Landscape Planning for Forest Biodiversity and Diverse Forestry

1. Objective and research questions

Introduction

According to the latest evaluation, it will not be possible to meet the Swedish Environmental Objectives *Sustainable Forests* and *A Rich Diversity of Plant and Animal Life* with current or planned policy instruments (Naturvårdsverket 2015). Nor does current Swedish forest management comply with international commitments, not least the EU Birds and Habitat Directives. This is much due to the lack of sufficient environmental considerations in felling. At the same time, timber production is essential for several reasons, not least as a contribution to achieve the Swedish environmental objective *Reduced Climate Impact*. Biomass plays a significant role in the conversion of the energy system and Sweden has international commitments also in relation to the climate policy, e.g. according to the EU Renewables Directive. This project presumes a demand for more diverse forest management so that, on the one hand, biodiversity is effectively protected in certain forest areas in order to comply with the requirements in e.g. the Habitats Directive and, on the other hand, intensive forestry production is accomplished in areas where conservation interests are negligible.

This situation calls for spatial planning of the landscape, instruments to internalize costs and benefits of ecosystem services and improved control and monitoring of compliance with legislation. The purpose of this project is to develop a new set of policy instruments for forest management, in which forest policy goals are met. Today's failure to reach the targets is in part due to the lack of landscape strategies and environmental considerations in felling (Naturvårdsverket 2014). The project will explore ecological and legal preconditions for spatial planning of forest landscapes in order to promote a more sustainable and diverse management of forests.

Many of the environmental services that forests produce are public goods, which do not generate income for forest owners. Negligence of these environmental services in management decisions leads to unsustainable patterns that existing legal instruments are unable to avert. The objective of this interdisciplinary project is to, in order to meet these needs, demonstrate a model for legal implementation of a landscape approach in forest management, complemented by the development of new economic policy tools.

Specific aims:

The project consists of three integrated components designed to:

1. Develop a model for forestry strategies on a landscape level, based on landscape ecological theories, in order to on the one hand create a green infrastructure for conservation of biological diversity and to implement the EU Habitats Directive in forest management and on

the other hand identify areas where conservation values are negligible and thus available for intensive forest production.

2. Develop a legal model and propose legal changes in order to implement the landscape approach in accordance with package 1. Legal research will be presented on how a regulation could be designed to set a legal framework for sustainable forestry by introducing provisions on ecological planning at different scales.

3. Design a new policy measure based on an environmental tax-fund system for conservation in Swedish forest landscapes. Ideally, this tax-fund system should be fully funded, internalize the cost of ecosystem services and address equity concerns by creating a more even distribution of the costs of conservation measures among forest owners.

Long term objective:

To achieve an ecologically sustainable forestry that meets national targets and complies with international agreements.

2. Current knowledge

Today, forest biodiversity in Sweden continues to degenerate, and the use of forest resources is not considered to be sustainable or in line with legal requirements, such as EU-law (Naturvårdsverket 2015, Forsberg 2012). A key reason for the reduction of forest biodiversity is the fragmentation and degradation of forests with long continuity. Today, the amount of such forests and other core sites are not sufficient to maintain biological diversity. Therefore, there is an immense need not only to preserve the values that still exist, but also to create new ones through restoration efforts.

At the same time, parts of the Swedish forestry land lack conservation values of importance. Some of these areas may be used for intensive forestry production, not least in order to to produce biomass as part of the climate change policy, but such production is hindered by the current forestry legislation (Michanek and Pettersson 2010).

The current management model

The current model of forest management in Sweden was established in 1993 and is predominantly based on the landowners' voluntary work. A landowner is expected to, beyond the minimum legal requirements, take voluntary environmental considerations in felling and set aside forest land in order to protect and promote different environmental values. There are however some concerns regarding the voluntary protected areas, especially when it comes to their quality, the duration of the protection and the usefulness of the protection from a landscape perspective (Forsberg 2012). Also in the context of formal protection of areas, which is a cornerstone in the preservation work, the areas are in principle selected without regard to landscape ecological needs. According to the Swedish Forestry Agency, it is a general dilemma in conservation that landscape connectivity is not considered (Skogsstyrelsen 2009).

The present management model does not provide for sufficient geographical differentiation with regard to how forest land should be used. The legal restrictions are to a considerable extent generally applicable, not sufficiently observing the conservation values and production potential of each forest area.

The Forestry Act and the subordinate regulations do not allow for an effective enforcement of conservation requirements. This poor legal construction cannot be regarded as a sufficient implementation of the EU Habitats Directive and results in a forestry that is in conflict with national and EU law (Forsberg 2012, Naturvårdsverket 2009).

The need for new instruments

The problems described should be seen in relation to Sweden's obligations under the Convention on Biological Diversity (CBD). In Nagoya 2010, the Contracting Parties undertook to, by 2020, conserve at least 17 per cent of terrestrial areas through ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures that are integrated into the wider landscapes. Furthermore, all stakeholders shall take steps to achieve or implement plans for sustainable production.

However, by the year 2010, forest management plans were developed for only 20 per cent of the productive forest land in Sweden (Skogsstyrelsen 2010). When legal requirements on forest management plans were abolished in 1994, it was expected that the planning would continue on a voluntary basis, assuming that the need for such planning was common knowledge. The Swedish government has highlighted the problems of the landowners' lack of planning, and hence their insufficient knowledge about their forests, and stresses that this prevents the enforcement of both environmental objectives and production targets (prop. 2007/08:108).

Planning may not only be seen as a legal requirement under CBD (Kiss & Shelton 2004), but also as a tool for implementing the EU Habitats Directive (Council Directive 92/43/EEC). Member states are obliged to establish a strict protection regime for some listed species. This includes the protection and establishment of the ecological functionality of certain habitats, such as breeding sites and resting places. According to the European Commission, merely a prohibition in a legal text is not sufficient in order to establish such protection – it must be supported by adequate legal enforcement mechanisms, including preventive measures such as planning systems and systems of prior consent. The Commission highlights the French system with species protection through forest management plans as an example (European Commission 2007). The Swedish legal framework on forest management, to a large extent lack such enforcement mechanisms (Forsberg, 2012). Research on ecological landscape planning has to some extent already been presented (Angelstam 1997) but the research on legal implementation of such plans is less developed (Christiernsson 2011). Furthermore, if exceptions from legal restrictions are introduced in the forestry legislation to allow for intensive forestry in areas where conservation values are insignificant, spatial planning is an important instrument to identify such areas. Without such planning, it would be necessary to require individual exemptions and the conservation values, e.g. the continued ecological

functionality of breeding sites, would have to be assessed in each case. Such a system would presumably be very complex and costly to administer (Michanek and Petterson 2010).

Previous economic research on landscape perspectives for biodiversity conservation has focused on voluntary, financial incentives, solutions being varieties of agglomeration bonuses – mechanisms that use financial incentives to induce landowners to voluntarily protect habitat into one contiguous area over private borders (Parkhurst et al. 2002, Parkhurst & Shogren 2007). However, this generally disregards the fact that the area of biodiversity rich land may be unevenly distributed between landowners and rarely discusses how a system should be financed. Applying a landscape perspective would most likely imply a very uneven distribution of restrictions in the right to use the land, as some forest estates have significantly higher biodiversity values than others. There is a need for policy instruments that can address such inequalities.

The hypothesis of this project is that a novel landscape planning approach can be used to address these deficiencies and serve as a tool to manage nature's dynamic character and implement legal requirements. Although planning incurs costs and may challenge the rights of property owners, by implementing a coordinated system both misgivings can be addressed. In particular, the approach seeks to amalgamate a model for forestry strategies based on landscape ecological theories, a legal framework for sustainable forestry and an environmental tax-fund policy to internalize the cost of conservation and to address equity concerns.

3. Project description, theory and method

Package 1: Model for landscape strategies and planning-simulation study

The aim of the simulation study is to make a general framework for theoretical landscape plans, in which the legal study in package 2 and the economic study in package 3 will be based upon. We will capitalize on an already prepared model landscape based on data from a landscape in the province of Värmland, western Sweden (Hof and Hjältén, unpublished data), in which different scenarios for conservation and forestry will be used. Information about current management strategies such as the average size of a clear-cut, average amount of forest that is being clear-cut or thinned each year, economic values of tree species, etc. will be taken from the Swedish forestry statistics from 2013 (Nilsson and Cory 2013). Conservation scenarios will be based on recent knowledge in conservation biology (e.g. concerning substrate requirement, dispersal, connectivity etc.), in order to optimise the survival for conservation species in the forest landscape of Värmland. An ideal focus species is the white-backed woodpecker (*Dendrocopos leucotos).* This species is an umbrella species, and the protection of such species may serve the protection of a range of other species (Roberge et al. 2008). Furthermore, habitat requirements for this species are well known (e.g. Aulén 1988), and a large restoration project is already in place. Conservation scenarios can be based upon restoration efforts in this project plan (Naturvårdsverket 2005). The plan will be made in cooperation with end-users, in order to optimize both conservation and forestry at a landscape level. In combination, the ecological study, the legal study and the economic study will serve

as a model for how implementation of landscape strategies in real forest landscapes might be possible.

Landscape planning may be carried out in many different ways, depending on the goals of the plan. In this study we will use a simulation approach based on scenarios for different landscape configurations and the goal with the landscape plan is related to the environmental objective "A rich diversity of animals and plants" which states that species must be able to survive in long-term viable populations. This means a need for the continued ecological functionality of breeding sites or resting places, as is also required under the Habitats Directive. In short this means that we will make landscape plans with high connectivity of key resources such as dead wood, old living trees, and deciduous trees, required by conservation species in this specific landscape of which several are listed under Annex 4 in the Habitats Directive, and under Annex 1 in the Birds Directive (2009/147/EC). To be able to do this we start with a model landscape (baseline scenario) with known distribution of key resources.

Baseline scenario: We have identified an area of about 125 km^2 and created a base landscape[1] in a forest simulation software (described below). Within this landscape there is a multitude of landowners and each forest estate has its specific characteristics in terms of key resources for biodiversity. In the baseline scenario we will simulate business-as-usual biodiversity conservation with 5% set aside of each estate and a level of nature consideration of 3-4% green tree retention at final harvest, selecting the stands and trees with the highest nature conservation value following a procedure developed by Drakenberg and Lindhe (1999), which is commonly used in practical forestry. We will simulate forest development over 100 years and evaluate the change in amount of key resources for biodiversity as well as the timber production in the landscape.

Model scenarios: In the model scenarios we will, in cooperation with legal and economic researchers in package 2 and 3, alter the distribution of key resources at the onset of the simulation – from a totally even distribution of key resources for biodiversity over the estates to a completely uneven distribution where all resources are concentrated on a few estates. As in the baseline scenario we will simulate development of both biodiversity key resources and timber over a 100-year period in the landscape, but in addition we will compare the business-as-usual biodiversity conservation approach with a landscape ecological approach where the amount of biodiversity key resources at the end of the simulation will be optimized. In these model scenarios different management alternatives will be applied where e.g. less considerations towards biodiversity conservation will be demanded on estates lacking biodiversity key resources. Hence, in these model scenarios there will a differentiation among estates varying from higher to lower demands for biodiversity conservation as compared with current legislation.

We will use LANDIS-II, developed for simulations in boreal forests, which allows the simulation of forest dynamics over large spatial scales and long timescales, accounting for individual tree species, biomass accumulation and decomposition, seed dispersal, disturbances such as wind-throw, fire, pests, harvesting, and for climate change (Mladenoff 2004, Scheller *et al* 2007, Steenberg *et al* 2011). LANDIS-II is the core model to which various optional extensions can be linked to incorporate a number of ecological processes, such as the effect of

fire, harvesting, pests, and the effect of changes in the ecosystem on the carbon pool (Scheller and Domingo 2011). The user is able to enter an unlimited number of user defined harvest and management scenarios. This makes LANDIS-II an ideal tool for simulating scenarios with both varying landscape configurations and varying management strategies. The model requires information about the current state of the forest and the environment, which will be obtained from KNN-Sweden (http://skogskarta.slu.se/). These data contain amongst others information on age, species, and timber stock of the woodlands in Sweden at a 25x25m scale. The forest estimates are based on forest data from the Swedish National Forest Inventory (NFI) combined with satellite images from SPOT 4 and SPOT 5 (Reese *et al* 2003). Potential effects of climate change on forest ecosystems can be accounted for in LANDIS-II. These data will be obtained from different sources through the Earth System Grid Federation (http://pcmdi9.llnl.gov/esgf-web-fe/). Specific species data required will be obtained from the literature.

Strict validation of models that simulate into the future is not possible since the future has yet to come. Both Landis-II and PNET have however been thoroughly validated (e.g. Ollinger et al., 1998; Scheller and Mladenoff, 2004). Furthermore, at the beginning of each simulation LANDIS-II does a spin-up to calculate the living and dead biomass values estimated for each site, which cannot be supplied by the user (Scheller 2012). To evaluate the ability of LANDIS-II to simulate the forest biomass dynamics in our study region, we will compare the forest composition simulated by the model at year 0 with the actual forest composition as reported by KNN-Sweden using Pearson correlation and the root-mean-square error (RMSE) following Thompson et al (2011). Model parameters can be adjusted until high correlation and low root-mean square errors have been attained.

The output of the simulations consists of a large range of maps of the study region for each year the simulation is running and from which data with regard to the yearly forest composition, structure and distribution can be extracted. Examples include data on timber volume per species, maximum age, biomass and distribution of the tree species, the volume of dead wood, aboveground and belowground net primary production, spatial and temporal distribution and frequency and severity of disturbances like fire and pests, spatial and temporal allocation of harvest prescriptions, biomass of tree species per age-cohort, the spatial and temporal distribution of tree species through the landscape including that of clear-cuts, species-specific dominated forest patches, age and species-specific dominated forest patches, forested and non-forested areas, and so on. These outputs will be analyzed to get a better understanding of the effect of different forest management practices on the forests' structure and timber production. Since high structural and compositional complexity in forests are thought to be good indicators for high forest biodiversity (D'Amato *et al* 2011, Lindenmayer *et al* 2000, Strassburg *et al* 2010), this knowledge is relevant to assess the value of forests for species diversity.

Package 2: Legal implementation of an ecosystem approach through landscape planning

The purpose of package 2 is to develop a legal system for implementation of the landscape strategy presented under package 1. This new legal instrument will fill a gap in the current legislation, which fails to provide for sustainable forest management; although one of the

objectives of the Swedish Forestry Act is to conserve biodiversity, there are no legal rules to effectively implement this objective. This entails that valuable sites for protected species continue to be harvested in accordance with the Swedish Forestry Act, but in conflict with environmental objectives and, in many cases, EU law (Forsberg 2012). At the same time, another environmental goal is to reduce climate impact. Forest biomass serves as an important factor to facilitate the transition to renewable fuels. A new forest management system should therefore encompass both these environmental objectives.

A key problem in legal implementation of environmental goals is to handle a dynamic nature with unpredictable alterations. According to the CBD, the management of natural resources should be based on an ecosystem approach and be able to handle inevitable changes in nature (COP 5 decision V/6). The legal system often aims at conserving established legal positions, to protect e.g. the rights of a land owner or a permit holder. A challenge for legal science today is to develop efficient and appropriate functions in law to meet nature's dynamic character while respecting the rule of law and avoiding non-proportional effects on individuals' legal rights.

In conservation biology research, the need for planning and managing the landscape in various scales is often highlighted (*Angelstam 2010*). Under package 2 we will study how the legal framework for sustainable forest management can be enhanced by introducing provisions on ecological planning at different levels; (preliminary) a strategic, tactical and operational level, and the legal consequences on such plans, not least in relation to land property rights.

To illustrate, legal forest planning may basically be constructed as follows. *The strategic level* refers to a strategic landscape plan as produced under package 1. The purpose of *the tactical level* is to implement the strategic planning through regional plans adopted as formal legal documents governing the forest management. These plans should aim at identifying where conservation measures should be prioritized in order to create functional ecological networks at a landscape level. From a legal perspective, it is necessary to identify breeding sites and resting places for the species listed under the Habitats Directive. The planning should also indicate areas that could be used for more or less intensive forestry production (Michanek and Pettersson 2010). *The operational level* refers to forest management plans designed to enforce the regional landscape plan. These forestry plans should classify each forest stand on the basis of the requirements on management and preservation as described by the regional plan, i.e. describe where and how timber extraction may take place and where preservation and restoration measures are needed. The forestry plan should form the basis for assessing whether a felling is in line with the Forestry Act.

The implementation of an ecological landscape planning as suggested in P1 involves the following legal research questions:

What kind of landscape approaches have been used in Sweden so far?
The first step is to inventory and critically analyse Swedish instruments for management and planning of land and natural resources, used today and historically, that in some way have implications for forest management; e.g. the spatial planning at various levels; Forestry plans;

Regional Landscape Strategies; and KOMET (Kompletterande metoder vid skydd av värdefull natur [Complementing Methods to Protect Valuable Sites]). Previous research on the subject (Forsberg 2012) should be updated. A joint workshop will be held during year one, where feedback from stakeholders on the functioning of current instruments and approaches will be provided. The inventory is expected to serve as a background.

Are there useful examples of landscape planning in other states?

The next step is to conduct comparative studies on existing landscape planning systems. The project will first conduct a broad survey of national landscape planning systems in different countries and select those which are of interest with regard to the objective of this project. It is already clear that the French and Finnish planning systems are among those that will be closely scrutinised.

The French forestry planning is e.g. considered by the EU Commission as a useful approach to implement the Habitats Directive (European Commission 2007). The implementation of the French forestry law is supported by different types of management plans at different levels (national, regional, local). These documents are approved by the administrative authorities and take full account of protected habitats and species. The French forestry plans go beyond the protection of current species and habitats. They also target the long-term viability of species populations, taking into account their conservation needs over time as well as space.

In Finland, legal changes have been made in order to fulfil the obligations under the Habitats Directive to protect the flying squirrel. To enhance the protection of breeding sites and resting places, a new notification system for forestry operations has been established, based on scientific data extracted from a landscape level. The Finnish model is also taken as an example on how to implement the Habitats Directive (European Commission 2017), and may provide deeper understanding of how the Swedish system can be improved but also of the problems to be avoided in the creation of a new legal planning model. The French and the Finnish examples will be analysed with a legal comparative method.

What can be drawn from other forms of legal planning of land and natural resources?

The project will investigate and discuss if approaches and components used in various planning instruments should be considered also for forestry planning. A specific question is how *adaptive* forestry planning should be construed in order to meet new demands, in particular due to the dynamics in forest ecosystems. We will therefore also study to what extent the Ecosystem Approach and existing adaptive planning systems, in e.g. the Water Framework Directive, could be transformed into planning of forest landscapes. These studies will be conducted with the legal dogmatic method, which means that the sources of law (legislation, preparatory works, case law, doctrine) will be studied and analysed (Hellner 2001).

To what extent could landscape planning interfere with the protection of property rights?
A number of legal issues need to be addressed regarding landscape planning and the right of compensation due to restrictions on ongoing land use granted by the Swedish Constitution (Chap. 2 sec. 15 Instrument of Government). Conflicts with property rights may occur if planning is given a direct binding force. What legal status a plan at various spatial levels should be given is therefore not easily decided. In a second phase of work package two, research will be carried out on how the boundaries of property rights affect and limit the possibility to regulate protection of natural values.

Previous research indicates different approaches in various states as regards what kind of nature conservation restrictions a land owner should tolerate without economic compensation (Michanek 1995). This comparative legal research, including the Swedish approach, should be updated and deepened. On a principal level, the discussion should also relate to the polluters pay principle, users pay principles and the European Convention on Human Rights.

How could legal planning at various levels be designed?
Given the results from package 1 and the findings of the above research questions in package 2, the following research step is to discuss alternative solutions on how to construct a new legal landscape planning system for sustainable forestry (see example above).

What additional legal changes and instruments should be considered in order to implement landscape planning?
In a final phase of work package 2, the consequences of the proposed legal planning system will be addressed. If the proposed planning system e.g. results in legal requirements beyond the level of what property owners are obliged to take without compensation – how can the legal system be linked to an environmental fund system where such environmental considerations can be financed? This research question will be analyzed in close cooperation with work package 3 and discussed during a joint workshop in year 3.

Theory and method
Work package 2 will be carried out on the basis of the environmental law methodology (e.g. Westerlund 2003, Christiernsson 2011). This means basically that legal instruments are analysed and discussed with respect to the function of implementing environmental objectives (e.g. sustainable forestry) and with special reference to the ecological preconditions (in this project indicated in package 1). To interpret and analyse applicable law, the legal dogmatic method will be used, i.e. the study of legal sources (Hellner 2001). A legal comparative method is used when analysing the French and Finnish (and possibly other nations) forestry planning (Zweigert and Kötz 1998). This necessitates a prior understanding of the wider legal context in the foreign state studied, especially as regards land and planning law and the protection of land property rights. However, the purpose of the comparative study is not a comparison of the legal systems as such, but to find inspiration for planning constructs possible to use in Swedish legislation.

Package 3: Forest policy measures for the landscape

Package 2 will derive findings on the extent to which compensation is required to implement landscape planning. Package 1 will provide details on different landscape scenarios. Package 3 sets out to design a novel environmental tax-fund system to provide for compensation and to achieve defined landscape scenarios.

In this policy, the fund would be alimented through a form of tree felling-tax and would redistribute the proceeds as a type of Payment for Environmental Service (PES). The aim of this funding scheme is to address the problems inherent in the uneven shares of conserved area among different land-owners necessary to realize the landscape scenarios developed in package 1.

Ideally, this tax-fund system should score high in terms of environmental goal achievement, be cost effective and involve low transaction costs, be transparent and politically acceptable, while at the same time not stifle forest owners' intrinsic motivations for conservation. It may be difficult (or even impossible) to fulfill all of these criteria simultaneously, but at least they can serve as evaluation framework for different combinations of felling-tax and PES policy designs and help identify possible trade-offs.

Scenario selection

The initial task will be to select 3-4 different scenarios developed in package 1. The scenarios will be chosen subject to guidance from Package 2.

The selected scenarios will also be discussed in expert interviews with representatives of the Swedish EPA (Naturvårdsverket), Östergötland County Administrative Board, the County Forestry Board, and the Forest Owners' Associations. Stakeholder inclusion from the beginning of the project is important to achieve political acceptability of the results.

Policy design and evaluation

The next step of the research is to design a tax-fund system, which will back up the legal forestry plans, where the fund financed through the tree felling-tax fully compensates the forestry restrictions imposed through the landscape scenarios. This will internalize the cost for ecosystem services and address equity concerns by creating a more even distribution of the costs of conservation measures. In a first design stage, the development of methods for imposing the tax, e.g. equitably (i.e. same amount per tree) or differentiated (e.g. more for old trees or trees in an ecologically important areas) must be clarified because the mechanism chosen to levy the tax itself has regulatory steering power.

Second, the methods for redistribution must be developed. Examples of methods include simple first comes first served projects, bid auctions (Ferraro, 2008), or conservation performance payments where payments are contingent on measurable environmental indicators. Sweden has pioneered the latter approach in wildlife conservation, while Finland (through the Metso-programme) and Sweden (through the Komet-programme) has attempted to do the same for forest biodiversity conservation (Zabel and Holm-Müller 2008; Zabel et al. 2011, Horne, 2006, Forsberg, 2012). An evaluation framework will be developed to rank different policy alternatives according to factors such as their propensity to attain the

previously defined environmental goal, their cost-effectiveness, transparency and political acceptability.

Stakeholder workshops and stated choice experiment
The policy design results will be presented and discussed at a stakeholder workshop that will be conducted close to the main study site. Feedback from forest owners, the County Administrative Board, and the County Forestry Board will help understand the political acceptability of the different approaches and may provide guidance for policy refinement.

Based on the workshop, two to three of the most promising policies will be selected for further analysis. A stated choice experiment will be developed and sent to forest owners in the form of a mail survey. The respondents will be confronted with different policy alternatives and landscape scenarios that will be made very explicit with amounts of money to be paid, respectively amounts that can be obtained for improvements in forest conservation. Next to this stated choice experiment, socio-economic information will be collected. Econometric analysis of the survey data will allow to conclude on forest owners' sensitivity towards a variation in monetary amounts within the same policy approach and, keeping amounts constant, across policy approaches.

Financial effects of this landscape strategy for conservation for individual land-owners
The final sub-package is to analyze the financial effects of the landscape strategies (with input from Packages 1, 2 and 3) for individual land-owners and the government. Such an analysis can also confirm that the even cost distribution between land owners - which is one of the main objectives of the scheme - is achieved. The natural measure to use here is the present value, also known as the soil expectation value, before and after the implementation of the tax-fund model. Concerning effects for the government, the ambition in the policy design stage is to create a fully funded system, i.e. the net effects for the government should be zero, but this needs to be confirmed using a representative sample of forest estates.

4. Practical relevance

Forest biodiversity is in decline due to unsustainable land use, which might lead to the loss of ecosystem services. The value of this research is to present legal instruments for ecologically sustainable forestry in which national targets are met and international agreements are fulfilled.

The result of package 1 will be a model for landscape planning. Probably, landscape planning is needed to be able to fulfil environmental goal and to combine forestry with conservation. Therefor it is important to present examples based on research. We believe that our example will have high relevance to finding a general model for landscape planning.

The findings and alternative solutions in Package 2 will provide a base for political decisions on future amendments in the Swedish legislation. A new legal framework for forestry landscape planning should create preconditions for implementation of the Swedish environmental objectives Sustainable Forests, A Rich Diversity of Plant and Animal Life and

Reduced Climate Impact, as well as several of Sweden's international commitments such as the obligations on species protection under the Habitats Directive.

The result of package 3 shall be a document describing a set of alternative policy designs for the tax-fond system along with a systematic evaluation of each alternative. At the national level, the results are expected to provide novel ideas on how to meet the Swedish Environmental Objective "Sustainable Forests". The knowledge gained through this project will aid decision makers make well-founded, informed choices.

Internationally, there is a nascent interest in this type of tax-fund system in forestry. Recently, the State of California has imposed a 1% tax on lumber products (which are largely imported to California from other states). The proceeds are earmarked for the enhancement of ecosystem service provision, in particular fire prevention investments within Californian forests (Bill number AB1492).

5. Organisation and management

Anouschka Hof (PhD) provides expertise on modeling techniques (LANDIS-II). She is currently a postdoctoral researcher at the Forest Ecosystem and Landscape Ecology Lab of the Department of Forest and Wildlife Ecology at the University of Wisconsin-Madison in the USA. LANDIS-II has been developed in this lab and expert input is therefore secured. She focuses on the effects of future climate change on species and biodiversity in boreal forests, using a variety of modeling techniques (e.g. LANDIS-II and Species Distribution Modelling techniques). She further has expertise in vertebrate ecology. She already has a number of peer-reviewed publications and a book chapter on this topic, showing that she is in an excellent position to conduct the proposed research.

Jörgen Rudolphi (PhD) has extensive experience in conservation biology. His research has mainly focused on the effects of different forest management systems on biodiversity. Currently he holds a permanent position as a researcher at the Department of Wildlife, Fish, and Environmental Studies at SLU, Umeå.

Johnny de Jong (PhD) works as a research leader at the Swedish Biodiversity Centre. He is specialized in conservation biology, landscape strategies and forestry. In this project Johnny will be responsible, together with Jörgen Rudolphi and Anouschka Hof, for the landscape planning, i.e. selecting model species and forest variables to put into the model.

Gabriel Michanek is professor of environmental law at the Faculty of Law, Uppsala University. He has long experience from legal research in, inter alia, protection of biodiversity, management of forests, water and other natural resources (including conflicts with property rights) and transformation to energy systems.

Maria Forsberg (LL.D in environmental law) works as a lecturer at the Faculty of Law, Uppsala University, and as a researcher at the Swedish Biodiversity Centre. She is specialized in biodiversity law and forestry law.

Göran Bostedt is associate professor and senior researcher at the Swedish University of Agricultural Sciences, Umeå, Sweden, and also part-time lecturer at Umeå University. His work has focused on several aspects of environmental and resource economics, partly dealing with environmental policy design.

Astrid Zabel is senior lecturer at the Bern University of Applied Sciences, Switzerland, and has conducted research in environmental policy design with a focus on market based instruments. Next to modelling and econometric analysis, stakeholder engagement has been a crucial component of her previous work in Sweden and Switzerland as well as in developing countries.

Hans Ekvall has worked as senior lecturer at the Swedish University of Agricultural Sciences, Umeå, Sweden, and his work has focused on economic planning for nonindustrial forest owners and costs for increased biodiversity.

6. External networks

Anouschka Hof and Jörgen Rudolphi are part of FOREST BIOCORE, a research group at the Department of Wildlife, Fish, and Environmental Studies, SLU-Umeå, and at the Department of Ecology and Environmental Science, Umeå University. The group works, along with associated researchers, on challenges associated with biodiversity**,** conservation and restoration in mainly boreal forest landscapes. Hof is also part of the international LANDIS-II community, assuring input with regard to forest landscape modelling from experts.

Maria Forsberg and Gabriel Michanek are part of a research group at the Faculty of Law in Uppsala University. The group, highly ranked in an international research evaluation 2011 (KoF 11, p. 246), arranges internal and external seminars continuously. In addition, environmental law scholars from all Nordic countries have since early 1990's been organized in networks (CeSam, NELN, Norsel) and the Nordic cooperation is intensive today, in form of mutual conferences and seminars and through direct contacts. The environmental law group in Uppsala is also closely cooperating with research colleagues in other states (e.g. in a global comparative project concerning the legal definition of "forest"), US (e.g. Vermont Law School and Law Faculty in Pace University) and China (law institutions in several universities).

Göran Bostedt, Astrid Zabel and Hans Ekvall, are active in the Swedish and Swiss as well as international research communities on forest economics and environmental policy design. Research results are planned to be presented at the annual Conference of the European Association of Environmental and Resource Economists, EAERE.

7. Plan for publication of data

Scientific publication in peer-reviewed journals and popular journals and a synthesis report on forest landscape planning.

Planned publications for P1:

- Methods for landscape planning based on model species and simulation with Landis II will be one separate scientific article. Besides that the conservation part of the project will be published together with the result from the other work-packages in the synthesis report.

Planned publications for P2:

- Forest planning in France and Finland – comparison with Sweden. Scientific article in peer review journal.
- New forestry planning and conflicts with property rights. Scientific article in peer review journal.
- A new forestry planning for Sweden – A discussion of alternatives and coordination with current legislation. Scientific article in peer review journal.
- Compensation through economic tax-fund system due to legal requirements in forest management. Scientific article in peer review journal written together with researcher from package 3.
- Working papers (published) related to the topics above.

Planned publications for P3:

- Scientific article taking an interdisciplinary perspective for the development of the working-definition of the environmental goal that is to be achieved through the fund system, to be written together with researchers from package 1.
- Scientific article presenting and discussing design options of the tax-fund system. Working paper version to serve as input to the policy discussion process; workshop feedback will later be incorporated into the paper.
- Scientific article presenting results from the stated choice experiment sent to forest owners.
- Scientific article on the financial effects of the landscape strategy for individual land-owners and the government.

Project publication

- Synthesis report addressed to Swedish authorities and political decision makers.

8. Communication

Communication with stakeholders is an essential part of this research. As described above, stakeholder feedback will directly feed into the research in terms of selection of policy alternatives for further analysis. Stakeholders that will be invited to the workshop include forest owners, the County Administrative Board, the County Forestry Board, the Swedish Environmental Protection Agency and NGOs.

Workshops: two workshops will be held; one in year 1, and one in year 3.

Conference: A closing conference will be held at the end of the project in 2018 where research results will be presented. Stakeholders that will be invited include forest owners, the County Administrative Board, the County Forestry Board, the Swedish Environmental Protection Agency and ENGOs. In order to facilitate stakeholder participation, the conference will have the function of a "webinar", i.e. the project presentations and discussion will be

filmed during the conference and made public at the university website. Those who attend the conference online will then be able to send comments by mail.

The research results will also be presented at national and international conferences.

9. Activity plan

2016

Workshop with end-users concerning landscape scenarios and modelling (all)
Landscape modelling (AH, JdJ, JR)
Comparative study on the French and Finnish planning system (MF, GM)
Research on property rights in relation to the user pays principle. (MF, GM)
Define environmental goal to be achieved through tax-fund system (all)
Design a set of alternative policy designs for the tax-fond system (GB, AZ)

2017

Stakeholder workshop (tax-fund system, all)
Send out questionnaire (mail survey, GB, AZvF)
Research on property rights in relation to landscape planning (MF, GM)
Comparative study on different adaptive planning systems (MF, GM)
Construction of a legal implementation of landscape planning (MF, GM)

2018

Econometric analysis of survey data (GB, AZ)
Analysis of financial effects (HE)
Synthesis of tools for landscape planning, juridical and economic policy tools (all)
Stakeholder workshop (all)
Papers for publication in peer-reviewed journals and popular journals (all)