sage species tested for their effect on type-2-diabetes in Denmark and Corydalis species on Alzheimer's disease (Christensen 2009, Adsersen et al. 2006).

Box 1: examples of Nordic bioeconomy and bio-innovations

Bioremediation and removal of undesired substance: The organic waste produced by paper mills is also a potential resource. Following this principle, methods to use paper mills' waste in protein biomass production have been developed. The pekilo process, for instance, has been developed in Finland for the production of single-cell feed using the fungi *Paecilomyces variotii*. The first commercial pekilo plant, built at the United Paper Mills pulp plant at Jämsänkoski, Finland, had an annual capacity of 10 000 tonnes of single-cell protein. Similarly, the fungi *Torula utilis* is used by the Boise-Cascade Corp. as a high protein food extender and animal feed. An industrial ethanol plant connected to a sulfite pulp mill is in operation at Örnsköldsvik in Sweden (Scheper et al. 2007).

Pharmaceutical and medical uses: The Armi Project co-ordinated by the Finnish Forest Research Institute (Metla) ran from 2001 to 2004 and isolated some 600 strains of microbes from boreal and Arctic environments in soil sediment, stream water, snow, lichen and moss from Lapland in Northern Arctic Finland and Svalbard in the Norwegian Arctic. A European pharmaceuticals company has subsequently bought the rights to start screening the collection of bacterial strains collected as part of the *Armi* research for anti-cancer drug candidates. In Norway, a total of 180 million NOK (~23.8 million EUR) has been committed to the MabCent initiative by the Norwegian Research Council, the University of Tromsø and the associated biotechnology companies. Approximately 25% of this funding has been provided by the commercial partners. (Leary 2008)

Nordic medicinal plants: One of the most interesting medicinal plants in the world is roseroot, *Rhodiola rosea L.*, (which grows wild in Nordic mountainous areas and is rare in temperate regions). Roseroot is said to be the northern ginseng and there are several roseroot products on the markets. In traditional medicine roseroot has been used for physical endurance, resistance to altitude sickness and in treatment of fatigue and depression. Worldwide there is high demand for roseroot, especially in the U.S, and the demand is calculated to be approximately 20-30 tonnes / year. Due to high demand wild roseroot has become seriously threatened species in Russia and in central Europe. There is no current threat to wild roseroot populations in Nordic countries and also successful cultivation trials of roseroot have been made in Nordic countries. (Asdal et al. 2006, Economo and Galambosi 2003)

Blue mussel farming to improve water quality: In Sweden, several initiatives and pilot projects are underway to use Blue mussel farming to improve water quality. In Lysekil Municipality, a payment mechanism has been set up whereby the polluter (the local waste water plant) pays mussel farmers to remove nutrients from the coastal waters. Payments

are based on the content of nitrogen and phosphorous in the harvested mussels. Project results show that 3,500 tonnes of blue mussels/year help to remove 100% of the nitrogen emissions of the Lysekil waste water treatment plant. The use of mussels to clean the nitrogen content of the waste water plant saves the municipality close to 100,000 EUR/year compared to using a traditional technique (Zandersen et al. 2009).

Conclusions and recommendations

Despite the significant gaps in the existing knowledge base, it is evident that a range of ecosystem services are of high socio-economic significance for the Nordic countries, either based on their market value or estimated value for the broader public. Natural capital (biodiversity, ecosystems and related services) also underpin socio-economic well-being in the Nordic countries. On the other hand, based on the existing evidence based it is also clear that several of these ecosystem services including, for example, marine fisheries, water purification and pollination, have been seriously degraded and several others, such as carbon storage, are facing serious risks. In addition, rather alarmingly the information available does not yet allow any conclusions to be drawn on the status of and trends in the majority of services, including processes and functions supporting their maintenance.

Integrating the value of ecosystem services into policy and decision-making processes has started in in several Nordic countries. A range of concrete examples can already be identified where the socio-economic importance of ecosystem services has been recognised, leading to "greener" and more sustainable solutions for the use of natural capital. However, the concept of ecosystem services is still new to several sectors and, consequently, it still remains to be integrated into national policies and strategies, and business sector accounting and investment decisions. Consequently, it seems evident that further policy actions are needed to address the situation. Nordic countries are already well on their way towards a transition to a green economy. While the approaches taken towards "greening" the economy (or economies) are likely to differ between countries, the results presented in this report clearly indicate that future developments should be based on a sound appreciation of the value and role of nature in underpinning sustainable socio-economic development.

The outcomes of TEEB Nordic emphasise that the first step towards integrating the value of ecosystem services into Nordic policies and decision-making processes would be to **identify and develop a common set of indicators** to assess and monitor the status, trends and socio-economic value of ecosystem services. While the identified key ecosystem services might differ from one country to another, an overarching common set of (core) indicators would be beneficial, enabling comparisons to be made within and between countries and regions as well as facilitating reporting under international policy-processes such as the UN Convention on Biological Diversity (CBD) and EU. As the assessment shows, there are significant gaps in the information available on the biophysical status of ecosystem services. Furthermore, there is a fundamental need to develop new and/or improve existing indicators in order to appropriately assess nature's long-term ability to supply services. In particular, appropriate indicators for many regulating

services, both in bio-physical and socio-economic terms, are largely still missing. More data is available for the socio-economic value of ecosystem services (especially provisioning services), however even this data is inconsistent and allows no clear comparisons to be made between different Nordic countries. Consequently, the development of ecosystem services indicators – both biophysical and socio-economic alike – is foreseen as one of the key required actions in the Nordic countries for future. It is foreseen that cooperation among the Nordic countries would be fruitful to ensure synergies and allow for comparative assessments.

The identification and development of indicators is needed to support the development of comprehensive **national frameworks for ecosystem and ecosystem services assessments** in the Nordic countries, finally paving the way towards the integration of natural capital into national accounting systems (see below). Significant synergies could also be achieved by enhancing Nordic cooperation in this area. In terms of developing frameworks for national assessments, a more comprehensive approach, better linking biophysical and socio-economic indicators, would be needed (e.g. linking the existing indicators into the "Drivers - Pressures – States – Impacts – Responses" model, DPSIR). The contribution of human-management of ecosystems' capacity to provide services, for example in the context of agriculture, should also be covered by the indicators, whilst it should also be been excluded from the natural measurement. Furthermore, there is a need to adjust the existing land cover databases to reflect the ecosystem related data to provide a more detailed and accurate knowledge about biodiversity, ecosystems and related services.

Building on the assessment and monitoring of ecosystem services, it is generally acknowledged that in order to be truly

sustainable, economic systems need to build on a more comprehensive appreciation and understanding of the value of natural capital. This requires the **development of natural capital accounts** that improve the evidence base on the stocks of natural capital, integrate ecosystem services into existing national and/or regional accounting systems and, in due course, take into account gains and losses in the stocks and flow of services. It is foreseen that the development of accounting systems - in cooperation with international and European initiatives - will be one of the key priorities for Nordic countries in the near future. A number of studies already exist exploring the possibilities for and implications of integrating the broader values of natural capital into regional and national accounts. These studies indicate that conventional accounts underestimate nature-related wealth and potential sustainable development based on natural capital.

To complement "greener" and more sustainable accounting systems, a range of complementary approaches towards a transition to a green economy can be identified. In addition to avoiding, reducing and restoring environmental damage and conserving nature (i.e. business-as-usual approaches) more active approaches towards management of natural capital can

be adopted. These include, for example, **pro-active investment in natural capital and nature-based risk management** via restoration, conservation and improved ecosystem management practices, including restoration of ecosystems for water management, carbon storage and other co-benefits, and implementation of protected area networks. For example, there is an increasing evidence base to suggest that restoration of wetlands can bring significant benefits to both people and biodiversity. A range of such examples also exist in the Nordic countries (e.g. Salminen et al. 2013). In terms of investment in natural protection, clear evidence is available from Nordic countries that financial support for the management of national parks can be a highly cost-effective investment at regional level, proving 10 EUR return for 1 EUR investment for the region (see Kajala et al. 2013).

Finally, approaches pursuing broader environmental sustainability such as measures for **eco-efficiency and wider resource efficiency** though resource pricing and fiscal reform can also be adopted (e.g. fisheries and agricultural subsidy reforms). Furthermore, **decoupling the economy from resource use and its negative impacts** through more radical innovation and changes in demand - supported by consumption choice changes through information provision - can be considered. Developing new clean products and processes, for example based on genetic and molecular resources, can also be a viable alternative for Nordic countries.

Building on this preliminary synthesis and insights Nordic policy and decision-makers at national, regional and local level can now show leadership and foresight in their actions to support the protection and sustainable management of benefits provided by nature. The policy response should not be limited to environmental policies, but should also be mainstreamed into key sectoral policies such as fisheries, agriculture, forestry, climate and energy, transport and tourism. Furthermore, action is needed at all levels of governance and across all key sectors, harnessing also the energy of markets, business, citizens and communities. TEEB Nordic has been the first attempt to gather and synthesise information on the socio-economic value of nature in the Nordic countries. It is hoped to be a useful resource for demonstrating and creating further policy action on the socio-economic importance of biodiversity and ecosystem services, both in the Nordic countries and on a broader internationally.

Finally, while the previously neglected economic values of ecosystem services need to be integrated into decision-making, it is also important to improve the Nordic decision-making systems so that they recognise - and equally consider - the full range of broader socio-economic values, taking into consideration qualitative, quantitative and monetary evidence. Similarly, the approaches highlighted in this report should be considered as complemententing – not replacing - already existing strategies for biodiversity conservation. A range of reasons and arguments for nature conservation (e.g. cultural and intrinsic values) cannot be replaced by economics.

Concrete key policy recommendations for future actions, as identified by TEEB Nordic, include:

- Development of indicators and elaborated (national) frameworks for the assessment of ecosystem services (e.g. the socio-economic valuation of ecosystem services as along the lines of the UK NEA 2011), including biophysical status and trends, and socio-economic importance and value. The list of Nordic ecosystem services accompanied with direct indicators and proxies identified in the context of this scoping assessment can form a useful starting point for these developments.

- Implementing the international commitment under the World Bank's WAVES (Wealth Accounting and Valuation of Ecosystem Services, of which Norway is a partner) initiative linked to the UN led SEEA (System of Environmental and Economic Accounting) to develop natural capital accounts with a dedicated focus on the non-market benefits provided by biodiversity and ecosystems, possibly benefiting from and working together with the European Environment Agency (EEA) who is leading work on Ecosystem Capital Accounts.

- A number of key gaps in the existing information base can be identified including, for example, lack of estimates reflecting broader cultural and landscape values, lack of data on nature's role in maintaining health, and lack of information on the indirect employment impacts of nature. In terms of ecosystems, there seems to be considerable gaps related to marine ecosystem services (beyond fisheries). Limited information is also available on the development of socio-economic importance of different ecosystem

- Services in the future, e.g. possible future value of yet unidentified benefits. Finally, there is a need to further explore how the substitutability of ecosystem services via international trade affects their socio-economic value. These areas are recommended to be further addressed in the future.

- Developing and further strengthening policy frameworks to manage the transition to a more resource efficient and green economies in the Nordic countries while working with nature and building on the pro-active management of natural capital. Key focal areas include securing the implementation of a comprehensive regulatory baseline, continued reform of harmful subsidies, making increased use of opportunities (including earmarking) for funding investment in natural capital (e.g. management of protected areas and restoration of ecosystems) and exploring innovative solutions for eco-efficiency and decoupling of economy from resources (e.g. via nature-based innovations).

- Working together with business to encourage improving corporate accounting and partnerships that promote conservation and sustainable use of biodiversity and ecosystems. Although not the main thematic focus of this assessment, a number of Nordic examples exist where private sector engagement has led to cost-effective solution and benefits for the environment and biodiversity.

- Identifying and agreeing on key areas for Nordic synergies and cooperation, including development of compatible and comparable sets of (core) ecosystem service indicators and frameworks for ecosystem services assessments and identification of thematic areas for cooperation (e.g. assessment and sustainable management of ecosystem services provided by Baltic Sea and other marine areas, sustainable production of forest-based biofuels, assessment of carbon stock and sequestration capacity at Nordic level etc.). To facilitate cooperation, consideration should be given to establishing a dedicated working group for ecosystem services under the Nordic Council of Ministers.

- In addition to advancing towards overall national level frameworks for integrating ecosystem services into decision-making, the Nordic countries (or specific regions) should also focus on identifying particularly important policy developments or implementation needs where assessment of the broader socio-economic value of nature would be important to secure sustainable outcomes, especially in the long term. Focusing on such problem- and/or challenge-based assessments is seen as important to complement the overarching assessments and monitoring of the state of Nordic ecosystems and their services and mainstreaming of this information into decision-making processes. While the specific policy challenges will vary across the Nordic countries, national TEEB initiatives and other similar approaches will help to catalyse the transition to a green economy.

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