Investigating new data sources for land and ecosystem accounts

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Investigating new data sources for land and ecosystem accounts

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Foreword

This project was done as part of the 2019 Grants call ESTAT-2019-PA5-E-ENVECO by Statistics Sweden. The aim with this study was to investigate if and how new national land cover data can be used to give a richer and more elaborate input data for land use accounts. Moreover the project aimed at extending the time-series on land use statistics by NACE.

The environmental accounts are a statistical system that describes the links between the environment and the economy. 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.

To investigate and show new statistics linking biodiversity and land use a reference group was set up. Statistics Sweden would like to thank experts at the Swedish Forest Agency, Swedish Environmental Protection Agency, Ministry of Environment, Swedish University of Agriculture Sciences and the Swedish Society for Nature Conservation for their input and valuable contributions.

The report was prepared by Statistics Sweden's Regions and Environment Department: Mia Bivered, Peter Guban, Jerker Moström, Viveka Palm, Susanna Roth and Nancy Steinbach.

Statistics Sweden, Stockholm, March 2021

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Summary

Ecosystem accounting is a rapidly growing field of the environmental accounts internationally. This report focuses on connecting ecosystem land types, such as forests, open land and arable land, with economic actors whose actions affect the conditions for maintaining various types of ecosystem services. The control of the land and its use is central to many analyses related to ecosystems and the services provided by ecosystems.

This report presents the latest progress on land accounts for ecosystem services at Statistics Sweden. This project has successfully introduced a new data source for land types which provides far more detail in the land accounts per industry. In this report we also used the dataset to explore the link between the use and ownership of forests and biodiversity.

We found that most forest belong to the agriculture, forestry and fisheries industry, using the Swedish Industrial classification, SNI 2007, which corresponds to NACE Rev. 2. From an institutional sector perspective, households and corporations own most forest land. The ownership structure is very divided, in terms of how much forest land individuals and organisations own, as almost half of the forest belong to a large group of forest owners who own less than 1000 hectares each, while approximately the other half of the total forest land is owned by a few very large-scale forestry companies. The new land cover data also includes information on productive and non-productive forest land. Most industries have less than 20 percent non-productive forest land compared to total forest area. This classification is commonly used in forestry statistics and affects whether the forest can be used for forestry activities such as felling and thinning through the Swedish Forestry Act.

By adding information from the Swedish Forest Agency about felling to the data set, we could analyse how intensively different sectors use the forest land they own. The agriculture, forestry and fishery sector have the highest shares of felled forest compared to how much productive forest land they own.

Furthermore, we successfully merged the Environmental Goods and Services Sector (EGSS) data on certified organic agriculture with the land account dataset and thereby showcased the possibilities of using other environmental accounts data in combination with the land accounts. As a result we can compare the environmental goods and services produced by certified farmers in EGSS with conventional farmers. The results show that certified farmers do not stand out compared with conventional farmers when it comes to what type of land or forest that is owned. If new information such as ecosystem condition

would be added to the dataset in the future, the link with other environmental accounts data could be investigated further.

To be able to track ownership structures and changes of different forest types over time are important first steps. This will be possible to do using this production system for land accounts when the new land type data exist for more than one time period. Especially interesting forest types to follow from a biodiversity perspective are e.g. temporarily non-forested forest land, as they could serve to indicate intensive forestry practices. However, in order to enhance the analysis of the effect of economic activities and ownership on biodiversity in forests, more information needs to be added to the data. Therefore, an important next step would be to add information about ecosystem condition, as well as factors regarding the use of the forest to the dataset. Statistics on the area of certified forestry and voluntary set-aside areas are available, but are currently not reported geographically and can thus not easily be added to this dataset. If it is possible to add these types of information in the future, topics such as how differences in forest management between certified and non-certified forestry affects biodiversity can be studied further. Meanwhile, geographical data regarding protected areas is available and can be added in future work.

Internationally, there is much ongoing work on developing and defining ecosystem accounts and their use. For example a new UN ecosystem manual is under development and there are ongoing discussions on extending the legal basis of the European environmental accounts to include ecosystem accounts. There might, however, still be some time until a fully developed, internationally harmonised statistical system on ecosystem accounting is in place. A hope is that this report can contribute to the discussion by highlighting different ways to analyse land use and land ownership and how the issue of biodiversity can be approached in land accounts, in the context of the environmental accounts.

1. Introduction

Ecosystem accounts can make it possible to study what pressures from the economy affect ecosystems and how, by connecting information about the extent of ecosystems, the services they provide and how they are linked to the economy. Ecosystem accounting is a rapidly developing field of the environmental accounts and new technologies have improved the detail of land type data.

Statistics Sweden has been working on developing ecosystem accounts since the government enquiry *Räkna med miljön* from 1991 (Official Government Reports 1991:37–38), where Statistics Sweden was tasked to develop a Swedish environmental accounting system. Large parts of the system have been developed since the enquiry, however including ecosystem variables that can highlight how the economy uses ecosystems and how they are impacted have yet to be developed. There is an intensive global debate at present regarding ecosystem services and how they can be taken into account within the context of the environmental accounts.

In 2017 a production system for land accounts was set up at Statistics Sweden. Some of the development potentials that were identified was to use more refined divisions of types of land, report on new types of land and use land categories that are closer to existing official definitions (Statistics Sweden, 2017). This report presents the progress made in the latest project to improve the Swedish land use accounts, using a new land cover data source which resolves some of the improvement suggestions from the 2017 report, in order to move towards a fully developed system of ecosystem accounts.

This report focuses on connecting ecosystem land types, such as forests, open land and arable land, with economic actors whose actions affect the conditions for maintaining various types of ecosystem services. The control of the land and its use is central to many analyses related to ecosystems and the services provided by ecosystems.

It should, however, be noted that 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. This report does not aim at drawing such conclusions but it may serve as a starting point for such analyses in the future. It should also be noted that calculating various monetary values connected to ecosystem services requires additional assumptions and is not the focus of this study.

Ecosystem accounting - an international outlook

The environmental accounts is 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) which forms the basis for continued work and development. 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 United Nations manual from 2012 covers several areas, such as biodiversity, carbon sequestration and the quality and extent of land, which 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 when published a report called *Ecosystem natural capital accounts: a quick start package*, with the assistance of experts from the environmental accounting community. The report was published to contribute to the development of data that can be used to follow-up on the Aichi targets.

A new SEEA manual on ecosystem accounting is in its final stages of publication at the time of writing. A number of issues are still being discussed in the global consultation such as if the title of the handbook still should include the word "experimental". Furthermore, issues related to valuation are unsolved. There has been disagreements regarding if the manual should contain monetary values on ecosystem services flows and ecosystem assets, or if this should be included as an application. These disagreements show that due to the complexity of ecosystem accounting, there might still be some time until a fully developed, internationally harmonised statistical system on ecosystem accounting is in place. However, the final version of the SEEA manual is expected to be submitted for adoption by the UN Statistical Committee in early 2021.

Eurostat has also at the same time launched a procedure for updating the legal basis for the European environmental accounts. Among other things, ecosystem accounts has been suggested as a new environmental account module. The module includes two types of ecosystem accounting tables: ecosystem extent accounts and ecosystem services accounts in the form of supply and use tables. The proposal builds partly on the experiences gained in the project Integrated system of Natural Capital and ecosystem services Accounting for the European Union (INCA) (European Commission, 2019). This project aimed to establish a methodology for natural capital accounting, including ecosystems and ecosystem services. The INCA project was implemented to support key objectives in the 7th Environmental Action Plan and EU Biodiversity Strategy.

Objectives

Statistics Sweden published a report on land accounts for ecosystem services in 2017, which this report builds upon. In the context of this report, we have produced a more detailed land account, enabled land use comparison over three time-periods and a case study on forestry and biodiversity. This project has had three objectives:

1. Follow up on the experimental framework that was developed in 2017 and investigate if and how the new national land cover data can be fitted into the existing framework to give a richer and more elaborate input data for land use accounts.
2. Extend the time-series compiling land use statistics by NACE.
3. Investigate and show new statistics linking the issues of biodiversity and land use.

Regarding the first objective, higher thematic resolution in the data can provide more relevant and accurate information on the links between land use and economy. This has further improved the level of detailed land types that can be published. Chapter 3 and 4 presents examples of how the results can be used.

The second objective was met and three time-periods could now be compared. However, the new more detailed data over land types does not extend backwards in time and comparison with this level of land types detail will only be possible with future years. Therefore, we have focused on discussing the possibilities of studying changes over time using the new data source in chapter 6.

In order to succeed with the third aim, a reference group was set up with experts from the Swedish EPA, the Swedish Forest Agency, SLU (The Swedish Species Information Centre) and the ministry of environment. This group has discussed paths forward for land accounts, user needs and how to link these data with habitats in the Art-and Habitat directive. The outcome of these discussions has been implemented throughout in the project process to help data exploring and identify valuable analyses and results from a user perspective. Chapter 4 and 5 explores forest ownership and use in more detail and provide suggestions for future work in order to capture the link between biodiversity and land use.

In the next chapter, the method and the new data source is introduced.

2. An updated method for producing detailed land accounts statistics

The method in brief

The key-element of the method is the integration of geospatial data on habitats (or land use object) and register based data on ownership, industries and enterprises. The data integration is conducted on the lowest possible geographical level, using geospatial analysis.

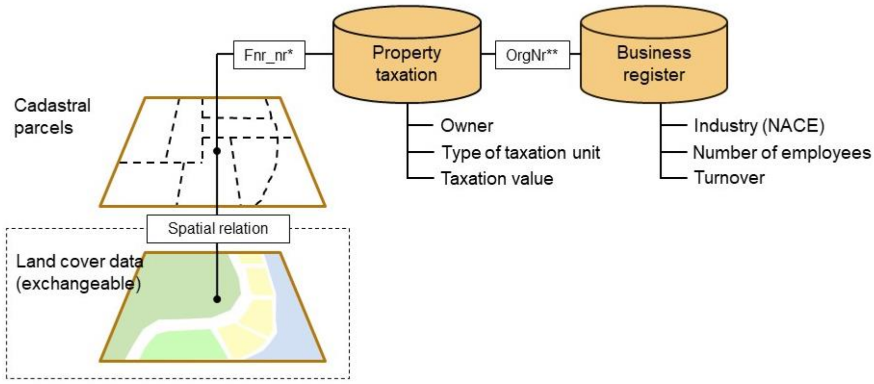
The conditions needed to be able to match a habitat data with data on ownership and industry are as follows:

- The habitat/land use must be well-defined as a geospatial object;
- The data on ownership, sector and industry classification must be available on a detailed (non-aggregated) geographical level;
- There must be a spatial "linkage level" between habitat and ownership information and it must be possible to transfer the information about ownership and industry to the habitat.

In our case, the “linkage level” consists of cadastral parcels. Cadastral parcels are the smallest building bricks in the Swedish land administration system. In total, there are more than 4.2 million cadastral parcels covering the face of the country. By means of a unique key, each parcel, can be associated with further information about ownership and land taxation. Data from the Business Register can also be linked to the cadastral parcel on the basis of the unique organisational number assigned to each legal entity. The organisational number is used as a key both in the Business Register and in the land administration and taxation systems (See figure 2.1 below).

By applying the cadastral parcel as a “cookie cutter” on the habitat data, the register data associated with the parcel can be linked to the piece of the habitat falling inside the parcel. Hence, this piece of habitat will inherit information on ownership and industry from the enclosing parcel.

Figure 2.1: Conceptual outline of the method to link business information with land



* Fnr_nr = Unique identity for each cadastral parcel

** OrfNr = Unique identity for each legal entity

In terms of input data on land, the method design is flexible. The method does not pre-suppose any specific land use, land cover or habitat data as long as it is well defined and has reasonably high spatial accuracy. In fact, the method is suitable for breakdown by industry of any phenomenon that can be represented as spatial objects.

In previous projects, input data was derived from a number of different sources. The main data source was the national, large scale topographical map (reference scale 1:10 000). As concluded in the previous project, this data source have a number of limitations:

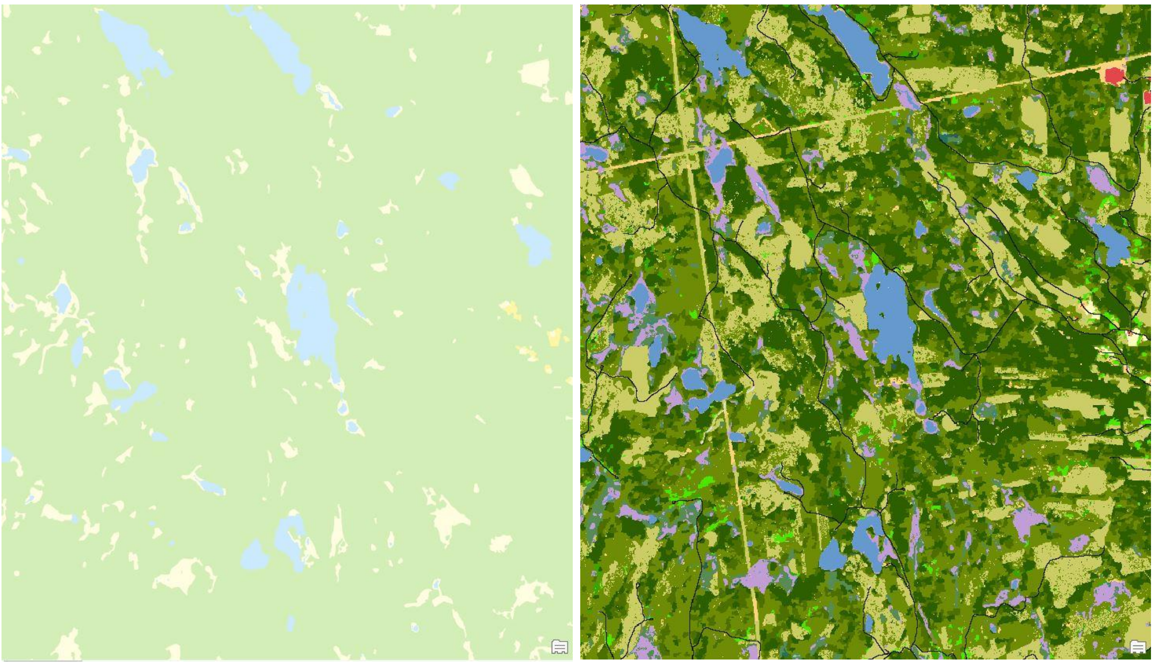
- Thematic resolution: the land use/land cover categories used in the topographic map is course. Forest land is portrayed under one single class, providing no options to assess different forest types. In addition, open (non-forested) land is represented as one single class providing no options to distinguish open, vegetated land from soil sealed land.
- Update frequency/procedure: The large scale topographic map is updated by the National Mapping and Cadastral Agency on regular basis but not all parts of the county are simultaneously updated. Priority is given to urban areas or regions of the country with more rapid land use changes. In some areas of the country the land use layer is lagging behind.
- Alignment to international land use/land cover definitions: The large scale topographical map is foremost a cartographic product, not primarily intended for analytical purposes. Delimitation of for example forest land does not strictly follow international definitions of forest.

New input data opportunities

One of the main conclusions from the previous project was that feeding better data on land use/land cover into the process would greatly increase the relevance and analytical depth of the output.

In 2017 (when the previous project was conducted), no alternative national data existed. Since 2017 a consortium of national agencies has been formed to produce a high-resolution land cover database, based on 10x10 meter Sentinel 2 imagery. In 2019, the first generation of the National Land Cover Database was released.[1] The National Land Cover Database provides a far richer and far more relevant data source for land accounting. As an example, instead of one single forest class this new data source portrays forest land in 16 different classes. Open land is separated into a number of classes, distinguishing soil sealed land from vegetated land.

Figure 2.2: Visual comparison between forested land portrayed by the national topographical map (left) versus the National Land Cover Database (right)



Source: National Topographical Map © Lantmäteriet, National Land Cover Database © Naturvårdsverket

[1] http://www.swedishepa.se/State-of-the-environment/Maps-and-map-services/National-Land-Cover-Database/

One of the main goals of the current project was to assess if and how the new Land Cover Database could substitute or complement the data sources used in previous project. Besides being a much richer dataset in terms of thematic resolution, the National Land Cover Database is produced and stored in raster format, whereas the data used in previous project was vector based, which is less suited for the purpose.

The main conclusion is that not only does the new data source provide a more relevant output, it is also speeds up the data processing step significantly. Instead of splitting up land use vector features into 4.2 million cadastral parcels, the parcels are used as zone units to tabulate the area of each land cover class falling inside the parcel. In spite of a large number of pixels in the Land Cover Data Base (71 273 columns * 157 992 rows), the processing is many times faster than using vector data.

The down-side of the new data source is that it is currently available only for one reference date. Updates of the Land Cover Database is planned for the years to come. Hence, currently no analyses on changes or time series analysis is possible based on the National Land Cover Database.

3. Land accounts by industry

The purpose of land accounts is to connect information about the extent of different land types with economic actors whose actions affect the conditions for maintaining various types of ecosystem services in Sweden. Therefore, the first step 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 done 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 equivalent NACE Rev. 2, 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.

Data description

The work presented in this chapter build upon Statistics Sweden's previous report on land accounts. However, the new data from the Land Cover Database provides far more detailed land type information than the previously used data. The results are based on data from 2018. The level of detail of the land type data can be seen in the first column of table 3.1. There is much new detail in forest types, for example temporarily non-forested forest land. This category captures forest areas where the trees have been felled. Being able to separate this type of land is an important step to be able to observe the effects of economic activities on ecosystems, since forests that have been felled differ substantially from older and extensively managed forests.

However, the level of detail in the data make it difficult to visualise in graphs and tables. Therefore we have when necessary used land type aggregates that reduce the number of forest types from 16 to 8, 4, 2 and 1 aggregated categories, the last being a total of all forest types. A few other land types have also been grouped, see table 3.1. Some land types in the data set will not be analysed in this report, including inland water, marine water and areas classified as outside mapping area.

Table 3.1: Land types and aggregated categories

Note: The colour indications in aggregate 2 shows how forest types have been grouped.

Detailed land type	Aggregate 1	Aggregate 2	Aggregate 3	Aggregate 4
Pine forest not on wetland	Coniferous not on wetland	Coniferous	Forest not on wetland	Forest
Spruce forest not on wetland				
Mixed coniferous not on wet-land				
Mixed forest not on wetland	Mixed not on wetland	Mixed		
Deciduous forest not on wet-land	Deciduous not on wetland	Deciduous		
Deciduous hardwood forest not on wetland				
Deciduous forest with deciduous hardwood forest not on wetland				
Temporarily non-forest not on wetland	Temporarily non-forest not on wetland	Temporarily non-forest		
Pine forest on wetland	Coniferous on wetland	Coniferous	Forest on wetland	
Spruce forest on wetland				
Mixed coniferous on wetland				
Mixed forest on wetland	Mixed on wetland	Mixed		
Deciduous forest on wetland	Deciduous on wetland	Deciduous		
Deciduous hardwood forest on wetland				
Deciduous forest with deciduous hardwood forest on wet-land				
Temporarily non-forest on wetland	Temporarily non-forest on wetland	Temporarily non-forest		
Open wetland	Open wetland	Open wetland	Open wetland	Open wetland
Arable land	Arable land	Arable land	Arable land	Arable land
Non-vegetated other open land	Open land	Open land	Open land	Open land
Vegetated other open land				
Artificial surfaces, building	Artificial surfaces	Artificial surfaces	Artificial surfaces	Artificial surfaces
Artificial surfaces, road/rail-way				
Artificial surfaces, other				
Inland water	Inland water	Inland water	Inland water	Inland water
Marine water	Marine water	Marine water	Marine water	Marine water
Outside mapping area	Outside mapping area	Outside mapping area	Outside mapping area	Outside mapping area

In addition to the land types presented in table 3.1 above, two other types of forest classifications were added to the data; felled forests and a division between non-productive and productive forests. Information about felled forest areas was added from data from the Swedish Forest Agency. The classification of non-productive versus productive forest land exist in the Land Cover Database. This classification runs across the forest type categories in table 3.1, meaning that there is non-productive and productive forest land area in each of the forest type categories.

The land type categories presented here are different compared to the previous land accounts report, due to the new data sources, and results cannot be directly compared. In the previous report, it was for example not possible to identify artificial surfaces. As already mentioned, there is also much more details in forest types, which will be highlighted in chapter 4.

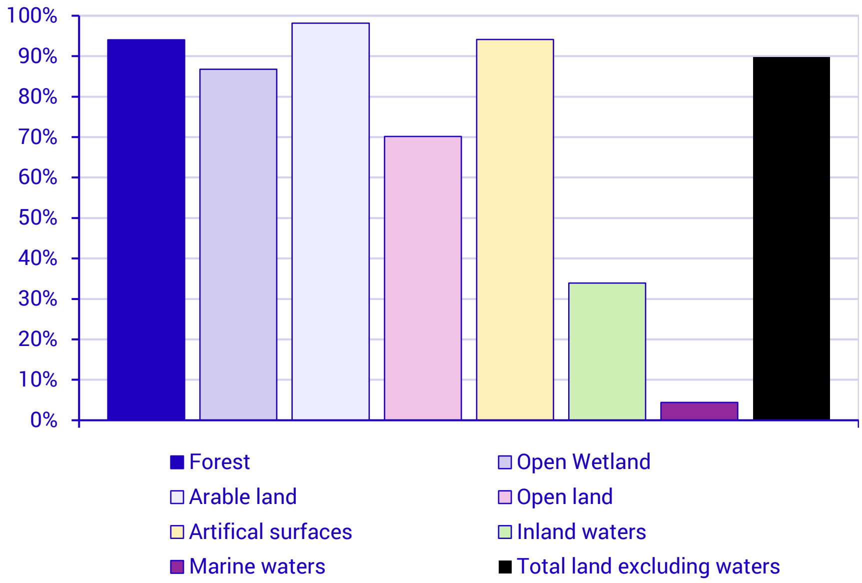
Although this report focuses on land account at the national level, all results could be reported in the following regional categories:

- River Basin Districts
- Country parts
- NUTS-areas
- Counties
- Municipalities

As the cadastral parcel 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. The system is flexible and allows the production of data for e.g., coastal zones, localities and other functional zones or other zones based on physical geography. Nevertheless, confidentiality rules must always be taken into consideration.

The new Land Cover Database is linked with information about ownership and land taxation as well as data from the Business Register to determine which industry the land belongs to. In this process some land area is lost in the linking process. This applies to for example land held by land cooperatives, where many different owners own a share of the land. There are also un-surveyed areas where the ownership has not been determined from a cadastral law perspective. In total the land accounts presented in this report cover 90 percent of total land area in Sweden see graph 3.1. As can be seen, this mainly affects marine and inland waters. Open land is another category with lower coverage, which is due to that the reason stated above affects parts of the mountainous regions in northern Sweden.

Graph 3.1 Coverage of land accounts data compared with total land area in Sweden, by land type, 2018



Selected results

Land ownership by industry

The results of the analysis shows that 83 percent of Sweden's land is concentrated in three sectors: agriculture, forestry and fishing, real estate and manufacturing. A detailed overview of land ownership per industry is shown in table 3.2. It shows that the agriculture, forestry and fishery sector is the sector that owns most forest, wetland and arable land in Sweden. This sector also owns the largest area of artificial surfaces, followed by households and the real estate industry. The real estate industry owns the largest area of open land. Graph 3.2 shows the share of each land type that is owned by different sectors.

Graph 3.2: Share of each land type owned by SNI sector, percent of total, 2018

Note: Forest categories are aggregated into coniferous, deciduous, mixed and temporarily non-forest.

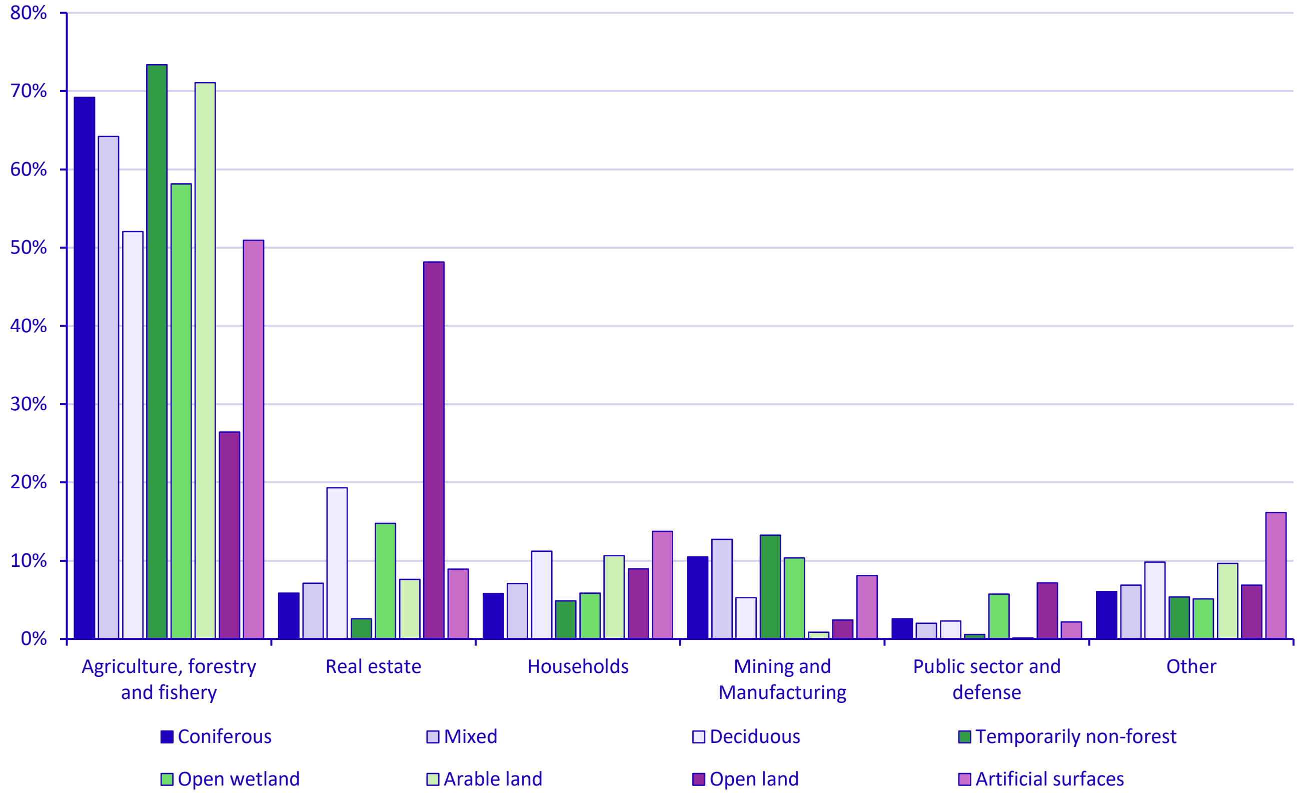


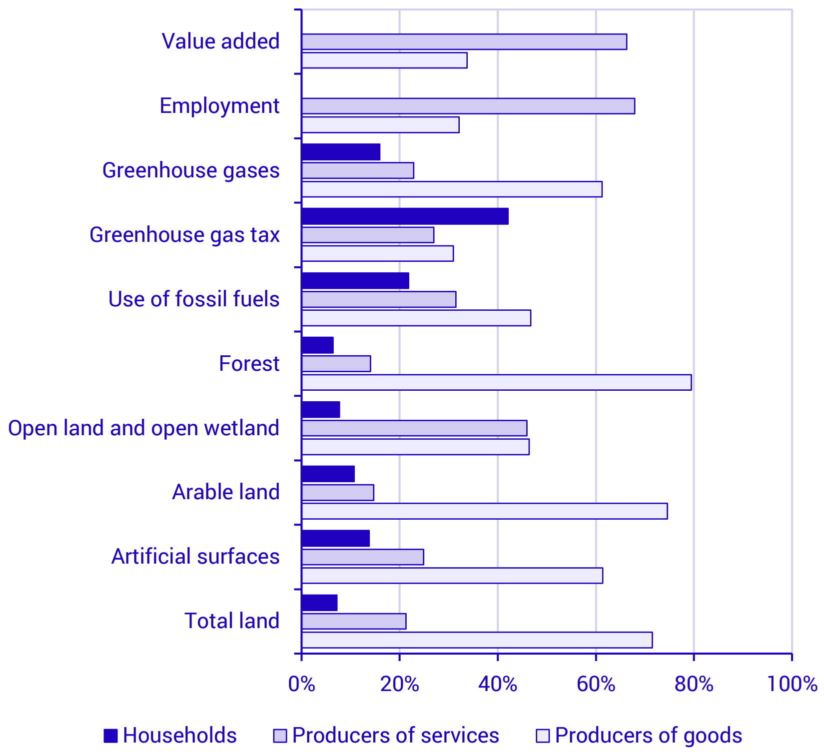
Table 3.2: Hectares owned per SNI industry and land type

Industry (SNI 2007)	Forest	Open wetland	Arable land	Open land	Artificial surfaces
Agriculture, forestry and fishery	17 065 116	1 928 759	1 801 970	1 235 187	465 199
Mining and quarrying	24 740	2 860	1 680	4 367	8 036
Manufacturing	2 682 227	340 309	20 429	107 714	65 854
Electricity, gas, steam and air conditioning supply	66 392	6 231	8 569	10 616	5 186
Water supply; sewerage, waste management and remediation activities	8 907	1 125	1 595	2 861	1 581
Construction	252 189	25 317	48 156	34 334	13 560
Wholesale and retail trade; repair of motor vehicles and motorcycles	145 991	14 788	17 712	16 433	9 481
Transportation and storage	59 431	6 013	10 592	11 392	7 150
Accommodation and food service activities	42 715	10 201	4 122	13 310	2 608
Information and communication	26 580	2 700	2 861	3 424	1 217
Financial and insurance activities	38 841	1 289	5 489	2 993	1 726
Real estate activities	1 766 976	490 038	193 388	2 249 694	81 588
Professional, scientific and technical activities	209 363	23 873	27 586	23 624	8 344
Administrative and support service activities	58 685	9 185	8 351	15 168	2 628
Public administration and defence; compulsory social security	528 632	190 549	2 727	334 395	19 628
Education	128 507	10 961	27 095	44 639	23 824
Human health and social work activities	370 868	27 822	47 054	93 275	58 456
Arts, entertainment and recreation	74 498	7 973	12 971	24 288	5 166
Other service activities	105 695	17 679	11 394	18 073	4 639
Households	1 630 299	194 513	269 907	418 997	125 678
Unknown industry	50 857	4 134	10 949	5 790	1 945
Total	**25 337 510**	**3 316 319**	**2 534 598**	**4 670 572**	**913 493**

Land and economic profiles
In Sweden the majority of land is owned by goods producers such as agriculture, forestry and paper and steel industries. 72 percent of all land area is owned by producers of goods, compared with 21 percent for producers of services. Households own around 7 percent of total land. From an economic perspective, however, producers of services contributes more to value added and employment. Industries in service industries contribute with 66 percent to value added and 68 percent of employment. For example, if national productivity is related to the area of land owned, the data indicates that producers of goods contribute with approximately 40 000 SEK (value added) per hectare while producers of services contribute with approximately 280 000 SEK (value added) per hectare.

Such comparisons can be narrowed down to investigate different types of land, specific industries or regions. This information can also be combined with data from the environmental accounts to give an expanded view of the environmental economic situation. Graph 3.3 includes information on greenhouse gases and environmental taxes by industry including households.

Graph 3.3: Environmental profile by producers of goods, producers of services and households SNI 2007, 2018 (public sector is excluded in graph)



Discussion and suggestions for further development

In this project, the new Land Cover Database has been tested to produce more detailed land accounts. In this chapter selected results from basic land accounts in the Swedish context was presented. The production system that was set up in 2017 is still working and compatible with the new Land Cover Database. The system is flexible and statistics can be reported in many different thematic dimensions and regions. Some potential applications of this new source data is further investigated in the next chapter where forestry and the potential link to biodiversity is investigated.

In terms of thematic resolution the new Land Cover Database provides more details regarding for example forest types with the possibility to link analyses to biodiversity and ecosystem services. The new data source also include information on land types that were unidentified in the previous analysis e.g. artificial surfaces. Moreover, land types presented in this study comply with existing international and official definitions, for example regarding urban areas and forest land. In this study forest land is further separated in deciduous, coniferous, mixed and felled woodland, and we use the classification of forest land as productive versus non-productive.

Other ways of reporting land accounts apply to social and other economic aspects. The data set can be extended and associated with the location of the population, socio-economic factors such as income as well as e.g. data about local infrastructure in different areas. The data can also be used to answer questions such as: 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?

The possibility to establish a link between land ownership and its economic values is important for several reasons. The services provided by different land types are largely affected by economic interests and the ecosystem services available in e.g. forests and arable land may be used for economic interests. In other words, by providing information on land use and ownership, land accounts help to track beneficiaries of ecosystem services and the economic values associated with those owners.

4. Application: forestry and its links to biodiversity

Introduction

Almost 70 percent of Sweden's total land area is forest land[2]. Therefore, the condition of the forest is of great importance for biodiversity in Sweden. Different forest types can be viewed as different ecosystems, as they provide habitats for different species. Graph 4.1 shows the area of each detailed forest type captured in the data. It shows that it is much more common with forest not on wetland than forest on wetland and the most common forest type is pine forest.

The second largest category in graph 4.1 is temporarily non-forested forest land. This category captures forest areas where the trees have been felled. Being able to separate this type of land is an important step to be able to observe the effects of economic activities on ecosystems, since forests that have been felled differ substantially from older and less intensively managed forests.

The forestry sector extracts wood and other forest products, which are a type of provisional ecosystem service. However, by increasing this production the pressures on forest ecosystems and biodiversity also increases. A report from 2011 about the condition of Swedish forests found that around 10 percent of evaluated species that live in forests are threatened by extinction (Larsson et al. 2011). The populations of 75% of the species which are threatened by extinction are decreasing, and in three out of four cases it is due to forests being felled and turned into monotone production forests. Intensive forestry is considered the factor with the largest negative effect on biodiversity in forests also in a report about the situation in 2020 (Eide et al. 2020). Furthermore, this report found that the share of evaluated species living in forests that are threatened by extinction has gone up to 20 percent, which can be compared to 10 percent in the previous assessment in 2011.

This chapter will focus on the ownership structure of forest land, by presenting how much of different forest types are owned by different SNI sectors and institutional sectors. We also use a definition of large-scale forestry to analyse how common it is. Finally, we discuss limitations and make suggestions about how this work can be further improved to capture the link between land use and biodiversity.

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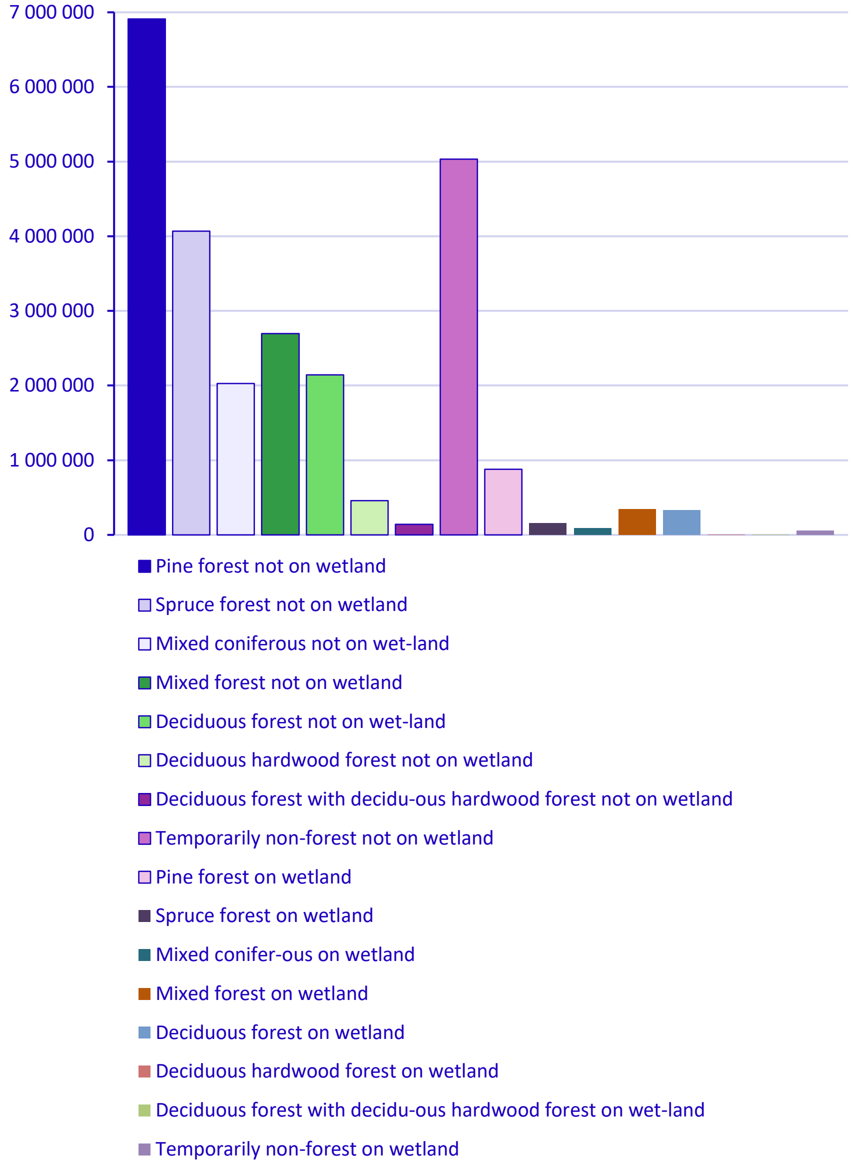
[2] Excluding inland and marine waters.

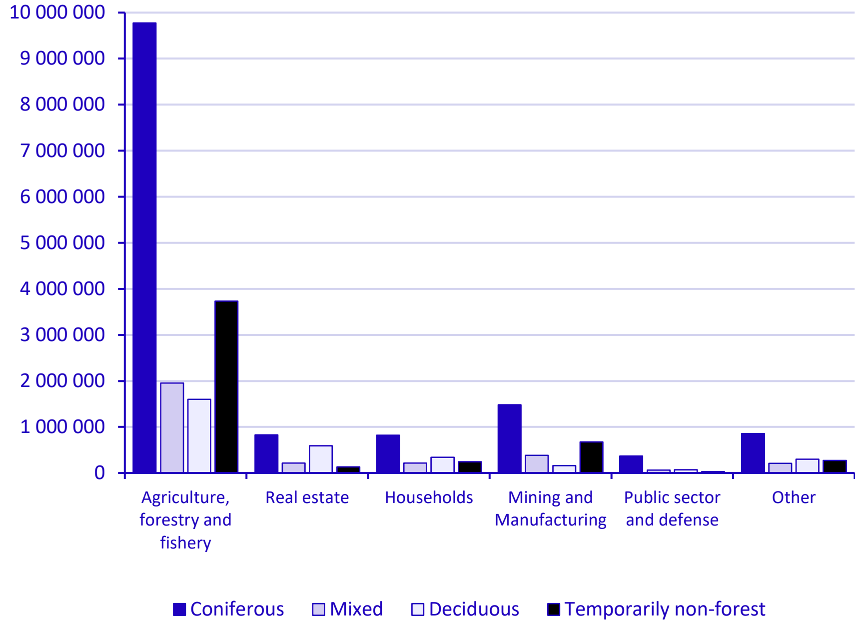
Graph 4.1: Area of each forest type (hectares), 2018



Forest ownership by industry

The data that has been produced for this report make it possible to analyse how much forest is owned by different industries. Graph 4.2 shows that as can be expected, the agriculture, forestry and fisheries sector own the largest area of forest, both in total and when categorised by coniferous, mixed, deciduous or temporarily non-forest. The forestry industry owns more than 80 percent of the forest area owned by the agriculture, forestry and fisheries sector.

Graph 4.2: Area of forest types owned by SNI sector (hectares), 2018



Forest ownership by county

Although this report focuses on land account at the national level, all results could be reported in different regional categories. Land ownership structures are different in different regions. One of the reasons for this is that forest types varies between regions, for example coniferous forests dominate in the northern parts of Sweden while it is more common with deciduous forests in the southern parts. Another reasons for differences in ownership structures is that the economy differs between regions. In some regions the economy is dominated by the service sector while in others the production of goods is most important.

Graph 4.3 illustrates how the different forest types coniferous, deciduous, mixed and temporarily non-forest varies between different counties. For example in Värmland county, coniferous and temporarily non-forest make up almost 90 percent of total forest area. Corresponding share in Skåne county is around 50 percent. This information on forest types by county could be further combined with ownership by SNI or by institutional sector.

This graph only illustrates forest types by county. More regional data for all land categories such as open land, wetland and artificial surfaces by county and by municipality in combination with ownership by SNI is available at Environmental Accounts website[3].

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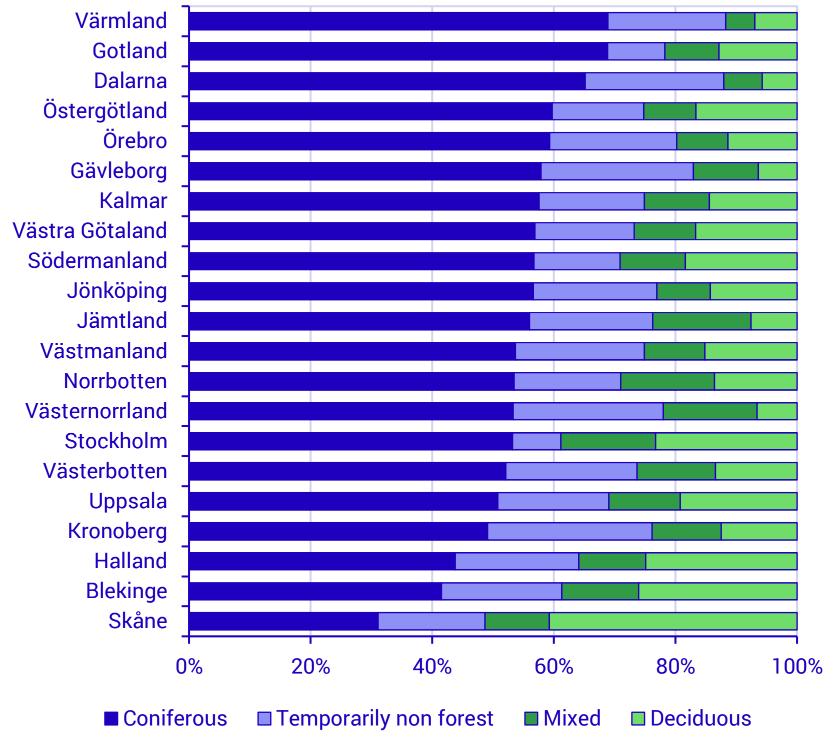
[3] Environmental Accounts' website: https://scb.se/mi1301

Graph 4.3: Area of forest types owned by SNI sector (hectares), 2018



Forest ownership by institutional sector

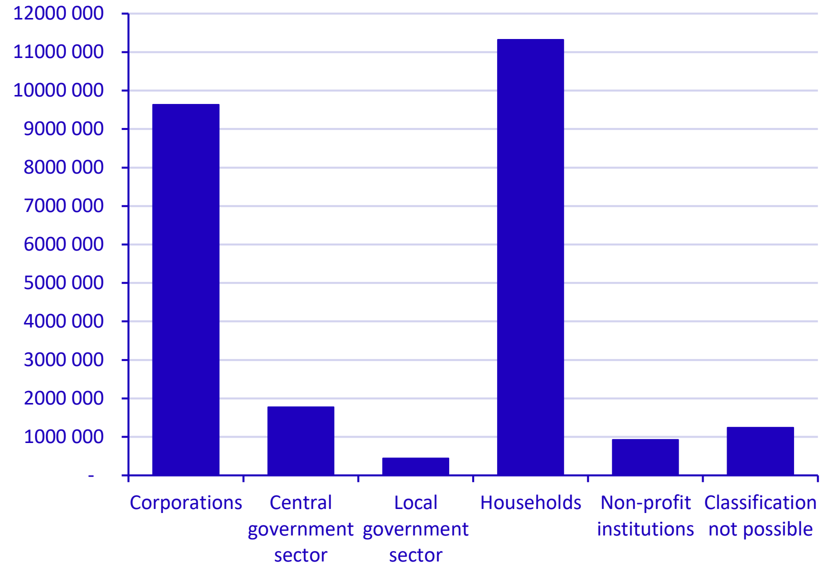
Another way to look at forest ownership is to categorise actors by institutional sectors, using INSEKT 2014. Institutional sectors are a way to group units with similar economic behaviour, such as corporations, government sector and households. All businesses in the Statistical Business Register are classified according to institutional sector.

Graph 4.4 shows that households own most of the forest area (11.3 million hectares). In this classification, households are classified by institutional sector and only households that have their main income from a business, rather than from a salary, are included. This can for example be farm owners, who often also own forest. As an example, 96 percent of the forest area owned by economic actors classified as SNI A01 (agriculture) have the institutional sector households. Corresponding number in the forest industry SNI A02 is 48 percent. In comparison, households in graph 4.2 are households which cannot be classified by SNI since they are not registered as a business in the Statistical Business Register, and in general their main income comes from a salary. Family forest owners often join forestry cooperatives, which provide forestry services and lobby private forest owners interests.

Graph 4.4 also shows that the second largest owner type is corporations, who owns 9.6 million hectares of forest. The remaining institutional sectors own much less forest. Forest owned by the central government sector include national parks and some nature reserves, although most nature reserves are owned by the local government sector (municipalities and county administrative boards). At a more detailed forest type level, shown in graph 4.5, it is visible that most of the intensively managed forest land is owned by corporations and households. Together they own more than 90 percent of the area that is temporarily non-forest. The graph also shows that there are differences in what type of forest different institutional sectors own. For example, corporations own a relatively small share of deciduous forest compared to their ownership of other forest types. The opposite can be seen for central government sector that has a relatively high ownership of deciduous forest compared with other forest types.

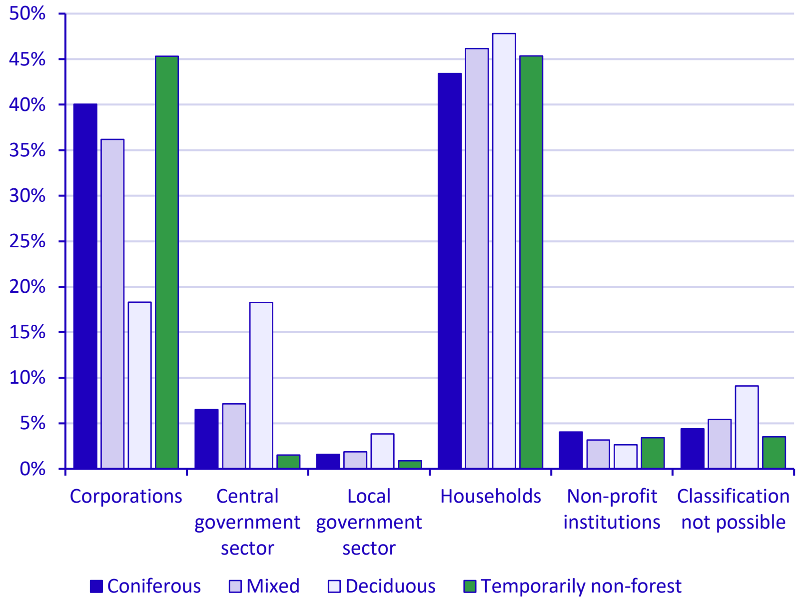
Graph 4.4: Forest area owned by institutional sectors, 2018

Note: Using Standard Classification by Institutional Sector 2014 (INSEKT 2014), aggregated



Graph 4.5: Percent of forest type owned by institutional sectors, 2018

Note: Using Standard Classification by Institutional Sector 2014 (INSEKT 2014), aggregated



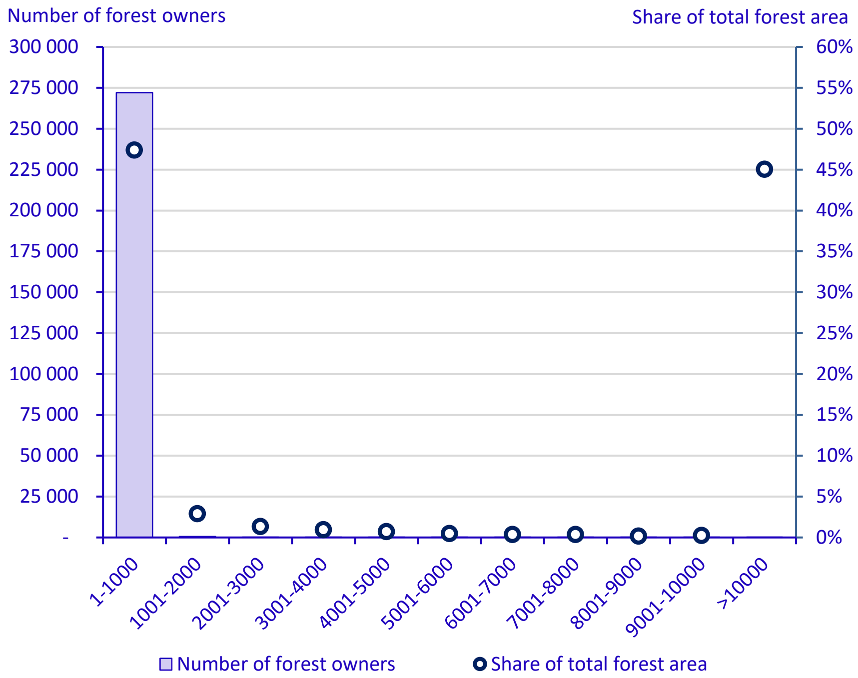
Large-scale forestry

In order to analyse forest ownership in terms of scale, the dataset can be categorised by the size of each owned forest area. We have used a definition of large-scale forestry from the Swedish Forest Agency, who classifies owning over 5 000 hectares of forest as large-scale forestry. For the purpose of this report we have not applied any definition of small-scale forestry, since the meaning of small-scale forestry can differ widely. The dataset can easily be adapted to other scale related ownership definitions in future work if needed.

Many households and firms own less than one hectare of forest. These areas add up to a total area of 34 thousand hectares of forest, of which households own 88 percent (using the SNI classification by industry). For the following analysis we have filtered out these forest lands, using the <1 hectares limit which is also used by the Swedish Forest Agency (Christiansen, 2018). These forests are likely not used for forestry, but are rather mainly part of residential plots.

More than 270 000 forest owners own between 1 and 1000 hectares of forest, see graph 4.6. The number of owners in the other forest size categories range between 5 and 534, meaning that it is much more common to own less than 1000 hectares of forest. Meanwhile, the graph also shows that while there are only 54 forest owners that own more than 10 000 hectares of forest, they own 45 percent of the total forest area. The corresponding figure for owners of 1-1000 hectares is 48 percent of the total forest area.

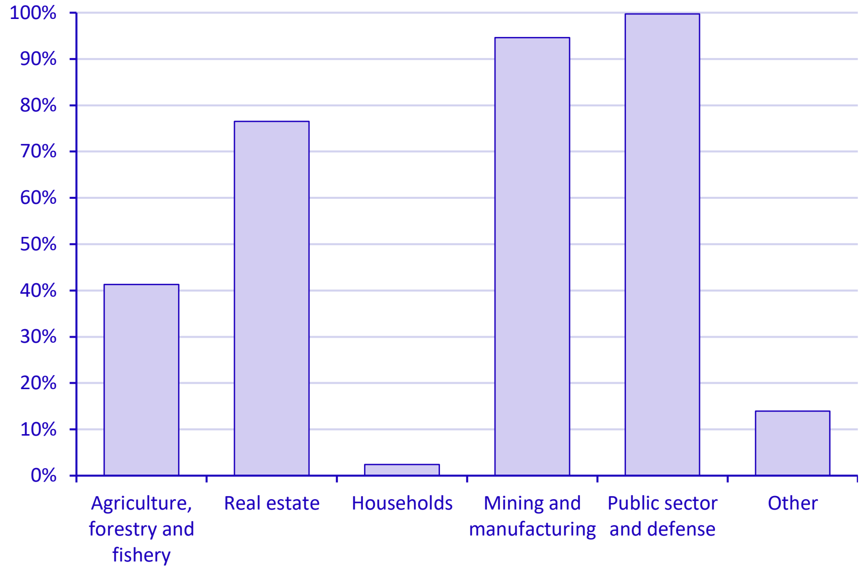
Graph 4.6: Number of forest owners and share of total area for different forest sizes, 2018



Graph 4.7 below shows how common large-scale forestry is in different sectors, by presenting the share of forest land that is part of large-scale forestry within each sector. An interesting divide can be seen as large-scale forestry is very uncommon among households whereas the majority of the area owned by most other sectors are part of large-scale forestry. The agriculture, forestry and fisheries sector has a mix of large-scale forestry and businesses with family owned forests which tend to be smaller.

Family forest owners often join forestry cooperatives. There are three regional associations in Sweden organized as producers' cooperatives. Together they have around 105 000 members who own approximately 6.3 million hectares of forest in total (LRF Forestry 2020). These organisations offer services to their members such as forest management, felling and selling the produce. Therefore, it is likely that the forests that are connected to these cooperatives are managed in a similar way.

Graph 4.7: Share of forest land that is part of large-scale forestry per SNI industry, 2018
Note: Large-scale >5000 hectares



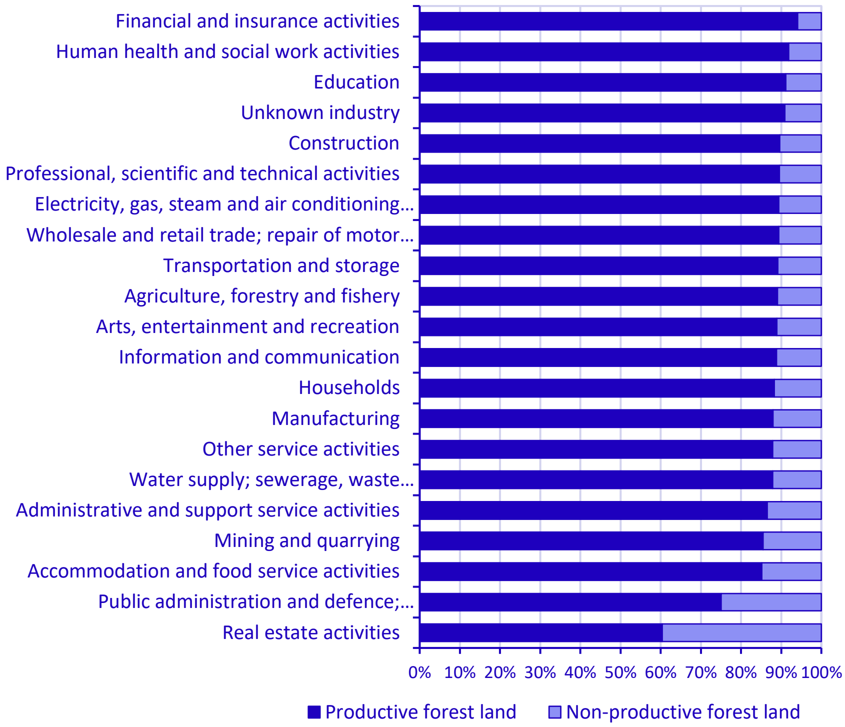
Productive and non-productive forest

In Sweden, forest land is often divided into productive and non-productive forest land for statistical purposes. Non-productive forest land is defined as forest land which on average produce less than a cubic meter of wood per hectare and year (Swedish Forest Agency 2019). The Swedish Forestry Act (13 a §) regulates the use of non-productive forest land, by restricting forestry activities to the felling of occasional individual trees. This means that in practice, non-productive forest land is not used for wood-supply and pressures of forestry activities on biodiversity should not affect these areas.

At the national level, 16 percent of forest land is classified as non-productive. Graph 4.8 shows that there is variation between industries, in terms of much non-productive forest they own as a share of total forest area owned by each industry. Three industries own less than 10 percent of non-productive forest compared to their total forest area, namely the financial and insurance industry, the human health and social work sector and the education sector. The highest share of non-productive forest is 40 percent of the total forest area in the real estate industry. Second highest is public administration and defence and compulsory social security with 25 percent. It is worth noting that both these categories of forest owners include public agencies, which to a higher extent own non-productive forest.

Investigating how much of each forest type, for example pine forest on wetland, that are classified as non-productive forest land would provide important information about how intensively managed these different areas are. This can be done in future projects.

Graph 4.8: Share of forest land classified as productive and non-productive by SNI industry, 2018

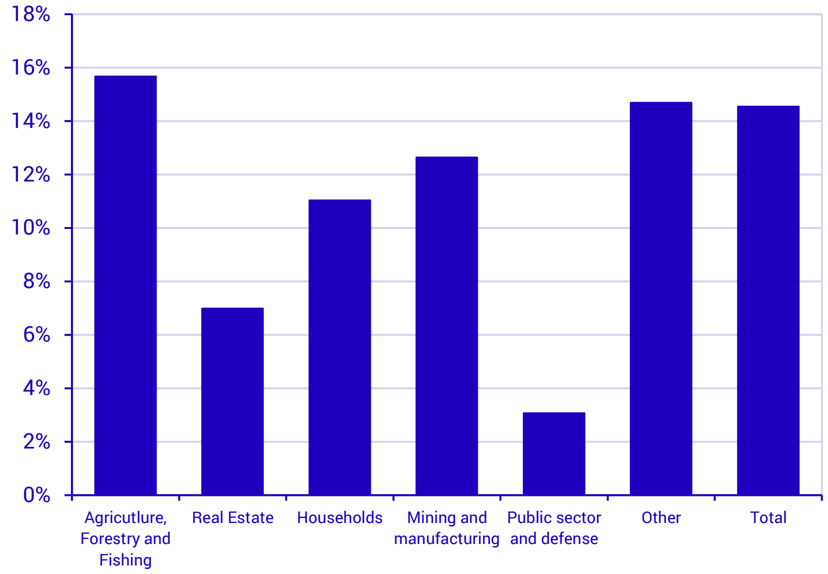


Forest felling by industry

The issue of biodiversity in forests is closely linked to the extent of monotone production forests. Intensive production forests is considered to have the largest negative effect on biodiversity in Sweden (Eide et al, 2020). One way to approach the issue of biodiversity in forest is therefore to look at felling statistics. The Swedish Forest Agency annually records areas where felling has occurred. This data has been combined with our dataset from the land cover database. Felled forest differs from temporarily non forests in the way that it includes accumulated actual felling since year 1999, while temporarily non forests give a snap shot of the situation (in this case year 2018). Moreover, temporarily non forests can also include other areas with felled forest such as power line areas.

Graph 4.9 illustrates the share of felled forest of total productive forest holding by SNI industry. Highest felling share can be found in Agriculture, Forestry and Fishing where 16 percent of the productive forest has been felled since 1999. In comparison, the lowest shares can be found in Public sector and Real Estate industry.

Graph 4.9: Share of felled forest (1999-2018) of total productive forest, by SNI industry, 2018



Discussion and suggestions for further development

This report has extended earlier work on land accounts at Statistics Sweden. The new data source has made it possible to identify much more detailed forest types, including temporarily non-forested land which show where economic activities have led to felling of forests. We have also analysed forest ownership structures such as what type of forest different sectors and institutional sectors own, as well as how many forest owners there are and how common large-scale forestry is. Most forest belong to the agriculture, forestry and fisheries SNI industry. From an institutional sector perspective households and corporations own most forest land. The ownership structure is very divided in terms of how much forest individuals/organisations own, as almost half of the forest belong to a large group of forest owners who own less than 1000 hectares each, while approximately the other half of the total forest land is owned by a few very large scale forestry companies.

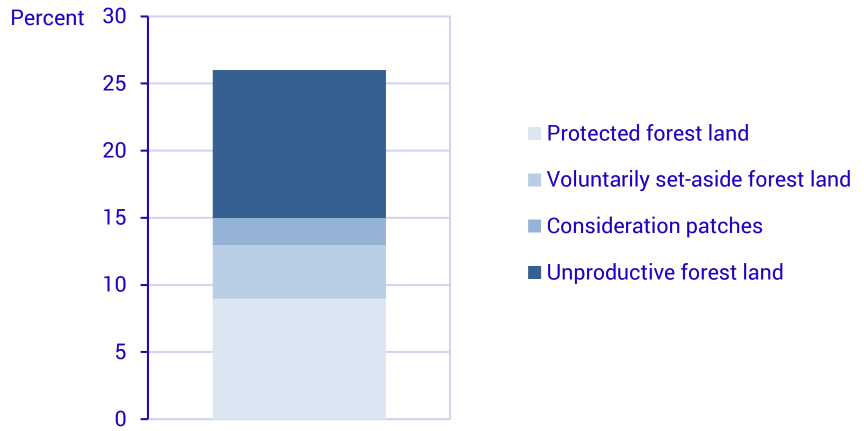
To be able to track ownership structures and changes of different forest types over time are nevertheless important first steps. Especially interesting forest types to follow from a biodiversity perspective are e.g. temporarily non-forested forest land, felled production forest and non-productive forest land. However, in order to enhance the analysis of the effect of economic activities and ownership on biodiversity in forests, more information needs to be added to the data. The next step would be to add information about ecosystem condition, as well as factors regarding the use of the forest to the dataset. Examples of the later include whether the forest is protected, whether the forestry is certified and if it is voluntary set-aside from felling by the owner.

These three factors are discussed in the next chapter, but in short: Statistics on the area of certified forestry and voluntary set-aside areas is available, but is currently not reported geographically and can thus not easily be added to this dataset. Meanwhile, geographical data regarding protected areas is available and can be added if deemed valuable, more about this in the discussion in the next chapter.

5. Protected and certified areas

Biodiversity can be protected by managing land and resource extraction sustainably and by designating nature conservation areas in areas with high biodiversity value. Information about protected areas and areas with certified production could thus be valuable additions to the land accounts. However, current statistics about certified and voluntary set-aside areas are not recorded with geographical location. Therefore, it is not possible to match these statistics with the land account dataset. In this chapter, we introduce the statistics that are currently available and discuss the potential of including these factors in future work on connecting land accounts and biodiversity.

Graph 5.1: Share of total forest area that is classified as formally protected, voluntary put aside, consideration patches or non-productive forest land, 2019



Source: Statistics Sweden 2020b

Not all forests are used for wood supply. Forestry activities are not taking place in forests that are formally protected, voluntary put aside[4], consideration patches[5] or are classified as non-productive forest land. As showed in graph 5.1, the areas which are not used in forestry added up to 26 percent of Sweden's forest land in 2019. The remaining forest area is likely used for forestry. Volontary set-aside areas and consideration patches are not permanently protected, and more research and better statistics are needed to analyse how these classifications affect biodiversity.

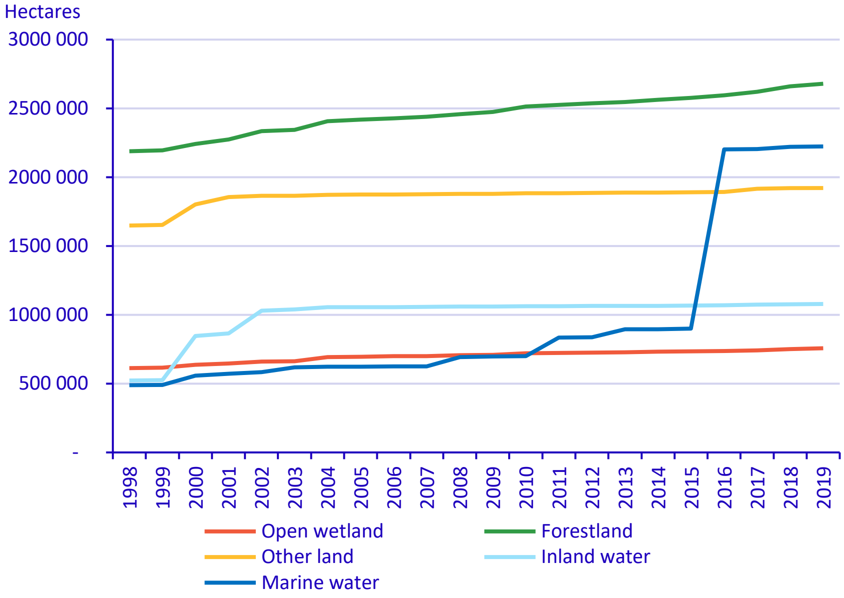
[4] Discussed in detail on page 33.

[5] A term which defines small forest areas which are left untouched when a forest area is felled. Often older trees or buffer zones close to water.

Protected areas

There are three main types of nature protection areas in Sweden: national parks, nature conservation areas and Natura 2000 areas. Graph 5.2 shows that more areas have become formally protected over time (by at least one type of nature protection). The protected area of forest and marine water have increased the most over the last twenty years.

Graph 5.2: Accumulated added formally protected forest and open wetland area



Source: Statistics Sweden 2020a

There are 5111 nature reserves in Sweden, covering 4 850 271 hectares of land, forming the largest proportion of protected nature in Sweden. Most of the area protected in nature reserves in Sweden, almost 85%, lie in the northern part of the country. County administrative boards and municipalities establish nature reserves, for the preservation of biodiversity and conservation of valuable natural environments. Other reasons to form nature reserves expressed in the Swedish Environmental Code is to meet the needs for outdoor recreation areas or to protect the natural habitats for endangered species. (Swedish Environmental Protection Agency, n.d.)

Sweden has 30 national parks, covering 743 238 hectares of land that is considered particularly important for the nature and the cultural heritage. Around 90 percent of the total area of national parks is in the mountainous regions (Sweden's National Parks, n.d.). National parks are owned by the state.

There are around 4000 Natura 2000 areas in Sweden, of which many overlap with nature reserves or national parks. Forestry and other human activities are not prohibited in Natura 2000 areas and most of the land remains privately owned, however new land uses have to be approved. (Swedish Environmental Protection Agency, n.d.)

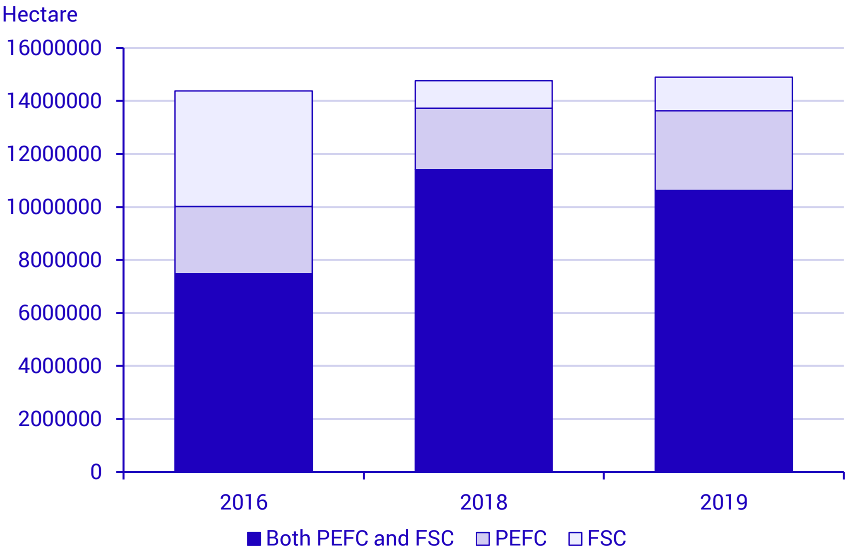
Potentials for including information about protected areas

Information about protection status can be added to the land accounts, since information about their geographical location is recorded[6]. However, because the ownership of areas protected as national parks and nature reserves is known (central and local government sector respectively, also discussed in chapter 4), the benefits of this procedure should be weighed against the cost. However because Natura 2000 areas can be owned by anyone, adding this data would generate some new information on ownership of protected areas.

Certified forests

The majority of Swedish forests are certified by sustainability certification systems. The two most commonly used certification systems are PEFC (Programme for Endorsement and Forest Certification) and FSC (Forest Stewardship Council). Many forests also hold dual certification, see figure 5.3. These certifications aim to improve the sustainability of forestry activities and to maintain biodiversity in forests.

Graph 5.3: Certified forests by PEFC and FSC, 2016, 2018 and 2019.



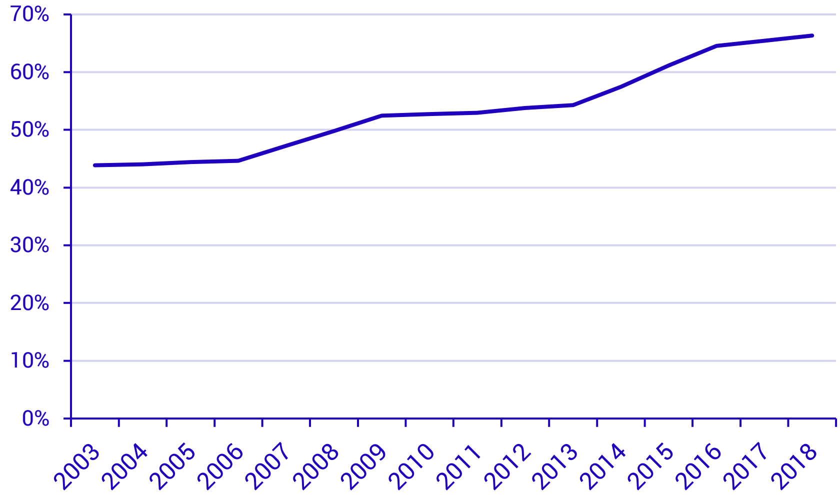
Source: Swedish Forest Agency, 2020a

[6] The Swedish Environmental Protection Agency provides a map tool that show protected areas geographically: https://skyddadnatur.naturvardsverket.se/

Around 66 percent of production forests in Sweden was certified by any or both of the two certification systems in 2018, see graph 5.4. Sustainable forestry is one of the sectors included in the Environmental Goods and Service Sector (EGSS), which measures the economic value of environmental goods and services. For sustainable forestry, no micro data is available and a macro model for estimating economic value is used. EGSS economic values in SNI A02 are estimated using the shares of certified forest.

The share has been calculated yearly as land area certified by PEFC and/or FSC. Data is, however, not available for both certification schemes for all years and therefore some assumptions have been made for calculating the shares for the whole time series. There is for example no available data for PEFC prior 2016, and therefore these shares are based solely on FSC, which probably is an underestimation.

Graph 5.4: Estimated share of production forests certified by PEFC and/or FSC, 2003-2018

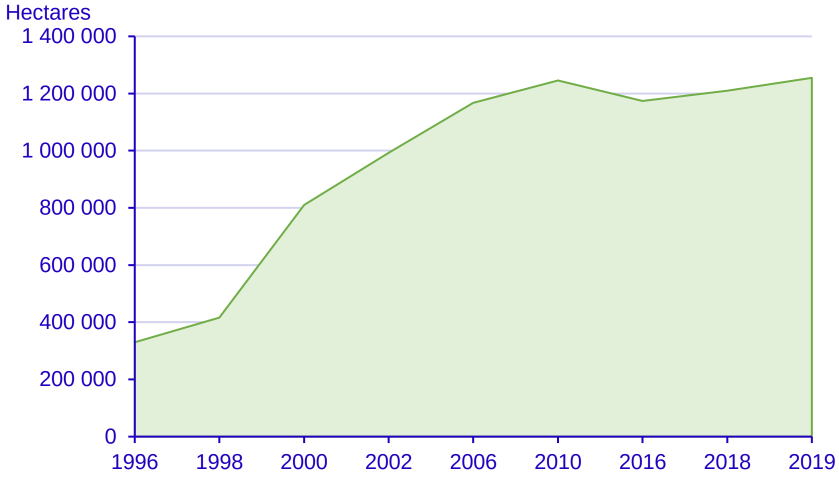


Source: PEFC, FSC. Data compiled and combined by Statistics Sweden

Voluntary set-aside forest areas

One requirement for certification is that a minimum of 5 % of the productive forest land area "is set aside and exempt from measures other than management to maintain and promote natural biodiversity or biodiversity conditioned by traditional land use practices" (FSC 2020, p.42). Currently, the available statistics on this matter is the total area that has been voluntary set-aside, shown in graph 5.5.

Graph 5.5: Voluntary set-aside forest area (productive forest land)



Source: Swedish Forest Agency

In the coming years, the Swedish government wants to extend the statistics about voluntary set-aside forest, since it is used for the national environmental milestone target regarding biodiversity. The target for 2020 was that voluntary set-aside forest area should have increased to 1 450 000 hectares (Swedish Government 2014). This target has not been reached, as can be seen in graph 5.5. A recent proposal to the government from the Swedish Forest Agency (2020b) suggests that all large-scale forestry owners should be required to report information about the area and geographical location of their voluntary set-aside areas. This is to make it possible to estimate the total size, duration of voluntary protection and quality of the land that has been set-aside. This suggests that these statistics might become available in the future, which could then be added to the land account dataset to improve the possibilities to analyse biodiversity in forests.

Potentials for including forest certification status

Currently, the sustainable forestry certification systems cannot be connected with the geographical land accounts data as illustrated in this report. However, identifying certified forest owners in the land accounts data set would be an interesting input to further work on e.g. forest biodiversity, given that the certification systems' purpose is to provide increased value for biodiversity.

Many of the major forest companies are certified directly by PEFC or FSC and are easy to identify. One way forward is thus to look at the largest forestry companies and connect them with information on direct certified forest land from any of the two certification systems. As an example, in PEFC only seven companies are directly certified, but they own over 10 million hectares, which corresponds to almost 40 percent of total forest land in our data base.

However, for small scale forest owners it is more common to join an umbrella organisation for certification. Therefore it is difficult to follow the certification by forest owner, i.e. to identify individual forest owners that are certified. This is particularly problematic because, as shown in graph 4.5 in the previous chapter, almost half of the total forest area is owned by forest owners who own less than 1000 hectares. This method of including certification status is thus likely to only work for the large-scale forestry.

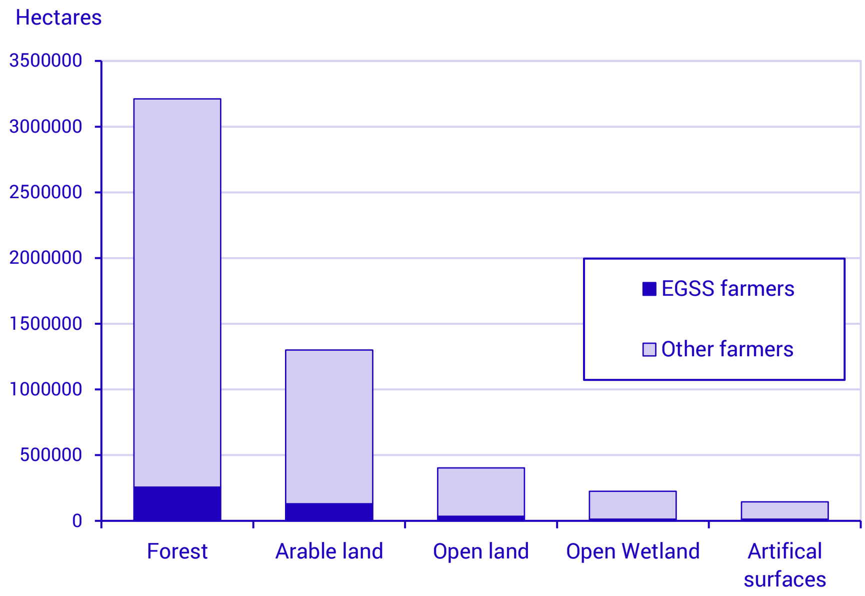
Certified farmers in the Environmental Goods and Service Sector

The SEEA framework includes statistics on several modules of which one is Environmental Goods and Service Sector (EGSS). This account measures the economic value of environmentally goods and services. In Sweden this is mainly done through a register with environmental companies. EGSS includes both organic farming and sustainable forestry. In this section, the possibility to combine EGSS data on organic farming with the land account data is discussed.

The Swedish data on organic farming in EGSS is mainly based on a mapping of farmers which are certified according to the Swedish KRAV label in SNI 01 (Crop and animal production, hunting and related service activities). The information in EGSS can be matched with the land accounts data since both include businesses' organisations number. EGSS data is limited to only include farmers which have their main industry classification in SNI A01. For this and other data processing reasons, the EGSS data presented below covers less areas than statistics from e.g. Swedish Board of Agriculture on organic farming or data published by KRAV. It can however be used to compare land ownership structures in SNI A01 with the economic statistics that is compiled within EGSS.

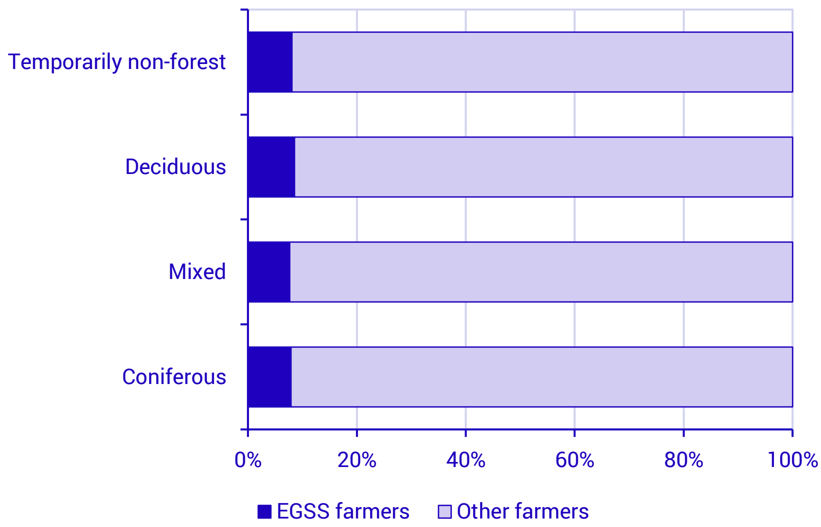
The graphs below show examples of how this data can be used together, with land ownership in NACE A01 divided by EGSS farmers and other farmers. It is most common that businesses in SNI A01 own forest and arable land, see graph 5.6. Described in percentages, SNI A01 represents 13 percent of total forest land in Sweden and 51 percent of total arable land. Farmers included in EGSS own 8 percent of total forest land owned by SNI A01, while other farmers own 92 percent. For arable land this percentage is 10 percent for EGSS farmers. This can be compared with e.g. statistics on sold organic food and drinks which was around 7 percent in 2019 (Statistics Sweden, 2019).

Graph 5.6: Land ownership in NACE 01 divided by farmers included in EGSS and other farmers



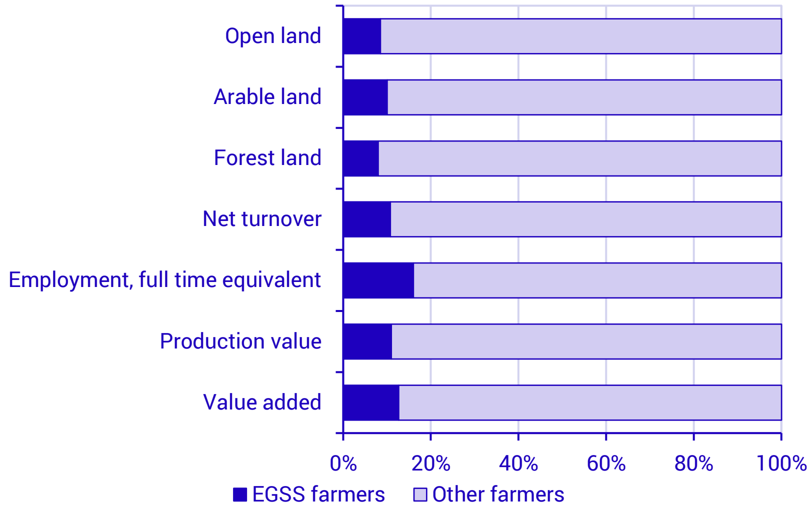
When looking at different forest types it is clear that there are no large variations or structural differences between farmers included and not included in EGSS, see graph 5.7. Regardless of forest type, certified farmers own 8-9 percent of the total area. There are for example no signs that certified farmers to less extent own temporarily non-forested forest land.

Graph 5.7: Land ownership in SNI 01 in different types of forest divided by EGSS and other farmers



Since EGSS data focuses on economic values, economic outcomes can be compared with land ownership data. Farmers included in EGSS have larger shares of value added, production value, net turnover and employment compared with their land ownership, see graph 5.8. This means that net turnover per hectare is higher for certified farmers included in the EGSS register compared with other farmers.

Graph 5.8: EGSS data and land accounts combined for SNI 01.



Discussion and suggestion for further development

This chapter has explored the data availability for protected and certified areas, which could be used to improve the possibility to analyse the link between biodiversity and land use. While the information about protected areas could be connected to the data set, it does not add much new information in regards to ownership as most protected areas are owned by the public sector. Meanwhile, the information about certified areas is currently not possible to merge with the data set. Adding this information when possible would for example make it possible to study how differences in forest management between certified and non-certified forestry affects biodiversity. One limitation for now is that this probably only can done for the largest forest owners.

Furthermore we successfully merged the EGSS agriculture data with the land account data set and thereby showcased the possibilities of using other SEEA data in combination with land accounts. As an example this gives information on the environmental goods and services produced by EGSS farmers compared with conventional farmers. The result also shows that EGSS farmers do not stand out compared with conventional farmers when it comes to what type of land or forest that is owned. Economic values such as turnover per hectare, however, is higher for certified farmers included in the EGSS register compared with other farmers. If new information such as ecosystem condition would be added to the dataset in the future, the link with EGSS data could be investigated further.

6. Changes in land use

By tracking changes in land types over time, in connection to information about economic actors and activities, one can analyse what pressures they generate on ecosystems and biodiversity. However, the new more detailed data on land cover categories currently only exists for one reference year (2018) and comparison with this level of land type detail will only be possible in future years. Therefore, we have mainly focused on discussing the possibilities of studying changes over time using the new data source in this chapter.

As mentioned earlier in the report, Statistics Sweden conducted a project on land accounts in 2017 (Statistics Sweden, 2017) with the latest reference year 2015. The land types were, however, on a more aggregated level in comparison to the new more detailed land cover data. To be able to follow up on the aggregated data of 2015, we have reproduced the same calculations with updated versions of the same data sources from 2018, see table 6.1 below. Due to changes in the data structure, the two years are not fully comparable.

We found that the forest land area increased with more than 1.4 million hectares. The main part of the increase in forest land comes from the category “other uncategorised land”. But some forest land was previously classified as wetlands, as open wetlands decreased by more than 399 000 hectares while the category forest on wetlands increased by approximately 445 000 hectares. Most of the changes can be retrieved from an update of the forest land data in the northern part of the country. In 2015, part of the vast northern inland had a simplified representation of forest land, depicting forest and wetland polygons less accurate and in a coarser scale. In the data from 2018, the forest land data had been harmonised, introducing some “false” changes in the time-series.

Another finding is that in the 2018 data, a greater number of owners have been matched with land areas. This is due to improvements in the cadastral information where previously unmatched cadastral parcels could be identified with its owner.

Table 6.1: Change in total area of land types between 2015 and 2018 (using different data sources so results should be interpreted carefully)

	2015	2018	Change between 2015 and 2018
Arable land	2 622 895	2 614 025	-8 869
Pasture	482 860	505 569	22 708
Forest land	25 837 494	27 252 143	1 414 649
Of which: Forest on wetlands	1 648 599	2 093 310	444 710
Open wetlands	3 327 393	2 927 415	-399 978
Other uncategorised land	4 413 998	3 472 474	-941 524
Total land	36 684 640	36 771 626	86 986
Open water	1 689 500	1 727 498	37 998
Total	38 374 140	38 499 125	124 984

Suggestions for further development

Time-series data presented in this chapter are based on the data sources used in previous projects. The drawbacks of these data sources are discussed in chapter 2. Currently, the National Land Cover Database only exists for one reference year, but the plan from the consortium responsible for the production, is to have an updated version in a couple of years. The plan is to publish a consolidated version of the Land Cover Database every five years.

High-resolution land cover data in time-series opens up a range of opportunities in terms of land accounting. First of all, land cover change can be measured using a pixel-by-pixel comparison approach to describe, not only the total stock of land cover categories for each point in time, but also the flows between different land cover categories over time. E.g. each pixel can be traced over time to follow land cover origin to land cover destination. Secondly, land cover change can be assessed in relation to industries or changes in land ownership.

Cross-tabulation of land cover data from two reference years will result in a matrix showing land cover categories for t_1 on the vertical axis and the same land cover categories on the horizontal axis for t_2. The flows between the land cover categories can be followed through the matrix. As illustrated in the matrix below in Table 6.2, most of the categories stay stable over time but some categories have “lost” or “gained” area from other categories.

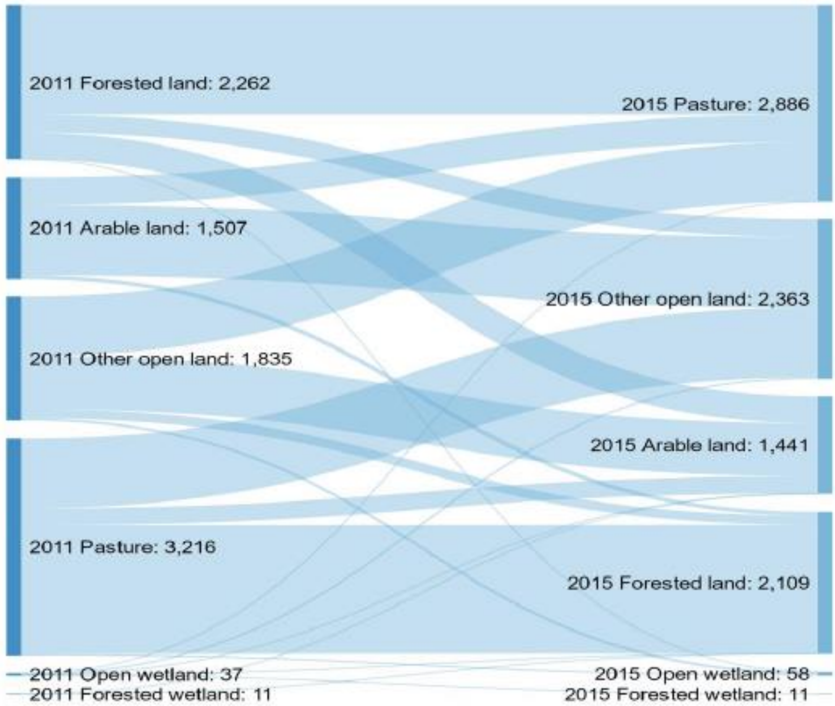
Table 6.2: Example of crass-tabulation matrix of changes in land use
Gotland County, Sweden (2011-2015)

		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	

Source: Statistics Sweden, 2017 p.40

This way of illustrating land cover change is very different from showing static land cover stocks for two reference years. In theory, the flows *to* and *from* different land use categories can be significant, but as long as the gains are more or less equal to the losses, the sum of acreage will be the same, giving the impression that nothing has changed. In addition to the change matrix, changes in land cover flows can be illustrated using a Sankey diagram (see figure 6.1 below).

Figure 6.1: Example of Sankey diagram showing changes in land types
Gotland County, Sweden (2011-2015)



Source: Statistics Sweden, 2017 p.40

Some of the more interesting applications for this type of flow analysis is assessments of land take or conversion of land from natural or semi-natural habitats to artificial surfaces. This is typically most relevant in urban regions. Time-series data can reveal not only where land take occurs but also what kind of land cover categories are subject to this transformation or urbanisation process. In addition to the land transformation itself, the data sources could be used to explore which industries are most likely to contribute to the transformation of land.

7. Discussion and conclusions

Ecosystem accounting is a rapidly growing field of both research and statistics. Much of what has been produced under the umbrella of ecosystem accounts has had an experimental nature. There are several different approaches to research and analysis of ecosystems and ecosystem services, with different focus and richness of details. Some projects study specific ecosystem services, such as how pollination affects agricultural production. Other aim to report ecosystem services in monetary values. Numerous other examples on how to approach the issue of ecosystem accounts exist in the research and statistical communities. At the time of writing this report, a new UN SEEA manual for ecosystem accounting is expected to be adopted in just a few months. Ecosystem accounts has also been suggested as a new environmental account module in the European environmental accounts, which would make it mandatory for all European countries to collect this data regularly. However, due to the complexity of ecosystem accounting there might still be some time until a fully developed, internationally harmonised statistical system on ecosystem accounting is in place.

The environmental accounts offer a structure for analysing the issue of land ownership which can be combined with other information such as environmental impact, production of environmental goods and policy instruments. Since the environmental account is a satellite account to the national accounts it can be complemented with economic statistics, such as production values, intermediate consumption, employees, to answer questions on input needed in the economy to produce goods and services.

In Sweden, the focus has been on testing land use accounts as a way to approach ecosystem accounts. This report has also focused on land use and ownership, as a necessary basis for analysing issues on biodiversity and ecosystem accounts. Land ownership is interesting to study for several reasons. The conditions of ecosystems are dependent on the owner of the land. Furthermore, incentives and economic interests differs for different types of land owners.

This project has successfully implemented new land cover data for the land accounts and thereby a more detailed land use accounts has been produced, see chapter 3 and 4. Using the new data, we found that most forest belong to the agriculture, forestry and fisheries industry, using the SNI classification. From an institutional sector perspective, households and corporations own most forest land. The ownership structure is very divided, in terms of how much forest individuals and organisations own, as almost half of the forest belong to a large group of forest owners who own less than 1000 hectares each, while approximately the other half of the total forest land is owned by a few very large-scale forestry companies. We also used a definition of non-productive forest which is commonly used in forest statistics. Our results show that there are large variation between different industries when looking at non-productive forest ownership.

By adding information from the Swedish Forest Agency about felling to the data set, we could analyse how intensively different sectors use the forest land they own. The agriculture, forestry and fishery sector has the highest shares of felled forest compared to how much productive forest land they own.

Furthermore, we successfully merged the EGSS agriculture data with the land account data set and thereby showcased the possibilities of using other SEEA data in combination with the land accounts. If new information on ecosystem condition would be added to the dataset in the future, the link with EGSS data could be investigated further.

In this project, important steps have been taken to be able to track ownership structures and changes of different forest types over time with a close link to biodiversity aspects. This will be possible using this production system for land accounts when the new land type data exist for more than one time period. It is, however, not known when a new reference year will be available, but data will likely be produced every few years, since land ownership structures and land types transformations do not change much from one year to another. The effects are better captured with longer time perspectives.

Especially interesting forest types to follow from a biodiversity perspective is e.g. temporarily non-forested forest land, felled forests and productive forests. They resemble intensive production forests that has been pointed out as particularly problematic from a biodiversity perspective, and therefore important to track by owner and over time. However, in order to enhance the analysis of the effect of economic activities and ownership on biodiversity in forests, more information needs to be added to the data. Information about ecosystem condition as well as factors regarding the use of the forest to the dataset are examples of such. Statistics on the area of certified forestry and voluntary set-aside areas are available, but are not reported geographically and can thus currently not be added to this dataset. Adding this information when possible would make it possible to study for example how differences in forest management between certified and non-certified forestry affects biodiversity. Meanwhile, geographical data regarding protected areas is available and can be added in future work.

Besides improving our understanding of land accounts and what type of statistics that can be produced with the new detailed land cover data, this report contributes to the future work by providing several examples on how land accounts statistics can be produced, understood and presented. The step from analysing land use to drawing conclusions regarding the extent or status of ecosystems can, however, sometimes be long and should be done with caution. Nevertheless, this study shows that there are possible pathways, and data availability, to explore this further. Important necessary aspects in the continuous work on developing ecosystem accounts, and in fact in all work on developing new statistical standards, are harmonised and comparable statistical methods as well as methods that are stable over time. The results presented in this report provide a foundation for this in a Swedish context.

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