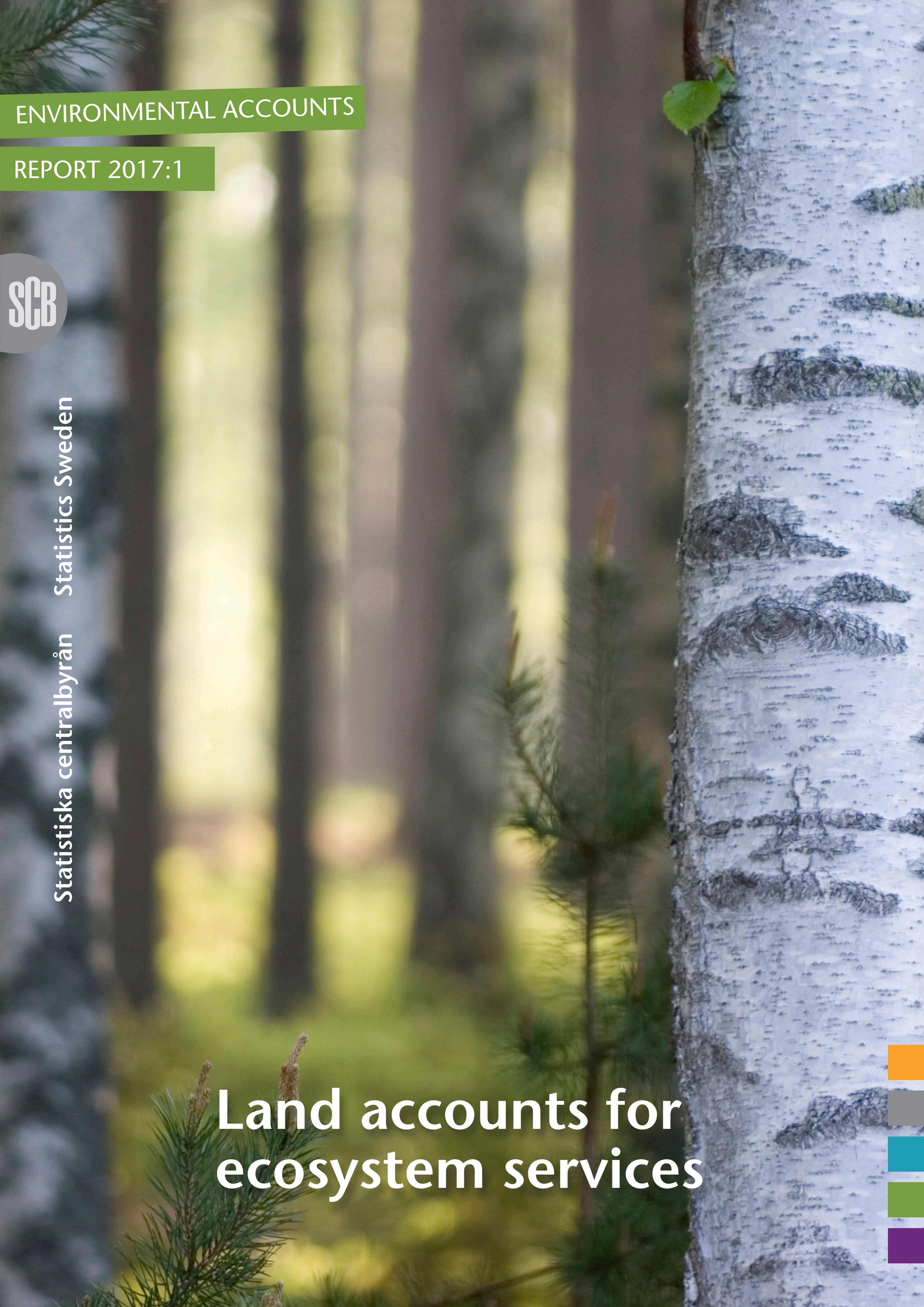
ENVIRONMENTAL ACCOUNTS

REPORT 2017:1



Statistiska centralbyrån Statistics Sweden

Land accounts for ecosystem services

ENVIRONMENTAL ACCOUNTS 2017:1

Land Accounts for Ecosystem Services

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Land Accounts for Ecosystem Services

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Foreword

This report was commissioned by the Swedish Ministry of Environment and Energy. Its aim is to describe experimental statistics within the framework of the environmental accounts connected to ecosystems.

The environmental accounts are a statistical system that describes the links between the environment and the economy. This is done by measuring the contribution from the environment to the economy (e.g. the use of raw material, energy and land) and the impact on the environment made by the economy (e.g. emissions to air). The environmental accounts also include transactions from the national accounts, such as environmental taxes and aid.

The hope is that it will be possible in the future to combine statistics about ecosystem services in a way that can build on already existing environmental accounts and provide a picture of how the economy affects the environment, and vice versa.

A statistical standard for environmental accounting has been established within the UN: the System of Environmental-Economic Accounting Central Framework (SEEA CF).

According to the UN, an environmental accounting system should cover:

- material flows in the economy
- economic variables of environmental interest
- natural resources and stocks (stores or inventories)

The report was prepared by Statistics Sweden's Regions and Environment Department: Jerker Moström, Nancy Steinbach, Sebastian Constantino, Viveka Palm, Jonas Bergström and Johan Stålnacke.

Statistics Sweden April 2017

Marie Haldorson

Kaisa Ben Daher

SCB tackar

Tack vare våra uppgiftslämnare – privatpersoner, företag, myndigheter och organisationer – kan SCB tillhandahålla tillförlitlig och aktuell statistik som tillgodoser samhällets informationsbehov.

Contents

Summary

Ecosystems are affected daily by the economy and decisions and actions in society. The use of statistics to show some of the complex interlinks that exist provides information that may contribute to a greater understanding and improved decisions for society and a sustainable development.

This project has further developed and improved a method of accounting for land ownership in the environmental accounts system. The environmental accounts is a statistical framework connected to the national accounts that links environmental statistics to economic statistics.

The study has three different components. The first component (the basis) has developed a production system with calculation routines and data management for the preparation of basic land accounts. The aim was that this production system should be fully harmonised with the environmental accounts system and be possible to put into operation. The method has also been tested for the production of complete statistics at two different points in time in order to assess changes over time. Proposals for improvements regarding input data are also provided.

The production system that has now been created for land accounts provides several ways of reporting by linking micro data with other registers and statistics. For the statistics produced in this project alone, the following information can be reported:

- Type of land by time and owner category according to the real estate assessment records.
- Type of land by time and property type code according to the real estate assessment records.
- Type of land by time and SNI code including section, division, group, class and detailed group.

All variables can be reported in the following regional categories:

- National level
- Water districts
- National regions
- National areas (NUTS)
- Counties
- Municipalities

Other ways of reporting apply to social and other economic aspects. The data set can be extended and be associated with the location of the population, income groups involved and the infrastructure in the area. This may provide a first glimpse into how land ownership is affected by cultural values within a region. Is the land owned by private individuals to a greater extent than by companies, has this affected the establishment and migration to the region, and does it affect enterprising in the area, such as small-scale tourism or the establishment of clubs and associations?

It is also possible to establish a link to the economy. As statistics show here, 92 percent of all land in Sweden is owned by companies and the state[1]. This means that the services provided by the land are largely affected by economic interests. The right of public access has established the starting point that land is freely accessible, but that a company owning land has control of how the land is used and may use it in its economic activity.

Landowner per industry

At the national level, 90 percent of the land is concentrated to four industries and the households. They are Agriculture, forestry and fishing, Real estate activities, Manufacturing industry, Public administration and defence and Households. Agriculture, forestry and fishing is the industry group that owns the most land by far.

In the first group, Agriculture, forestry and fishing, forestry dominates land ownership with approximately 17 million hectares, of which 13.8 million hectares consist of forest land. The Real estate activities stands out by chiefly owning other types of land (land that does not constitute arable land, pasture, forest land or wetlands). It can be assumed on good grounds that it largely involves various types of built-up land, but as there is no input data for built-up land at present, this category cannot be distinguished in the statistics.

The Real estate activities is also the second largest owner of forest land, with approximately 1.5 million hectares of forest land, and of wetlands, with approximately 500 thousand hectares of open wetlands.

Manufacturing industries, including the manufacturing of pulp and paper, steel and furniture, constituted the fourth largest group of landowners in Sweden. Approximately 93 percent of the industrial group's total land ownership is by companies in the pulp and paper manufacturing industry, and these companies primarily own forest land.

In Figure S.1, which is a typical example of variables from the environmental accounts, landowners are categorised into service and goods production. The variables are the groups' value added (their contribution to GDP), employed persons, carbon dioxide tax, use of fossil and biogenic fuel, greenhouse gases, forest land, pasture and land (which is the sum total of forest land, pasture and arable land, wetlands, built-up land and other land). This type of graph provides a snapshot of the structure for all of Sweden, showing who has the largest share of the various factors.

According to the figure, the largest proportion of land in Sweden is owned by goods producers, including agriculture and forestry and paper and steel manufacturing. The second largest group of owners comprise service producers, including property management and government activities.

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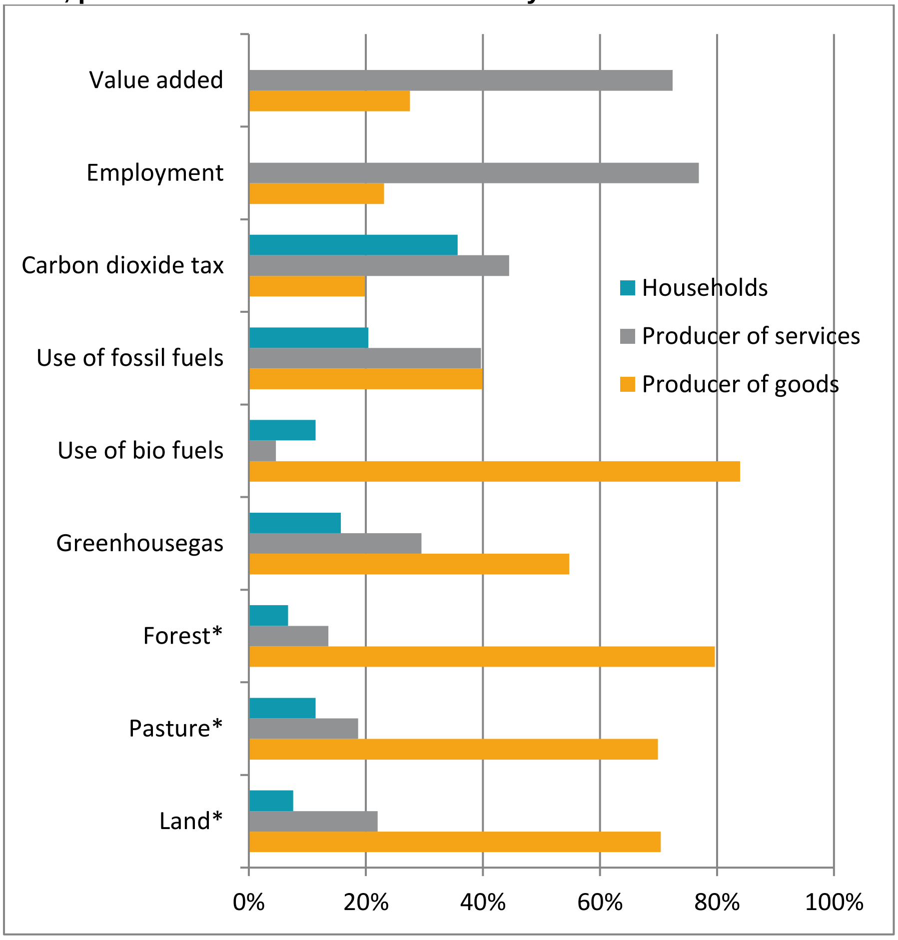
1 Compared with the publication in 2013 in *Land use in Sweden* that showed that 48 percent of all land in Sweden is owned by private individuals, there is a major difference. In this respect, it is important to note that the division based on the Swedish Standard Industrial Classification is based on the companies' activities whereas the division in the 2013 publication was based on tax law principles regarding private individuals (actually legal persons).

In general, service production contributes a major share of employment and value added (contribution to GDP) but owns a smaller share of land compared with agriculture and forestry.

Figure S.1
Environmental-economic profile by industry (SNI2007) and households in 2014, percent of total value for the country



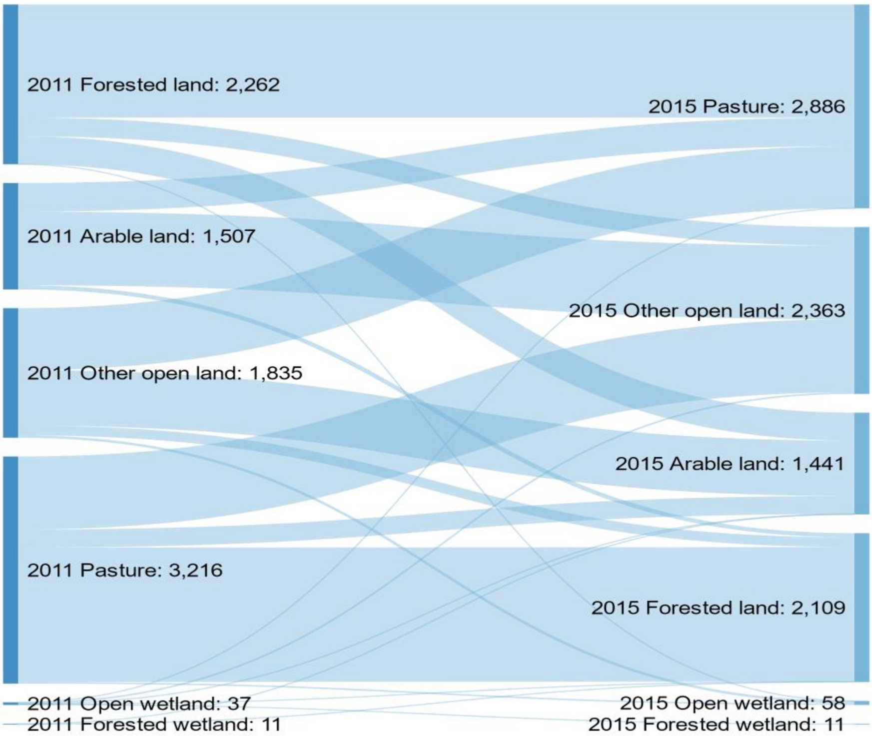
Footnote: * The data relates to 2015

Source: Statistics Sweden's environmental accounts

The second component of the study has investigated the conditions to describe systematically how land changes over time, from one type of land to one or several others. The relevance from an ecosystem services perspective is the ability to show how conditions for maintaining several types of services change over time, for example, to show where and how agricultural land is converted into forest, which ultimately can be used to assess potential losses or reinforcements of various types of ecosystem services. The aim of the second component was to test methods in order to assess the potential of the approach and assess any further developments required rather than creating a comprehensive concept.

Figure S.2 shows the changes in land use in Gotland County between 2001 and 2015 as flows between types of land. The idea is that the reporting of flows between types of land contributes to a better understanding of the transformation processes affecting conditions for various types of ecosystem services. In the long term, it is assumed that this will have significance for the design of various types of instruments and measures constructed by the government.

Figure S.2
Sankey diagram showing changes in land types from 2011–2015 in Gotland County.



The third component of the study was more experimental in nature. The intention was to investigate the possibility of preparing closer links to ecosystem service accounts. In this respect, the aim was to test and describe opportunities rather than providing a complete concept. A number of minor tests were carried out but most importantly, proposals for potential continued development were prepared.

It is believed there is great potential to develop land statistics further, allowing its use to assess changes relevant to ecosystem services.

Further development is possible within classifications, links to workplaces for local connections, a more detailed breakdown of existing types of land, such as built-up land and sealed soil. It is also possible to build further on the connection with ecosystem services associated with land, such as by using agricultural statistics, information about carbon sinks and biodiversity.

Ecosystem services depend on water conditions, land use on different types of land and biodiversity as well as on decisions made by landowners regarding the management of the land. The statistics are intended to link the analysis between ecosystems and players in society through the environmental accounts.

Finally, the project made a brief comprehensive overview regarding the information required for the follow-up on the United Nations' Sustainable Development Goals, Agenda 2030.

Of these goals, four can be associated with land ownership statistics: Goal 6 regarding clean water and sanitation, Goal 11 regarding sustainable cities, Goal 14 regarding the sea and marine resources and Goal 15 regarding ecosystems and biodiversity. As these statistics are new, there are no direct proposals for indicators from the international United Nations group that developed the current list. But it is fully possible that statistics on landowners can contribute to the knowledge base required to follow-up on the goals. Considering the fact that data on ecosystems have been identified as an area without sufficient information and that a considerable amount of new statistics have been produced lately within the environmental accounts framework, it would be interesting to analyse the requirements for follow-up where this type of statistics might be useful. This could include Agenda 2030, the Convention on Biological Diversity and the Habitats Directive, to mention but a few.

1. Introduction

Measuring sustainable development and welfare is central to the promotion of the green economy, both nationally and internationally. Sweden has international obligations within this area, including as a part of the strategic plan to protect and preserve biological diversity adopted at the tenth meeting of the Conference of the Parties to the Convention on Biological Diversity in Nagoya in 2010. One of the targets involves the integration of the value of biodiversity into development plans, economic decisions and national accounting. This target has been included in Sweden's environmental objectives system in the milestone target *Importance of biodiversity and the value of ecosystem services*, but without any explicit reference to the national accounts.

The Swedish milestone target states that by 2018, the importance of biodiversity and the value of ecosystem services are to be generally known and integrated into economic positions, political considerations and other decisions in society where it is relevant and reasonable to do so.

As a result of the government enquiry *Räkna med miljön* from 1991 (Official Government Reports 1991:37–38), Statistics Sweden, the Swedish Environmental Protection Agency and the Swedish National Institute of Economic Research were assigned the task of developing a Swedish environmental accounting system. Large parts of the system have been developed since the enquiry, and international statistical standards have been developed with a contribution from Sweden.

The Swedish ecosystem services enquiry (Official Government Reports 2013:68) emphasised the importance of an increased knowledge base, as recurring statistics and data are missing in this field. Through Statistics Sweden's many data sources, supplemented by databases kept by authorities and researchers, new opportunities can be created for additional information in this field.

Regarding certain issues, however, methods to highlight how the environment and the economy interact have yet to be developed. There is an intensive global debate at present regarding ecosystem services and how they can be taken into account by using statistics linked to economic considerations. The EU has stressed that it intends to examine whether this can be achieved within the environmental accounting system. The Organisation for Economic Co-operation and Development (OECD) and the United Nations Statistics Division (UNSD) have also raised the matter.

The ecosystem area involves provisioning services such as food, water supply and raw materials. It also includes regulating and supporting services such as the regulation of waste, pollution, and the physical and biotic environments. Finally, it also includes cultural aspects such as the natural and cultural heritage, recreational activities and health.

Purpose

According to Statistic Sweden's appropriation directions, the agency shall develop methods for including the value of ecosystem services in environmental accounts by compiling existing information on links between land and water use, economic development and biodiversity. When conducting the assignment, the agency shall consult with the Swedish Species Information Centre at the Swedish University of

Agricultural Sciences (SLU) and other relevant agencies that are responsible for the follow-up and evaluation of environmental quality objectives.
SLU and the Swedish Environmental Protection Agency have been given the opportunity to comment and continue these discussions on how to best use the data in order to understand which areas need to be developed.

The assignment also includes the task of submitting proposals on how to improve the statistical material.

The added value of classifying the statistics by industry

The framework for the project is a statistical system called environmental accounting. The statistics compiled within this concept make it possible to link environmental impact to economic players and product groups.

As the framework is connected to the national accounts, there will be good opportunities to compare statistics on an international basis.

The conditions are met for the environmental accounts to contribute standardised information by industry, but also by sector that measures ecosystem services and biodiversity, such as information about areas such as land use, water use, fishing statistics and agricultural statistics.

The economic-oriented approach means that information on who (which industry, according to the Swedish Standard Industrial Classification) owns or is in control of the land. This means that public institutions are chiefly described based on their activities, e.g. a property management company owned by the public sector sorts under the Real estate activities industry code (SNI 68). In future projects, such information can provide a picture of valuable natural areas that are not covered by environmental protection laws and regulations, i.e. where companies and households own the land. Also, it will be possible to obtain a picture of the structure in the industries. This can be achieved by producing statistics on the distribution between small and large companies that may have differing views of their external environment, their financial resources, such as turnover and number of employees and the number of workplaces they have at their disposal compared with the industry as a whole. Approximately 64 percent do not own any of the types of land investigated (in this case, forest land, arable land, pasture, wetlands and land in total).

An international concept

In the world of statistics, methods are being developed to create the concepts and quantities needed to incorporate the ecosystem area in the environmental accounts.

The environmental accounts are a statistical framework linked as a satellite system to the national accounts. This means that definitions, delimitations and standards are consistent, making it possible to link standardised statistics from the economy to the environment.

Statistics and accounts on ecosystem services are still in an experimental phase within this system. In 2012, the United Nation published the manual *System of Environmental-Economic Accounting 2012 Experimental Ecosystem Accounting* (SEEA – EEA) that forms the basis for continued work and development. As the United

Nations manual covers several areas, such as biodiversity, carbon sequestration and the quality and extent of land, various areas have been picked up by different statistical agencies, researchers and international organisations. For example, UNEP-WCMC issued guidelines on biodiversity accounting in 2015 called *Experimental Biodiversity Accounting as a component of the SEEA-EEA.*

Also, the Secretariat of the Convention on biodiversity was a pioneer in 2014 and with the assistance of experts from the environmental accounting community, a report called *Ecosystem natural capital accounts: a quick start package* was published. The report was published to contribute to the development of data that can be used to follow-up on the Aichi targets. The report describes different topics, such as land accounts, carbon accounts, water accounts and functional services accounts.

There is a draft technical guide linked to the work from 2012 on experimental ecosystem accounts. The guide, called *SEEA Experimental Ecosystem Accounting: Technical Guidance*, intends to convert these tests and new knowledge into more developed methods.

The major international initiatives are largely based on the efforts made by countries and experts. Countries that have come far with the work on testing and developing methods within ecosystem accounting include the United Kingdom (Connors 2016), the Netherlands (de Jong et al 2016), Australia (ABS 2015), South Africa (Driver et al 2015) and Canada (Statistics Canada 2013). An increasing amount of data is becoming available through the World Bank Initiative Wealth Accounting and the Valuation of Ecosystem Services[2].

In statistics, the extent of land types is measured as a proxy for ecosystems (as forest land, grass lands and mountain) while it is more difficult to provide a comprehensive picture of the data related to ecosystemic quality.

Changes in the extent of various types of land can be shown in an asset table, as in the example below in Table 1.1. It is possible to show e.g. land types instead of the division into land ownership.

The asset table shown here is adapted to the structure in the national accounts. However, it is difficult to obtain relevant information for the classification of the management of land types. The table describes changed land use, which is now linked to changes in habitats that may affect the functionality of different ecosystems.[3] This is a simplified picture, as identified in UNEP-WCMC 2015. It identifies that land cover is a function of vegetation, climate, soil and hydrology as well as of land use, which means that land cover cannot be translated directly into ecosystems. But land cover or land use work as a proxy,

2 www.wavespartnership.org/en

3 as described in SEEA 2003 for instance.

Table 1.1
Terrestrial extent (hectares) – an asset table

	Built-up land	Forest	Meadow and pasture	Other land	Total
Opening extent					
Additions					
Growth in terrestrial extent					
Of which, managed regeneration					
Of which, natural regeneration					
Reclassification upwards					
Total additions to terrestrial extent					
Reductions					
Reduction of terrestrial extent					
Of which, land clearing					
Normal loss of terrestrial extent					
Of which, natural disasters					
Downwards reclassification					
Total reductions in terrestrial extent					
Total change in terrestrial extent					
Closing extent					

Adapted according to Eigenraam, M., Chua, J. & Hasker, J. (2013).

By using the same classifications and categories for statistics in the area of ecosystem services, regardless of whether they concern water, land, climate or biodiversity and the economic statistics as used in the national accounts, the scope for analysis increases.

Ecosystems are affected daily by economic and political decisions and actions. The indication of a subset of complex links between ecosystems, economics and politics provides the basis for greater understanding and ultimately better informed decisions.

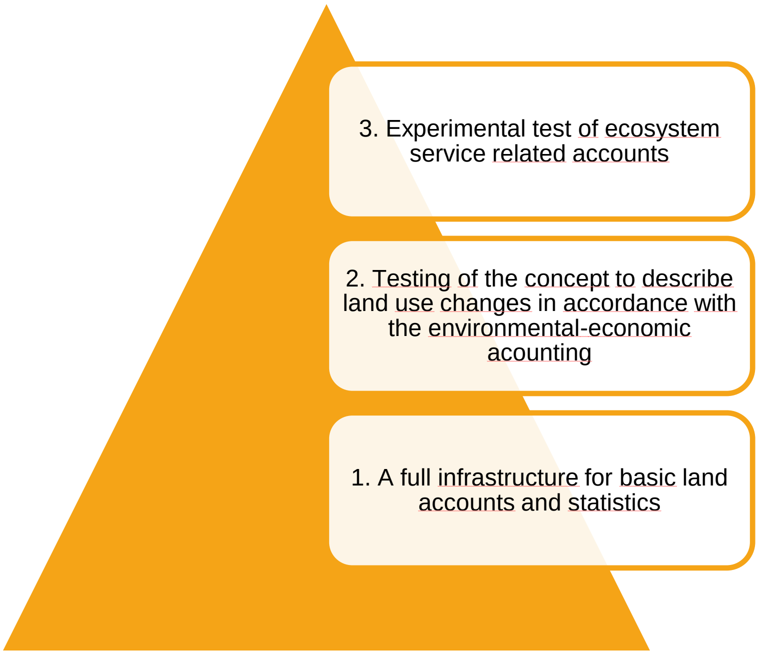
The study's design

The study has three different components. The first component (the basis) involved the development of a production system for the preparation of basic land accounts. The aim was that this method should be fully harmonised with the environmental accounts system and be possible to put into operation. The system has also been tested to produce complete statistics for two different points in time. Proposals for improvements regarding input data are also provided.
The second component was carried out as a more limited test of the conditions for systematically describing changes in types of land over time. The relevance from an ecosystem services perspective is the ability to show how conditions for maintaining several types of services change over time, for example, to show where and how agricultural land is converted into forest, which ultimately can be used to assess potential losses or reinforcements of various types of ecosystem services. The aim of the second component was to test methods to assess the

potential of the approach and assess any further developments required rather than to create a comprehensive concept.

The third component of the study was more experimental in nature. The intention was to investigate the possibility of applications more closely connected to ecosystem services ("ecosystem accounting"). In this respect, the aim was to test and describe opportunities rather than providing a complete concept. A number of smaller tests were carried out but most importantly, proposals for potential continued development were prepared.

Figure 1.1
The three components of the study



2. Basic land accounts by industry

The purpose of basic land accounts is to describe and define players whose actions affect the conditions for maintaining various types of ecosystem services in Sweden. The ecosystem services concept brings with it the need to know which players are making use of services linked to a certain type of land, but also to know which players or groups of players contribute to the weakening or disappearance of certain ecosystem services. Therefore, the first basic step in order to integrate ecosystem services with the environmental accounting system is to link the land and its characteristics with landowners and groups of economic actors. This is made in a way that is harmonised with the classification system already used in the environmental accounting system.

The Swedish Standard Industrial Classification (SNI), with its European and international equivalents NACE[4] and ISIC[5], is a well-established classification system that is used in the entire statistics system, both nationally and internationally. SNI also forms the basis for the environmental accounting system. By describing statistics related to land use and land cover in accordance with the SNI system, suitable conditions are created for its integration with other statistics on economics and social conditions. This makes it possible to widen the perspectives relating to who is or are in control of the land, the industries' contribution to the economy and potential effects of structural changes within the economy on land use and ecosystems.

Procedure

The aim was to create a production system for the preparation of basic land accounts where a number of land use categories are distributed according to industry classification. The system should be fully harmonised with the environmental accounts system and be possible to put into operation.

The procedure is entirely based on the processing of already existing data sources and administrative registers. No new data collection in the form of questionnaires or interviews is carried out. The basis for the method is the linked processing of data describing land use with information from registers on land ownership, industries and companies linked to the property, which comprises both land and buildings. This linked processing requires a geographical analysis on a low geographical level. More information is available in Chapter 6 How the statistics are produced.

The method was tested in Statistics Sweden's MIR2015:2 in connection with a pilot project regarding the use of data used in the reporting under the Habitats Directive. The method has now been improved and refined and is consequently considered robust. It can be applied to new future data to update the statistics. It is modular, so parts of it can be replaced without any need to change the structure. Most importantly, this may apply to new and improved land data with higher thematic resolution (read more about this is under the heading *Potential for development and possible improvements*).

4 Statistical classification of economic activities in the European Community

5 International Standard Industrial Classification of All Economic Activities

The first step is to create an interface between land use and legal and economic data such as ownership and industries. According to the method, this interface will consist of real property units. A real property unit has a consistent delimitation in space and well-defined ownership, and by using keys in the Real Estate Register, a link can be made with economic data in the Business Register.

The second step is to select data that describe the land use in a consistent manner. As the real property unit was chosen to link ownership and economic data with the land, the data used must also have high geographic resolution.

In table 2.1, the land use categories used in the study are reported along with the data sources used for each category.

Table 2.1

Land use categories used in the study and data sources used to represent each category

Land use category	Data sources
Arable land	The Swedish Board of Agriculture's land block database
Pasture	The Swedish Board of Agriculture's land block database
Forest land	The forest mask from the GSD-Property Map*
Wetlands (open)	The wetlands mask from the GSD-Property Map**
Wetlands (forested)	The wetlands mask from the GSD-Property Map** combined with the forest mask from the GSD-Property Map*
Water	The water mask from the GSD-Property Map
Total land area	The land mask from the GSD-Property Map

*The forest mask from the GSD-roadmap has been used for the parts of the counties in Norrland where the forest mask is missing from the property map.

**The wetlands mask from the GSD-roadmap has been used for the parts of the counties in Norrland where the wetlands mask is missing from the property map.

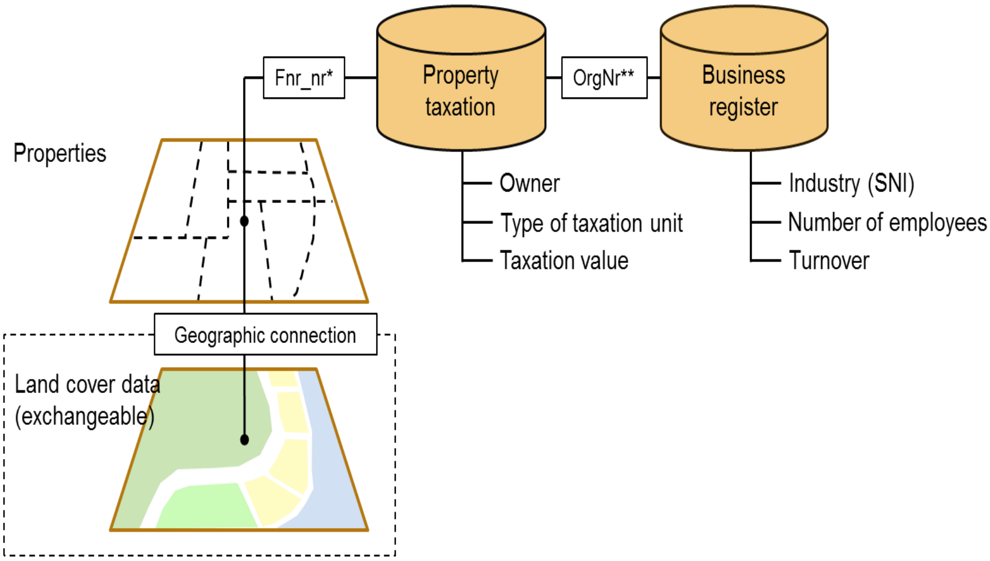
The Swedish Board of Agriculture's land block database is a system for the national administration of compensation under EU agricultural policy. The agricultural blocks undergo systematic annual revisions in accordance with the farmers' applications, making the data source reliable and suitable for use as a basis for comparisons over time.

The land information in the GSD-property map, on the other hand, should primarily be regarded as a cartography product that is not directly linked to any administrative systems. Also, the updating of information takes place according to a rolling schedule where parts of the map information is updated. Different objects in the property map may therefore have significant difference as to their dates of creation and updating. Consequently, the GSD-property map land information is less reliable for comparisons over time. Also, the delimitation of forest land and wetlands are not fully compliant with the international land type definitions that are used by the National Forest Inventory and are implemented in the Forestry Act. This means that the area of forest land as delimited in the GSD-property map may deviate from the area data in the forest statistics.

However, there is no better background data available for use at present when describing forest land or wetlands at the detailed level required to link land, legal and economic data at the property level. Neither is there any data at present that provide a comprehensive description of built-up land. In the section *Potential for development and possible improvements* below, the possibility of instead using input data based on detailed land cover data is discussed.

The next step is to link the land use information with the real property division to aggregate the area of each type of land with the area of each individual real property unit. When this has been performed, the property area and the associated land type information is linked to the landowner, sector or industry based on information in the real estate assessment records and the Business Register. The links between the different data sources are illustrated in Figure 2.1 below.

Figure 2.1
Outline of the production system for land accounts



Footnote: * Fnr_nr is a unique code used to identify a real property unit, which code is used as a key in the Real Estate Register. The code can be used to link the areas of real property units in GSD-property map with data in the Real Estate Register and the Real Estate Taxation Register
** OrgNr is a company's unique corporate identification number, which is used as a key in the Business Register. The corporate identification number can be used to link data between the Real estate assessment and business statistics.

Ways of reporting

The production system that has now been created for land accounts provides several ways of reporting by linking micro data with other registers and statistics. For the statistics produced in this project alone, the following information can be reported:

- Type of land by time and owner category according to the real estate assessment records.
- Type of land by time and property type code according to the real estate assessment records.
- Type of land by time and SNI code including section, division, group, class and detailed group.

All variables can be reported in the following regional categories:

- National level
- Water districts
- National regions
- National areas (NUTS)
- Counties
- Municipalities

As the real property unit is the smallest building block, it is theoretically possible to report data at an even lower level, but confidentiality issues preclude highly detailed reporting levels. It is possible to choose a basis for reporting based on other than administrative principles, however. The system is flexible and allows the production of data for coastal zones, localities and other functional zones or other zones based on natural geography. Nevertheless, confidentiality rules must always be taken into consideration.

Other ways of reporting apply to social and other economic aspects. The data set can be extended and associated with the location of the population, income groups involved and the infrastructure in the area. In a long-term perspective, this may provide a first glimpse into how land ownership is affected by cultural values within a region. Is the land owned by private individuals to a greater extent than by companies, has this affected the establishment and migration to the region and does it affect enterprising in the area, such as small-scale tourism or the establishment of clubs and associations?

It is also possible to establish a link to the economy. As can be seen from the statistics produced as part of this project, 92 percent of all land in Sweden is owned by companies and the state[6]. This means that the services provided by the land are largely affected by economic interests. The right of public access has established the starting point that land is freely accessible, but that a company owning land has control of how the land is used and may use it in its economic activity.

Problems and shortcomings

The creation of a production system where different sources are linked regarding the use of land and legal and economic information is complex, and there are certain associated problems. In the present case, it is chiefly about two matters:

A certain proportion of the land cannot be divided according to industry or owner as there is no clear link between the property division (land), ownership and economic activities. This applies chiefly to land held by land cooperatives, where many different owners own a share of the land. There are also uninvestigated areas where the ownership has not been determined from a cadastral law perspective. Land cooperatives and uninvestigated areas correspond to approximately 4 percent of the total land area in Sweden.

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6 Compared with the publication in 2013 of *Markanvändning i Sverige* that showed that 48 percent of all land in Sweden is owned by private individuals, there is a major difference. In this respect, it is important to note that the division based on the Swedish Standard Industrial Classification is based on the companies' activities whereas the division in the 2013 publication was based on tax law principles regarding private individuals (actually legal persons).

Water is generally difficult to handle in the calculation system, for the same reason as reported above. The majority of water areas have not been divided into properties. Only approximately 25 percent of water areas can be attributed to real property units; the remaining 75 percent either constitute land cooperatives or uninvestigated areas. The conclusion is therefore that water should not be handled in the same manner as land in the system created for land accounts.

Selected results

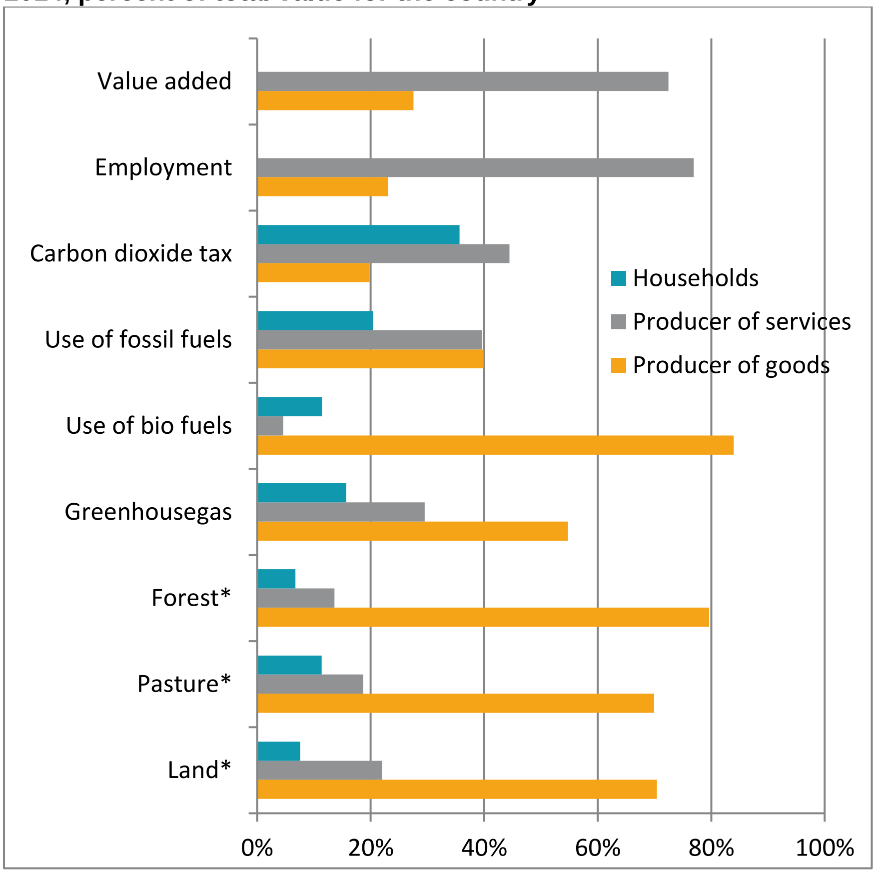
The national situation

In Sweden, the majority of land is owned by goods producers, such as agriculture, forestry, paper and steel industries, as shown in Figure 2.2. The second largest group of owners comprise service producers, including property management and government activities.

From an economic perspective, service production is the largest contributor to employment and value added (the contribution to GDP) while service production requires less land than agriculture and forestry. If the national productivity is related to the area unit land, goods producers contribute approximately 30,000 per hectare while service producers contribute approximately 245,000 per hectare.

Figure 2.2

Environmental-economic profile by industry (SNI2007) and households in 2014, percent of total value for the country



Footnote: * The data relates to 2015

Source: Statistics Sweden's environmental accounts

Landowner by industry

At the national level, 90 percent of the land is concentrated to four economic groups and households. Agriculture, forestry and fishing, Real estate activities, Manufacturing industry, Public administration and defence and Households. Agriculture, forestry and fishing is the industrial group that owns the most land by far.

Table 2.2
Land owner by type of land, hectare, År 2015, total Sweden

Industry	Land	Fields	Pasture	Forest	Open	Other land
Agriculture, forestry & Fishery	22 017 218	1 885 924	328 878	17 329 143	1 867 392	605 881
Mining and manufacturing	3 666 283	22 830	5 606	3 151 787	402 163	83 897
Electricity, gas, water, waste water, waste and sanitation	82 499	9 197	1 166	53 942	5 603	12 591
Construction	335 689	46 113	7 578	231 718	20 821	29 459
Wholesale and retail trade	201 541	18 944	3 443	145 966	14 158	19 031
Transport and storage	90 851	10 266	1 682	59 774	7 149	11 979
Accommodation and food service	73 044	4 264	1 505	43 594	10 674	13 007
Information and communication	33 663	3 012	802	24 715	2 053	3 081
Finalncial and insurance	46 004	4 999	907	36 992	1 089	2 017
Real estate	4 767 676	187 208	31 191	1 502 554	494 484	2 552 239
Professional, scientificc and technical	360 291	32 447	8 112	257 909	32 212	29 611
Public administration and defence	1 068 872	2 930	11 677	539 410	192 540	322 315
Education	214 764	27 507	5 747	114 760	9 096	57 653
Human health and social work	617 899	48 919	11 240	396 427	26 157	135 156
Arts, entertainment and recreation	258 901	24 017	6 446	165 185	22 629	40 623
Households	2 779 792	281 585	54 964	1 736 473	214 678	492 092
Unknown industry	4 356 515	65 147	28 673	1 671 390	513 936	2 077 369
Total	**40 971 502**	**2 675 312**	**509 616**	**27 461 740**	**3 836 834**	**6 488 001**

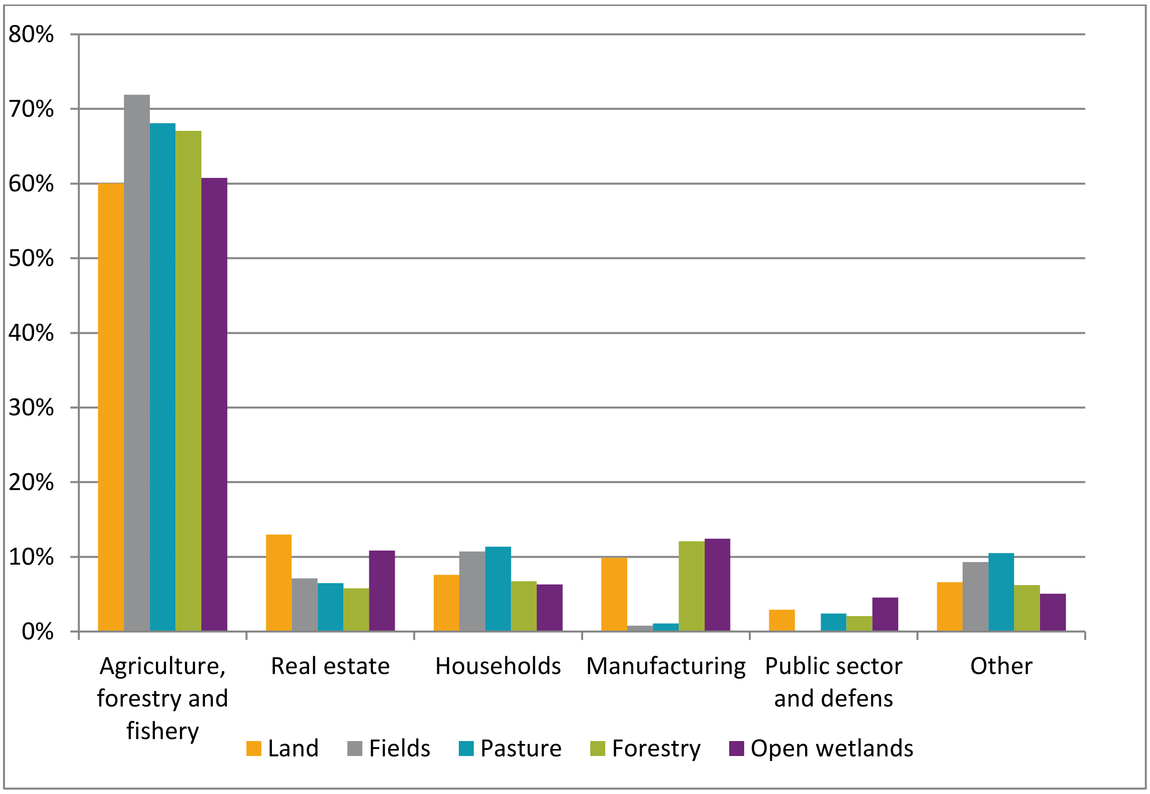
Source: Statistics Sweden's environmental accounts

In the group Agriculture, forestry and fishing, forestry dominates land ownership with approximately 17 million hectares, of which 13.8 million hectares consist of forest land, see Figure 2.3. The Real estate activities industrial group stands out by chiefly owning other types of land (land that does not constitute arable land, pasture, forest land or wetlands). It can be assumed on good grounds that it largely involves various types of built-up land, but as there is no input data for built-up land at present, this category cannot be distinguished in the statistics.

The Real estate activities industrial group is also the second largest owner of forest land, with approximately 1.5 million hectares of forest land, and of wetlands, with approximately 500 thousand hectares of open wetlands.

Manufacturing industries, including the manufacturing of pulp and paper, steel and furniture, constituted the fourth largest group of landowners in Sweden. Approximately 93 percent of the industrial group's total land ownership is by companies in the pulp and paper manufacturing industry, and these companies primarily own forest land.

Figure 2.3
Landowner by industry (SNI2007) and type of land, 2015, percent of total type of land

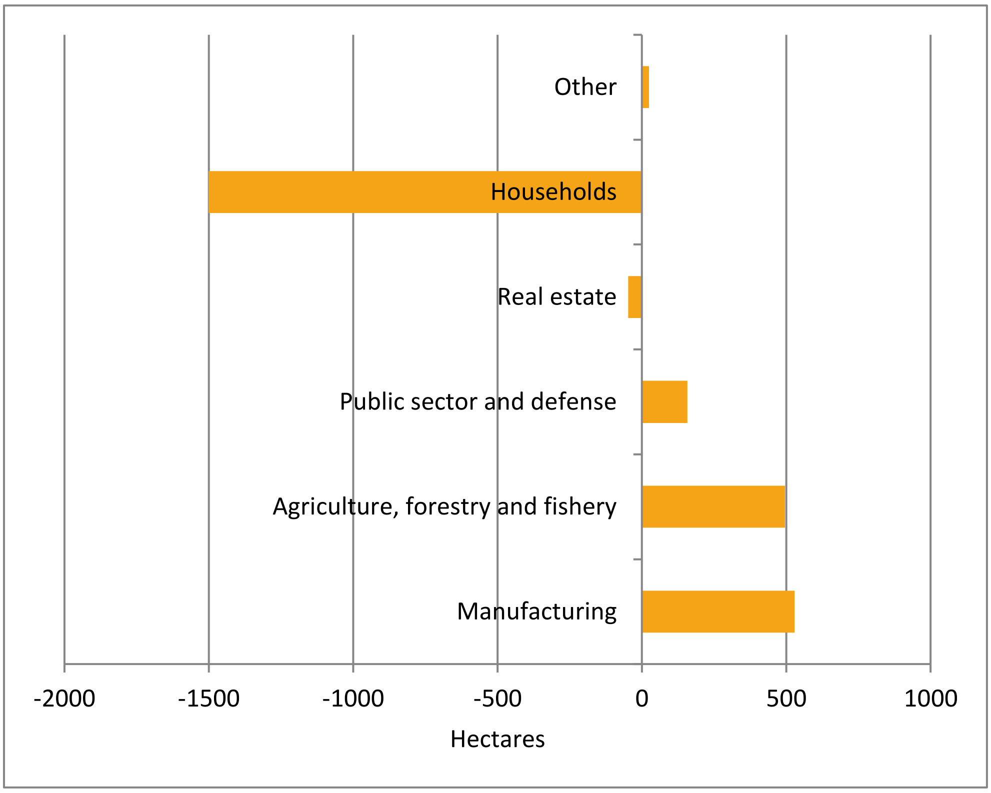


Footnote: In addition to arable land, pasture and forest, the land type "land" includes all other unspecified types of land.
Source: Statistics Sweden's environmental accounts

Structural changes in society and the economy are also reflected in ownership structures. Even if changes in ownership occur slowly and therefore must be studied over relatively long time, certain changes can be observed also for shorter periods of time (approximately 4–5 years). For example, household ownership dropped by approximately 2 million hectares from 2011 to 2015, see Figure 2.4. This reduction in extent chiefly related to forest land, thereafter arable land. A possible explanation is the sale of (whole or parts of) agricultural and forestry properties that are not included in active agricultural companies. The land is then transferred from the household sector to other industrial groups.

The manufacturing industry, on the other hand, increased its land ownership the most. From 2011 to 2015, this industrial group increased its total land ownership by approximately 550 thousand hectares. It was primarily the ownership of forest land that increased.

Figure 2.4
Change of land ownership by industry (SNI2007), 2011–2015, total land, hectares



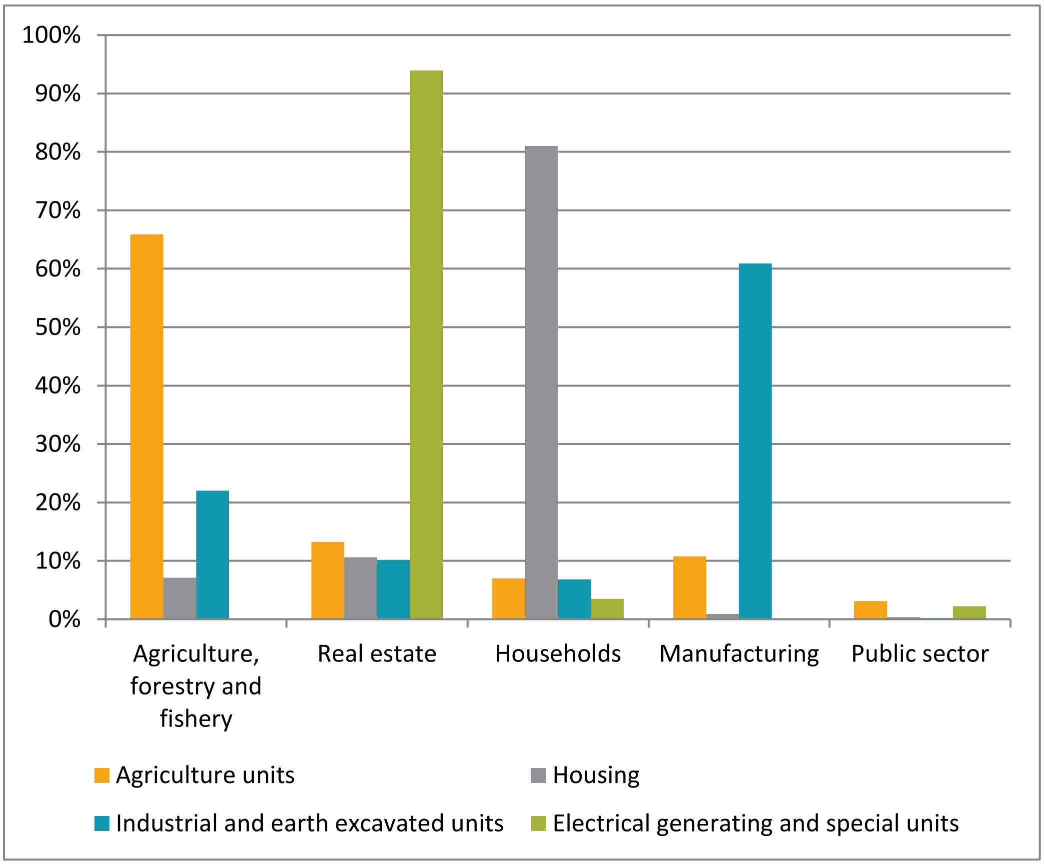
Footnote: The mapping of water improved in 2015, which may contribute to some changes.
Source: Statistics Sweden's environmental accounts

Land use per industry

The fact that a certain industry owns a specific type of land does not necessarily mean that the land is used for production linked to the specific industry in question. It may vary greatly between industrial groups if the land is used in production or if it chiefly contributes raw materials. An illuminating example is the manufacturing industry, which is one of the industrial groups that own a considerable amount of land, chiefly forest land. The greater part of the land owned by the manufacturing industry is not used for manufacturing industrial processes *per se*. A more accurate interpretation is that the manufacturing industry uses its land ownership to be in control of the chain from raw materials (which in this instance largely consists of forest products) to finished product. The link between the true use of the land and the industrial group's production can be further elucidated by combining industry data with information on the tax assessment of the land according to the Real Estate Taxation Register.

Statistics produced for this project show that of the five largest industrial groups, agricultural units are the type of taxation to which the majority of land is linked, see Figure 2.5. The fact that the land sorts under agricultural units means that it is chiefly used for agricultural or forestry purposes. It is therefore natural that the majority of land owned by the industrial group Agriculture, forestry and fishing also constitutes land considered to constitute agricultural units from a tax perspective. For this industrial group, there is consensus between the production and how the land is actually used. There is a similar clear link between the industrial group Households and land that from a tax perspective sorts under housing.

Figure 2.5
Industry and property types, 2015, percent of property type



Source: Statistics Sweden's environmental accounts and the Real estate assessment

Land of particular importance for ecosystems – a quality aspect?

Within the EU, there is an agreement on the preservation of species and habitats[7]. Particularly important species and habitats have been identified for protection, and

[7]Habitats Directive, Article 17 (Directive 92/43/EEC)

there is an obligation to ensure that their conservation status is favourable. This means that their natural range, area and population dynamics should be preserved.

The most recent reporting on the Directive showed that within both forested and grass land habitats, the conservation status is poor (Wenche Eide (editor) 2014)[8]. Forest is a natural resource in great supply in Sweden, but the majority of the present woods lack qualities that are considered important in the Habitats Directive. This refers to old forests, for example, that affect species that need a long-term approach to regenerate. Grasslands, on the other hand, are threatened by the discontinuation of agricultural land and a change in the use of the land (Wenche Eide (editor) 2014).

The valuable “Western taiga” habitat, as defined in the Habitats Directive, constitutes approximately 17 percent[9] of the total forest land in Sweden, see Figure 2.6. In absolute terms, most of the taiga is owned by forestry companies, but if their total holding of forest land is considered, then taiga only constitutes a proportion of approximately 12 percent. For Public administration and defence, the reverse is true. In absolute terms, his industrial group owns the smallest area of taiga, but if the sector’s total forest land ownership is considered, the taiga, which is valuable according to the Habitats Directive, amounts to around 43 percent.

The habitats of particular value according to the Habitats Directive that are linked to the agricultural landscape’s meadows and pastures constitute approximately 6 percent of the total area of meadow and pasture in Sweden. Meadow and pasture are chiefly owned by Public administration and defence, and their share of the total meadow and pasture in the agricultural sector is 48 percent.

The fact that the majority of the habitats in the Habitats Directive, which have been examined herein, are held by Public administration and defence reflects the government’s strategy to safeguard valuable nature by purchasing land and establishing nature reserves. Government agencies are also represented within property companies and managers, whose ownership of forest land is characterised by the high proportion of the taiga habitat.

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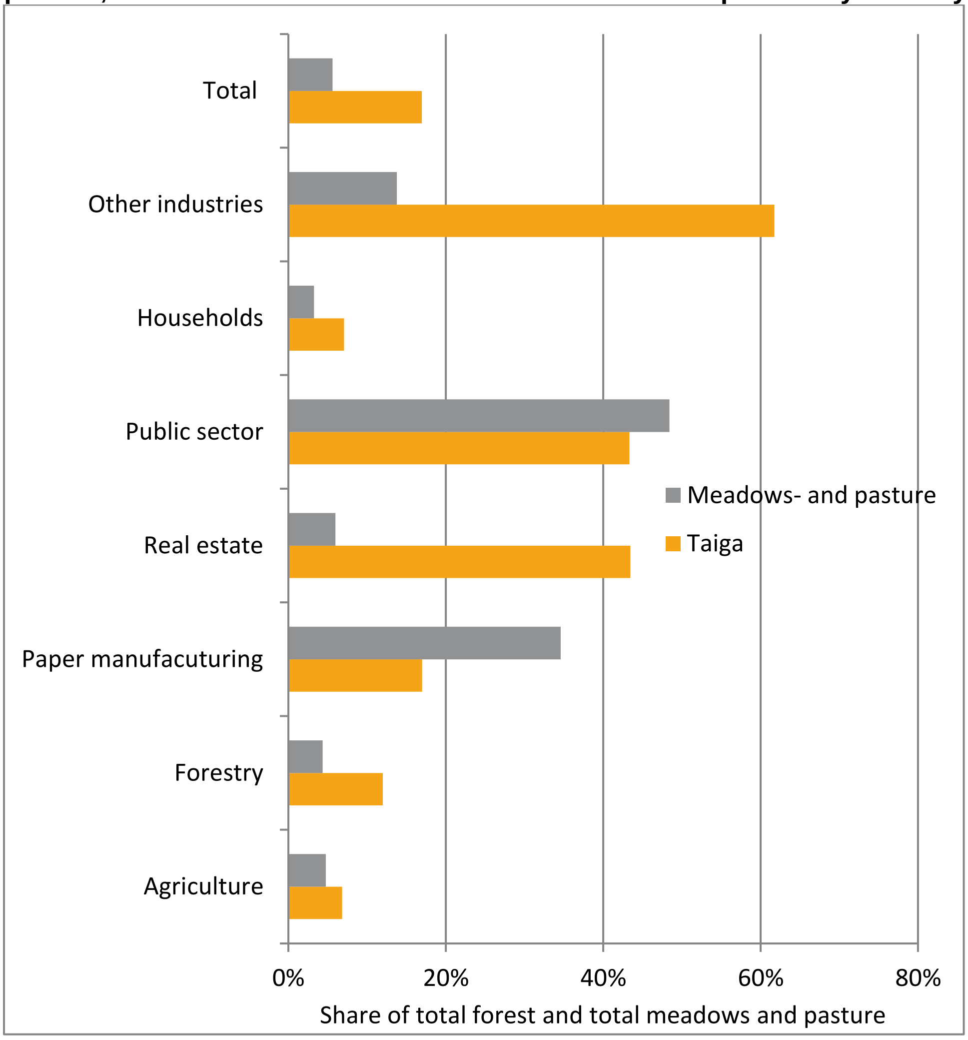
[8]The conservation status of one habitat is considered favourable when its natural range and the areas covered by it is stable or increases, when the structures and functions required to preserve the habitat remain for the foreseeable future and if the conservation status of its typical species is favourable as well.

[9]According to a calculation by Statistics Sweden within the project Land accounts for biodiversity – a methodological study. MIR 2015:2.

Figure 2.6

Share of taiga as highlighted by the Habitat Directive as well as meadow and pasture, of the total area of forest land and meadow and pasture by industry



Source: Statistics Sweden's environmental accounts and special adaptations from kNN, FTR and FD

A regional approach

Changes in the use and ownership of land between industries are often minor, geographically outspread and slow. When looking at the situation at a lower geographic level, more important variations can be found in the statistics. The method used in this report is based on information on a geographically detailed level. This enables the national statistics to be broken down into counties and municipalities, or other alternatives such as water districts, if desired.

As the composition of land ownership varies considerably from region to region, it is relevant to develop regional "profiles" that may shed light on varying situations related to ownership structures and economic structures.

There are plenty of space in Sweden, on average in 2015, just below 4 000 hectares per capita was available, see table 2.3. The regions differ, e.g. in Stockholm county about 300 hectares per capita is available, while in Jämtland county the population have on average 36 000 hectares per capita. The population growth in Sweden is slow but does impact on the change of available land. In Stockholm and

Södermanland county the highest population growth took place between 2011 and 2015, that impacted on hectare per capita.

Table 2.3
Hectare per capita, and change between 2011 and 2015

Code	County	2011	2015	% change
				2015/2011
01	Stockholm	306	282	-8
03	Uppsala	2 344	2 246	-4
04	Södermanland	2 170	2 001	-8
05	Östergötland	2 424	2 296	-5
06	Jönköping	3 062	2 952	-4
07	Kronoberg	4 556	4 393	-4
08	Kalmar	4 712	4 570	-3
09	Gotland	5 353	5 354	0
10	Blekinge	1 889	1 848	-2
12	Skåne	867	825	-5
13	Halland	1 771	1 683	-5
14	V. Götaland	1 468	1 410	-4
17	Värmland	6 278	6 162	-2
18	Örebro	3 012	2 897	-4
19	Västmanland	1 986	1 897	-4
20	Dalarna	9 679	9 476	-2
21	Gävleborg	6 379	6 275	-2
22	Västernorrland	8 816	8 747	-1
23	Jämtland	36 734	36 495	-1
24	Västerbotten	19 971	19 745	-1
25	Norrbotten	27 957	27 370	-2
Total		**3 912**	**3 744**	**-4**

Source: Statistics Sweden environmental accounts and population statistics

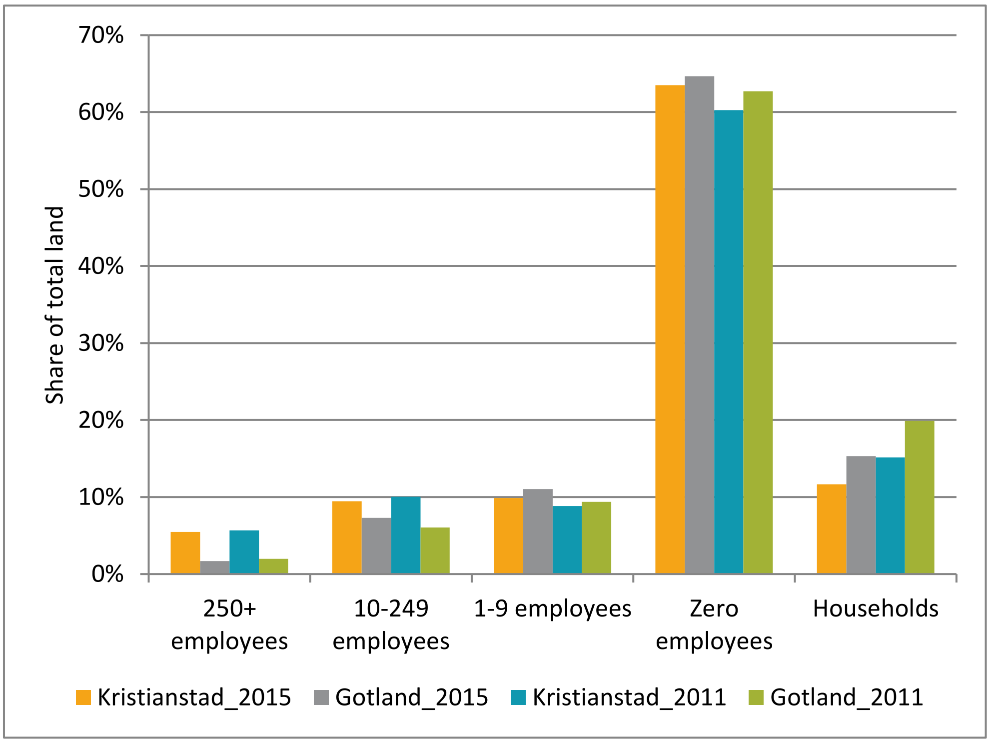
An outlook at owner structures in the municipalities

A minor comparison between the ownership in Kristianstad Municipality and Gotland Municipality, for example, shows that in Kristianstad and on Gotland, self-employed people constitute the largest group of landowners.

In Figure 2.7, self-employed people appear in the group with zero employees. This group contains companies where the owner is the only person active in the company, i.e. a “one person company”. The person cannot be employed as he or she already owns the company. As shown in the figure, these smaller “one person companies” are the most common type of landowner on Gotland, with approximately 65 percent of the land area, and 63 percent in Kristianstad. The category “one person companies” often comprises small agricultural and forestry companies, which explains why they own such a large proportion of the land area.

Other conditions shown include that more large companies are landowners in Kristianstad than on Gotland. It is also apparent from the figure that trends differ between the municipalities. In Kristianstad, the proportion of major companies owning land is growing, while it is declining in Gotland Municipality. The same applies to households; in Kristianstad, their share is growing, while it is decreasing in Gotland Municipality.

Figure 2.7
Gotland and Kristianstad – Company size, in number of employees, land total

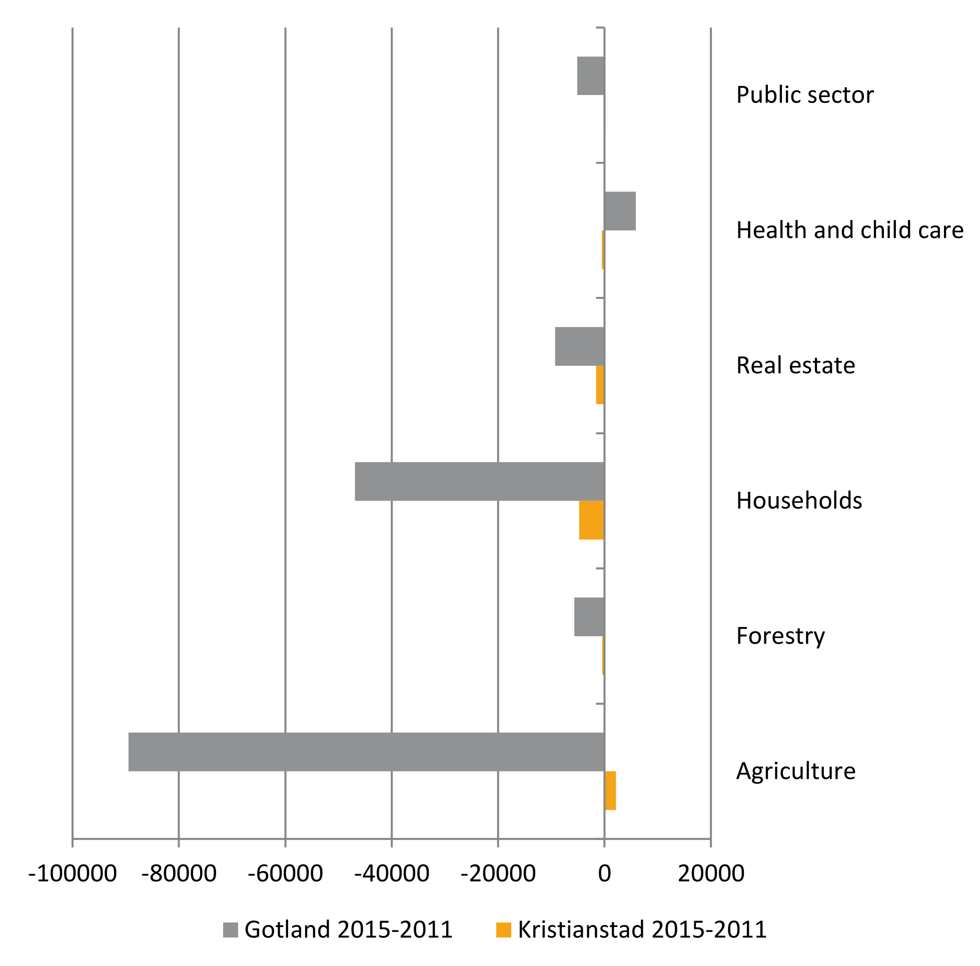


Source: Statistics Sweden's environmental accounts and the Real Estate Taxation Register

When properties are sold, it means that the land and any buildings located on it change owners. Sometimes the change in ownership is between owners in the same industry, but sometimes the land is transferred to a different industry. A continued comparison between Kristianstad Municipality and Gotland Municipality shows that in both municipalities, land owned by households dropped, see Figure 2.8. On Gotland, households primarily sold forest land, then arable land. In Kristianstad, primarily arable land and then forest land were divested.

The difference between the municipalities is even greater in the agricultural industry's land ownership. On Gotland, the industry reduced its ownership by just over 90 thousand hectares, while increasing its ownership in Kristianstad. The increase in Kristianstad Municipality primarily refers to arable land, but pasture, forest land and open wetlands were also affected to some extent. On Gotland, the agricultural industry reduced its ownership of forest land significantly, then arable land, pasture and finally open wetlands.

Figure 2.8
Gotland and Kristianstad – Changes in ownership, total land, hectare by selected industries, between 2015 and 2011

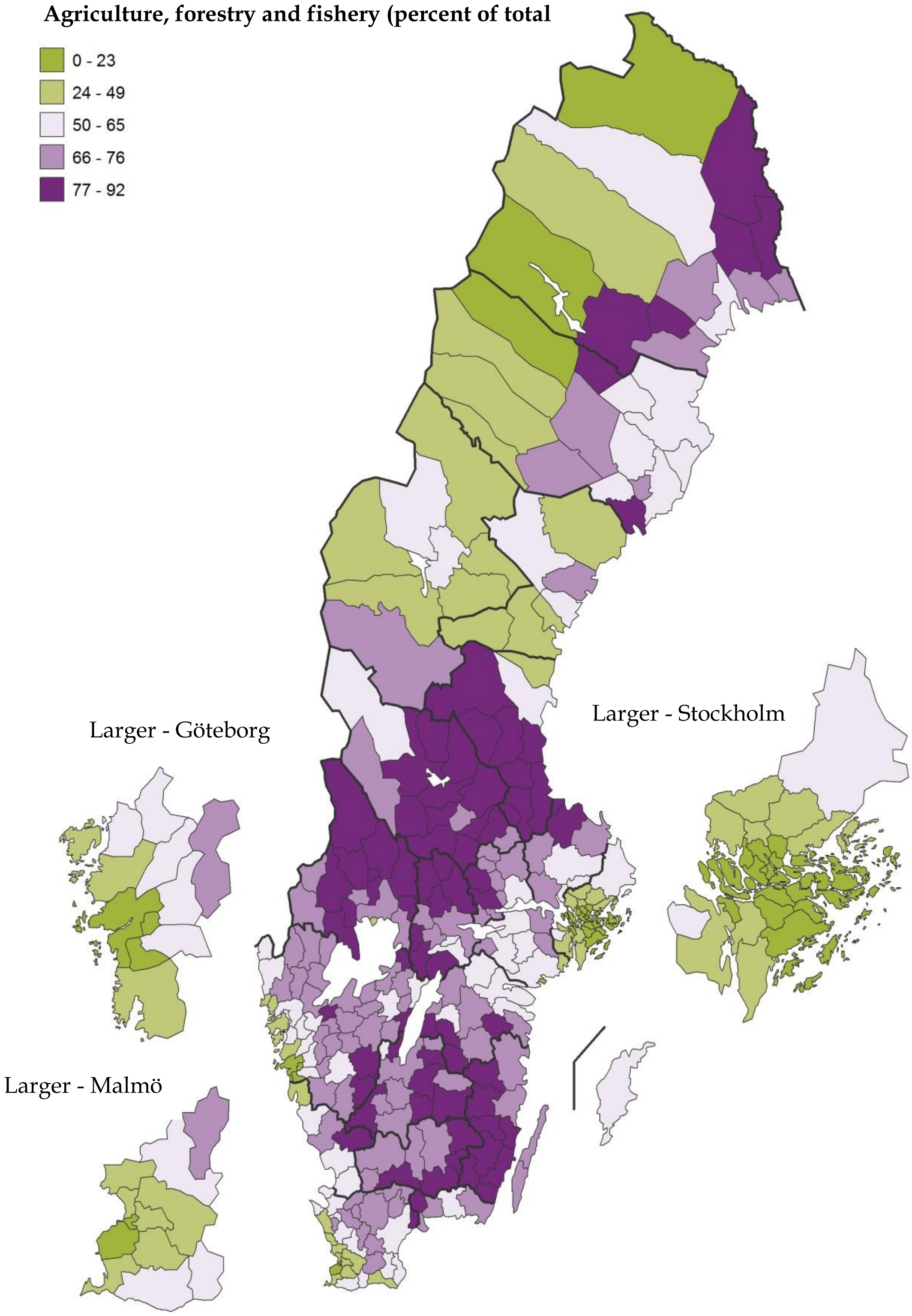


Source: Statistics Sweden's environmental accounts and the Real estate assessment
Comments: Note that the municipalities' totals differ, which means that comparisons of changes in absolute terms may not always be relevant.

The maps below show the large regional differences that exist with relation to ownership between different sectors of the economy. Agriculture, forestry and fishery is the dominating landowner in Värmland, Bergslagen and the counties surrounding Småland. The ownership of land of households are most clear in the larger city regions.

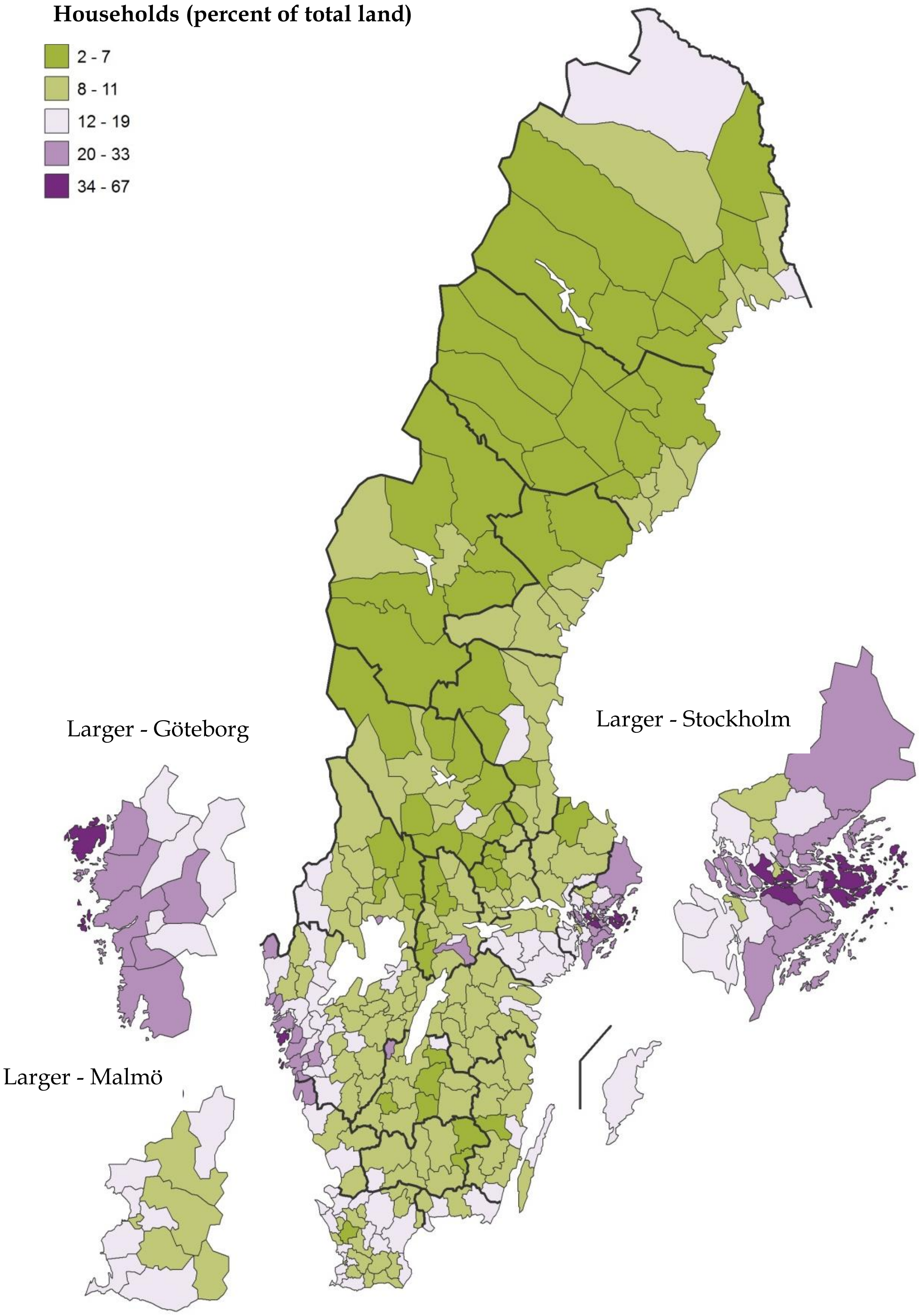
Map 1

The map shows the share of total land area, by municipality, owned by Agriculture, forestry and fishing



Map 2

The map shows the share of total land area, by municipality, owned by households



Potential for development and possible improvements

Statistics Sweden considers that the development of the production system that has now been developed for basic land accounts is finalised. The system is flexible and capable of reporting statistics with many different divisions, both thematic and geographic.

It is estimated that the foremost development potential lies in the use of other input data that may provide a better classification of the land. As described above, there is currently no alternative to the data sources at the national level used in the study. For the past few years, a consortium consisting of Statistics Sweden and a number of other authorities under the leadership of Metria has developed a concept for a new national land cover product[10]. As of 2016, the work in the consortium has continued, now under the leadership of the Swedish Environmental Protection Agency. The aim is to create a new national, regularly updated land cover map based on the European Sentinel satellite system. A new land cover product could replace the land data currently used in the project, resulting in with several significant advantages:

- A more refined division of the existing types of land could be reported
- New types of land that are currently missing completely could be reported, such as built-up land/sealed soil
- A delimitation of land types based on land cover data should be closer to existing official definitions, for example regarding forest land (productive and unproductive, respectively). Statistics produced based on land accounts would then harmonise better with other statistics in the land use area.

There is potential for further development regarding other data sources and variables that can be linked to the land, such as the localisation of workplaces. This would enable a linking of the activities actually carried out with land use and the contributions it provides by way of income, production and environmental impact.

Each new data source should be evaluated based on its definitions and methods to allow an assessment of how well it agrees with existing land account statistics.

[10] http://metria.se/CadasterENV/About-CadasterENV/

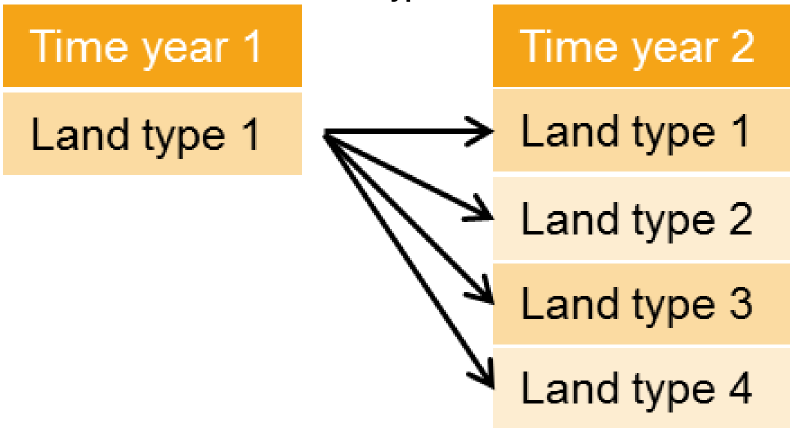
3. Changes in land use

To illustrate how the conditions for various types of ecosystem service change over time, and in the long-term also counteract undesirable changes using various instruments, detailed data about changes in land use are required.

The total changes in land use over time are already described in the official land use statistics produced by Statistics Sweden on a regular basis. However, the description chiefly covers total hectares of various types of land at different points in time. By comparing data between years, it can be determined whether the extent of a certain type of land has decreased or increased. The official land use statistics do not describe from what and into what a specific type of land is converted over time, see Figure 3.1.

Figure 3.1.

The figure shows the principle for how changes in land use can be tracked as flows over time between land types.

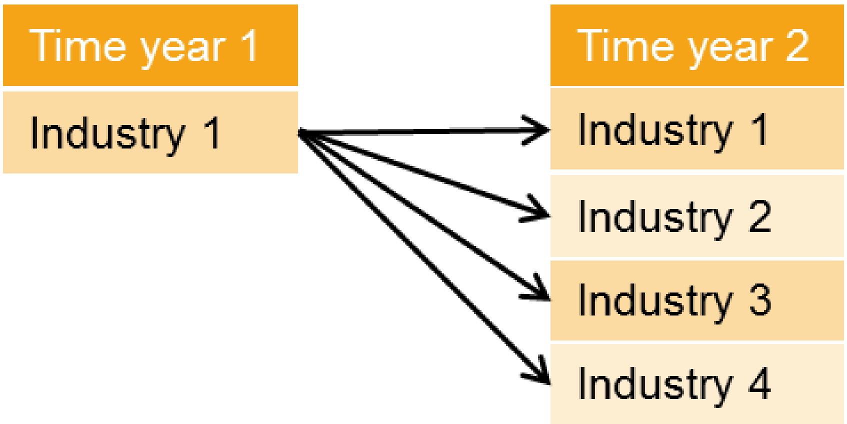


The ability to track changes in land use in this manner is important if the total impact on ecosystem services is to be determined. For example, it is of major importance if a pasture is transformed into built-up or into forest land, as the loss of ecosystem services linked to the pasture can be compensated in some way by strengthening other forest-related services.

It is also important for the assessment of the conditions for maintaining an ecosystem service to know where the change between types of land occurred, as the surrounding land use may be crucial. The loss of the specific area unit of pasture in an intensive agricultural area or in a forest area can have different consequences for matters like pollination.

The link to industries is also relevant for changes in land use, see Figure 3.2. By studying one type of land and investigating the flow between industries over time, conclusions can be drawn on how changes in the economy interact with the changes in land use.

Figure 3.2.
The figure shows the principle for how changes to a specific type of land can be tracked as flows over time between industries.



At present, no data describes flows between types of land systematically over time at a detailed level. Internationally, the conversion of land cover over time is analysed based on sources describing the land cover with relatively low resolution, such as CORINE land cover. Analyses of such data provide a relatively good picture of the main trends in land use at the European level, for example, but they do not reflect small-scale or geographically spread changes of land. For example, the smallest map unit in CORINE land cover is 25 hectares.[11]

For Sweden, the National Forest Inventory prepares the basis for Swedish climate reporting, in which flows between types of land are reported according to the same principle as in Figure 3.1.[12] However, the National Forest Inventory data is based on estimates based on samples, so the changes/flows cannot be identified in detail. They cannot be linked to industries either, as the resolution of the National Forest Inventory data does not allow links to real property units.

Procedure

This part of the project was carried out as a more limited test of the conditions for systematically describing changes in land over time. Accordingly, the aim was not to create a complete concept but to test methods to allow an assessment of the potential of the approach and assess any further development required.

The approach is largely based on the same production system as used in the project's first component, but with the difference that land data for two points in time are compared to create a "picture of differences". The picture of differences contains surfaces where the type of land has changed between the measurement times.

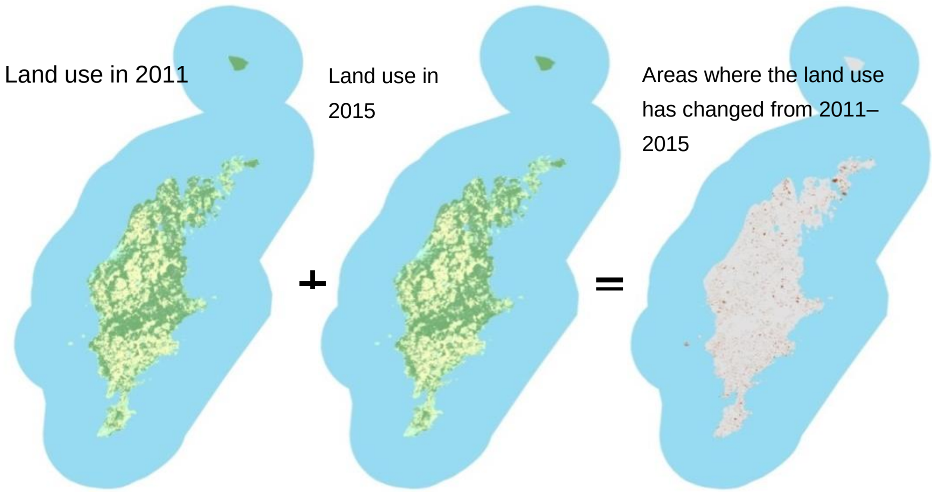
As the calculation of picture of differences for all types of land over time is a highly calculation-intensive procedure, only a limited study has been carried out, comprising Gotland County. The points in time compared were 2011 and 2015, the

[11] OECD 2016.

[12] Swedish Environmental Protection Agency 2016.

same as for total land use. The principles for how the picture of differences is calculated is illustrated in Figure 3.3.

Figure 3.3
The figure illustrates the principle for tracking flows between land use categories over time by creating a picture of differences.



Explanation: The red areas on the right-hand side of the map represent areas where the land use has changed between the measurement times.

Selected results

The result of the "picture of differences" show changes in land use, i.e. how and when a type of land is converted into something else. The appearance of small and geographic changes is typical. In total for the period 2011–2015, the use of 8,865 hectares of land (of the types of land studied) has changed in the entire Gotland County.

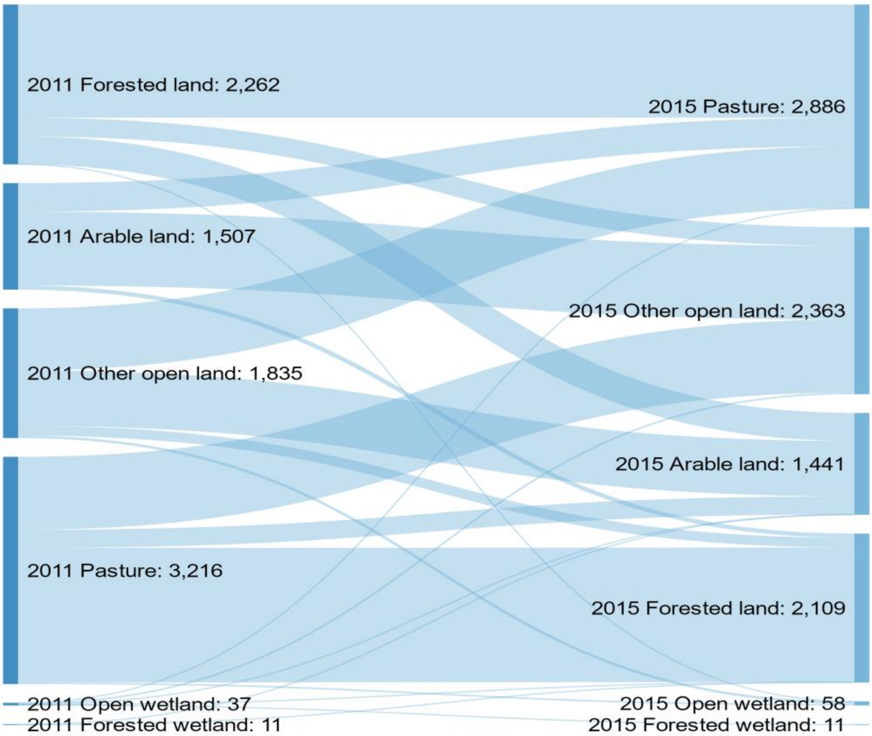
Table 3.1 below shows a cross-tabulation of data from 2011 and 2015. To track the development from 2011 to 2015, the table should be read from left to rate. Of the 87,268 hectares of arable land that existed in 2011, 85,760 hectares remained arable land in 2015 while 406 hectares had been converted into pasture and 1,042 had been converted into open land. To investigate the opposite direction, i.e. to study which types of land in 2011 that "contributed" to arable land in 2015, the table should instead be read from the top down. It will then be apparent that the type of land that contributed the most to arable land in 2015 was "Other open land", which contributed 784 hectares.

Table 3.1.
Cross-tabulation of land use from 2011–2015 in Gotland County

		2015						
		Arable land	Pasture	Other open	Forest land	Wetlands, open	Wetlands, forest	Total
2011	Arable land	85,760	406	1,042	59	0	0	87,268
	Pasture	256	25,309	1,034	1,904	22	0	28,525
	Other open	784	878	35,067	138	35	0	36,901
	Forest land	396	1,601	264	153,758	0	0	156,019
	Wetlands, open	0	1	23	0	6,862	11	6,897
	Wetlands, forest	4	0	0	7	0	1,015	1,026
	Total	87,200	28,194	37,431	155,867	6,919	1,026	

An easier way to visualise the flows between types of land would be to use a Sankey diagram. The diagram shows the stock of different types of land on each side. The changes in types of land are illustrated as flows. Figure 3.4 only shows the areas that have changed in either direction. Unchanged areas (i.e. those that are the same at both points in time) have been removed so that the change flows to appear more clearly.

Figure 3.4.
Sankey diagram showing changes in land types from 2011–2015 in Gotland County.



The result shows that the largest flows are between types of land such as arable land and pasture or between pasture and open land, which is expected, as there is a certain natural and sometimes short-term movement between these types of land. Agricultural land is temporarily removed from use and is then converted into other open land. It is also clear that there is a great exchange between pasture and forest land, which is also to be expected, as pasture that reaches sufficient crown cover is formally considered to be forest land. The reverse applies, as well; clearance of land that at one point had sufficient crown cover to be classified as forest land can relatively easily be converted into pasture.

On Gotland, however, it is more unusual relatively speaking for forest land to be converted to arable land or arable land to be converted to forest land. There are flows in both directions, though. Figure 3.5 shows and example of a land surface that has been converted from forest to arable land.

Figure 3.5

Example of a land surface that has been converted from forest to arable land between 2011 and 2015. The left picture clearly depicts the felling of forest, which has then been cultivated.

Potential for development and possible improvements

An important conclusion from the study is the lack of land data describing the relevant land use flows. As already mentioned in the previous chapter, national land data at the national level is missing for land such as sealed soil and built-up land. Perhaps one of the most important issues where this type of high resolution statistics of flows between land types can be of use is to show how the expansion of new buildings and infrastructure affect the conditions for maintaining various ecosystem services.

A project for new national land cover data[13] led by the Swedish Environmental Protection Agency (see above) is now in its developmental phase. The project could entail major opportunities to produce a better basis for land account of relevance for the local level, i.e. municipalities and localities. Here, the link between industries and ownership could be of interest to show the processes behind the conversion of land more clearly, i.e. which industrial groups are represented in the major flows between types of land.

[13] http://metria.se/CadasterENV/About-CadasterENV/

Such descriptions of the directions of flows between types of land and industries at the regional and municipal level could form valuable background data for regional and municipal policy work related to planning and land use.

4. Applications closely connected to ecosystem services

The assessment and quantification of ecosystem services can be handled in many ways and have different aims, from more qualitative estimates to more quantitative applications closely linked to statistics. It is primarily the latter that can be produced within the framework for international and national statistics systems. The quantification of ecosystem services in statistics is currently being developed under the concept "ecosystem accounting".[14]

Ecosystem accounting is an extensive framework involving several different statistical areas. It consists of measures for assets in certain kinds of ecosystems and depicts their changes over time. It also includes measurements showing how the flow between an asset, such as forest land, and the service(s) that ecosystems contribute to benefits to humanity such as felling, absorptive capacity or other. This includes the flow of economic transactions affecting both access and flows between ecosystems, such as taxes, investments and maintenance. In practice, it may involve land use and the quality of land, carbon sequestration and biodiversity.

The aim is to produce a formalised description of how to measure the contribution from biodiversity (ecosystems and biodiversity) to human welfare and the economy, by explicitly describing the role of the status and quality of ecosystems and the what is required to generate future ecosystem services.

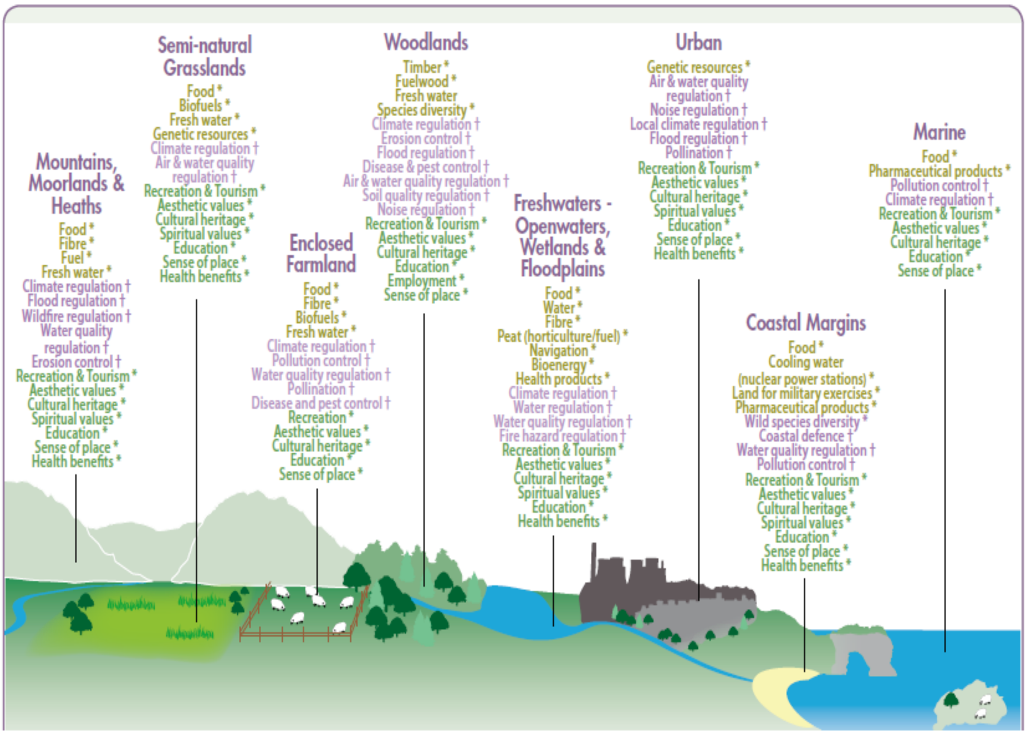
For natural reasons, the control of the land and its use is central to many analyses related to ecosystems and the services provided by ecosystems. But the step from analysis of land use to drawing conclusions regarding the extent or status of ecosystems can sometimes be long and require a number of assumptions and models. The qualification and monetary calculation of the values of the services provided by these ecosystems requires additional assumptions.

An assessment of eight habitats and the types of services they could contribute has been carried out in the United Kingdom. Box 4.1 shows an extract from this assessment. The evaluation has brought us one step closer to the quantification of the link between types of land and ecosystem services.

14 http://unstats.un.org/UNSD/envaccounting/eea_project/default.asp

Box 4.1

Eight broad habitats assessed in the UK National Ecosystem Assessment



Footnote: * refers to goods, + refers to services
Source: UK national ecosystem assessment 2011

A couple of examples of applications closely connected to ecosystem services, where the project has attempted to take the link between land accounts and ecosystem services one step further, have been set out below. Two concrete ecosystem services were used as the basis. The first example refers to the role of forests as carbon sinks (a regulating ecosystem service) and the second example is based on the forests' significance for food production, more particularly in the form of blueberries (a provisioning ecosystem service). Both services have in common that they can be considered to be relatively easy to quantify and that available data and research facilitate quantification.

The two examples are followed by two sections discussing the possibility to include biodiversity in the statistics and providing thoughts on monetary estimates related to ecosystem services.

Carbon sequestration in ecosystem accounting

One of the most important forest-related ecosystem services is the regulation of the climate through carbon sequestration. In Sweden, one cubic metre of forest sequesters one tonne of carbon dioxide per year on average. For each cubic metre that has been felled, the emission of approximately 470 kg of fossil carbon dioxide is avoided. If growth in the forest would increase by 50 percent until 2035, which is a possible achievement with intensified silviculture, the total climate effect can be doubled.[15]

The forest's ability to sequester carbon in biomass is an example of an ecosystem service that is relatively easy to quantify. The general knowledge about the carbon content of biomass that can be converted into calculation factors is good, and there are good estimates of the amount of available biomass. Quantification is already carried out based on data collected in the National Forest Inventory, as a basis for Sweden's climate reporting.[16]

The idea behind the example is to investigate whether it would be possible to quantify the carbon content of a forest to show the potential of ecosystem accounting.

Methodology

The Forest Map, previously known as kNN-Sweden (k nearest neighbours), is a nation-wide database with information on Sweden's forests. The database is maintained by the Department of Forest Resource Management at SLU.[17] The basic format is raster-based, highly detailed digital maps that cover the majority of Sweden's forest land. The estimated variables are growing stock per hectare, average age of stand, average height and biomass (above and below ground added together). The Forest Map was developed by combining field data from random sample inventories from the National Forest Inventory with comprehensive data from satellite images. A method called kNN is used to estimate the values of the satellite image pixels, hence the previous name of the database. The estimates have only been made for forest land in accordance with the delimitation in Lantmäteriet's roadmap. The Forest Map was prepared for 2000, 2005 and 2010. However, the biomass variable was only estimated for 2005 and 2010. An alternative source for estimating the carbon content of biomass is the Swedish Forest Agency's basic forest data.[18] Based on laser scanning data, the Swedish Forest Agency has produced a number of different forest variables, including biomass, which are reported on a detailed geographic level (12.5 x 12.5 meter pixels). The basic forest data is only available for one individual year, so we used the Forest Map in the project instead.

The carbon content above ground per square of 25 x 25 meters was calculated by first converting the Forest Map's estimated variable *kg biomass per hectare* to an absolute amount of biomass per square (in kg). Thereafter, the kg of biomass were multiplied with a factor of 0.5 to obtain the carbon content.[19]

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15 Swedish Environmental Protection Agency 2015. *Guide för värdering av ekosystemtjänster*. Report No. 6690.

16 Swedish Environmental Protection Agency 2016

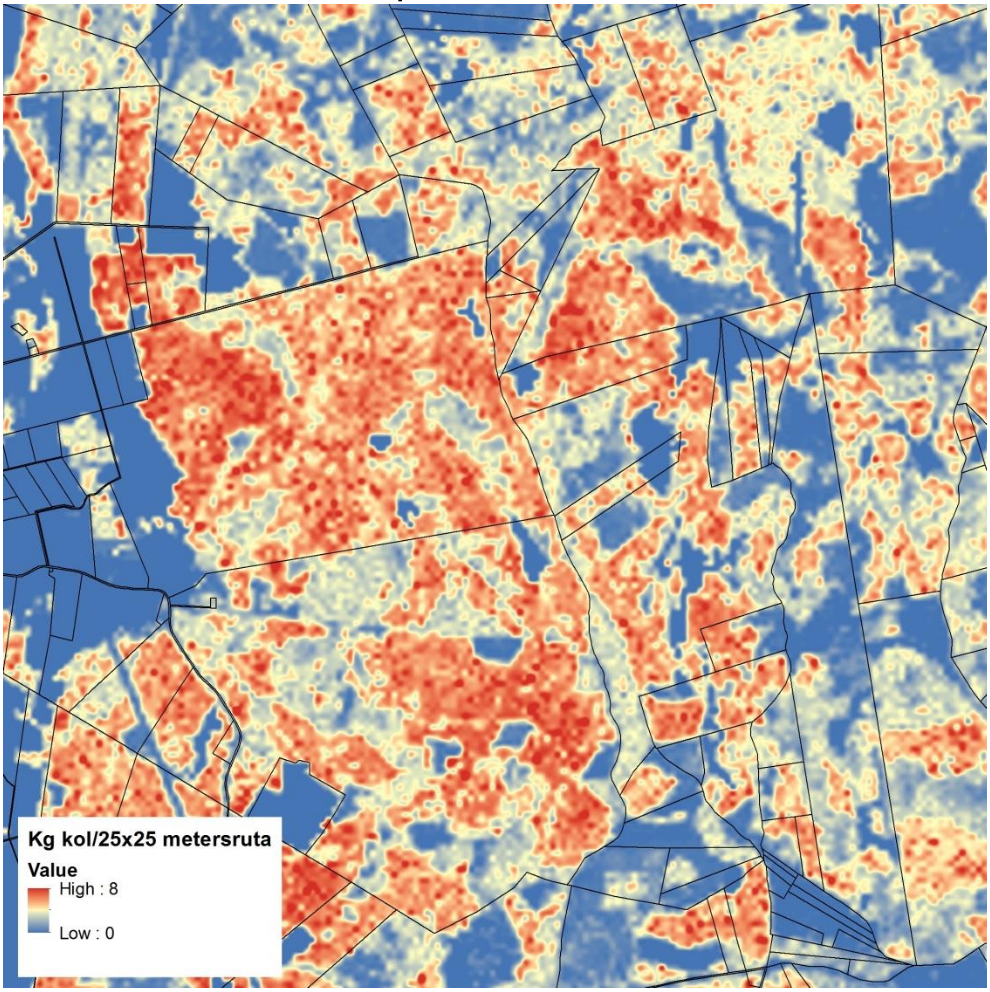
17 http://www.slu.se/centrumbildningar-och-projekt/riksskogstaxeringen/statistik-om-skog/slu-skogskarta/

18 http://www.skogsstyrelsen.se/skogligagrunddata

19 Swedish Forest Agency 2000.

Figure 4.1

Subsection of the Forest Map 2005 where the content of biomass per pixel has been translated into kg of carbon. The colour red indicates a high carbon content and the colour blue a low colour content. Property borders have been overlaid on the Forest Map



In total, the calculation provides that approximately 6,600 tonnes of carbon were sequestered in the biomass above ground in the forests on Gotland in 2010, while the corresponding figure for 2005 was 4,800 tonnes, as shown in Figure 4.1.

By combining the weight of carbon per square of 25x25 meters geographically with the property division, it is possible to calculate how the amount of carbon can be divided by property, owner and industry.

Application

Based on the type codes from the real estate assessment records, it is perhaps not that surprising that forest land belonging to agricultural properties contains the greatest amount of carbon. This type of taxation unit also owns most of the forest land, nearly 95 percent, see Table 4.1. The distribution of the amount of carbon largely follows the area-related distribution of forests, which means that variations in the amount of biomass per surface unit is reasonably evenly distributed between different types of properties. For agricultural properties, the amount of carbon per surface unit of forest land is somewhat higher, as close to 96 percent of the carbon is located in just under 95 percent of the forest land.

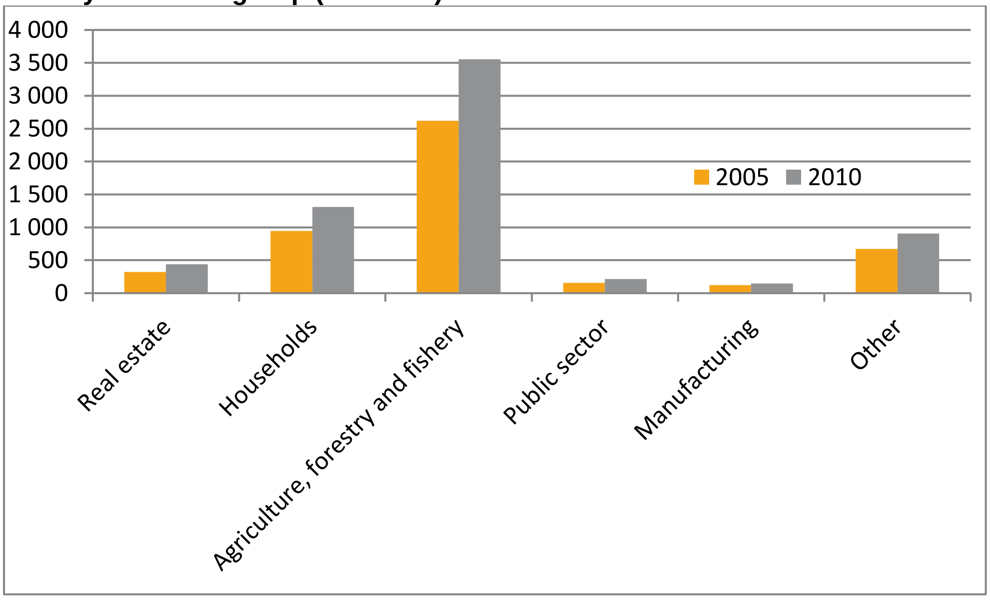
Table 4.1
Above ground carbon content in forests on Gotland and forest area by type of fiscal property.

Type of property	Tonnes carbon 2005	Tonnes carbon 2010	Hectare of forest 2011	Proportion of forest land in 2011 (percent)	Proportion of carbon in 2010 (percent)
Unknown	39	53	1,470	0.9	0.8
Agricultural properties	4,618	6,289	149,033	94.8	95.7
Properties with one- or	67	86	2,607	1.7	1.3
Multi-dwelling building	2	3	114	0.1	0.1
Industrial units	20	26	804	0.5	0.4
Quarries and electricity	1	1	26	0.0	0.0
Special units	89	116	3,199	2.0	1.8
Total	4,836	6,575	157,253	100.0	100.0

Even if other types of property contribute a relatively small proportion of the total amount of carbon, it is interesting to note that taken together, forests on properties with one- or two-dwelling houses (lots for housing) and special units contribute just over 3 percent of the collective carbon store.

Figure 4.2 shows the distribution of the carbon stores according to the same industrial groups used in Chapter 2. Just like in the distribution by property type according to the real estate assessment records, the dominant industrial group that owns forest, Agriculture, forestry and fishing, is also the group that contributes most of the carbon stores.

Figure 4.2
Above ground carbon content (in tonnes) in forests on Gotland and forest area by industrial group (SNI 2007).



The differences between the different ways of distributing the carbon content are perhaps most obvious with regard to the household sector, which is defined more widely in the division of industries compared with a division principle based on the codes for the types of taxation. The household sector does not only constitute land associated with one- or two-dwelling houses, etc., but based on the industry perspective, it can also include land on agricultural properties that are not included in agricultural companies.

Calculations can be improved and data may need a quality review, but the idea with the present examples is mostly that it can be regarded as an experimental illustration of what a breakdown of statistics by type of industry or type of property may contribute compared with general carbon accounting at the national level. By viewing the carbon stores in relation to industries, for example, attention may be drawn to players can contribute or take responsibility for the maintenance of certain ecosystem services.

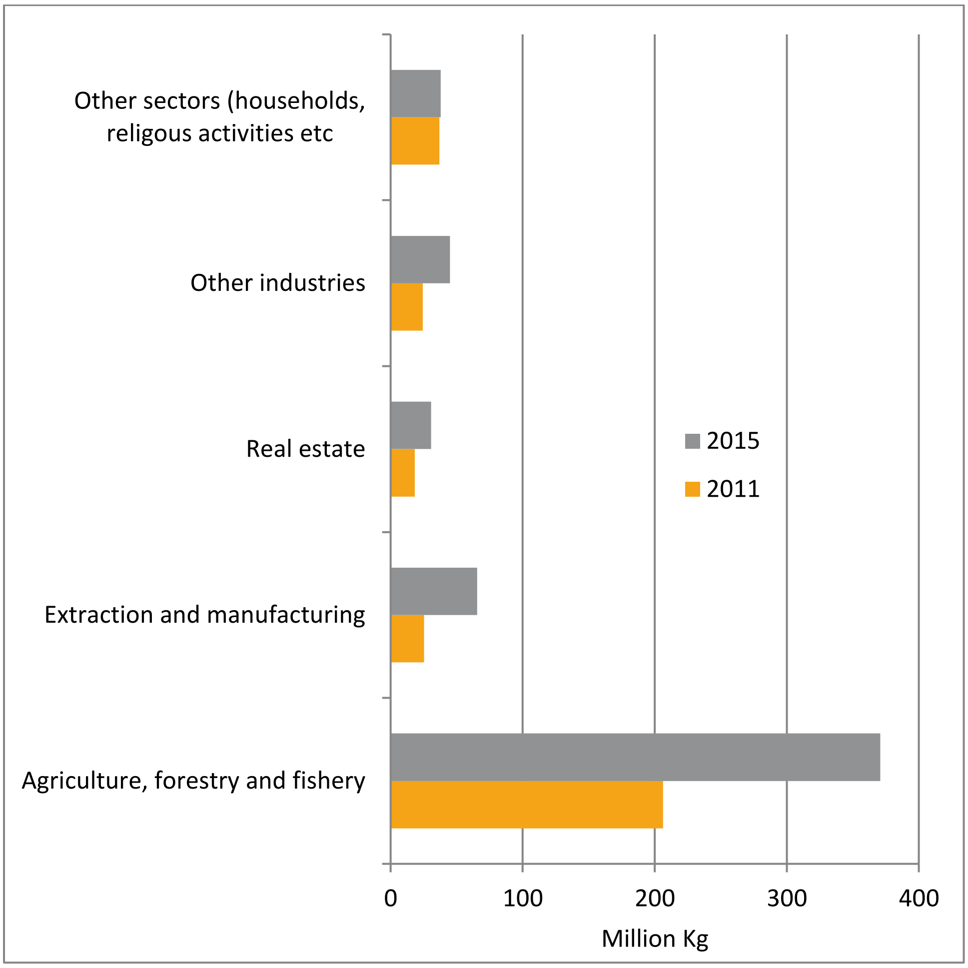
A blueberry in ecosystem accounting

Another ecosystem service that is carried out in the forest is the production of blueberries. The National Forest Inventory carried out by SLU calculates annual forecasts and outcomes of the presence of blueberries in productive forest land. The number and kg of blueberries per hectare are estimated for four of Sweden's national regions: northern Norrland, southern Norrland, Svealand and Götaland.

The following section is a short experimental investigation into how data on an ecosystem service can be combined with the newly developed statistics on landowners created in this project. In the example, we use the blueberry production for 2011 and 2015 as the basis, but data presented in Figure 4.3 should not be regarded as statistics and not be used for "blueberry related" investigative work, as the blueberry estimates are really created by national region, but in this example, they are divided into a level that is much more detailed than the one they are intended to be used for.

Figure 4.3

Outcome of blueberry presence in 2011 and 2015 on productive forest land, by landowner, SNI 2007, million kg blueberries. Please note!These results constitute experimental calculations and are not intended for investigative work.



Source: SCB and the National Forest Inventory

Methodology

Based on the National Forest Inventory's estimates of the presence of blueberries, they can be matched, so that each property is provided with a form of calculation factor. For example, there were approximately 19 kg of ripe berries per hectare of productive forest land in northern Norrland, according to the National Forest Inventory's outcome in 2015. This factor can be combined with map data from this project at the property level, to identify properties with productive forest land and calculate a result.

This result is then calibrated according to the National Forest Inventory's national totals for the blueberry outcome, so that only the relative distribution remains from the original calculation. An example is provided in Figure 4.3, where the blueberry presence for different land owner categories is reported for 2015 and 2011. Agriculture is expected to be the dominant owner of land with a presence of blueberries. There is a major difference between 2011 and 2015 for the reason that 2015 was a better year for blueberries than 2011. The greatest difference was noted in southern Norrland and Svealand, which had just over 10 kg more blueberries per hectare in 2015 compared with 2011. It is interesting to note that the year with an abundance of blueberries did not have any effect on properties owned by other societal sectors, primarily households. However, it is hard at present to know whether the result is robust or if it only depends on the simplified method of calculation used in the example. A further analysis of details such as this will allow improvements to be made that create more knowledge regarding the presence of blueberries and other ecosystem services that can be associated with land surfaces.

Application

Accordingly, this is an example of how an ecosystem service that is also a benefit to the general public can be linked to the new landowners' statistics using calculation factors. With more factors like these regarding the presence of various types of ecosystem services, advanced calculation systems can finally be developed, which in the long term will enable the creation of a framework for national statistics on ecosystem services. The database can then be used to see how losses or additions of habitats affect a number of different ecosystem services. Different kinds of property groups or habitats will be tracked to see what they have changed into and it will be possible to obtain an estimate of which ecosystem services are lost or added, such as when forest land is developed or pasture becomes overgrown, turning into forest land.

From a previous project, *Kartläggning av datakällor för kvantifiering av ekosystemtjänster* (Statistics Sweden, 2013), there are already several ecosystem services that can be associated with land, and their inclusion in land statistics is a natural development for future projects.

It is chiefly the provisioning ecosystem services that are already included in some form of production of statistics that can be linked (such as the production of grain), but with further development and additional cooperation between researchers and government agencies producing statistics, it is possible that more types of ecosystem services factors can be used in conjunction with data on landowners.

Can a monetary value be attached to ecosystem services?

An issue in statistics regard the quantification of services generated by a certain type of land. For example, the national assessment in the United Kingdom identified that tourism is an important activity on forest land. This gives rise to the following issue: if the forest land would be changed by the establishment of buildings, how would this affect the tourism? How can such an effect be quantified?

In the United Kingdom, some test calculations have been created to evaluate how much recreation and tourism contributes to value creation in monetary terms.

Their method was based on the following formula:

Recreation=travel cost + entrance fee + time,

where time is: hours used for recreation*(UK average salary*0.75[20])

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[20]The value 0.75 was chosen to reflect the imbalance related to choosing leisure time over work.

This approach provided that 15 percent of the cost related to travel costs and entrance fees and the remaining of the time used for recreation.

But there are several ways of calculating the monetary value of ecosystem services. The basis for value creation can be calculating by adding up various variables, just like the British Office for National Statistics (ONS) did, or, alternatively by using other methods, such as hedonic pricing[21] or surveys regarding people's willingness to pay, see box 4.2.

Box 4.2

An example of how recreation and tourism can be valued in monetary terms

Source: E. Connors, ONS 2016

From a statistical perspective, there are additional issues regarding the value added by this type of calculations. For example, by using the method developed for land statistics by industry as described above, several parameters would be added.

For the example using tourism, the surface of the buildings need to be delimited and indicated in the statistics in relation to types of land, as a first basic step. Thereafter, knowledge is required regarding the geographic presence of tourism in the same area and the associated economic players. In addition, the changes in income, employment or environmental impact can be calculated for hotels, restaurants and guided tours, before and after the development.

It will be a bit more difficult to do this for recreation. There are some surveys on leisure time and living conditions in Sweden. The result from such a survey, the survey on living conditions (ULF/SILC), showed that a higher proportion of women than men spent time in forests and fields in the survey year 2014–2015.

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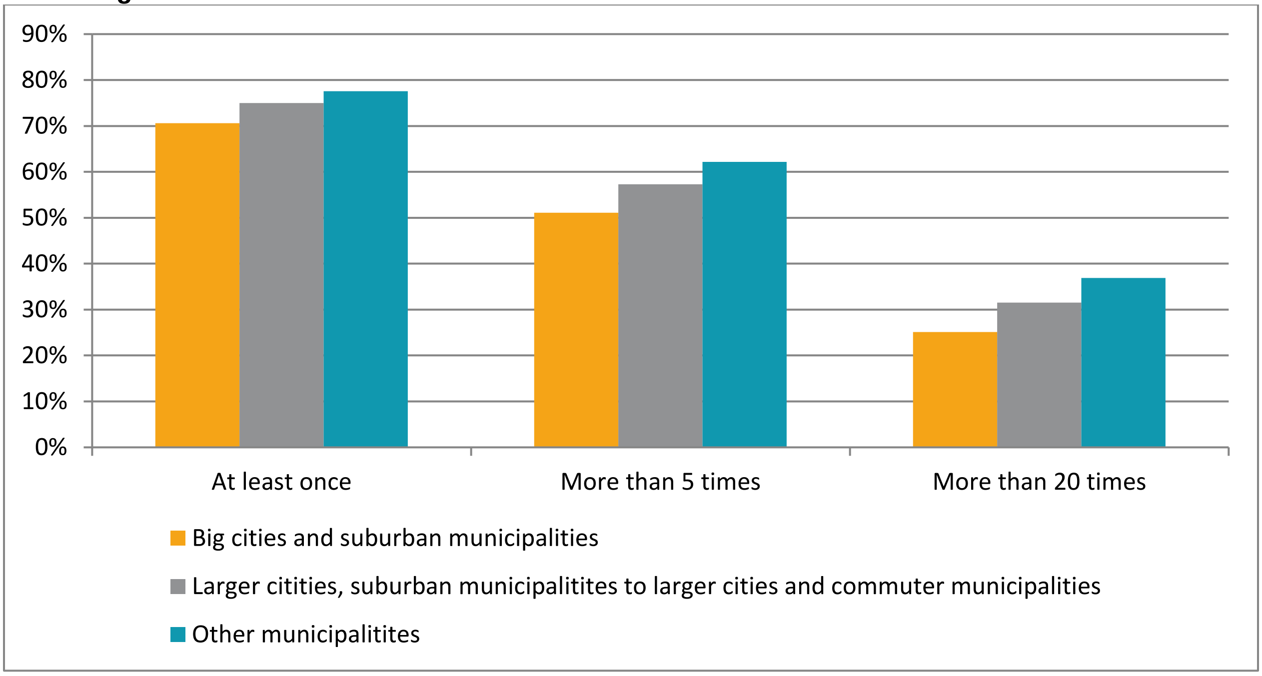
[21]Hedonic pricing is a regression model that is often used in connection with the valuation of housing that includes size, noise, views, etc.

There are major differences for those living in a metropolitan or suburban area, large city, suburban area of a metropolitan area and commuter municipalities or other municipalities, see Figure 4.4. Residents in other municipalities, i.e. those outside major regions, spend a greater share of their leisure time in forests and fields.

Figure 4.4
Leisure 2014–2015: Visited forests and fields in the past 12 months
Percentage



Source: Statistics Sweden, Survey of Living Conditions (ULF/SILC).

This leisure time could be converted into money. But the right of public access applies in Sweden, and even if there were facilities nearby various walking trails, no fees are charged for the use of forests and fields. There are reasons to calculate this in monetary terms, e.g. to view it in relation to other economic priorities regarding the preservation of forests and fields. But it is possible to take existing statistics on activities related to leisure and recreation as they are and view them in relation to the possibility of preservation and other economic uses of the same section of forest and fields.

It will be even more difficult to quantify other areas such as aesthetic values, training and health effects from the ecosystem services context.

An approach to the calculation of the economic contributions made by ecosystem services is to use the model used in the national accounts to calculate the resource rent. The ecosystem service is then calculated as a residual of the total income after deduction for the cost of input goods, cost of employees and the cost of use for investments. This means, however, that there must be a market price in the background.

If this is not available, such as for aesthetic values of various ecosystems, other models can be applied. Some approaches may involve avoidance costs, social costs, the cost of replacements or hedonic pricing methods. A study by Statistics

Netherlands and Wageningen University tested the methods from the national accounts in connection with the other approaches in order to create a balance table in the form of asset and use tables (Statistic Netherlands and Wageningen University 2016).

Ecosystem services were valued, such as the addition of agricultural products, groundwater, PM_{10} capture, carbon sequestration, nature tourism and cycling. The additions of agricultural products were assigned high monetary values in EUR per hectare (approximately EUR 39 million per hectare) while the additions of meat from hunting, carbon sequestration and nature tourism were assigned low values (approximately EUR 2 million per hectare each).

There may be properly justified reasons for the wish to calculate ecosystem services in monetary terms. But as the wish to include areas with no market value requires various discounting factors as mentioned above, the results are associated with major uncertainties. A starting point, Statistics Sweden refers to registers and surveys to capture whatever can be found in statistics. For other assessments for monetary estimates of ecosystem services, it is good that researchers and analysts contribute their knowledge.

Through the tax system in Sweden, an assessed value is attached to all land and properties, and these values are compiled into statistics.

The real estate assessment value is set to 75 percent of the unit's market value. The market value is the price that is likely to be paid for the unit in case of a sale on the general market. (No real estate assessment value is attached to special units[22].) The market value is set with consideration for the average price level two years prior to the most recent general or simplified real estate assessment for the type of property in question.

A typical example is the relationship between the number of hectares owned and the assessed value of the real property unit. A calculation shows that condominium units have the highest value per hectare and quarry units and agricultural units have the lowest, see Figure 4.5.

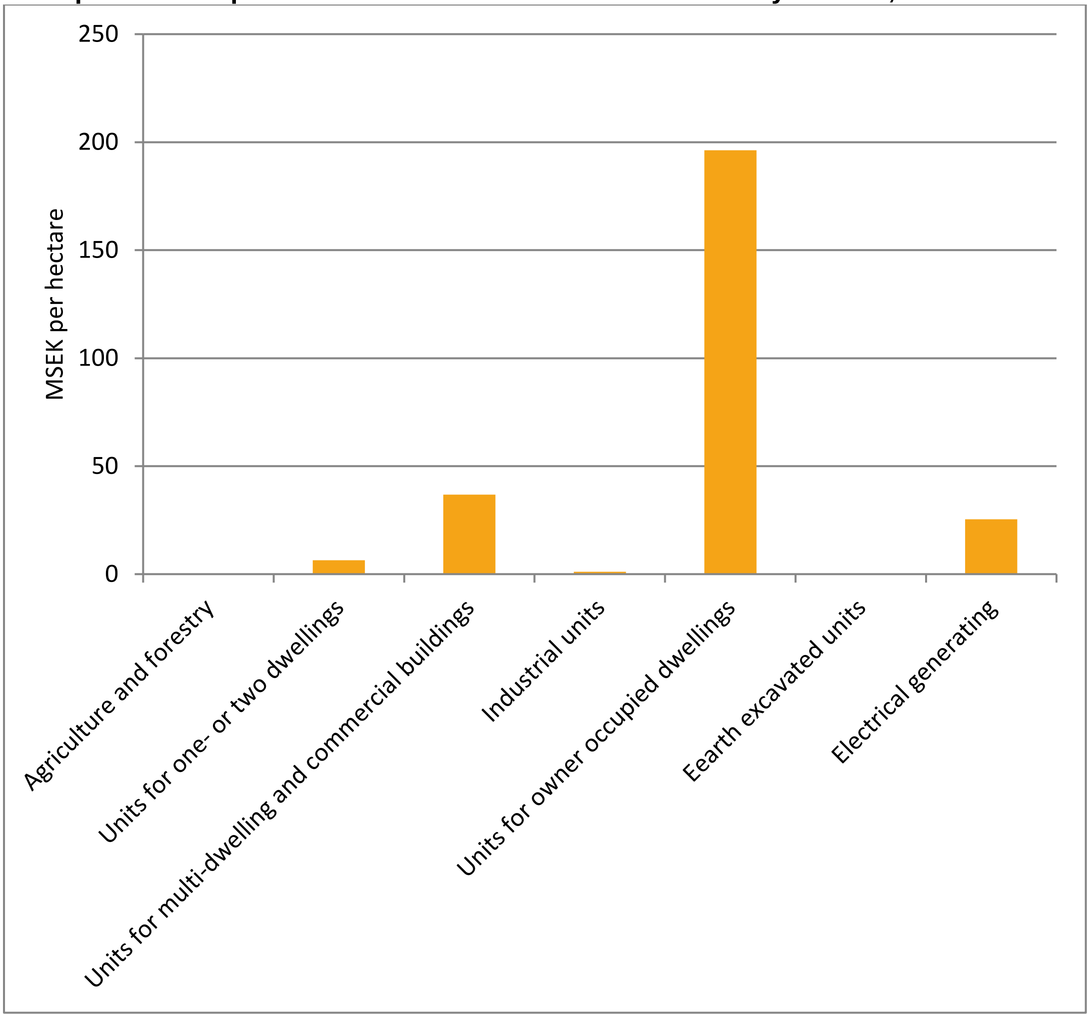
The statistics in this report have shown that the highest proportion of land is owned by the industrial group Agriculture, forestry and fishing.

A question that arises is whether a low real estate assessment value on pasture and arable land can create incentives to convert a part of the cultivated land into lots for housing? It is clear that according to tax regulations, land intended for lots for housing is "worth more" than land used for other purposes.

The model developed to distribute land ownership by industry makes it possible to also investigate aspects such as real estate assessment values and obtain more detailed knowledge of the industries that may be affected by assessed values and their design.

[22]Examples of special units are purification plants, healthcare facilities and defence facilities

Figure 4.5
Example of a compilation of real estate assessment values by hectare, 2015



Source: Environmental Accounts and real estate assessments, Statistics Sweden

Biodiversity approaches within ecosystem accounting

One of the ecosystem accounting areas involves biodiversity. A technical recommendation was published in 2015, in which a variety of tables and approaches are proposed (UNEP-WCMC 2015).

Four areas were identified in the recommendation where the follow-up on biodiversity may constitute an important basis.

1. The conservation and sustainable use of biodiversity are included in most conventions and national strategies;
2. Species of animals and plants can be seen clearly in the surrounding environment;
3. There is extensive research on species and measurements and many countries have long-term surveillance programmes in place;
4. Species are often used as an approximation for biodiversity in general contexts, and they are important for the functionality of the ecosystems.

A proposed basic table is an asset table, see Table 4.2, similar to those on terrestrial extent described in Table 1.1. By using a similar table, the authors state in the report that it is possible to identify reasons for additions and reductions in biodiversity. In practice, access to data measured directly in habitats and various ecosystems is required. But steps can be taken here, as well, by linking to land ownership or land use. Biodiversity is considered to be an indicator for the status or quality of ecosystems.

As there are many reasons and forces driving change in an ecosystem, it is important to also produce this type of information, such as fragmentation, invasive species and "ecotones"[23].

Table 4.2
Example of a summary of species – an asset balance table

	Animals					Plants	Main indicator*
	Mammals	Birds	Reptiles	Fish	Invertebrates		
Opening population							
Additions							
Immigration							
Reintroduced							
Reductions							
Local extinctions							
Closing population							
Net change							

* The main indicator refers to the quality of the biodiversity

In the results in the previous chapter, it was described who owns which type of land. In the Gotland example, small-scale farms owned most of the land, chiefly agricultural land followed by arable land, forest land and finally pasture.

SLU and the Species Information Centre are actively involved in supervising biodiversity in Sweden. In its 2015 Red List, red listed and threatened species are described. By looking at the statistics distributed by industry and the presence of species in nature, the knowledge is widened regarding the contexts and situations in the regions of Sweden.

Table 4.3 depicts the natural environments where organisms are present in the example, Gotland County. For beetles, vascular plants and butterflies, the agricultural landscape is an important habitat.

Approximately 68 percent of the reported beetles in Gotland's agricultural landscape are threatened or vulnerable. In the forest landscape, macrofungi are vulnerable; of 251 registered macrofungi, approximately 96 percent are threatened or vulnerable.

An expanded analysis would be possible, for example using data from the Agricultural Register with additional details on agricultural production and various influential factors. Such an analysis was not carried out in this project.

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23 A border zone between types of vegetation

Table 4.3
Habitats for different groups of organisms on Gotland, species facts

Group of organisms	Agricultural landscape	Urban environment	Forest land	Sea and water
Mammals	23	18	23	9
Birds	99	73	86	75
Fish	0	0	0	42
Amphibians and reptiles	9	5	7	7
Other animals	671	318	424	227
Plants	526	129	372	108
Macrofungi	135	26	251	6
Total	1463	569	1163	474

Source: SLU, the Swedish Species Information Centre, output in December 2016

Potential for development and possible improvements

This section describes two examples of applications closely associated with ecosystem services based on the forests' role as a carbon sink and its significance for food supply in the form of blueberry production. Both services were based on relatively simple calculations where existing factors and coefficients could be used.

There are good opportunities to continue on this path, particularly regarding the calculations of forests as a carbon sink. There are several examples where countries have produced statistics on carbon sequestration in the form of carbon accounting, including Australia and the United Kingdom. The example involving the production of blueberries illustrate that as long as documented models or factors can be applied, it is possible to use the system for basic land accounts also for applications that are more closely linked to ecosystems. This is an important condition if statistical agencies are to contribute to the development of different approaches for working with ecosystem services. Statistical agencies rarely have the skills required to create the models, assumptions or factors required to convert the information on land, for example, into calculations of ecosystem services. This is primarily a research task. Close cooperation between statistical agencies and research in the area would be beneficial, however.

Two sections discussed other areas that are also included in the framework for ecosystem accounting.

Biodiversity is an urgent matter for a closer investigation, as there are clear signals that biodiversity is diminishing and the quality of the land is deteriorating in Sweden. In this respect, environmental accounts can contribute a basis, if data on biodiversity and the quality of land types recur and can be linked to geographical information.

The pricing of ecosystem services is difficult from a statistical perspective. It requires continued commitment and in-depth analysis of how various types of pricing models can be used. This is a task that needs to be carried out in cooperation between research and statistics.

5. Discussions and the way forward

Through international cooperation and agreements, it is possible to develop joint methods for how a certain type of statistics are to be collected, processed and analysed. Since the early 1990s, environmental accounts have been designed through this kind of international contacts and are currently established in many countries around the world. For a long time, much of what was produced was of an experimental nature, and many pilot projects tested approaches and methods through cooperation between researchers and statistical agencies.

The situation for the development of ecosystem accounting is similar. The area was properly raised in the discussions on environmental accounts in the early 2000s and ended up in a publication on experimental ecosystem accounting in 2012 (UN SEEA-EEA 2012). But what does the link between ecosystems and environmental accounts look like?

The traditional approach states the following: which input is needed for the economy in order to produce goods and services, such as how many employees do companies have, how much energy do they use, how much materials do they need? Which impact does the economy have on matters such as emissions to air, and how much do companies contribute to GDP? Is the economy becoming more efficient in its use of resources, and does it contribute to reduced emissions? The economy can also be regarded from a balance perspective, i.e. how much resources such as forest were available at the first point in time and how much remained at the second point in time?

Many of the methods and approaches developed internationally and which are tested involve balance tables of various kinds and looking at individual ecosystem services in specific analyses. There are studies that can report on how pollination affects the production of agricultural products (such as FAO 2006), how carbon sinks are distributed (Ajani et al 2014, Freeman 2016) and what they look like, and what the capacity is for various types of ecosystems (Schröter et al 2013). Studies can also report on the valuation in monetary terms in the access and use of ecosystem functions (CBS and Wageningen 2015).

This project has focused on land and its ownership status as a general and necessary basis for approaching various kinds of ecosystems. It is primarily the person who owns the land that is in control of what occurs on it and is therefore able to greatly influence the conditions for various kinds of ecosystem services. Through the environmental accounts, there is information on the industries, what they produce, the amount of emissions they generate and which instruments influences decisions in the activities. In the long-term perspective, with access to data, it will be possible to develop the analysis further. For example, if registers and inventories provide detailed information on the quality of the types of land, it would be possible to link this to the production that takes place there.

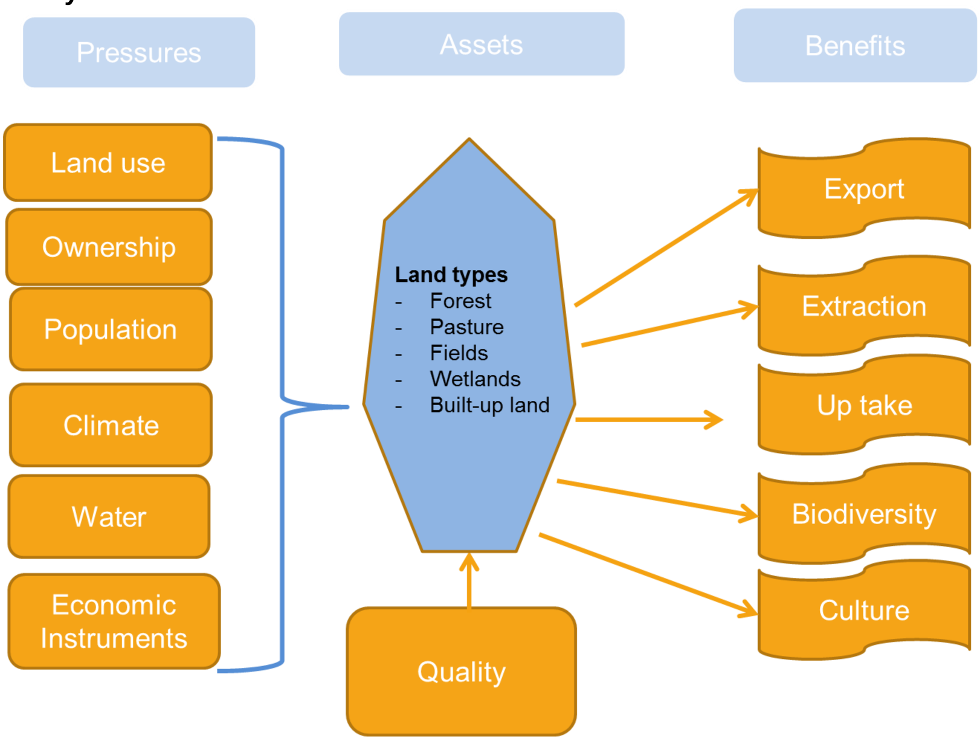
Information on exports of various products could be linked, for example forestry products, or how much a service, such as tourism, is used on a specific type of land. In some cases, there may already be a sufficient amount of existing statistics, and in some cases, assumptions and coefficients may be needed for analyses to be possible.

In Section 4, an example is provided regarding biodiversity on Gotland. New in-depth statistics could enable the linking of data on type of land with data on the habitats required by species for their production. It would show, for example, which industries are in control of which species, through their production and indirect impact on society and buildings.

It would be interesting to link the people who uses the assets on a specific type of land with the goods and services produced there, as exemplified in Figure 5.1. There are no linear links between the type of land and the production of goods and services, but aided by certain assumptions, it is possible to understand the link better. For example, [24]forests contribute forestry products that are used by the forestry industry and refined into pulp and paper, furniture and also indirectly through research on forests. The import of forestry products should naturally be linked to this, and exports of the domestic good. Analyses of this kind should be possible within the environmental accounts framework, for example through physical asset and use tables. Such a query could be: In order to produce a value added of SEK 1 million within the pulp and paper industry, how much forestry materials are required in the production, and what is the amount of forestry products required in other industries that provide input goods to the pulp and paper industry?

Figure 5.1

An outline of the connection between environmental-economic accounts and ecosystem services



[24]The monetary asset and use tables distribute the asset (Swedish production and imports) and the use of various goods and services. Added to GDP

The environmental accounting system has the conditions required to connect the economy and ecosystems, but continued work is required by the international and national research community and the statistics community to reach maturity. It is necessary to develop both a harmonised way of making calculations and statistical methods, and identify the approaches that can be considered stable and provide reasonable values for ecosystem services. Highly specific knowledge about a specific ecosystem service is often needed to make the calculations. A service must have reached a certain "maturity" regarding research, knowledge supply and data to be capable of integration into the statistical system.

It is not enough to have data on a specific type of land describing general conditions for a certain type of ecosystem service. To produce credible statistics, properly established "factors" are generally required (such as kg carbon per tonne of biomass) to make reasonable and relevant assumptions.

Many services are difficult to quantify, either due to the lack of data charting the presence of a specific service, or due to the fact that the service is based on subjective opinions that are difficult or even impossible to capture in statistics. This is a particular characteristic of social and cultural services.

Examples of statistics that can be produced through linking to statistics in this project to come closer to a part of the reasoning could be over data for analysing green infrastructure, for example. It is possible to describe "hot spots" to illuminate whether it is possible to find land with many competing users, such as nature areas or forests close to localities, mining concessions versus living and cultivating land, wind power versus military facilities and water protection areas close to roads.

A link to Agenda 2030 – the United Nations' global sustainable development goals

An integrated way of managing economic, social and environmental development is a key concept in the formulation of the United Nation's global sustainable development goals. This though recurs also in the Convention on biodiversity, but it can be difficult to rephrase in statistical follow-up.

There is ongoing intensive work on the evaluation of existing statistics in relation to the global sustainable development goals and to identify gaps in knowledge.

The environmental accounts were identified earlier as a way of integrating the environment with the economy, to analyse connections and impact. For example, in 2016, Statistics Sweden linked Goal 12 regarding sustainable consumption and production patterns with statistics from the environmental accounts. In a similar manner, it is possible to link the global goals with land use statistics and ownership.

Figure 5.2
An overview of statistics on land ownership by habitat and the link to Agenda 2030

Four of the sustainable development goals have been identified as needing statistics linked to land ownership. In most targets regarding ecosystems and biodiversity (Goal 15), statistics on land ownership could contribute to increased knowledge of who is responsible, where they are located and what their situation is like. According to the description of the main goal, terrestrial ecosystems should be protected and restored and sustainable use should be promoted, as well as the sustainable management of forests. Accordingly, the new land statistics show who is responsible for which habitat and which region is involved. If there were registers or inventories linked to the quality of the habitats, the knowledge base would be further reinforced. Linking quality assessments to land statistics was tested by Statistics Sweden in 2014, and it can be extended by continued methodology development.

Goal 6 regarding clean water and sanitation is yet another goal connected with the new land statistics. This chiefly refers to the goals regarding improving water quality by reducing pollution and protecting and restoring water-related ecosystems, which also includes mountains, forests, wetlands, floods and lakes. By producing regional statistics, it is possible to link activities near coasts and lakes and monitor the development of landowner structures over time.

Goal 11 links to cities, and particularly target 11.4, which focuses on strengthening the efforts to protect and safeguard the world's cultural and natural heritage, is of interest. Using the landowner map, it is possible to make a connection to where the cultural heritage sites are located. Particularly important habitats such as those identified in the Habitats Directive are already included in the statistics produced, but it is possible to make a closer link if the basis for the data is provided on a regular basis.

Goal 14 tracks the development of seas and marine resources. Just like Goal 6, part of the follow-up involves preventing and reducing all kinds of marine pollutants from terrestrial activities and managing and protecting marine and coastal ecosystems. The same type of information is important here as the information that can be monitored in Goal 6, for example.

As these statistics are new, there are no direct proposals for indicators from the international United Nations group that developed the current list. But it is fully possible that statistics on landowners can contribute to the knowledge base required to follow-up on the goals. Considering the fact that data on ecosystems have been identified as an area without sufficient information and that a considerable amount of new statistics have been produced lately within the environmental accounts framework, it would be interesting to analyse the requirements for follow-up where this type of statistics might be useful. This could include Agenda 2030, the Convention on Biological Diversity and the Habitats Directive, to mention but a few.

6. Facts about the statistics

The project aims to examine the scope for producing new statistics on land use and habitats covering a national area and adapting it to the industrial classification (SNI 2007) in the environmental accounts.

Scope of the statistics

The basis of the method is the matching of data on habitats with register data on ownership, industries and enterprises. This matching is done with the help of geographical analysis on a low geographical level. The conditions needed to be able to match a certain habitat with data on ownership and industry are as follows:

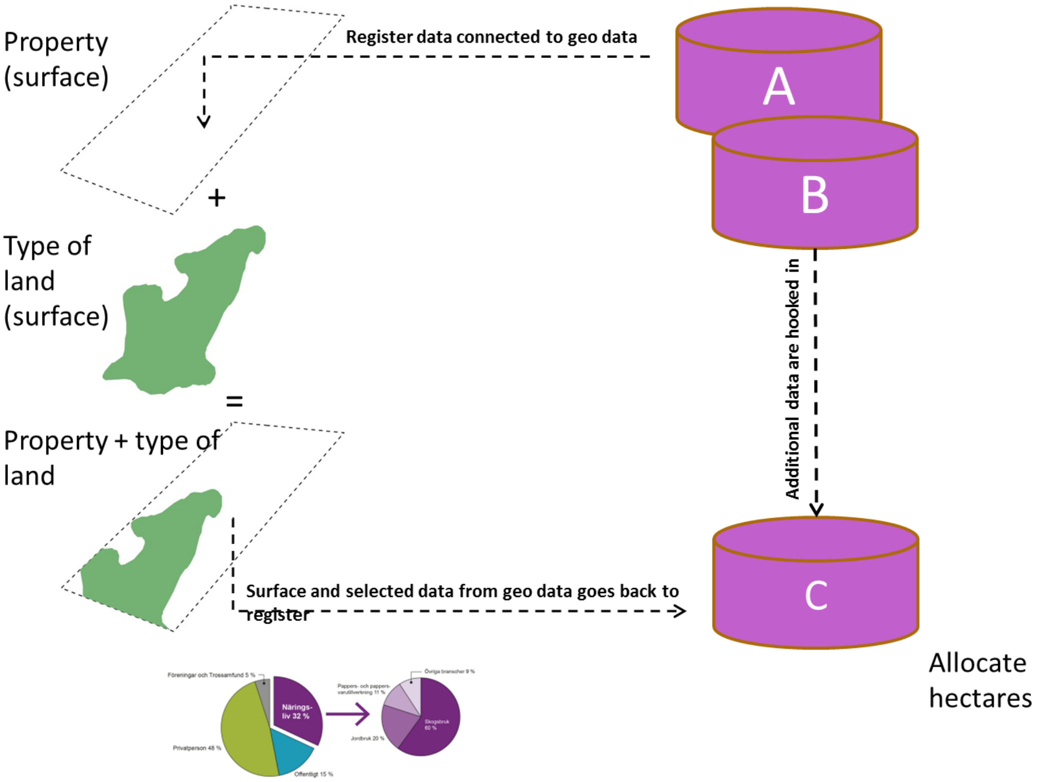
• The habitat must be well-defined as a geographical site;

• The data on ownership, sector and industry classification can be presented on a detailed geographical level;

• There must be a geographical "linkage level" between habitat and ownership information and it must be possible to transfer the register information to the habitat.

In our case, the linkage level is properties that are defined as geographical surfaces in the GSD-Property Map. Data on the assessment and ownership can be matched to the geographical delimitation of the property on the map via keys in the Real Estate Register and the Real estate assessment respectively. Data from the Business Register can also be linked to the property, i.e. if the business own the land the activity of the business can be recorded in the form of an industry code (SNI 2007) connected to that land. By using the property as a "cake tin" around the land data, the register data associated with the property can be transferred to the land.

Figure F.1
Graph of the information flow according to the method



The method is generic in that it can be used to match all types of land and/or habitats with ownership and industries, as long as the above conditions have been met.

Additional information about the method is provided in Statistics Sweden MIR 2015:2.

Definitions and explanations

A basic definition that determines how statistics are presented in this report is the view of the landowner's activity and the distinction between companies and households. In this project, a landowner has been assessed based on its activity according to the Swedish Standard Industrial Classification (SNI 2007). This means that if a landowner is also registered in the Business Register (FDB) with an associated SNI code, the land will be reported using this code and the landowner will be regarded as a company.

Another way of defining the distinction between companies and households is to use information about the legal status of the landowner, where natural person and a variety of legal persons are available. The difference between those two methods is that sole traders are included in the Business Register without being legal persons. They own a considerable amount of land in Sweden – over 40 percent. In this project, they have been categorised by activity according to the SNI standards.

How the statistics are produced

These statistics are entirely based on the processing of existing statistics and administrative registers. No new data collection such as questionnaires or interviews has been conducted for the information in this report.

To identify landowners and link them to a geographic area, the Real Estate Taxation Register (FTR) was required. The register is used regularly in Statistics Sweden's statistics activities, for statistical purposes such as describing the country’s stock of properties and buildings, in the national accounts, to calculate the housing item in the consumer price index, as a sample frame for statistical investigation on housing and energy and for special processing on commission.

In the FTR, a landowner can be linked to an assessment unit. The assessment unit usually corresponds to the real property unit’s boundaries, but there are situations where there are several assessment units on a single property or where the assessment unit does not correspond to the real property unit’s boundaries. In such cases, a representative assessment unit must be selected for each property. FTR is usually used in the production of housing statistics, where the property’s housing space is used as the basis for selecting a representative assessment unit; the one with the largest housing space is used. For the purposes of this report, the assessment unit’s land surface has instead determined which unit represents the property. The focus in this report is not housing but the production of statistics on ecosystem services, so land provides a better approximation for which assessment unit should represent the property in cases where the real property unit and the assessment unit differ.

The data regarding the property owners is now added to the Business Register (FDB) to allow a distribution of landowners by industry. The Business Register (FDB) is a register of all enterprises, authorities, organisations and their workplaces. FDB plays a central role as a sample framework and coordination instrument for statistical production within Statistics Sweden. This is particularly true regarding economic statistics.

In case a company owns land, economic data about the company can be linked to the land, by using FDB.

Additional information about the land’s division into types of land or land use categories can then be added. In addition to total land area, this project has covered the following types of land: arable land, pasture, forest land and wetlands. Wetlands can be further divided into open and forested wetlands.

Reliability of the statistics

The data sources that have been combined in this study are registers or administrative data. That means that the data may have been produced for a different purpose than the one used in this study, and a considerable amount of work has therefore been spent on investigating variables and how they can be used together, between different registers. An important element was to identify matching variables (keys) between registers. Examples of such keys are: The ID number FNR_FDS which is used to link land data with the Real estate assessment. Another example is the corporate identification number that is used to link data from the Real estate assessment (where the owner is a company) with data from the Business Register.

In each matching using such keys, a certain part of the population will be properly matched, and a link can be established. But there will also be instances where an ID number is missing for certain observations in the database, or where an ID number is available but lacks a link to the matching dataset for that specific ID number. An account of the most important matches and the extent of the failed matches is provided below.

The geographic data used contains the ID number FNR_FDS, which has been central to this study. It was difficult at times to link an individual FNR_FDS to a real property unit, which is necessary to match information on land ownership. Such observations or failed matches have been studied and the total land associated with them can be added up. They account for approximately 1 percent of the land in this study.

When the matching against the Real estate assessment (FTR) is made, a part of the FTR cannot be matched against other geographic data. When this land is added up (based on the size of the property in the FTR), failed matches correspond to 1–2 per thousand of the land in the FTR.

For the matching with the Business Register (FDB), it is more difficult to measure in this way. This is because only a subpopulation of landowners is made up of companies. In the study, it was assumed that if there is a match between FDB and FTR, the landowner is a company. There is a large number of companies in the FDB that are not landowners (approximately 63 percent), but this is not unexpected and is not the result of failed matches.

A special case in the FTR is the situation described in the chapter "How the statistics are produced", where the assessment unit does not correspond exactly to the property and a representative owner must be selected. In general, the assessment unit with the greatest housing space is used as the representative owner, but in this project, the assessment unit with the largest land surface was chosen instead. This caused 2 per thousand of the properties to have a different representative owner than used in the regular method for housing statistics.

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The environmental accounts comprise a system of information that has been developed to systematically describe the connection between the environment and the economy. Statistics on the environment and the economy provide a basis for cost calculations of environmental measures and environmental damage, analyses of environmental and economic policies as well as indicators of the state of the environment and sustainable development.

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