REPORT

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POLICYMIX - Assessing the role of economic instruments in policy mixes for biodiversity conservation and ecosystem services provision

Assessment of existing and proposed policy instruments for biodiversity conservation in Norway

David N. Barton, Henrik Lindhjem, Graciela M. Rusch, Anne Sverdrup-Thygeson, Stefan Blumentrath, Maja D. Sørheim, Hanne Svarstad, Vegard Gundersen

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David N. Barton (NINA), Henrik Lindhjem (NINA), Graciela M. Rusch (NINA), Anne Sverdrup-Thygeson (NINA and Norwegian University of Life Sciences, Department of Ecology and Natural Resource Management, INA), Stefan Blumentrath (NINA), Maja D. Sørheim (NTNU), Hanne Svarstad (NINA), Vegard Gundersen (NINA)
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Spruce forest, Norway. Photo by Vegard Gundersen

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CONTACT DETAILS
Henrik Lindhjem
Norwegian Institute for Nature Research
Gaustadalléen 21
N- 0349 Oslo
Norway
Henrik.Lindhjem@nina.no

Index

Summary and conclusions

Abstract

This is a summary description of the coarse grain analysis for Norway and a description of further research questions and tasks for fine grain, local case studies that come out of the coarse grain analysis.

Introduction and background

In June 2009, Norway established a Nature Diversity Act, which includes all previous laws related to land use and biodiversity in one act. This act is the most important legal framework for all future regulatory and economic instruments in the area of forest and biodiversity conservation – both inside and outside protected areas.

Forests cover around 40% of the Norwegian land area of which only around 10% are owned by the state or municipalities. The rest is owned privately or by local common property institutions. Currently 2.5% of productive forests are protected, while a much cited biological evaluation recommended 4.6% as a minimum to achieve biodiversity/landscape protection goals. The main challenge in Norway is thus to create incentives for private forest owners to take biodiversity and ecosystem services into account, beyond what they would otherwise do, in their forestry and other land-use activities.

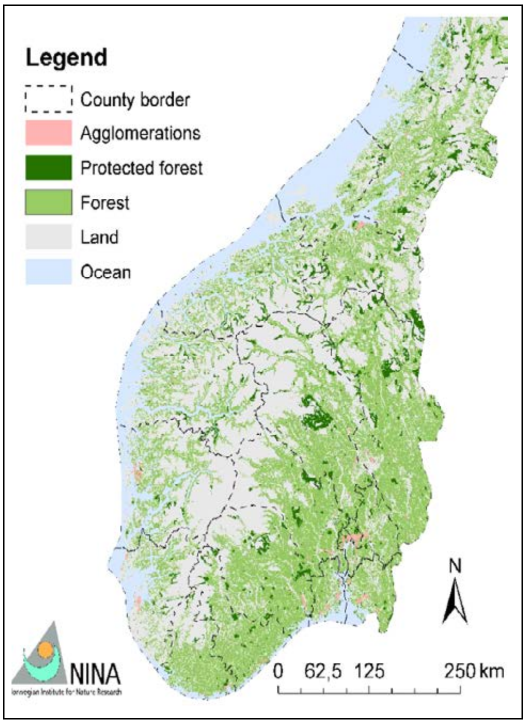

Figure 1: Southern part of Norway

National level coarse grain analysis

Main economic instruments in use in forest/biodiversity conservation and related regulatory instruments

Traditionally, the main regulatory instrument has been state appropriation of private forest land for forest reserves against compensation based on the value of the standing timber. This approach was the source of conflicts between forest owners, the state and environmental NGOs in the 1990s and can be viewed a "command-and-control" instrument, despite the monetary transfers involved.

In 2000, the national forest owner association proposed a new voluntary conservation approach (VCA), where forest owners report to the association areas available for protection, which are then negotiated with the state (or county). The rules of compensation are quite similar - the main difference compared to traditional conservation seems to lie in the process. Since 2003, nearly all new conservation processes have been in the voluntary form. The voluntary conservation approach may be viewed as more similar to a standard economic instrument.

There are currently few, if any, "pure" economic instruments in use in forestry conservation, or biodiversity conservation more generally, in Norway. Compensation (at the county level) can be obtained for setting aside areas of 'Complementary Hotspot Inventory' ("MiS" in Norwegian). Forest owners with biodiversity hotspots covering at least 1% of the productive forest area in their property can receive compensation (generally small amounts). Recently, forest owners with large areas of MiS can propose the establishment of a nature reserve on their property as part of the voluntary conservation approach and receive full compensation if the forest area fulfills the criteria for protection as a nature reserve.

In addition, grant schemes are proposed under the act outside protected areas to stimulate the conservation of what the act terms "priority species" and sustainable use of "selected habitat types". This is not compensation, but "positive incentives" that are meant to stimulate landowners, rights holders, organizations and municipalities to take care of these species and habitat types. The funds will go to measures to maintain priority species and selected habitat types, through active operational management or other measures that will help to maintain or restore the ecology of the area. A large part of forests that are actively managed are under certification (under the European Program for the Endorsement of Forest Certification Schemes). Certification is primarily a market-driven process, though government has to some extent been involved in setting the criteria.

Other direct regulations or wider economic instruments may also be important. There are a range of economic support schemes for forestry (and agriculture in forest areas) that potentially run counter to conservation objectives (e.g. planting exotic tree species, forest road construction, harvesting in difficult terrain). There is also a lack of integration of forest in environmental impact assessment in other sectors (e.g. of small scale hydropower development). Other direct regulation that affect biodiversity, include the forestry law and planning, building and other acts concerning land use and the right to environmental information act (which opens up for previously confidential biological and management information from private forest owners). There is also a new specific law ("Markaloven") governing the management of forests around Oslo for recreation purposes. A description of the relevant direct regulation instruments and sector instruments affecting conservation is given in section 3.2 and 3.3 of this report, respectively. The presentation of the main economic instruments in operation is given in sections 3.4-3.7.

New instruments under consideration or to be assessed

The new Nature Diversity Act provides the general framework for economic instruments affecting biodiversity and forests for the near to medium term. Other economic instruments may be conceivable for the longer term.

The relatively recent VCA is and will continue to be the backbone of government policy to increase forest conservation. More generally under the act, if the protection makes ongoing use more difficult, or if the protection prohibits ongoing use and the owner or the rights holders can document financial losses, this loss will be compensated by the Government. All forestry is classified as ongoing use and will be compensated if the protection makes the use more difficult or if the use is prohibited. The compensation rules have been simplified and better standardized (e.g. for different protection categories). Previously around 30% of the costs were due to lawyers and external experts (e.g. land valuations). There has been a small increase in the budget for protected areas, especially for operational management measures, which has received little emphasis until now. However, the main current impediment to voluntary conservation seems to be generally low budgets for compensation payments. The voluntary forest conservation approach will be central in our national and local case study assessments. One specific combination of instruments that may be considered in the fine grain analysis is the use of conservation auctions within the voluntary forest conservation scheme. We discuss this in section 4.4.

There is no allowance under the act for general compensation – fiscal ecological transfers (EFT) – to municipalities affected by protected areas. This was decided by the Government when they passed the Nature Diversity Act, without objection from the Norwegian Parliament. However, there is interest in exploring an EFT-type instrument that makes part of the current government transfers to municipalities depend on their contribution to a positive performance for the recently constructed Norwegian Nature Index. This is the subject of coarse and fine grain analysis (see sections 4.3, and 6).

For the longer term, at least four economic instruments may be worth sounding out and assessing in the project:

- Habitat banking and biodiversity offsets (see section 4.5).
- Subsidy reform (related to support schemes that round counter to conservation objectives) (see sections 4.2, 5 and 6)

Have instrument use or proposals been influenced by other countries?
Norway has a similar tradition as the other Nordic countries, especially Sweden and Finland, in terms of the right of access of everybody to forests owned privately. Both Sweden and Finland have had similar voluntary (and traditional) forest conservation schemes, to the Norwegian program. The introduction of voluntary schemes has been a response to the high conflict levels. While Finland through its METSO scheme has introduced innovative elements (e.g. “natural values trading”, auctions etc.), Norway has been more conservative in sticking to the voluntary scheme in an unaltered form since its conception. It is therefore hard to see any influence from e.g. Finland to conservation policy in this area. Although Norway is keen to promote PES internationally, nationally there are few if any real PES schemes. Hence, there is a divide between international ambitions and local actions. This is the case for many economic instruments that are promoted, by Norway and others, through the UN convention on Biological Diversity. At home the will to try out and finance economic instruments in conservation is very limited.

Analysis of instrument interactions – coarse and fine grain analysis
This report first presents some preliminary ideas for further exploration of instrument interactions for the fine grain analysis in section 5. This section presents results from a recent study that has investigated the spatial coverage of environmental restrictions in forestry and the specific overlap between different types of restrictions (from national parks and reserves to other protection categories). Further, areas that are generally not profitable for forestry, without specific subsidies (so-called “zero areas”), are singled out as specifically interesting for analysis for fine grain analysis, as these areas may be biologically valuable (since the areas are often located in steep and inaccessible terrain) and have low opportunity costs. Some ideas are presented on how incentives can be targeted, based on Table A.

Table A: Matrix of spatial functional roles of environmental regulation versus forestry subsidies on a specific forest location

Spatial overlap between row&column	Environmental regulation X is 100% effective	Environmental regulation X is <100% effective	"Zero area" only without current forestry subsidies	"Zero area" independently of current forestry subsidies
Environmental regulation Y is 100% effective	**Mutually redundant** (either X or Y)	Regulation X is **redundant**	Incentive is redundant and **unilaterally reinforcing** Y	Incentive is **redundant**
Environmental regulation Y is <100% effective	Regulation Y is **redundant**	**Mutually reinforcing**	Incentive is **conflicting** with Y	Incentive is **redundant**
"Zero area" only without current forestry subsidies	Incentive is redundant and **unilaterally reinforcing** X	Incentive is **conflicting** with X	The importance of the functional role will be measured by the area overlap as a % of productive forest area.	
"Zero area" independently of current forestry subsidies	Incentive is **redundant**	Incentive is **redundant**		

Note: Functional roles: 'conflicting (perverse)' , 'redundant' , 'unilaterally reinforcing' or 'mutually reinforcing'. Functional roles defined relative to an objective of forest biodiversity conservation.

The first part of chapter 6 (sections 6.1-6.6) presents an example (scoping) of a national level coarse grain analysis. We combine the Norwegian Nature Index (which measures "deviations" from a natural state) as a surrogate indicator of conservation value with a proxy measure for opportunity costs (i.e. forest productivity). We then analyze how national parks, voluntary conservation, nature reserves and other conservation areas "score" in the landscape on these two dimensions. This is used as basis and explored further in the fine grain analysis (see section 6.7).

Local fine grain analysis – further research tasks to be conducted

Based on the types of instruments and ecosystem services of interest and the conservation gaps related to forest biodiversity (as described in Chapter 2 of this report), South-Central Norway has been chosen as the geographical area of the case study (see map figure 2). The case study is divided into four interconnected tasks that are described in turn below.

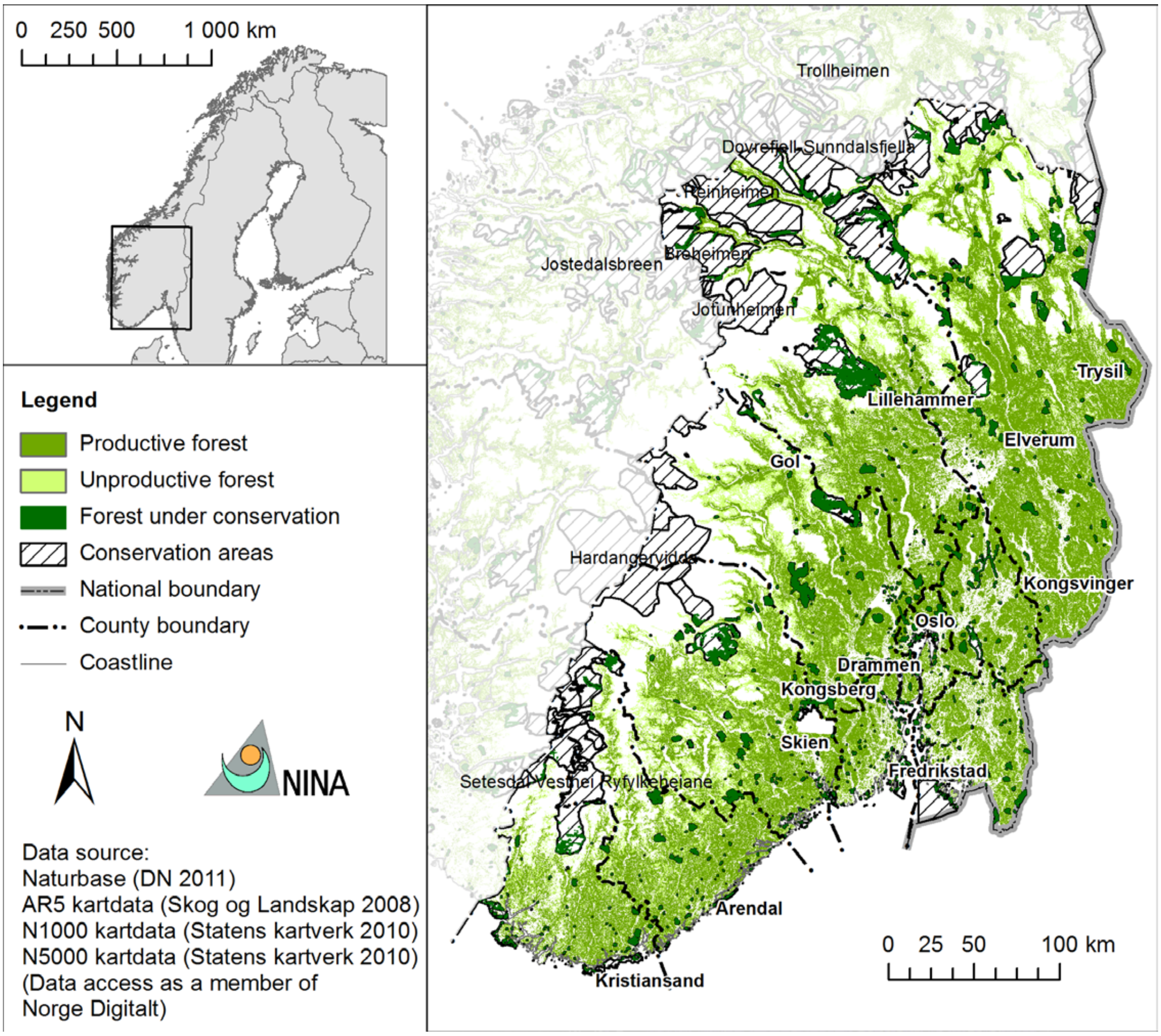

Figure 2: Study area, forest cover and protected area network in Southern Norway

Note: "Conservation areas" are the total areas, while "forest under conservation" is the part that is forest.

Prioritization of new conservation areas

In Norway, as internationally, protected areas are disproportionally located in relatively unproductive and biologically poorer areas. When moving towards 4.6% or even 10% protection as a share of productive forests in the longer term, new areas will have to be prioritized according to a combination of biological criteria and opportunity costs. On this background, this subtask will investigate how economic instruments can be spatially better targeted to achieve more "biology for the buck". Implementing cost-effective solutions will have to be based on an understanding of how instruments can motivate forest owners to achieve conservation goals, and especially to achieve larger, interconnected areas. Such instruments will likely have to be more complex to reach the targets. The objectives of this subtask are:

- Assess the impacts of forestry instruments (especially support for forest road building, harvesting in steep terrain, and VCA) with specific emphasis on areas that are not generally profitable for forestry activities ("zero areas").

- Assess the effects on biodiversity from further conservation in "zero areas" compared to other, underrepresented areas and the opportunity costs of forestry under different conservation scenarios.
- Assess the sensitivity of the conclusions by assessing the value of carbon sequestration and other ecosystem services (where data is available).

The analyses proposed here will be based on two types of datasets: (1) Statistical analysis of the country wide forestry inventory (not linked to GIS) and/or (2) Spatially explicit forest inventory data in the two counties of Buskerud and Telemark. Appropriate proxy indicators will be developed that can be used, together with opportunity cost data for forestry, in applications of Marxan for reserve site selection and prioritization. This part of the case study will primarily utilize the WP3 guidelines on ecological effectiveness and ecological surrogate indicators and the WP4 guidelines on costs and benefits. Examples of this type of analysis and questions for further analysis are given in Chapter 6.1-6.7.

Forest owners' and public preferences for voluntary forest conservation

This sub-activity will investigate the main conservation instrument, voluntary forest conservation approach (VCA), ex post and ex ante. We will also consider the effect of the use of auctions. Some of the following research questions will be sought addressed:

Ex post assessment:

- What are the experiences ("impacts") with voluntary forest conservation (VFC) in Norway? Main hurdles, challenges and opportunities?
- How do the actual compensations paid under the VFC compare with the government lead compensations?
- How do actual participation rates among forest owners compare with stated compensation rates?
- How can the VFC program be improved? Alone or in combination with other instruments? Are auctions an option?

Ex ante assessment:

- What would motivate forest owner participation and how can more cost-effective targeting of areas be achieved?
- What would be the forest owners' stated levels of compensations, would they be willing to forego timber revenue for protection and how does the compensation depend on observable characteristics of forest owners and their forests?
- What are people's preferences and willingness to pay for forest conservation – is more necessarily better?
- Comparing costs and benefits, what is the "optimal level" of voluntary forest conservation, in terms of percentage protected?
- What are people's and forest owners' preferences regarding alternative instruments?

This part of the case study will primarily utilize the WP4 guidelines on costs and benefits. There is also a link to WP5 (e.g. forest owners' opinions of the fairness of the conservation process and the compensation levels) and WP6 guidelines (e.g. institutional/process hurdles for more effective VFC instrument/process). Some of the WP5-related issues (fairness, conflict, legitimacy) will be investigated in the next subtask (see below). The data for this subtask comes from a series of stated preference surveys of forest owners and the general public that have been conducted. Data on actual compensations paid under the voluntary conservation program will also be collected, if possible, from the Directorate of Nature Management. The main "biological indicator" in the surveys of public preferences for conservation, and the link to WP3 guidelines, is the percentage of productive forest protected in reserves (and some very limited descriptions of what would happen to main species groups depending on the percentage share of forest protection). A more detailed description of this task is given in Chapter 6.8.

Legitimacy and social impacts of instruments

In this case study activity as part of the fine grain analysis, particularly drawing from the guideline in WP5, we apply a narrative analysis from sociology. This is a qualitative methodology to study the variety of ways that various actors tend to tell about a case. We have selected a case area with three municipalities in which an intense conflict took place a few years ago about the establishment of a protected area. Trillemarka-Rollagsfjell Nature Reserve was established by the government in 2008. It is an area of about 148.000 da in Buskerud county in south-east Norway (see figure 3).

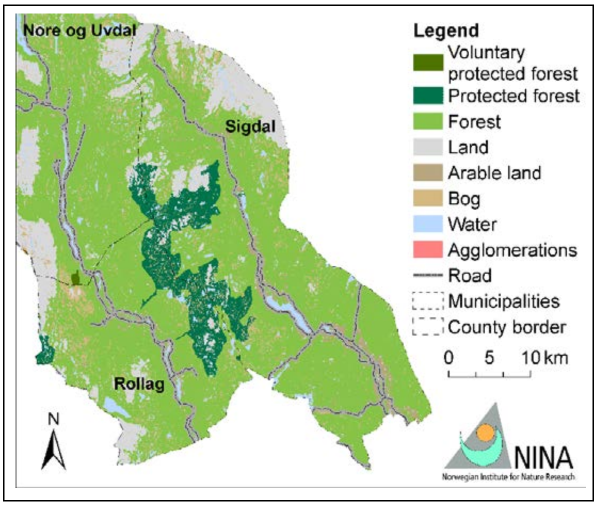

Figure 3 – Buskerud county

This constitutes the largest forest reserve in the country and the most high-profile cases of the classic approach to conservation in recent years.

Through analysis of written sources, such as newspaper coverage and opinion pieces, we look at varieties and patterns in ways that the planned protected area was narrated during the conflict. Furthermore, through qualitative interviews we reveal present narratives of the protected area. From the beginning, Trillemarka-Rollagsfjell must be seen as a more or less traditional case of "fortress conservation". Later on, however, substantial funds were offered from the central government to the involved municipalities and forest owners. Thus, we ask whether there is a change in the local production of narratives that indicates a changing "sense of justice" and legitimacy of the conservation. In the discussion of explanations of the findings, we will particularly look at the potential roles of procedural and distributional justice.

Within the same area of Buskerud county, we will also carry out a narrative analysis on a case of voluntary conservation, and in a comparison to the case of protected area, we will discuss explanations of the sense of justice also in this case. A description of this subtask is given in Chapter 6.9.

Ecological Fiscal transfers and the Norwegian Nature index

The Norwegian Nature Index (NNI) was recently developed to track status of different habitats and environments over time. There is work ongoing to disaggregate the NNI for forests to the municipality level. If reliable municipality level sub-indicators can be developed, they may conceivably be used to reward municipalities that achieve above-average progress in the value of the indicator (and improve the data coverage and provision to reduce the uncertainty in the index). This could be done by tying parts of the state transfer of funds to the municipal level, to ecological progress, i.e. a type of ecological fiscal transfer instrument. This subtask will look into the efficiency and distributional impacts of a hypothetical EFC instrument in Norway, and assess ways the instrument could be designed to give the highest impact on the indicator. There are links to several of the WP guidelines, and to the other subtasks described above.

1 Introduction

1.1 Background

Loss of biodiversity and important ecosystem services is one of the main challenges of environmental policy. Over the last few years economic instruments – policy mechanisms that provide pecuniary incentives to persons or entities who through their behavior may affect the environment – has been much discussed and gradually introduced in several countries. The rationale is that such instruments may be more effective – in terms of costs and results – than more traditional, regulatory instruments. However, there are also concerns that economic instruments may not fulfill their promise, especially as they function in the context of a range of other policy instruments that may be conflicting, complementary or overlapping. Investigating these issues from a national perspective in Norway is the aim of this report, which is deliverable D7.1.1 under the POLICYMIX project[1] funded by the European Commission. An outcome of the report will be clearer research questions and tasks for the local fine grain analysis that will be carried out under the project.

1.2 Research questions and objectives

The objectives of this report are to:

- Conduct a “coarse grain” assessment of the role of existing and potentially new economic instruments in policies for forest biodiversity conservation at the national level in Norway.
- Describe the legal and institutional context of these economic instruments to be assessed at the fine grain, more local, landscape and/or site specific level.[2]
- Provide the basis for cross-case comparisons of legal and institutional, and instrument roles context between different case studies in the project by using the POLICYMIX analysis framework (WP2) and assessment criteria proposed in the draft guidelines (WP3-WP6).
- Provide recommendations on improving policy mix analysis methodology and assessment criteria as a basis for updating draft Guidelines.
- Contribute policy impact and design conclusions to the EU, federal and national science-policy dialogue on economic instruments in biodiversity

The questions of particular interest are:

- How do *existing* economic instruments for biodiversity conservation function in Norway?
- How would *proposed or potential* economic instruments function?
- What are/would be the interactions between existing and new instruments and the broader set of instruments at work?
- Which instruments and instrument interactions are worthy of detailed case study analysis and how?

The report prepares the ground for more detailed regional/local assessments of priority instruments to be conducted in the forthcoming fine grain analysis. It also aims to provide inputs to the revision of WP3-WP6 guidelines for instrument assessment (se next section).

[1] “Assessing the role of economic instruments in policy mixes for biodiversity conservation and ecosystem services provision – POLICYMIX”. http://policymix.nina.no/

[2] I.e. Deliverable D7.1.2 Assessment of impact of proposed policy instruments for biodiversity conservation at local/municipal level in Norway.

1.3 Methods and clarifications

The "coarse grain" analysis in this report is mostly a desk-based review of relevant policy documents and literature on economic instruments in biodiversity conservation. In addition, we supplement the review with some analysis on the national level (Chapter 6). This analysis aims to correlate the biodiversity values of current protected area categories (national parks, reserves etc.) with the opportunity costs of protection. In this way, it is possible to identify whether current protection regimes have achieved to enroll those areas which potentially have the highest biodiversity to cost ratio. Looking ahead, this analysis can give relevant information when prioritizing where and how to expand the protected area network.

This report will primarily focus on policies related to conservation of biodiversity in forests. That means that we do not explicitly cover agro-forest systems or agricultural landscapes. Further, to simplify the analysis, we do not cover ecosystem services, as this concept is much broader than biodiversity. Following the policy mix analysis framework the report will also address some key policies and instruments in other sectors that are in synergy or conflict with forest biodiversity conservation.

The analysis of the role of economic instruments in the policy mix draws from the framework provided by Ring et al (2011) in WP2[3] (see Figure 4). In more detailed case study analysis to be conducted later, steps 2 and 3 will be repeated – iteratively – at a finer grain at local case study sites and in relation to specific land uses except at a finer grain (geographically and in other ways).

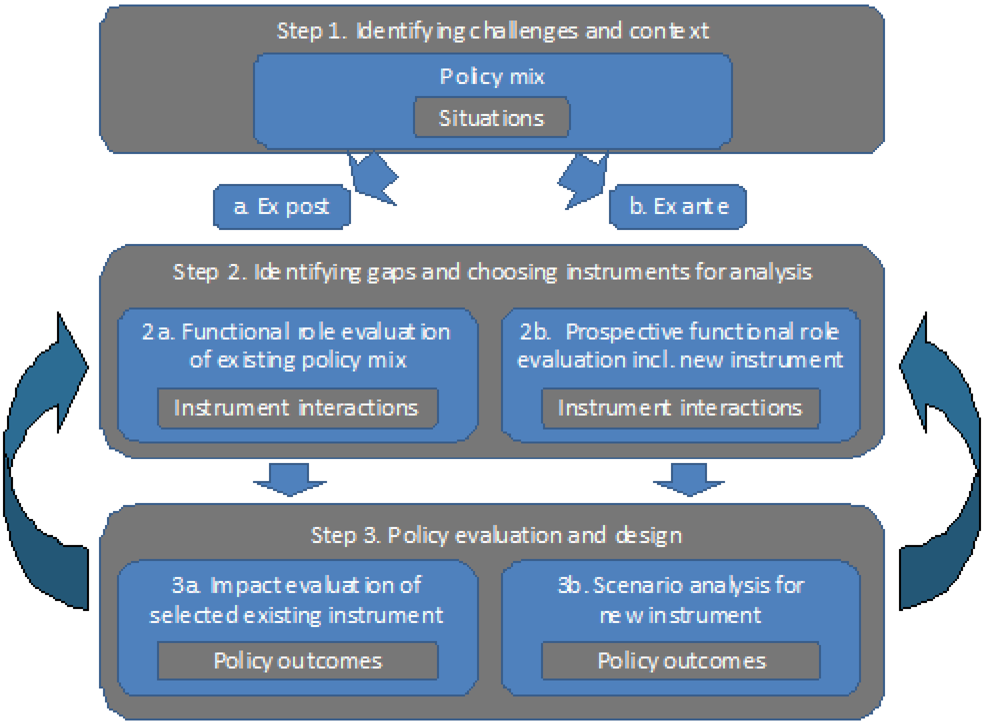

Figure 4: Policymix analysis framework and pathways

[3] See also WP2 Technical Brief 5.

Further, specific guidelines developed during the project's WP3-WP6 are used for the assessment under Step 3, i.e. how to assess individual instruments along the four important criteria of:

- Conservation effectiveness (WP3)
- Cost-effectiveness and benefits (WP4)
- Distributive impacts and legitimacy (WP5)
- Institutional options and constraints (WP6)

1.4 Case study comparisons - instrument, methodology and ecosystem services clusters

The POLICYMIX project contains seven case studies from six different countries. Table 1 gives an overview of comparative dimensions of instrument types for analysis and methodologies for detailed case study analysis (or for some, even at the national, coarse grain level).

Table 1 Elements of commonality and synergies between case studies

Case clusters			**Costa Rica**	**Mato Grosso**	**São Paulo**	**Portugal**	**Fin-land**	**Germany**	**Norway**
Instrument		**Specification**							
	REDD+	international/national	P	P	P				
	EFT	national/state		C&P	C	C&P		P	P
	Certification	national/state	C	C			C		C
	Offsets/TDR /HB	national/state		C	C				(P)
	PES	national / state agri-env.	C	C&P	C&P	C	C	C	C
		project /local		C	C				
		C=current, P=proposed or potential. Table includes only economic instruments addressed in 2 or more case studies							
Methodologies		*Only methodologies addressed in 2 or more cases studies*							
WP3	**GIS mapping**								
		Composite B&ES indices	?	?		?		?	X
		Biodiversity & habitat quality	X	X	X	X	X	X	X
		Pollination&pest control	X	X	X				
		Carbon & timber	X	X	X	X	X	X	X
		Run-off &infiltration&erosion	X		X	X		X	
		Non-timber forest products	X	X					
		Recreation	X					X	X
		? = subject to findings of the coarse grain analysis							
	Landowner & forest user surveys								
WP4 & WP5		Value transfer - available datasets	?	?					X
		Choice experiment - contract design				X		X	
		Opportunity costs	X	X	X	X	X	X	X
		Transaction costs	X	X	?	?	X	X	X
		Social impact & legitimacy				X	X		X

		? = subject to findings of the coarse grain analysis							
WP6	**Existing instrument evolution, path dependency**		X	?	?	X	?	?	X
	Proposed instrument architecture		X	X	X	X	X	X	X
WP3-WP4..WP9	**BACI:Before-after-control-impact evaluation**		PES	EFT		?	PES		
WP3-WP6..WP9	**Scenario evaluation, incl. GIS mapping**			EFT				EFT	
WP3-WP6..WP9	**MCA: Multi-criteria analysis**								
		MacBeth , other MCA software	?		X		?		?
		Marxan - spatial site selection	X			?	?		X

1.5 Outline of report

The outline of the report is as follows. Chapter 2 provides thorough overview of the biodiversity status, challenges and context for biodiversity conservation policy in Norway. This is drafted loosely based on Step 1 in the policy mix analysis framework described in the previous section. We also provide a timeline describing when key policy instruments were introduced in Norway. Chapter 3 provides the assessment of the most important current economic instruments along the four criteria mentioned in the previous section. We also give a brief background to direct regulation and other instruments (economic or otherwise) that may be important for the assessment of instrument interactions. Chapter 4 follows the same logic as chapter 3, except that a number of proposed or potential economic instruments are briefly assessed. These two chapters draw from Steps 2a and 2b, respectively, of the policy mix analysis framework. Chapter 5 makes a brief synthesis of chapters 3 and 4, with particular emphasis on how instruments interact (i.e. corresponding to a synthesis of Step 2). Further research questions regarding functional role analysis for local fine grain analysis are also identified. Finally, chapter 6 first makes provides an example of a national level coarse grain analysis, and then outlines the research questions and activities for the fine grain analysis that is under way in the project.

2 Identifying biodiversity status, challenges and context (Step 1)

2.1 What to conserve: The forest cover in Norway

2.1.1 Climate and other sources of natural variation of forest

In Norway, forest is an extensive land-cover type, covering approximately 38% of the mainland (Grønlund et al. 2010, Table 2), and forestry an important economic sector. About 60% of the ca. 31 000 species that are known to occur in mainland Norway are associated with forest (Gjerde et al. 2010). Therefore, the ways forests are managed have important consequences for biodiversity and the services that forests provide to society.

The forest in Norway has been a significant source of products for humans since postglacial times, and the use of these resources has, in turn, determined the extent of the forest cover (Prøsch-Danielsen & Simonsen 2000, Molinari et al. 2005, Karlsson et al. 2007) and shaped forest structure and composition (Bergman et al. 2004, Bjune et al. 2009). There is however, a strong geographical pattern of bio-physical conditions and of the kind and magnitude of impacts that affect forests.

Table 2: Land cover types in Norway. Source: Statistics Norway http://www.ssb.no/areal/

	%	**Km^2**
Total	100.0	323 782
Urban areas & constructions	1.4	4 533
Agricultural land & pastures	3.2	10 361
Mires & wetlands	5.8	18 779
Water bodies & glaciers	7.0	22 665
Forest	**38.2**	**123 685**
Alpine area without forest cover	44.4	143 759

Climate is the key driver of regional ecological differentiation determining growth potential and the distribution of tree and other forest species. The first major climatic gradient is defined by temperature ranges and by variables that determine the length of the growing season, and range from South to North (latitudinal differentiation), and from lowland to high altitude areas (altitudinal differentiation). A second regional gradient is controlled by the distance to the sea, determining seasonal temperature amplitudes and rainfall, and establishing a range from oceanic to continental climate (Bakkestuen et al. 2008, Hanssen-Bauer et al. 2009). By combining classes along the altitudinal/altitudinal and the oceanic-continental gradients, twenty six bio-regions have been defined. Classes along these gradients correspond to vegetation zones and sections, respectively (Table 3), Moen 1998). Forest vegetation can potentially occur in twenty-one of these regions. Within climatic bio-regions, forest composition and structure is determined primarily by a series of factors acting independently and in interaction with each other such as: bedrock and quaternary deposits, soil, landform, orientation, forest dynamics, as well as land management and silvicultural practices.

Table 3: Vegetation classes defined by regional climate gradients: oceanic-inland (vegetation sections) and altitudinal/latitudinal (vegetation zones) (Moen 1998).

Vegetation sections (oceanic-continental gradient)	**Vegetation zones (altitudinal and latitudinal gradient)**
Strong oceanic	Alpine
Clearly oceanic	Northern boreal
Weak oceanic	Middle boreal
Transitional oceanic-continental	Southern boreal
Weak continental	Boreonemoral
	Nemoral

2.2 Major forest and woodland types

Three major forest and woodland types can be distinguished, according to their distribution along ecological gradients, total cover, historical and present use, and levels and drivers of anthropogenic impacts. All these differences have a bearing on national and local conservation objectives and also on the kind of conservation instruments that are most relevant to counteract impacts and threats on the persistence of biodiversity and of ecological functions.

2.2.1 Nemoral and boreonemoral woodlands

Along the coast in southern Norway, and in localities with particular local climatic conditions in the lowlands, there are occurrences of woodlands in the nemoral and boreonemoral zone (Fig. 5). The nemoral zone has a very restricted distribution and is localed below 150 masl. In Norway it is characterized by the absence of typical boreal species such as spruce. The boreonemoral zone covers 7 % of the land in Norway, including 80% of Østfold and Vestfold counties. The vegetation contains a mix of nemoral and boreal species, and nemoral species tend to dominate south-west facing slopes on nutrient rich soils (Moen 1998). The zone extends approximately along the coast, from Oslofjord to Ålesund. In the Oslo area, this kind of vegetation extends up to 200 masl but can reach 300-400 masl in southern valleys with locally warm climate conditions.

The predominant species are deciduous trees that require high summer temperatures and long growing seasons such as ash (*Fraxinus excelsior*), alm (*Ulmus glabra*), lime (*Tilia cordata*) and hazel (*Corylus avellana*) (Gjerde et al. 2010). These woodlands occupy a small area in Norway at present, but dominated once the landscape during the warm postglacial period (8000-4000 BP) (Storaunet & Gjerde 2010). Spruce (*Picea abies*) expanded naturally as a consequence of the colder and wetter climate (Bradshaw et al. 2000) in the period around 3000 BP. At present, some very rare deciduous forest types such as the calcareous lime forest are considered to be relicts from the period prior to the expansion of spruce (Brandrud et al. 2011). The nemoral and boreonemoral woodlands harbour species with very local distribution that are not found in other parts of the country, and also a comparatively large number of red list species (Fig. 6). The main threats are related to their location in densely populated areas, and are particularly vulnerable to construction of infrastructure and urbanization. Also the invasion of spruce can be a threat (Brandrud et al. 2011), but forestry practices are not of relevance since remnants of these forests are generally outside the range of the forest production areas, but could potentially be subject to increased pressure with, for example, an increased exploitation for bioenergy production (Lindgård and Henriksen 2011).

2.2.2 Coniferous boreal forest

Coniferous forest occurs in the three boreal zones (Table 3and Fig. 6), and occupies the large majority of the forest area in Norway. Two species of coniferous trees are dominant both in old-growth and younger forests: Scots Pine (*Pinus sylvestris*) and Norway Spruce (*Picea abies*). Birch (*Betula pubescens*) is the most ubiquitous deciduous species, occurring in mixed stands with pine and spruce (Moen 1998). Larger areas of continuous boreal forest occur in Eastern (Østlandet), Southern (Sørlandet) and Central (Midt-Norge) Norway (Gjerde et al. 2010). Spruce dominates the forest landscape in Southeastern and Central Norway whereas pine is predominant in areas with continental climate and close to the mountains (Storaunet and Gjerde 2010). The Middle Boreal and South Boreal spruce dominated forest is the commercially most important forest in Norway. Here the forest landscape is formed by a patchwork of forest stands of different age, density and tree species (Gjerde et al. 2010). In the North Boreal zone, a conifer tree line is used to divide the vegetation dominated by Mountain Birch from that dominated by spruce and pine (*Barskoggrense*). The altitude at which coniferous trees grow ranges from nearly 1100 masl in some areas in inland Norway (Jotunheimen), 400 and 500 masl at the coast (Bergen and Trondheim respectively), and 200 masl in Northern Norway (Harstad).

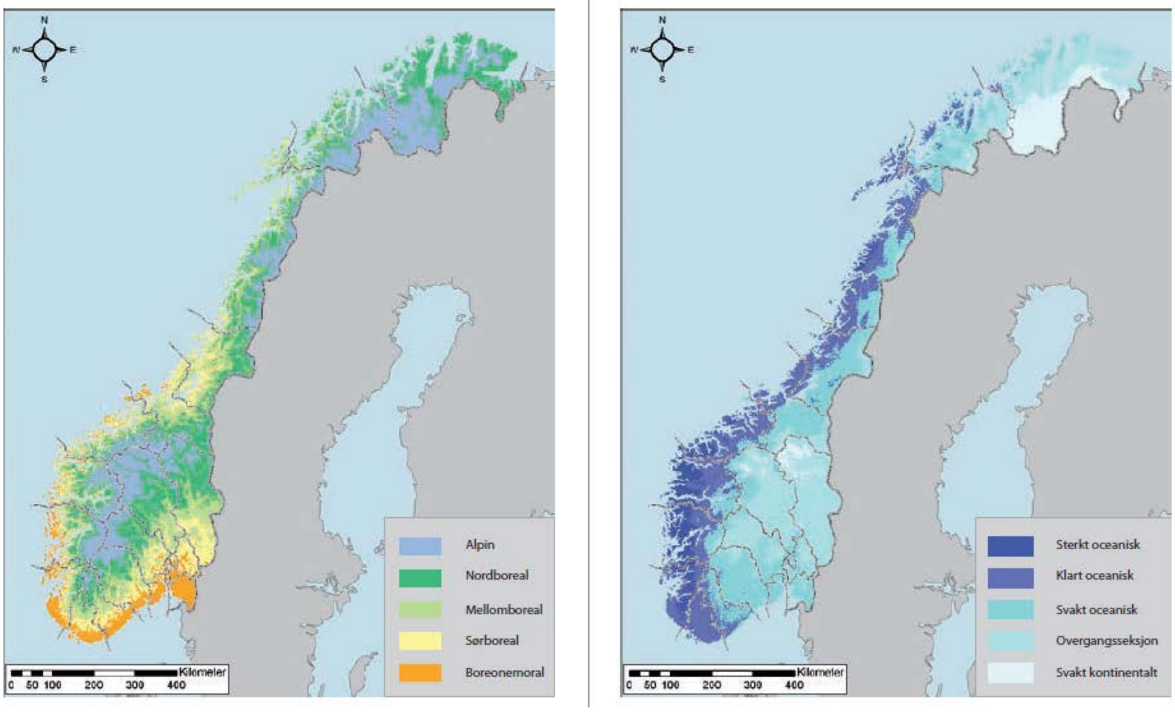

Figure 5. A) Vegetation zones in Norway. The vegetation zones reflect different climatic conditions. Forest occurs in all zones expect for the alpine zone. Alpin: Alpine; Nordboreal: North Boreal; Mellomboreal: Midle Boreal; Sørboreal: South Boreal and Boreonemoral: Boreonemoral. B) Vegetation sections in Norway reflecting the oceanic – inland gradient. Sterkt oseanisk: Strong Oceanic; Klart oseanisk: Clearly Oceanic; Svakt oseanisk: Weak Oceanic; Overgangseksjonen: Transitional Oceanic-continental; and Svakt continental: Weak Continental. Source: Maps by V Bakkestuen, Natural History Museum, UiO, Artsdatabanken 2011.

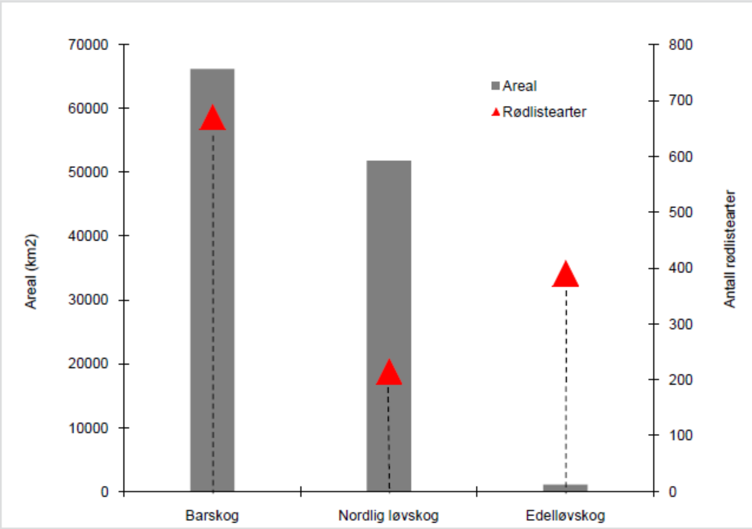

Figure 6: Number of redlist species is high in boreal coniferous forest, but comparatively lower than in deciduous southern (nemoral/boreonemoral) woodland when considering the area. Barskog: coniferous boreal forest, Nordlig løvskog (northern deciduous woodlands), Edelløvskog (broad-leaved deciduous woodland). Antall rødlistedearter: No of redlist species. Source: Gjerde et al. 2010.

History of boreal forest use and its bearing on conservation

The structure and composition of these forests has changed considerably during the last 9000 years. During the warm postglacial period (8000-4000 BP) the forest in south-eastern Norway was dominated by deciduous trees (Storaunet & Gjerde 2010) until around 3000 BP when they were largely replaced by spruce (Molinari et al. 2005). Spruce became a dominant forest species in Norway relatively late as a consequence of a colder and wetter climate after 3000 BP.

After the expansion of spruce, the most intensive changes in forest structure have taken place in the period from AD 1200 to AD 1850 (Molinari et al. 2005). Cultural impacts, including large needs for fuel for the ore industry from the 1600s, and anthropogenic fires, animal grazing and climate have interacted to produce these changes. At the start of the 20th century the forest structure was very open, which is thought to have facilitated the local dominance of deciduous trees such as lime, hazel and oak in south-eastern Norway (Molinari et al. 2005). High conservation values are also attached to legacies from this period, for example the conservation of hollow oaks as habitat for a large number of rare and threatened species (Sverdrup-Thygeson et al. 2011). Also, light demanding deciduous species such as poplar, rowan, ash, maple and birch are likely to have been more common elements in boreal forest stands at the turn of the last century. Since the first forest inventory in 1925 the forest cover and growth rates in Norway have increased more than the felled area and harvest rate.

Around 1950 drastic changes in forest management were introduced, including clear-cutting, high density planting, even-aged stands, the use of genetically uniform plants, in some cases of foreign provenances and felling at younger tree ages. They are made possible through mechanization, silvicultural practices and selection of genetic material.

The forest that established until approximately the World War II has regenerated to a large extent naturally (Fig 7) and has been managed with selection felling. Between half and two-thirds of the forest established in this period has already been felled (Storaunet & Gjerde 2010). The forest in the remaining area has attained such age that it has features of ‘natural forest’, with a complex forest structure, the occurrence of old trees and decayed dead wood (Storaunet & Gjerde 2010). However, these forests differ from ‘pristine’ forests by being of considerably younger age (old trees 100-150 years old compared to 200 years old in ‘old-growth’ forests). Stands of these older forests have a more complex structure, uneven age of trees that have established from local seed sources and a mixture of species, primarily spruce and pine, but particularly in the south, deciduous trees can also occur.

The threats to forest species (Fig.6, Gjerde et al. 2010) are associated with current forestry practices (Gjerde et al. 2010, Nybø et al. 2010), but is also due to the fact that the open forests that were dominant 100 years ago, where light-demanding deciduous species could thrive, have developed into denser forests (Molinari et al. 2005). Patches dominated by deciduous species that are typical of early successional stages of boreal forest patch dynamics have become increasingly rare in the modern boreal forestry landscape with important consequences for the maintenance of species that depend on deciduous species stands for their persistence (Löbel et al. 2006). In addition, the fact that trees in modern forestry stands attain considerably lower ages than they would under forest natural dynamics reduces the amount of available habitats for species that require old trees as a substrate and long time for dispersal and establishment (DN Rapport 3 1988).

Other impacts of modern forestry are those on groups of organisms that have important roles in particular functions of the forest ecosystem. For example, a large number of species in the Red List are involved in the decomposition of standing dead wood and other wood debris in Norway (Gjerde et al. 2010) and other Scandinavian countries (Berg et al. 2002). The quality of the wood debris, e.g. whether it originates from coniferous or deciduous trees (McGuire et al. 2010, Dahlberg et. al 2011) and its size and decay stage (Jonsson et al. 2006), determine the composition of the wood decomposer community. Practices that reduce the amount and simplify the variety of debris qualities have consequences for the persistence of organisms that can decompose wood and of other dead-wood dependent species in the boreal forest (Ranius & Roberge 2011).

Forest mycorrhiza fungi, a group with important functions in forest nutrient economy and dynamics has also considerable representation in the Red List (Gjerde et al. 2010). The distribution of these species is sensitive to both forest stand composition and the physical ecological conditions (e.g. Brandrud et al. 2011, Dahlberg 2002).

Geographical patterns of impacts on the boreal forest

The magnitude of forestry activities varies considerable between different regions in Norway, and even if the amount of productive forest is higher than twice the felling rate at the national level, there are large regional differences. Felling of spruce is considerably higher than that of pine and the magnitude, both in terms of growth and standing volume, is much higher in eastern and central Norway than in other parts of the country. The state of biodiversity in terms of the value of the Natural Index (NI) for forest approximately corresponds geographically with the areas of highest forest exploitation (Fig. 7, Storaunet og Gjerde 2010).

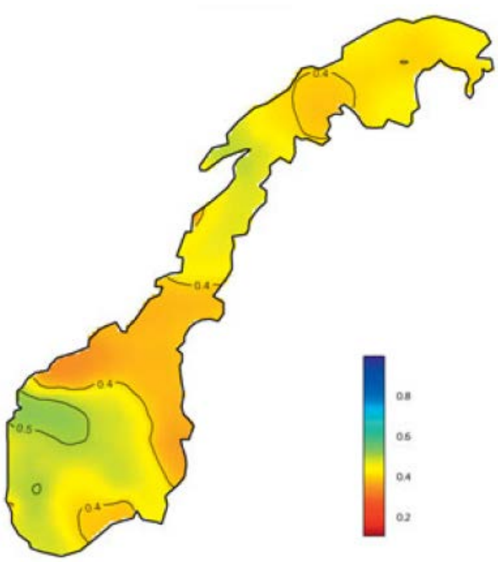

Figure 7 : Geographical distribution of the Natural Index for forest based on 72 indicators in 2010. Source: Storaunet og Gjerde 2010.

2.2.3 Mountain forest

The North Boreal zone, is the zone close to the altitudinal tree line and borders the alpine zone. It covers a total of 28% of the land area in Norway and is covered by woodlands with a predominance of Mountain Birch (a subspecies of Downy Birch), which generally builds the altitudinal forest line (Moen 1998). In the lower parts of the North Boreal zone mixed stands of birch with coniferous trees occur, but in Northern Norway, Mountain Birch grows down to the sea level. The trees have low growth rates and grow sparsely, and the woodland is known as "mountain forest" (*Fjellskog*).The Scandinavian Montane birch forest is one of the Global 200 biomes, two thirds of its distribution is in Norway.

In the northern areas, there has been a notion that the impacts of human use have been limited compared to the effects of climate. However, recent studies provide evidence of extensive deforestation and other activities that have altered mountain forest vegetation in Northern Fennoscandia (Berg et al. 2011) but these impacts became evident rather late. Karlsson et al. (2007), for example, show evidence of human-induced deforestation around settlements ca 800 BP that converted forest into alpine heath. Other impacts of long-term Sami land use causing significant changes in forest vegetation have also been documented (Karlsson et al. 2007 & 2009, Josephson et al. 2009, Berg et al. 2011). These observed patterns of use in mountain forests are likely to have been similar in other parts of the Scandinavian mountains.

Compared to other forests in Norway, the Northern woodlands have lower levels of threat. It houses both a lower number of Red List species (Fig. 6) and also a larger portion of the total area is protected in association with the protection of alpine areas, of which 36 % of the area is protected (Framstad et al. 2010). However, this forest type could be subject to increased exploitation with higher levels of bio-energy production (Lindgaard and Henriksen 2011).

2.3 Conservation objectives for forest in Norway

In Norway, the legal and regulatory frameworks to protect biodiversity have been strengthened, and conservation efforts both in terms of the number of protected areas and the certification of forest production have increased since the 1970'ies (see also Chapter 3). However, these measures are not yet detectable in terms of positive changes in biodiversity status, according for example, to the national metrics, the Naturindeks (NI) (Nybø et al. 2010).

2.3.1 The Nature Diversity Act

The Nature Diversity Act (Naturmangfoldloven LOV-2009-06-19-100) is the most central law for nature management. The Act embraces all nature and all the sectors that manage or make decisions that have consequences for nature. The law defines explicit conservation objectives that need to be considered in all decision-making about nature. It has two main instruments to achieve it aims: through nature protection and through regulations for sustainable use.

1. Aims to establish protected areas

The Act has a general decision in § 33 about the purpose to establish protected areas that includes the protection of:

1. The range of variation of natural types and landscapes
2. Species and genetic diversity
3. Threatened nature
4. Areas with important ecological functionality for priority species
5. Larger areas of pristine ecosystems
6. Nature that has been shaped by anthropogenic use through time.

The Act defines four categories of protected areas that are relevant for forest protection each of them aimed at the different conservation objectives listed above.

National parks are aimed to protect larger areas of ecosystems or landscapes that have very limited anthropogenic intervention and that are representative of a particular type or that have particular characteristics. **Landscape protection areas** are aimed to protect natural or cultural landscapes of ecological or cultural value. Land-use forms at the time of establishment can continue. **Nature reserves** are established on areas that have natural values that are threatened, rare or vulnerable, that can represent a particular type of nature, or that have particular importance for biodiversity protection or for research. In nature reserves all human activities can be banned if the conservation objectives are threatened. **Habitat protection** aims at protecting areas that have an ecological function for one or more particular species. It can be used for all species either they are protected or not.

Under all these forms, particular conservation objectives are defined when the protected areas are established.

2. Aims about sustainable use

The Law establishes that through regulation of use, the diversity of natural types is maintained within their natural geographical ranges, including their characteristic diversity of species and ecological processes. The aim is also that the structure, functions and productivity of the ecosystems is maintained. Use and management decisions will be based on scientific knowledge about species population status, the distribution of natural types, their ecological status, and about the effects of use on these conditions.

The principle of environmental and ecologically friendly techniques and praxis *§ 12* provides guidelines about the choice of techniques, practices and of the location of activities that will provide the best result for society. Generally, the best solution for the environment will be chosen even if it results in extra costs. In that case, the best alternatives for society will be chosen, weighing in the protection of biological diversity as an important factor.

In the Law § 13, *the King of Norway has the authority to establish the quality standard for biodiversity*. The standard can be related to the occurrence of particular natural types or species, or other conditions that have relevance for the biodiversity.

We will return to specific instruments under the act in Chapter 3.

2.4 Conservation goals for coniferous forest

The forest type and the kind and intensity of the land-use provide the background for the conservation objectives and the most appropriate instruments for conservation.

2.4.1 Protection of the range of variation of natural types and landscapes and of larger areas of pristine ecosystems

The guidelines for the conservation of coniferous forest propose a series of conservation goals for boreal coniferous forest in Norway (DN 1988). Two main goals are set:

1. To "*conserve the typical and the rare/threatened coniferous boreal forest in Norway*". It is strengthened that the plan should contain a selection of representative types of coniferous forest that covers the variation of types at the national level.
2. To establish a *number of larger protected areas* with coniferous forest.

Forest qualities and bio-geographical representation

The guidelines stress the conservation value of relicts of 'pristine forest' but recognizes that these remnants are few and that forests that maintain features of old-growth forests should be prioritized to cover the representation of forest types. Old-growth forests, managed with selective felling and that have been established through natural regeneration are recommended in this case.

The guidelines use the existing bio-geographic regional classification as the basis to select the regional representation of forest types (Nordisk Ministerråd 1984, in DN 1988) and an earlier version of the national vegetation atlas (Moen 1998), vegetation regions in Norway (Moen 1987). It was estimated that 13 bio-geographical sub-regions were already represented as 'core areas' in the existing protected area network. The plan pointed out that the following regions had limited representation in the existing network: boreal forest along the coast from Vestlandet to Troms, boreal forest between 0-400 masl in Østlandet and the Agder provinces, and in the interval 0-100 masl in Central Norway. It is highlighted that in Norway there is barely any protection of boreal forest in high productivity areas and points to the national and international importance of coastal boreal forest. The plan proposed provides two alternatives with a recommendation of the total area to be protected in each case of 1 300 km^2 and 550 km^2, respectively.

An evaluation of protected areas conducted 20 years later (Framstad et al. 2010) also stresses the low representation of productive forest types and of the lowlands, particularly along the southern coast of Norway. The report shows that less than 5% of the total area of the nemoral, boreonemoral and south boreal vegetation zones is protected and barely 6% of the area of the middle boreal zone, and that coniferous forest has the lowest proportion of protected area (3.8%).

Network properties

Three kinds of conservation categories and criteria are proposed in the conservation plan for boreal forest (DN 1988). The '*core area*' should be representative of a bio-region, including its climate, topography and soil type mosaic. A size of 10 km^2 is recommended to maintain the forest natural dynamics and to protect against human disturbance.

The evaluation by Framstad et al. (2010) points further to the small average size of the protected areas. They indicate that almost 90% of protected areas are less than 0.1 km^2 and have no core area when a boundary zone of 100 m is subtracted. On the other hand, the report questions the potential of the ecological functionality of the network in the lowlands and along the coast due to the many small and scattered protected areas.

Protection of threatened nature, species and genetic diversity

The plan for the conservation of coniferous forest (DN 1998) indicates that 'core areas' should be complemented by '*supplementary areas*' with patches of forest with particular features not included in the 'core area', and '*areas of particular conservation value*" that contained rare and threatened elements.

At present, the main documents that describe forest natural types and habitats *of particular importance for conservation of biodiversity* that are considered under the Nature Diversity Act because they are particularly rare or threatened are defined in the handbook for mapping of *nature types* (DN 2007), the handbook to record *important habitats in forests* (Complementary hotspot inventory (CHI), Gjerde et al. 2007, Skog og landskap 2001) and in the guide to prescriptions on *selected natural types* (DN 2011) (Table 4).

Table 4: Current important habitats considered for protection in forests under the Nature Diversity Act (DN 2011) as described in DN 2007, Skog og landskap 2001 and DN 2011. Prioritized habitats for conservation reflect the importance of forests with limited distributional ranges in Norway and Europe (e.g. Coastal coniferous forests, nemoral/boreonemoral forests), and particular forests stages, habitats and elements that have become rare with the intensification of forestry production in modern times (see sections above about the distribution of forest types and history of forest use).

Important nature types (DN 2007)	Rich nemoral/boreonemoral woodland Old nemoral/boreonemoral woodland Calcareous forest Rich birch woodland (Birch woodland with high stature perennial herbs) Alder (*Alnus incana*) and Bird Cherry (*Prunus padus*) woodland Rich swamp forest Old-growth deciduous tree woodland Rich mixed (coniferous and deciduous tree species) forest in lowland Old coniferous forest Canyons Burnt areas Coastal (oceanic) spruce forest Coastal (oceanic) pine forest

Important habitats for forest species (CHI, Skog og landskap 2001)	Hollow deciduous trees Trees with rich bark Rich understorey vegetation Mature secondary succession with deciduous tree dominance Rich understorey vegetation Old trees canyons Burnt areas Trees with epiphyte lichens Trees with epiphyte lichens Standing dead wood Downed dead wood Rich understorey vegetation Ravine
Selected nature types according to ND Act 12.May.2011 (DN 2011)	Calcareous lime woodland Hollow oaks

Framstad et al. (2010) conclude that various types of boreonemoral woodlands, calcareous forest, alder-bird cherry woodland, rich swamp forest, temperate rain forest, pine forest on sand and rich mixed forest have limited representation in the current protected area network.

2.5 Quantitative conservation targets and current gaps

2.5.1 Conservation gaps of forest and quantitative conservation targets

The previous sections of Chapter 2 have discussed the historical and current levels of protection, and the broad aims of biodiversity conservation in forests. In this section we review the degree of spatial representation of indicators of conservation value and quantitative conservation targets that have been suggested for forests and woodland habitats in earlier assessments. This is a necessary background for spatially explicit analysis such as reserve site selection modelling using tools such as Marxan in the fine grain analysis (see Chapter 6.7).

2.5.2 How can the targets be defined at different scales/hierarchy levels?

The methods for spatially explicit analysis are flexible to incorporate elements of conservation value with different spatial extents and levels of spatial resolution. The conservation elements can range from broad vegetation types, habitats, groups of taxa and individual species in a single analysis. A pre-requisite for this kind of analysis is the identification of the conservation elements and setting of conservation targets. For this purpose, three steps are necessary: i) the identification and description of the conservation elements, ii) an assessment of their abundance or extent, and iii) an assessment of the degree of threat (Rouget et al. 2006)

At a second stage, if not stated in national or local legislations, regulations or prescriptions, the setting of targets will be part of the decision-making process at various levels, because targets will set explicit and quantitative conditions about the allocation of land to different purposes and uses. Specific conservation targets are often set according to the degree of rareness or level of threat of a particular conservation element. For example, in some national and regional conservation planning exercises, the target to conserve very rare and/or threatened species or nature types has been the full protection of these types (Rouget et al. 2006). A scenario modelling exercise can be conducted to make explicit the differences between conservation alternatives with different targets.

2.5.3 Current definitions of forest conservation elements, extent and targets in Norway

Plan for the conservation of coniferous forest (DN 1988)

The basis of the proposed plan elaborated in 1988 was a network of protected areas that sampled forest types across the main environmental gradients and that were of large enough size to enable the maintenance of fundamental processes of forest dynamics (gap dynamics, fires). The network would be combined with forestry practices in production forests that would counteract the most significant impacts of forestry. Natural gap dynamics and the maintenance of openings in the forested landscape (e.g. forest edges), would ensure the persistence of light demanding tree species (primarily deciduous trees), and other species associated with them, that are particularly disfavoured by current practices.

The conservation network would be formed by a set of areas representing major forest formations, supplemented by more rare forest types, particularly important in Norway, both in a national and international context. The definition of forest types and a coarse map is provided in the plan, as well as the degree of representation in the protected area network at that time (DN 1988). This plan has provided the most specific, quantitative targets for boreal forest conservation in Norway. Two alternatives are proposed with particular targets of area and size of the conservation areas (table 5). The plan also specifies that, in the first place, conservation areas would be located in state-owned forest.

Table 5: Proposed total protected area in addition to the area protected in 1988 according to two alternative plans for coniferous forest conservation in Norway (DN 1988)

Alternative A		**Alternative B**	
Description	*Area (km^2)*	*Description*	*Area (km^2)*
53 forest type areas à 10 km^2 in average	530	Forest type areas (10 km^2 and larger), including forest types with unique distribution in Europe (boreal coastal rainforest and continental mountain forest)	200
Larger forest areas (>10 km^2)	200	Protected areas with forest type representation function	150
20 supplementary areas à 1.3 km^2 (primarily forested areas in the lowlands, not adequately covered by main forest type areas)	26		
Special areas	540	Special areas	200
Total	**1296**	**70% of area in productive coniferous forest**	**550**

Conservation targets for productive forest

At the national level, it has been argued that a target of 10% of the productive forest (forest with a growth rate higher than 1 m^3 ha^{-1} $year^{-1}$) should be conserved in Norway (Liebe et al. 2011). However, this assessment lacks a distinction between different kinds of forests, other than the fact that the forests are classified as productive. Therefore evenly high levels of threat by logging are assumed. The area of forest to be protected is not theoretically grounded. It is difficult to establish a meaningful protection target, because of the high uncertainty and variability about the capacity of species to maintain viable populations, disperse through forest matrices, and to colonize unoccupied habitats. There is also no indication about how this area should be distributed in terms of area size and how the environmental variation should be sampled.

Another recent study has analysed the proportion of productive forest under different protection forms (Søgaard et al. 2012, Table 6) according to law regulations, prescriptions and certification schemes. Seventy per cent of this forest area is under forestry production. The study concludes that approximately 15% of the productive forest volume is under some form of protection and that ca. 31% of the productive forest area in Norway is under moderate to strong regulations for conservation purposes. A comparatively large proportion of the area is in forest of lower density and productivity classes.

The study uses the conservation elements that have been defined through guidelines that are used in the implementation of the regulations, prescriptions and certification standards (Skog og landskap 2001, DN 2007, Living forests 2006, Nature Conservation Act 2009). The study does not conduct a spatially explicit analysis of the distribution of forest qualities, however, the areas calculated can provide a benchmark of conservation targets for each conservation instrument against which spatially explicit conservation gains, a more detailed differentiation of forest types, and opportunity costs could be calculated. These data could potentially be compared with the targets set in the coniferous forest conservation plan (DN 1988).

Table 6: Area of productive forest under different kinds of conservation measures. Source: Sørgaard et al. 2012.

Protection form with decreasing degree of conservation strength	**Area (% of total productive forest)**
1. Protected areas (national parks and nature reserves) per December 2011	2.6
2. Area protection (key habitats Hot Spot Inventory, buffer zones and protected landscape areas; and habitat management areas	10.9
3. Multiple use forestry (urban forests and mountain forest)	13.1
4. Production forest (with some restrictions due to small scale game habitats and recreation areas)	ca 70

Biologically important forest types (Framstad et al. 2011)

This study encompasses all types of woodlands and forests that are considered of high biological value. The descriptions have combined a series of conservation criteria from different sources, e.g. the occurrence of important nature types (DN 2007, Table 4), high incidence of red-listed species, priority forest types for protection (Framstad et al. 2010), as well as the Red List of forest types according Nature Types in Norway (NiN) (e.g. Lindgaard et al., 2002). It combines therefore most of the existing woodland and forest typologies describing important forest conservation elements.

These forest conservation elements have been further linked to descriptions of forest stands in the National Forest Inventory (NFI) (Framstad et al. 2011).

Approximately 30 biologically important forest types are defined (Table 7 in Framstad et al. 2011) that include climatic and substrate type criteria, tree species composition and age. However, the final analysis aggregated the types into 8 classes (Table 7) in order to calculate the area of the types. Some of the forest types in the fine-grain classification are too rare to be captured in the NFI, and others occurred in too small areas to give reliable calculations based on the extrapolation of NFI data (Framstad et al. 2011).

The study indicates the extent of the occurrence of the types and an estimate of the degree of threat. The results show that biologically important forest types make up a considerable amount of the forest area, ca. 2.9 mill ha, encompassing approximately 27% of the forest area. Unproductive old-growth deciduous forests (mainly dominated by birch) alone account for more than 15% of forest land (50% of the biologically important forest area). These forests are the ones described as northern and coastal woodlands in the boreal zone. The other forest types make up 2-4% of the area. The highest conservation values are to a large extent associated with these latter types, including rich forest and old-growth forest and woodlands (Framstad et al. 2011). Further, a large area, particularly that occupied by boreal woodlands is of low economic value. Two types are likely to have the highest level of conflict with forest exploitation interests; rich coniferous forest and old coniferous forest.

The calculation of the forest type area (Table 7) together with the analysis of deforestation risks based on the economic value of the types can provide a basis for setting conservation targets for these types in a spatially explicit conservation plan (e.g. Rouget et al. 2006, Reyers, et al. 2007, Cowling 2003) (see also Chapter 6 of this report). For the rare types an important constraint is the limited area available; large continuous areas of intact nemoral and boreonemoral woodland simply do not exist anymore (Timonen et al. 2011), they have been extensively converted to agricultural land. The expansion of the area of these types would require reforestation/habitat restoration, in many cases at the expense of arable land. At the moment no specific targets have been set for either the minimum size of the conservation areas or the proportion of the existing area to be protected, except for two habitats that are fully protected by law (Table 4, DN 2011); thereby their conservation target is 100%. Regarding the other habitats with narrow distribution, there is a an implicit aim to protect as much as possible of the remaining cover, but no quantitative conservation targets have yet been defined.

Based on Framstad et al. (2011), two main challenges arise for the spatially explicit analysis of conservation impacts. First, due to the coarse-grain aggregation in their study some forest types are not captured in the analysis and the coarse classes include forest types with quite distinct ecological characteristics and attached conservation value. A second important constraint is that there is no geographical representation of the types. Given the need to group forest types for meaningful area calculations, the extrapolation of the types to a geographical space is likely to be challenging.

Table 7 Area of biologically important forest types. There is overlap between categories G1-G3 and G3-G8. Calculations of total area are therefore based on the area of types G3-G8. Source: Framstad et al. 2011.

Forest type	Area (ha)
G1 Rich deciduous forest nemoral-boreonemoral	417 817
G2 Rich coniferous forest	246 930
G3 Old boreal deciduous forest (poor)	1 679 287
G4 Old boreal deciduous forest	440 665
G5 Old deciduous forest with nemoral species	193 396
G6 Old spruce forest	265 234
G7 Old pine forest	354 346
G8 Older coastal forest	245 594
Total	**2 932 929**

Conservation targets at the municipality level

At the municipality level, the conservation of habitats becomes part of the local territorial planning, which is implemented through the priority nature type registration program (DN 2007, Table 4). A constraint for a spatially explicit analysis at this level is that the extent of the area mapped and the quality of the mapping varies considerably among municipalities. A recently adopted hierarchical classification of nature types provides the methodological tool to map habitat types at various spatial scales and levels of resolution (Halvorsen et al. 2008) in the future. Testing of mapping of this classification system started in 2011, but a complete mapping at national or even local levels are expected to be very demanding in terms of time and resources.

As indicated in the previous studies (Framstad et al. 2011), the incomplete mapping of these habitats limits the potential of a spatially explicit impact assessment of policy instruments at this level of decision-making. On the other hand, priority nature types encompassing nemoral and boreonemoral woodlands are to a considerable extent protected because the risk of forest exploitation activities is low (Framstad et al. 2011), they occur in terrain with limited accessibility. In the case of land-use change due to urbanization and/or infrastructure construction, environmental impact assessments must be conducted. In this case, the evaluation of the priority of these habitats will be part of the decision-making process at the municipality level, together with the strong regulations of the Nature Diversity Act (DN 2011).

2.5.4 The Nature Index – an indicator of the state of nature

The Nature Index (NI) in Norway has been developed to provide a basis to evaluate the state of biodiversity and to link the state to the management of nature. The Norwegian NI is currently based on more than 300 indicators covering all major taxonomic groups and ecosystems (Nybø 2010). The indicators can represent any aspect of biodiversity from genes to ecosystems, but in the current implementation for Norway, the indicators are mainly species (Skarpaas & Pedersen 2012), although in the case of forests, the important habitats for forests (CHI, Table 4) are included (Figure 8) . It has been envisaged that the NI can be applied to assess the overall state and trends of biodiversity, particularly regarding the report of progress towards the national 2010 and 2020 targets of the Convention on Biological Diversity (Skarpaas & Pedersen 2012).

The NI has been recently incorporated to the set of indicators of sustainable development reported annually in the National Budget and several studies explore other applications that link the indicators with human activities and management plans (Skarpaas & Pedersen 2012).

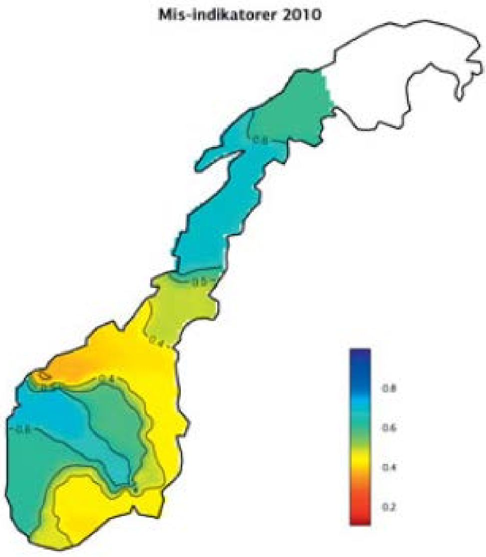

Figure 8: The state of the Nature Index for 6 CHI indicators (mature secondary succession with deciduous tree dominance, old trees, standing dead wood, downed dead wood, trees with rich bark, trees with epiphytic lichens (see Table 4) in 2010. Source: Storaunet & Gjerde 2010.

To what extent is the reference condition for the NI a conservation target?

A fundamental concept built into the NI is that the indicators are scaled relative to a reference value, *i.e.* their value at a reference state (Certain et al. 2011). It is assumed that the reference state for each indicator reflects an ecologically sustainable state, and the scaled value measures the deviation from this state: a value of 1 means that the indicator is in the reference state, whereas a value of 0 means a seriously degraded state (Skarpaas & Pedersen 2012). The NI can then be calculated for a particular geographical area (e.g. municipalities), biome and particular time, as a weight average of the scaled indicator values (Certain et al. 2011) providing an overall metrics of the state of biodiversity in each case, along a sustainability gradient. The reference state can therefore be potentially considered as a target for improved conservation measures, new instruments and sustainable management of, e.g. a particular area, biome or nature type.

The data basis of the NI sets the boundaries of its applicability in terms of the spatial extent, the degree of spatial detail, the comparability between geographical areas, and the time interval at which it can be calculated. At present, for a set of well-known taxa, estimates originate from monitoring programs and modeling of population dynamics, but the bulk of the information in the NI comes from expert assessments of indicators (Skarpaas & Pedersen 2012). Such information is useful for evaluation of long-term trends and goals like the 2020 target, but is less well suited for reporting of short-term changes (such as the annual sustainability indicators in the National budget) and for devising management goals and options for the future (Skarpaas & Pedersen 2012).

Ongoing improvement of the knowledge base about the statistical structure of the data will contribute to more reliable assessments and widen the applicability of the NI in the future (Pedersen

& Skarpaas 2012). The applicability of the NI for instrument assessment, for example ecological fiscal transfers and different protected area categories, will be explored further in the fine grain analysis of this project (see Chapter 6).

The degree of uncertainty in the data is also reflected in the difficulties in forecasting future states based on current conditions. These projections of the NI into the future would provide a reference or benchmark of a 'business as usual' state. A series of methods have been evaluated to improve forecasting of future states, which appears to be a promising avenue for future applications of the NI (Skarpaas & Pedersen 2012).

2.6 Historical policy context

Many interests, often conflicting, have to be taken into consideration when managing natural resources. Most are regulated through Acts, regulations and other measures, as the ones presented in the timeline below. The political, and hence the juridical, landscape is however very variable with time as new knowledge is gained and the public opinion changes.

Forestry has historically been, and still is, one of the most important industries in Norway, and the policy has aimed to secure stable, long-term conditions for the production. From the first regulations of forestry with the Forest Protection Act from 1932, where the purpose of the restrictions were merely of economical character, the focus has changed gradually from the 1970s and up until the present policy. However, laws and legislations relating to environment and biodiversity today have some exceptions or clauses for the forest industry. There is still given substantial subsidies to ways of managing forest that may be environmentally harmful, and protecting areas of productive forest is still a source of major conflicts due to economy and jobs, as it was when the work on establishing national parks first started. However, the conflict has abated somewhat with the introduction of the voluntary forest conservation program (see next chapter).

Decentralisation and regional policy has historically had a strong place in Norwegian policy along the whole political axis. Since the report to the Storting (Parliament) No. 23 (1979-80) *On distribution of functions and administrative arrangements within the jurisdiction of the Ministry of the Environment*, one has endeavoured to increase the local administration and regulation of environmental issues. The discrepancy between environmental and forestry policy should therefore be viewed in the light of this.

In 1965 the Forest Protection Act of 1932 was revised, and a Forestry Levy was implemented with this new legislation. The intention was to secure that a certain amount of income from forestry was re-invested in forestry (e.g. in tree planting). In 1970, the Agricultural Developments Fund (LUF), providing direct grants for e.g. establishing and maintaining forest roads, was established by the Storting. In the 1980s the forest owners were also granted a tax deduction advantage on all income put aside for further investments. In 2005 the name changed to the Forest Trust Fund. Some of the measures supported by the Forest Trust Fund, and hence releasing the tax advantages are, among others: establishment of forest, young forest tending, thinning, clearing of ditches, planning, construction and maintenance of forest roads, measures to promote special environmental values, as well as alternative harvest promoting investments (see also chapter 3 below).

In relation to the renaming of the Forestry Levy in 2005, a regulation relating to governmental subsidies for industrial and environmental initiatives in forestry (NMSK) was passed. The aim was to stimulate to increased creation of economic value, and the scheme includes financial support for e.g. building forest roads and operating in steep and inaccessible terrain. The municipalities are responsible for the executive work.

Over the years, there have been a multitude of sources for funding for forestry activities. Although there has been discussion of possible harmful environmental side effects of these subsidies, and of the gain for society in supporting otherwise unprofitable forestry methods, there have been repeated Storting resolutions to change these subsidy schemes. However, in 2007 the tax advantage was raised from 60 to 80 per cent and expanded to include maintenance of existing forest roads as well. Below, a time line of the major forest laws, regulations and economic instruments is presented.

TIMELINE

Classical nature conservation.

Conservation goal: Protect a specific specimen, or a species. Unspoiled nature that are not to be exploited.

Sustainable development and use.

Conservation goal: Increased focus on conserving nature, but also through using it in a sustainable way.

1967 The first plan for creating national parks, passed.

1970 New, revised nature conservation act: Act of 19 June 1970 No. 63 Relating to Nature Conservation. Gave access to protected areas with different levels of restrictions, ranging from landscape conservation areas to nature reserves.

1970 The Agricultural Development Fund (LUF), providing direct grants for e.g. establishing and maintaining forest truck roads, established by the Storting.

1972 The Ministry of the Environment established.

1976 A new Forestry and Forest Protection Act was passed in 1965, and in 1976 it was revised and adjusted. Smaller clear-felling areas and less monoculture were emphasized, and outdoor recreation was now taken into consideration more explicitly.

1981 Report to the Storting on conserving nature in Norway (St.meld. nr. 68 (1980-1981) *The nature conservation report*). First to have an integrated view on the national conservation policy.

1987 Report of the World Commission on Environment and Development: «Our common future». A changeover in international as well as Norwegian politics, with its focus on sustainable development and a coherent policy.

1989 Provisions regarding environmental impact assessment studies added to the Act of 14 June 1985 No. 77 the Planning and Building Act.

1988 The report *Suggestions for guidelines in protecting coniferous forest* (Report from the Norwegian Directorate for Nature Management No. 3, 1988), written by the Conifer Forest Committee, lead to the compilation of a conservation plan for coniferous forest.

1989 New political instructions were made by the Government's answer on «*Our common future*»: The Report to the Storting No. 46 (1988-1989) *Environment and development. Norway's follow-up on the World Commission's report* enabled a superior and overall way of thinking about sustainable development. All ministries were from now on to a greater degree to consider the environment when performing their activities.

1993 The second plan for creating national parks, Report to the Storting No. 62 (1991-92) *New plan for national parks and other large protected areas in Norway*, passed. Ensuring a representative

Overall ecosystem perspective. Biodiversity.

Conservation goal: Species conservation by protecting the species *and* its habitat.

Implementation of certification schemes for forests.

selection of the variety on Norwegian nature in conservation areas and national parks was emphasized.

1994 The first plan for creating national parks completed. Norway had at that time 18 national parks, most of them covering mountainous/highland landscape. The Nature Conservation Act (of 1970) had specific requirements as to where the national parks were to be created; the area had to be unspoiled and mainly be on governmental ground. Productive coniferous forest was hence poorly represented among the 18 parks.

1998 The Living Forest standards, a national certification scheme, established. A set of standards developed from a cooperation between forestry interests and NGOs among others, on how to conduct forestry in a sustainable way. Resulted in a certification scheme that lasted until 2010 when the parties no longer agreed to the standards. The certification system was then continued as part of the PEFC organisation. Within 2002 the greater part of Norwegian forest land was certified. See also chapter 3.6.

2000 Registrations of environmental values and biodiversity in forest (the MiS project), financed by the Ministry of Agriculture and Food. An implementation of the sectorial responsibility forestry has on preserving environmental values, as a follow-up on the new political course made by the Report to the Storting in 1989. See chapter 3.6.

2000 On initiative from the National forest owner association, a new agreement on forest conservation was reached, based on the forest owners voluntarily offering areas for conservation. Almost every conservation processes since 2003 has been on a voluntary basis, or in state owned forest. See chapter 3.4.

2003 Passing of the new Act of 9 May 2003 No. 31 Relating to the Right to Environmental Information and Public Participation in Decision-making Processes Relating to the Environment.

2005 In their declaration *Soria Moria 1*, the Government aimed at stopping the loss of biodiversity by 2020, and increase the protection of coniferous forest in order to preserve biological diversity.

2005 Act of 27 May 2005 No. 31 Relating to forestry (Forestry Act). The purpose of the Act is «to promote sustainable management of forest resources in Norway with a view to promotion of local and national economic development, and to secure biological diversity, consideration for the landscape, outdoor recreation and the cultural values associated with the forest».

Ecosystem services

Conservation goal: Protect biological, geological and landscape diversity and ecological processes through conservation and sustainable use.

Conservation goal: Recreation purposes and aesthetics.

2005 Regulation relating to governmental subsidies for industrial and environmental initiatives in forestry (NMSK) pursuant to the Forestry Act.

2006 Regulation on sustainable forestry. The purpose of the regulation is to promote a sustainable forestry that protects the environmental values of the forest, and makes the forest owner obliged to take biodiversity into consideration when managing the forest.

2007 The tax advantage from the NMSK scheme was raised from 60 to 80 per cent and expanded to include maintenance of existing forest truck roads as well.

2007 The Office of the Auditor General of Norway (Document No. 3:11 (2006–2007)) with severe criticism at the national area policy. They concluded that the area management till now had contributed to making areas the Storting had emphasized should be conserved, unproductive through development.

2008 Amendment to the Planning and Building Act. The municipalities are now to elaborate a long-term plan, taking future development and use into consideration.

2008 The process of mapping governmental subsidy schemes with harmful environmental consequences starts on assignment from the Ministry of Finance.

2009 Act of 19 June 2009 No. 100 Relating to the Management of Biological, Geological and Landscape Diversity (Nature Diversity Act) passed. Replaces all previous Nature Conservation Acts, and is unique in the way that it is based on a more integrated ecosystem perspective. Also, land owners are compensated according to land value when protecting, or restricting the use of an area. See also chapter 3.2.

2009 "Markaloven", a special case law governing the management of forests around Oslo for recreation purposes, passed after many years with debate since the first proposal in 1981.

2010 The first Nature Index issued. A documentation of the overall development for species and nature types to map out the state of the ecosystems, carried out on assignment from the Government. The aim is to use this knowledge to improve the management, and get a clear view on where the need for taking measures is the highest.

2.7 Choosing instruments for analysis

The by far most important economic instrument in Norway is the voluntary forest conservation scheme, introduced in 2000. There is fairly wide political support and legitimacy and acceptability for continuing this mechanism. This scheme will therefore be topic of more thorough analysis (especially in the fine grain case study analysis to follow) (see chapters 3.4 and 6.8).

In addition, the voluntary scheme does not seem to be able to reach the conservation targets, both due to limited budgets and due to too “blunt” incentives for forest owners to provide the biologically richest areas for protection (which may also be very important for forestry). Hence, additional instruments seem to be needed to reach the biodiversity policy objectives described in Chapter 2. The recently introduced support schemes for priority species and selected habitat types under the Nature Diversity Act, seem promising, though it is early to tell how they will function. Of potential or proposed instruments, we have in our analysis paid particular attention to two instruments: auctions and ecological fiscal transfers. Auctions, which have been tried in Finland (and in a few other countries), may be able to enroll forest land at lower costs, compared for example with the voluntary forest protection scheme as it is currently operating (see chapter 4.3).

Ecological fiscal transfers has been discussed as a channel to reward municipalities in Norway for extra efforts to stimulate forest conservation (see chapter 4.4). There is an interesting link between this potential instrument and the mentioned recently developed Nature Index for Norway, which in disaggregated form could form the basis for rewarding municipalities for positive developments in the index over time. We also cover other potential instruments, though more cursory.

3 Role of existing economic instruments

3.1 Introduction

This chapter provides a description and an assessment of the most important current economic instruments along the four criteria of conservation effectiveness, cost-effectiveness and benefits, distributive impacts and legitimacy, and institutional options and constraints. The chapter aims to describe the different conservation instruments’ characteristics that later can be used to explain their ‘functional role’. The chapter corresponds to the first part of step 2a in the policy mix analysis framework. Each instrument and its stand-alone purpose are described. Assessment of interactions is carried out in Chapter 5.

For each of the instruments in the chapter, this structure is (roughly) followed:

- Brief description of how the instrument works in the specific Norwegian context. More specific literature relevant to Norway and studies performed in the Norwegian context are cited when relevant.
- Brief assessment according to the four instrument assessment criteria.
- Short summary/conclusion regarding pros and cons in terms of delivering on the challenges identified in Chapter 2

3.2 Direct regulations

This section contains a brief overview of the main direct regulation policies of relevance to biodiversity, as background and context to the main focus of this report: economic instruments.

In June 2009, Norway established the Nature Diversity Act, as noted in Chapter 2, which includes all previous laws related to land use and biodiversity in one act. This act is the most important legal framework for all future regulatory and economic instruments in the area of forest and biodiversity conservation – both inside and outside protected areas. The act regulates two relatively new economic support instruments for management of priority species and selected habitat types (see Chapter 3.5). This Act is also the primary instrument for Norway to follow up on its international commitments under the Convention on Biological Diversity, to which Norway is a signatory. Norway has also signed most (if not all) other international treaties, such as e.g. the Convention on International Trade in Endangered Species (CITES), the UN framework convention on climate change, RAMSAR, the Bern Convention and the Bern Convention.

Norway's involvement with the EU through the European Economic Area arrangements means that the country does not have to adopt EU environmental regulations, such as the Habitat Directive (which Norway has not yet done). However, EU policies do influence Norwegian policy-making (and the other way around).

The prime "command and control" instrument used historically by the Norwegian authorities for biodiversity conservation purposes nationally is the establishment of protected areas, primarily based on appropriation of private land (against compensation) of biologically rich areas. Since this instrument met with large opposition and conflict, it was superseded by a voluntary scheme, with many similarities in terms of compensation payments (see chapter 3.4). The last such conservation area of a relatively large size was established in 2009, the Trillemarka nature reserve (147 km2). The command and control way of establishing protected areas are currently almost dormant, and it is unclear whether it will continue to be so. That depends primarily on the progress and results of the voluntary scheme.

The second law of particular importance for forestry and forest biodiversity is the Forest Act, which regulates sustainable forestry. Sustainable use is also included as one of the mechanisms in the Nature Diversity Law, as noted in Chapter 2. In addition to this law, most of the productive forest land is under certification (see chapter 3.6).

There are a range of laws and regulations, within the broad category of "direct regulation", that may also potentially have bearings on activities (forestry and otherwise) that have impacts on forest biodiversity. Chief among these are perhaps the spatial planning apparatus (on local, regional and national levels), including requirements for environmental impact assessments etc., for example in relation to construction of forest roads and other forestry infrastructure. There is also a specific law ("Markaloven") that has recently entered into force, governing the management of forests around Oslo for recreation purposes. Recently, areas have been singled out for protection based on a methodology that identifies both recreational and biological values.[4]

[4] http://www.fylkesmannen.no/fagom.aspx?m=4790&amid=3560009

Another important law that has recently entered into force, and that may be important for biodiversity conservation, is the freedom of environmental information legislation. Effectively, this law means that private forest owners cannot withhold information about, for example, biologically rich areas on their land if they have such documentation. A verdict in a Norwegian court, gave an environmental NGO access to information from a large Norwegian forest owner. Increased transparency is usually good for environmental outcomes – not just in the area of biodiversity conservation. However, it may also increase forest owner incentives to degrade or remove biologically rich elements, if they know such information may increase the likelihood of stricter regulation (e.g. as observed under the Endangered Species Act in the USA).

3.3 Sector instruments potentially affecting conservation

How the instruments work

There are a number of policy instruments that may affect biodiversity conservation, which were introduced for other reasons than promoting biodiversity conservation. Many of these instruments that are chiefly handled by non-environmental ministries and directorates may have a negative "side effect" on biodiversity. The perhaps most prominent sector policies worth mentioning here are:

- Forestry policy
- Agricultural policy
- Energy and infrastructure policy
- Regional development and distributional policies

Each of these policy areas contains both direct regulation and various economic instruments. We will not discuss the number of economic instruments under each of these policy areas, only mention a few of the most important.

Forestry policy is mainly aimed at promoting timber harvesting and has a much longer history than environmental policies. There are a range of economic instruments in operation (see e.g. Bergseng and Solberg 2007), aimed for example at increasing tree planting, thinning and other silviculture and harvesting in areas where costs are high. Agricultural policies are numerous and complex. Many of the economic instruments are targeted a production, while some are directed more towards environmental stewardship. Since many farmers combine agricultural activities with forestry, policies that affect agriculture may also more or less directly affect farmer decisions regarding forestry. Support for renewable energy and various types of infrastructure (roads, power lines etc.) gain in importance, and is an increasingly potent impact factor for biodiversity conservation. Finally, there are numerous government policies that aim to counteract dominating forces of centralization, unemployment and inequity in local areas. Many of these instruments are economic support schemes that may affect forest biodiversity.

Assessment of the instruments

All four policy areas above may counteract conservation instruments directly or indirectly. Most directly, support for road construction and harvesting in rough forest terrain, for example, may directly oppose conservation goals (as many of these areas are relatively untouched, they may contain relatively high biodiversity). Similarly, support for energy projects and infrastructure may come in conflict with conservation goals that stress connectivity between conservation areas. Finally, support of regional development often tend to be “softer” on environmental restrictions and promote traditional activities such as forestry and new activities such as construction of recreational homes, both of which counteract conservation policies.

To what extent are they in the way of conservation policies?

A challenge in all policy making is the need to balance a number of objectives that are often conflicting. In practice, objectives are weighted and traded-off against each other. It is beyond the scope of this brief assessment to analyze this problem complex, except to note that the most important place to start to address potential conflicts with conservation instruments, is the forest policy area. There are degrees of conflict with conservation polices. For example, some support for forest planting and silviculture may not be particularly bad for conservation objectives, while the support for harvesting in steep and inaccessible terrain maybe more directly in conflict. We will therefore analyze these particular policies more in detail in the fine grain case study analysis. The fine grain analysis will also consider if it is possible to analyze more in detail the sector policy interactions according to which conservation objectives that the policy instruments affect.

3.4 Voluntary forest conservation

How the instrument works

Traditionally, the main regulatory instrument for conservation in Norway, in addition to the forest law and forest certification schemes, has been state appropriation of private forest land for forest reserves against compensation based on the value of the standing timber. This was the source of serious conflicts between forest owners, the state and environmental NGOs in the 1990s. In 2000, the national forest owner association proposed a new voluntary conservation approach, where forest owners first take the initiative to report areas available for protection to the county government.[5] Relevant areas are then submitted to field evaluation of nature values, following standard procedure for such evaluations. For evaluated areas of sufficient value and quality, the next step is a negotiation process, where compensation (usually in the form of a one-time payment), specific area and terms for the reserve area are agreed. The compensation is based on timber values, while harvesting costs are subtracted and the net value discounted.

The ownership of the reserve remains with the forest owner, but he/she relinquishes all rights to extractive activities for perpetuity. This is different from the Finnish scheme “Trading in Natural Values”, for example, where contracts are time limited, 10 years in the pilot program (Mäntymaa et al. 2009). The rules of compensation are quite similar between the mandatory and the new voluntary approach though there seems to be some more room for negotiation (Skjeggedal et al., 2010).[6]

[5] The Directorate for Nature Management has a set of priority forest types that it uses to select voluntary forest areass among those offered by owners. One clear objective is to use the scheme to strengthen the robustsness (larger size) of existing protected areas.

[6] The information about the compensation amounts paid is currently not public.

However, the main difference compared to mandatory conservation seems to lie in the process steps and the central element of voluntariness. Since 2003, nearly all new conservation processes have been in the voluntary form, and there is general political agreement only to pursue the voluntary approach in the foreseeable future. To date around 2.5-2.6 percent, as noted in chapter 2, of the productive forest area in Norway is protected (including both voluntary and mandatory protection).[7] However, in addition to the voluntary scheme aimed at private forest owners, an official strategy has also been to conserve forest areas within the state owned forests. Many of the state owned forests are not located in prime, productive forest areas.

Assessment of voluntary forest conservation

The instrument has not undergone a full impact evaluation to assess *conservation effectiveness*. A recent assessment concludes that especially low lying, productive forests and endangered species and habitat types in Southern Norway, the area of our analysis, are still highly underrepresented in the protected area network (Framstad et al., 2010). The areas under voluntary forest conservation do contribute to the conservation objectives, but there are still gaps, especially for low-altitude areas in Southern Norway with nemoral or boreonemoral forest, habitats for red list species and other specialised species related to productive forest areas and unique habitats in low-altitude areas (Framstad and Blindheim, 2010). A reason why some of these areas are not well-covered is that some of the areas may not be forestry areas, e.g. could be remnants close to urban areas where the main threats are urbanization and infrastructure development. Even so, compared to the traditional conservation approach, it is clear that the government loose some control over the conservation outcome.

Further, enrolling sufficient NIPF owners into the scheme will be crucial to achieving conservation objectives. Around 75 percent of the Norwegian forest area is owned by ca. 120 000 private forest owners, many of which are organized in forestry organizations (the Norwegian Forestry Association is the biggest). A handful of them own large areas, while the majority of the holdings are small and owned by the non-industrial private forest owner category. Currently, the main obstacle to further progress of enrolling more forest owners is lack of sufficient budget in the Ministry of Environment.

Regarding *cost effectiveness*, we do not have much quantitative information to base the assessment on. Compared to the mandatory scheme that preceded the voluntary scheme, there are indications that the voluntary scheme is less costly in terms of process and litigation costs (i.e. key components of transaction costs). This is due to the voluntary element of the process. The costs in terms of compensation payments compared to environmental values (“value for money”), are uncertain. One study indicates that payments are slightly higher under the voluntary scheme (Skjeggedal et al. 2010), though the formula for calculation of the compensation payment has formally not changed. It may be that the attitude from the authorities is to be slightly more generous, though this is not confirmed.

Given the high hostility and conflict level associated with the mandatory scheme, the voluntary approach has a higher legitimacy and acceptability among forest owners (which is of course as expected since the largest forest owner association proposed the scheme). However, among conservation NGOs and to some extent other stakeholders, the voluntary approach has a lower

[7] http://www.dirnat.no/content/500044095/Kongen-verner-skog-

acceptability. This is because they doubt that the remaining, prime areas (and areas of sufficient size) will ever be enrolled through voluntary means. Hence, they argue that the mandatory approach should be used in parallel to better cover holes in the protected area network. There seem to be some movement on the forest owners' position in this respect, although their general argument still mainly holds, that (re)introduction of the mandatory scheme will undermine trust and goodwill among forest owners to continue with the voluntary scheme. It seems that the Directorate for Nature Management and the political community in general, still put considerable faith in the mechanism as the main scheme to be used for the future. Hence, it may be that it is the low conservation budgets, rather than lack of biologically interesting offers, that now hinders progress in reality.
Institutionally, the voluntary scheme is very similar to the mandatory scheme. Hence, there are no major constraints or challenges related to the working of the voluntary scheme.

Can the instrument deliver on the challenges?

The voluntary scheme has many advantages, but as mentioned the conservation progress is very slow compared to ambitions. A major hurdle is the low public budgets to compensate those forest owners who have submitted proposals for conservation reserves. Also the mapping of priority forests for conservation which is a pre-requisite set by the Directorate of Nature Management slows the process down. Maybe more effort could be put on a description of habitats or kind of forest stands that forest owners could identify on their property. There may also be other ways to improve

However, it is likely that increased budget is not enough on its own: additional measures or changes to the current voluntary scheme may be needed to address gaps in the conservation targets that as of now have been difficult to cover through the voluntary scheme.

Depending on which instrument is chosen to supplement the voluntary approach (which is likely to continue due to its wide political support), there may be various degrees of trade-offs between instrument assessment criteria. If the mandatory scheme is (re)introduced, for example, transaction costs are likely to rise and legitimacy of the whole conservation enterprise may again be under threat.

Research questions. There are several interesting research questions for fine grain analysis. These are discussed in Chapter 6.8.

3.5 Incentives for prioritized species and selected habitat types under the Nature Diversity Act

How the instruments work

The Nature Diversity Act makes specific provisions for what it terms "priority species" and "selected habitat types". The former term means specific species that have a serious population status, have most of its distribution in Norway and/or are covered by specific international commitments. Selected habitat types have a similar interpretation as for priority species, except that it relates to habitats and has a fourth assessment criterion related to whether the habitat is important for any priority species. The Directorate for Nature Management is in the process to assess and assign certain species and habitats this new status. This status enhances their protection, and activities that may harm them are prohibited. A list has been made, that is continuously updated.[8]

For priority species where active management is required to maintain the population, action plans are developed. A dedicated support scheme for management and other measures has been established. This is not compensation, but "positive incentives" that are meant to stimulate landowners, rights holders, organizations/institutions and municipalities to take care of these species. In some way this scheme is an "embryonic" PES scheme in the Norwegian context. The required measures will depend on the type of threat, e.g. from urbanization vs. forestry activities. The funds (27 mill NOK in 2012)[9] will go to active operational management or other measures that will help to maintain or restore the ecology. There is a similar support scheme for the selected habitat types[10]. The Directorate for Nature Management has designed an online application system, where each support scheme has its own application form. The application is sent to the county governor's office for assessment. It is unclear exactly how proposals will be evaluated and how the size of the incentive is determined.

Assessment of the instruments

The support schemes have very recently been introduced and it is a bit early to tell how they will function. In terms of conservation effectiveness, a gap in the current conservation policy has been covered with the introduction of specific legal status and the accompanying support for management linked to the protection of priority species and habitat types. In that respect, the mechanism should give clear biodiversity benefits. However, it is not absolutely clear how (and how many) priority species and selected habitat types will be chosen, how extensive the support scheme will be and how the impacts of the law will play out on other activities that may have to be abandoned or considerably revised in the face of the new law. Some conflicts are likely to be encountered. In the process discussing the law, heated debates with e.g. forest owners were observed and the law is a result of several compromises. For example, the habitat type "hollow oaks" is only given selection status if it is not placed on land characterized as productive forests. See text box below for details. This was an exemption negotiated based on the argument that it would unnecessarily hamper normal forestry activities.

It is likely that the new measures will have a positive impact on conservation objectives, though it is too early to tell at what cost. Further, distributional impacts and legitimacy concerns may also have to be judged once impacts of the specific implementation of the schemes have been observed for a few years. The institutional set-up for the mechanism is still a bit immature, though a guideline for the implementation of the priority species scheme has recently been published.[11]

Can the instruments deliver on the challenges?

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[8] http://www.dirnat.no/naturmangfold/trua_arter/prioriterte_arter/ . http://www.dirnat.no/content/500044756/Flere-arter-og-naturtyper-skal-beskyttes

[9] http://www.dirnat.no/content/500044798/Milliondryss-til-trua-arter-og-naturtyper

[10] http://www.dirnat.no/content.ap?thisId=500040813

The two support schemes for management of priority species and selected habitat types are promising, though they are relatively minor compared to for example the voluntary forest protection scheme. As such, the direct regulation elements of the fairly comprehensive Nature Diversity Act, of which priority species and selected habitat types are only one of several elements, is likely to be more important for conservation benefits, than the incentives created through two small support schemes. It is also important to note that many of the priority species and selected habitat types will be outside the forestry decision making sphere, as they are not influenced by forestry activities directly.

Text box 1: Illustration of the interaction between general forestry regulation and specific subsidy program for management of selected habitat type "hollow oaks".

Hollow oaks have been designated as a selected habitat type in a regulation under the Norwegian Nature Diversity Act, as they harbor a rich, rare and unique biodiversity. Many hollow oaks have grown up in a well-lit cultural landscape and developed large, wide crowns that require good access to space, light and water. With changes in agricultural land use, shrubs and trees often invade the area under large trees' crowns and the surroundings slowly turns into a forest. This affects the vitality of these hollow oaks and reduce their potential life-span. In addition, many of the red-listed species associated with such oaks experience suboptimal conditions when their host tree becomes shaded by regrowth. The State provides subsidies for measures to look after selected habitat types, like removing regrowth around wide-crowned, hollow oaks trees. But as the regulation does not apply to hollow oaks in managed forests, many of the trees most in need of this measure do paradoxically not qualify for economic subsidies. The forest sector claims that hollow oaks are taken care of with existing regulation in production forests, however, this is highly uncertain. Hollow oaks in production forests were left out as a result of negotiations between forest sector representatives and the government.

Photo credit: Anne Sverdrup-Thygeson.

[11] http://www.dirnat.no/content/500045605/Veileder-til-forskrifter-om-prioriterte-arter

For a description see: http://www.regjeringen.no/pages/17018907/Hollow_oaks_Selected_habitat_types.pdf

3.6 Incentives for biodiversity "hot spots" and certification on private land

How the instrument works

A large part of Norwegian forests that are actively managed for forestry are under certification (formerly known as Norwegian "Living Forests", now a standard under the European Program for the Endorsement of Forest Certification Schemes). Certification is primarily a market-driven process, though in Norway the criteria for the certification were negotiated between the forest industry, the labour movement, outdoor recreation organizations and environmental organizations starting from 1998. In June 2010 these negotiations broke down, especially due to disagreement over the use of exotic tree species. The Norwegian forests are still certified, though not under the FSC.

Government compensation (at the county level) can be obtained for setting aside areas of "Complementary Hotspot Inventory" ("MiS" in Norwegian), as a requirement under the certification scheme and under the forest law (sustainable forestry). Forest owners with biodiversity hotspots covering at least 1% of the productive forest area in their property can receive compensation (generally small amounts, up to NOK 75 000). The program was started in 2001 and initiated and financed by the Ministry of Agriculture. The aim has been to develop and test a tool that can be used in forestry planning for registering and potentially monitor environmental qualities for biodiversity.

Recently, forest owners with large areas of MiS can propose the establishment of a nature reserve on their property as part of the voluntary conservation approach and receive full compensation if the forest area fulfills the criteria for protection as a nature reserve.

Assessment of the instrument

The certification scheme may potentially have a fairly large impact on conservation values, since the certification is relevant for almost all forests not currently under formal protection – i.e. the large majority of forests. The certification scheme itself is a market driven instrument, and the forest owners and associations have some incentives to make sure that forest owners adhere to the certification standards. If not, the customers will lose trust in the mechanism and perhaps refuse to buy the timber. However, there are also clear incentives for the individual forest owner to infringe, to make private gains at the expense of all the others. This has also to some extent been observed in Norway (e.g. harvesting in the hotspot areas) and in other countries.[12] Such behavior may lead to a "race to the bottom" and undermine the certification standards. Hence, conservation effectiveness depends on internal stringency for its external legitimacy.

It is hard to assess how important the economic support given for registering MiS or to forest owners who have a high share of MiS. Little is known about how the MiS registration support scheme has worked. Sverdrup-Thygeson et al. (2009) found that the mechanism has achieved some of its intensions and objectives. Cost-effectiveness is further also hard to judge, as is the institutional set-up.

[12] It is not always clear if this has happened with the deliberate intention to gain financially. It may also in some cases be due to lack of knowledge and uncoordinated behavior on the forest owner part.

Can the instrument deliver on the challenges?

This section has described both forest certification as an instrument, and the support scheme established to induce forest owners to register biological values on their land. This registration (MiS) may then in turn be used as part of the certification or even to apply for compensation through the voluntary forest conservation scheme (if the biologically rich area is large enough). Given the large areas under normal forest management, how the forest law and the certification scheme are designed to maintain biological and wider environmental objectives, is potentially very important for conservation effectiveness. It is therefore a concern that the certification scheme is not widely endorsed nationally, though the certification is effective under PEFC scheme.

3.7 Other financial instruments

In addition to the economic instruments within Norwegian boundaries, discussed above, Norway also contributes to policy development internationally of relevance to biodiversity. Its support to the REDD+ initiative has biodiversity conservation as a likely co-benefit. A part of the official foreign assistance, in addition to the REDD funds, also have

The Norwegian Government has over several years built up a large savings fund from the petroleum wealth. The foreign part of this fund, called the Government pension fund, global, is invested in foreign firms globally. There are ethical guidelines governing the types of firms the fund can own. Some of these guidelines apply environmental criteria that may benefit biodiversity.

A recent report by report by Rainforest Foundation Norway and The Norwegian Society for the Conservation of Nature discusses the conflicting objectives and practice between Norway’s international climate and forest conservation policy, and Norway’s international financial investments of revenues from the oil and gas sector in its national pension fund (Regnskogfondet and Naturvernforbundet 2012).

We will not discuss or assess these instruments further in this report, though the workings of REDD as an instrument nationally will be covered in other case study analyses in the project.

4 Roles of proposed and potential new economic instruments

4.1 Introduction

This chapter provides a description and an assessment of the most important *proposed or potential* economic instruments along the four criteria of conservation effectiveness, cost-effectiveness and benefits, distributive impacts and legitimacy, and institutional options and constraints. The chapter aims to describe the different conservation instruments' characteristics that later can be used to explain their *prospective* 'functional role'. The chapter corresponds to the first part of step 2b in the policy mix analysis framework. Each instrument and its stand-alone purpose are described. Assessment of interactions is carried out in Chapter 5.

For each of the instruments in the chapter, this structure is (roughly) followed:

- Brief description of how the instrument would work in the specific Norwegian context. More specific literature relevant to Norway and studies performed in the Norwegian context are cited when relevant.
- Brief assessment according to the four instrument assessment criteria.
- Short summary/conclusion regarding pros and cons in terms of delivering on the challenges identified in Chapter 2.

4.2 Subsidy reform – proposed[13]

How subsidy reform is intended to work

Subsidies come in many shapes and forms. A common definition of a subsidy is "….government action that confers an advantage on consumers or producers in order to supplement their income or lower their cost" (OECD 2005). Subsidies are most commonly thought of as direct from the government to private or civil-society actors. A subsidy can be sensible and efficient if given to reduce so-called environmental externalities or encourage positive ones. PES schemes try to stimulate the generation of positive externalities (or avoidance of further negative ones), given that landowners often in practice are seen to have the right to keeping the existing situation (or to cause further environmental degradation). The overall level of subsidies in Norway is large. There are a number of subsidy schemes with potentially harmful environmental effects (SWECO 2008). Subsidies to agriculture in Norway, the largest of all subsidies, are estimated at around 20 billion NOK (including the subsidy value of customs duty protection). Subsidy reform has been on many government agendas since the early 1990s, including Norway's, and has been pushed after 2000 by for example a series of studies by the OECD (OECD 2003; OECD 2005).

Of particular importance for forest biodiversity are the schemes in Norway that support construction of forest roads and harvesting in rough terrain and planting of exotic tree species (see also chapter 2). The support for construction of forest roads and harvesting in rough terrain has been evaluated

[13] This section to some extent draws from Vatn et al. (2011).

by SABIMA (2011). The budget for this scheme has been increased for 2011, even though it is a subsidy that Norway has committed to phase out within 2020.[14]

There are also others schemes, e.g. compensation schemes for losses of sheep to predators in forests (i.e. lynx, bear, wolverine and wolf). Reform of these, and many other incentive schemes, may have potentially, large positive impacts on forest biodiversity.

Assessment of subsidy reform

Many subsidies all too often end up distorting prices and resource allocation decisions, typically also harming the environment. Whether subsidies are good or bad often comes down to their objective and their specific design and implementation. The main rationale for subsidy reform is to restore resource allocation efficiency, i.e. direct scarce resources to areas of production and consumption where they are valued the highest. Further, subsidies are typically financed by taxes that create their own efficiency losses in collection. Finally, as inefficient subsidies are cut, scarce government resources can be freed for more productive uses, including funding of conservation policies. Although some subsidies may be particularly bad for biodiversity and ecosystem services, such as those mentioned above, it is important not to restrict subsidy reform only to those subsidies that are explicitly bad for the environment.

Achieving these efficiency gains through subsidy reform (or removal) has proven tremendously challenging, in Norway and globally. Although the *effectiveness* and *efficiency* arguments for removing or reducing many types of subsidies are compelling, issues of *equity and process legitimacy*, and share complexity of reform, are effectively halting progress in this area. Hence, removing or reducing ineffective subsidies that have no current legitimate objective is often a painful process for the interest groups that stand to lose and they will fiercely oppose such changes. This is also observed in Norway. Such potential conflicts can be sought alleviated through broad stakeholder engagement, transitional assistance (to ease the pain), increased transparency and information exchange (which may increase the broader support for reform).

Can subsidy reform deliver on the challenges?

Some subsidies may serve sensible and legitimate purposes, such as many PES schemes, however a larger share of subsidies create distortions, demand scarce public resources and may be harmful for the environment. While other countries currently are under fiscal distress and subsidy reform gains momentum, Norway has been sheltered from the financial storm. This means that subsidy reforms are still hard to promote by any government. In Norway, there is some potential that subsidy reform may have a positive impact on forest biodiversity, especially if the forestry support schemes stimulating road construction and harvesting in inaccessible areas, are abandoned. In the Norwegian fine grain analysis, we will consider having a closer look at the specific forestry-related subsidies, especially those that stimulate harvesting in areas that would otherwise may not be profitable (so-called “zero areas”).

[14] http://sabima.no/sider/tekst.asp?side=1033

4.3 Ecological fiscal transfers using the nature index - potential

How ecological fiscal transfers are intended to work

Fiscal transfers refer to state-to-local transfers of public finance to cover local government provision of public goods and services. In Norway fiscal transfers to municipalities from the State are calculated based on three basic principles (Håkonsen 2009):

- Inhabitant grant. The starting point is an equal transfer per inhabitant of the municipality
- Expense equalization. The State compensates for expenses beyond the control of municipalities.
- Income equalization. The State redistributes tax income from high earning to low earning municipalities.

A 'distribution key' is currently used to compensate municipalities for expenses in the agricultural (76%) and environmental (24%) sectors combined, wherein the environmental share is calculated based on number of inhabitants (70%) and a fixed amount (30%). Hakonsen and Lunder (2009) have evaluated the fiscal transfer system and the 'distribution key' to cover disproportionate municipal expenses on environmental responsibilities. The results of their evaluation are discussed below. Their analysis discussed later in this section addresses compensation for expenses.

Ecological fiscal transfers (EFT) as analyzed in Brazil and Portugal by Ring and colleagues addresses fiscal transfers as a mechanism for compensation of tax-income losses from conservation. Ecological fiscal transfers have in Brazil also been implemented as an instrument to provide incentives for local governments to support creation of and maintain conservation areas within their territories (Ring, May et al. 2011). It is seen mainly as a measure to compensate local government for lost tax revenues from protected area restrictions on landuse. Direct compensation of landowners for expropriation or use restrictions in the context of protected area creation is not addressed by EFT. Ecological fiscal transfers for biodiversity conservation build on existing protected area regulation in that they use officially designated protected areas – their area and sometimes also conservation-based indicators of quality – as an indicator to allocate fiscal transfers. Fiscal transfers are funded from tax revenues or redistribution of international transfers in the context of e.g. REDD+. In the case of Brazil tax funds are raised as a share of the value-added tax (VAT). Transfers are lump-sum payments - none of the EFT schemes in place in Brazil and Portugal require earmarking of transfers to conservation-related spending at the municipal level. In some Brazilian states the introduction of EFT has coincided with a strong increase in public protected areas, and in some cases funds have been used for municipal support to private conservation efforts. However, attribution of an increase in protected area or quality is difficult to establish statistically due to many confounding effects and a lack of a comparable control group of municipalities (Ring, May et al. 2011).

Assessment of ecological fiscal transfers in Norway

EFT are discussed in the Norwegian context for a number of reasons, none of which call for EFT directly but which suggest increasing state-to-municipal transfers for nature conservation. These arguments pertain to general policy reform; performance payments at municipal level; municipal responsibilities, capacity and financing under the Forest Act and Nature Diversity Act; and current practices in compensation of municipalities of opportunity costs of protected areas.

General policy reform. The government Proposition for the Nature Diversity Act (Ot.prp.nr. 52, 2008-2009) proposed increasing financial measures for maintenance of protected areas, as well as compensation of economic losses caused by protected areas. The white paper on global environmental challenges for Norwegian policy (NOU 2009: 16) called for positive economic incentives to encourage protection of biodiversity [..] and payment for ecosystem services" and a search for "other schemes tied to state grants to municipalities".

Performance payments at municipal level. State-to-municipal transfers to promote nature conservation have also been advocated by environmental pressure groups (Friends of the Earth Norway). In their comment to the TEEB report for Local and Regional Policy Makers (TEEB 2010), Friends of the Earth Norway have advocated that "in Norway the State's distribution of block grants to municipalities using the so-called 'municipal distribution key[15]' can be adjusted so that the municipalities that are best at protecting valuable nature, and in turn biodiversity and ecosystem services, are rewarded. Municipalities that don't take local responsibility and degrade valuable nature and undermine future ecosystem services we all depend on, should have their block grants reduced." Lars Haltbrekken[16]). In response, the former environment minister Erik Solheim "did not want to address this particular proposal, but thought the idea was a good one" (Kommunal Rapport 10.9.10). Kommunal Rapport notes that compensation for results from protected areas is the basis for the Norwegian REDD+ initiative - the Climate and Forest Project – and is a criteria when establishing protected areas and national parks in Norway.

Municipal responsibilities, capacities and financing. Transfers to municipalities for environmental management have been criticized as falling while municipal responsibilities in environmental management have been increasing (Håkonsen 2009). Municipal environmental coordinators were financed with earmarked state funding (MiK) between 1992-96. After the financing was withdrawn in 1997 58% of municipalities had closed these environmental positions (Kommunal Rapport 2001)[17]. Today a small minority of municipalities have environmental consultant positions (Kommunal Rapport 2009).[18] On the other hand municipal forest managers/ the forest service administration is financed by interest earned on the Forest Trust Fund (Bergseng and Solberg 2007).

Municipal responsibilities in forest management are defined in the Forestry Act (27. mai 2005). Municipalities can ask forest owners to carry out forest registration, resource inventorying and management plans (§5). Municipalities are charged with evaluating the environmental impacts of and granting permissions for tree planting and forest management (§6) and timber harvesting (§8). Municipalities grant permission for building of roads for the purpose of forestry (§7). Municipalities can require forest owners to remediate damages from forestry activities (§8) or other environmental damages to the forest. If forest owners do not take action municipalities have the power to undertake remediation activities at the expense of the forest owner (§10). Municipal government is charged with managing wildlife such as deer and elk that can damage vegetation (§9). Municipalities or other forest authorities can where necessary for compliance with the Forestry Act require forest owners to give 'prior notice' of harvesting or forest management activities. Municipalities are

[15] "kommunenøkkelen" in Norwegian

[16] http://naturvernforbundet.no/nyheter/loennsomhet-i-naturbevaring-article17382-166.html

[17] http://www.kommunal-rapport.no/artikkel/nedtrapping_foran_johannesburg

[18] http://www.kommunal-rapport.no/artikkel/klima_kroner_og_kommuner

responsible for enforcing collection of funds for the Forest Trust Fund (§14), and granting reallocation of forest owners' shares in the fund to other forests in their possession (§15).

Municipal responsibilities for protected areas are defined under the Nature Diversity Act (2009). Responsibilities. Municipalities are charged with land use zoning under the Planning and Building Act (2008). Municipal authorities may make regulations so that 'selected habitat types' also apply to other specified habitat types in the municipality (§53). Municipal authorities must be notified and grant permits for forestry projects affecting 'selected habitat types' even when these do not require forest permits. This pertains also to §6 and §8 under the Forest Act (above).

Current practices in compensation of municipal opportunity costs of nature protection. Under the labour lead government of Jens Stoltenberg, the directorate for nature management (DN) has started providing compensation to municipalities for opportunity costs of the creation of protected areas through 'local development trust funds'.[19] In the case of the Trillemarka-Rollag Nature Reserve a fund of 30 million NOK was established to be paid over five years to the three municipalities affected (Roolag, Sigdal and Nore og Uvdal). [20] The year after a local development trust fund of 10 MNOK was also proposed for the municipalities affected by the landscape protected area planned for Naustdal–Gjengedal (St.prp. nr. 67 ,2008-2009) and 150 MNOK for protection of the Vefsna watershed (Vefsn, Hemnes, Grane og Hattfjelldal municipalities). While 'local business / development trust funds' are an established local development policy in Norway, the practice of establishing them in connection with protected area plans seems to have been ad hoc and initiated by the particular level of conflict in the Trillemarka-Rollag case. The recent examples of other conservation-related development funds indicate perhaps that a new type of municipal incentive for protected area policy is in the making.

Earmarking value added taxes to forest management and biodiversity conservation. A final reason to discuss EFT in this context is the Norwegian Forest Trust Fund (FTF). This is financed through a tax on timber sales at the first point of purchase (Bergseng and Solberg 2007), not unlike a value-added tax, but unlike EFT it is earmarked. Unlike EFT in Brazil and Portugal, FTF deposited funds are attributed to the forest owner, as well as being earmarked for specific forest management and conservation purposes on private land laid out in state regulations. Deposits to the FTF are kept in the name of the forest owner and treated as costs, while disbursements are treated as non-taxable income in annual accounts of forest owners.

Can ecological fiscal transfers deliver on the challenges?

Challenges can be evaluated according to procedural and outcome legitimacy, the latter separated in effectiveness, efficiency/cost-effectiveness and distributional equity. Håkonsen and colleagues evaluated the distributional and efficiency implications of a revised 'municipal fiscal distribution key' to better address nature and environmental responsibilities of municipalities (Håkonsen 2009; Håkonsen and Lunder 2009).

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[19] 'lokalt utviklingsfond' ; 'næringsfond'

[20] A majority of Finance Committee members with the exception of the government members from the Labour and Socialist Left parties voted for a larger fund of 100 million kroner to both compensate for income lost by local landowners and stimulate new business opportunities. St.prp. nr. 59 (2007–2008)

The authors identified municipal expenses that could be associated with environmental management in the municipal reporting system KOSTRA. Environmental management expenditure categories[21] were then correlated with the land area of protected area categories[22] and population density and distribution variables[23] that were expected to affect expenditures on environmental management. Environmental management related expenditures as defined here constitute 0,162% of total municipal expenditures in 2004. Expenditure categories in KOSTRA are coarse and authors argue that any environmentally based adjustments to fiscal transfers will require greater precision in the definition of environmental expenditure categories.

Proposed revised fiscal distribution key. Using multivariate regression, they find the area of Landscape Protection Areas to be significantly correlated with municipal expenditures, while the area of National Parks is only significant when analysed independently of other protected area categories (there is some multicollinearity between the area of national parks and landscape protection areas in municipalities that was not researched). Based on their best fit model (Rsq=0.56), Haåkonsen and Lunder (2009) propose a revised fiscal transfer/distribution key as follows:

- Total number of inhabitants (76.16%)
- Share of population in rural areas (11.92%)
- Protected area per inhabitant (4.52%)
- Total area per inhabitant (2.46%)
- Constant share (4.95%)

Distributional impacts. The authors find that the revised fiscal distribution key leads to the largest per capita gains in income for municipalities with large outerlying land areas and high income from hydropower, and leads to the largest income losses for cities and small land area municipalities.
In effect, a distribution key that compensates for additional environmental expenditures would compensate the wealthiest municipalities in per capita tax income terms. While the authors argue that this is based on objective criteria, and that expense compensation and income compensation features should be evaluated separately, they mention the problems with political legitimacy of such a redistribution.

Efficiency (cost). The proposed fiscal redistribution key would only reallocate 0.16% share of municipal expenditures on environmental management. Håkonsen and Lunder question whether revising the fiscal distribution system with additional administrative burden/costs can be justified by such a small reallocation of fiscal transfers. The reallocation is miniscule relative to other municipal public service responsibilities (kindergartens, schools, care of the elderly).

Effectiveness. On the other hand Håkonsen and Lunder's calculations show that in absolute terms reallocations to rural municipalities are sufficiently high to pay for one or several environmental

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[21] Building permit evaluations, mapping and surveying, recreation in urban areas, nature management and cultural heritage site protection. Further research should clarify whether forestry management expenditures are accounted for in these expenditure codes?

[22] area of Landscape Protection, National Parks and Nature Reserves

[23] Area per inhabitant, share of protected area of total land area, number of inhabitants, tax income per inhabitant, share of population in rural areas, zone criteria.

coordinator positions, similar to those that were lost after the MiK programme of earmarking funds was closed in 1997 (total increases of 1,2 MNOK – 4,3 MNOK for the ten most favoured municipalities). Håkonsen (2009) discusses whether reform of an expenditure redistribution key has any incentive effect on environmental management in municipalities. He concludes that basing fiscal transfers on municipal area criteria might confound environmental expenditures with other municipal responsibilities. The causal relationship between protected area in a municipality and specific expenditures also needs to be established (municipal area varies between 6 and 9704 km2 in Norway).

After reviewing alternatives to fiscal equalisation of expenditures such as earmarking of transfers, discretionary transfers, local trust funds and regulation Håkonsen (2009) concludes that environmental expenditure equalization of fiscal transfers is possibly too coarse an instrument to address the multiple objectives of nature and environmental management activities at municipal level. They propose a municipal policymix whereby earmarking of transfers is used to incentivise specific (new) municipal environmental responsibilities during phase in periods. State-imposed regulations are used in combination with **local development trust funds** to compensate for loss of municipal income from protected area establishment in achieving national policy objectives (because these protected areas are exceptional). Adjustments in fiscal transfers are justified to address expenditures increases due to general environmental responsibilities that apply to all municipalities.

Research questions. The literature does not debate the proposition by environmental advocacy that municipalities should be rewarded for higher quality conservation and environmental management, following TEEB recommendations. Indeed, the practice of the State providing compensation at the municipal level for foregone income is in itself quite new, and still a further step away from voluntary conservation incentives at the municipal level.

A research question would be whether 'local development trust funds' could become a permanent policy instrument for compensation of opportunity costs of PAs at municipal level, similar to the compensation negotiated with forest owners for voluntary forest conservation agreements (VCA). Criteria for calculating foregone tax income from avoided forestry (possibly net of immediate gains in other sectors such as tourism development) would need to be established. The size of development trust funds as compensation for conservation has so far been largely ad hoc, or politically motivated.

The problems in identification of environmental management expenditures shows the complication in finding objective and generally applicable criteria for ecologically adjusted fiscal transfers. Currently Statistics Norway (SSB) and NINA are conducting research on calculating a Nature Index (Certain, Skarpaas et al. 2011) at municipal level. With sufficient validation this might be used in future to provide incentives for additional conservation effort by municipalities.

Earmarking of public funds for specific (environmental) purposes is generally opposed by the Ministry of Finance, because it may lead to competing state sector interests and pacification of local priority setting (Håkonsen 2009). Earmarking can also be justified in correcting for external effects across municipal borders. This might be sufficient justification for earmarked fiscal transfers addressing for example one municipality's maintenance of large protected areas to the benefit of a neighboring municipality's tourism and recreation. This kind of earmarking requires specific spatial economic analysis. Because earmarking of tax funds is difficult, further research is needed to demonstrate municipal externalities of protected areas. The ECOSPACE (Wageningen University) in association with POLICYMIX Norway may be used to assess such externalities in the case of Telemark County. Further justification for earmarking of tax funds could also be found in the current practices of the Forest Trust Fund.

EFT may be less relevant as an incentive for voluntary creation of protected areas by municipalities because municipalities have not historically been initiators of nature protection. The Nature Diversity Act (§53, discussed above) seems to open up for the possibility of municipalities themselves identifying 'selected habitat types' that have been declared a priority under the act. Municipalities' role here requires further research as it may open a possible field for use of positive incentives for conservation.

4.4 Utilizing auctions as part of the voluntary conservation approach – potential[24]

How auctions are intended to work

Auctions have been used by governments to trade a range of different commodities, including e.g. electricity, broadcast spectra, emission permits etc. Auctions come in many forms and the main idea is to harness market forces to induce participants in the auction, the bidders, to compete and through the bidding process reveal their true valuation of the auctioned good. The underlying challenge for regulation, and the rationale for use of auctions in funding conservation, is that the landowner knows more about the on-site costs and local impacts of various activities than the conservation agency. This may lead to a tendency where landowners who already are engaged in environmentally friendly practices and have low costs of additional such activities, enroll more often in PES programs. This may next result in low environmental benefits (low additionality) and overcompensation of compliance or opportunity costs. In addition, contracted landowners have incentives not to comply with the contract terms, if compliance monitoring is costly or difficult.

Auctions have increasingly been considered as the most promising mechanism to deal with the information asymmetries and increase cost-effectiveness of publicly managed PES programs. The two main forms of price setting in ordinary PES schemes to date are (1) bilateral bargaining between the conservation agency ('the buyer') with a single (or group of) landowners ('the seller') where a price is agreed and (2) posted fixed-price payment schemes. The former is the one most closely resembling the voluntary forest conservation approach in Norway (see chapter 3.4). The latter is for example used in the Costa Rican PES scheme and in EU agri-environmental programs to support biodiversity (Rousseau and Moons 2008).

In a PES procurement auction, on the other hand, landowners are invited to submit bids (their required payment or compensation to enter into a PES contract) for delivery of the types of conservation activities the conservation agency has specified. Since the environmental service and

[24] This section draws from Vatn et al. (2011). and Romstad et al. (2012).

biodiversity outputs are difficult to contract directly, the rewards are normally based on a specific set of activities, i.e. change of land management practices, rather than conservation outcomes (e.g. particular ecosystem services or biodiversity benefits). If these activities or practices are relatively homogenous, the conservation agency can rank bid proposals according to cost, and accept bids until the conservation budget is met. Alternatively, the conservation agency may have a target (e.g. number of hectares) to enroll and will accept bids until such a target is met. If the quality of biodiversity vary among available land areas, not just the opportunity costs, the conservation agency typically ranks bids based on a combination of the (expected, proxied) environmental benefits and the payment levels (costs), e.g. in an index.[25]

The most common forms of bidding rules are the uniform and discriminative price auctions. In a uniform price auction the winning landowners are all paid the same price, typically the highest winning offer price or the lowest rejected offer. In the discriminative price auction each bidder rewarded a contract is offered their own winning offer bid. In the uniform auction, the landowner has no incentive to make a bid above his opportunity cost, since what is paid is independent of the bid. However, the conservation agency will have to pay landowners a compensation which is higher than their revealed, true costs (since all landowners will get the same payment). On the other hand, in the discriminatory auction the conservation agency will pay only what the winning landowners bid, but the landowners have an incentive to inflate their bids since what they get depend on their bid. However, this comes at a cost which is the higher chance of not getting a contract. Hence, the auction mechanism will not be able to eliminate all so-called "information rents" on parts of the landowners.

Assessment of auctions

The main question related to ***conservation effectiveness*** is whether auctions can deliver biodiversity benefits over the more standard PES-schemes, e.g. the voluntary forest conservation scheme in Norway. As with auctions, standard PES schemes are subject to the problem that landowners have an incentive to cheat on their contract obligations resulting in lower-than expected environmental benefits. The conservation auction literature is not well-developed to deal with this problem. According to Latacz-Lohmann and Schilizzi (2005) the incentives to cheat are expected to be highest when landowners' compliance (opportunity) costs are high in relation to the payment levels (and the detection probability and fine in case of non-compliance detection are both low). This means that overcompensation may reduce the risk of non-compliance (and therefore the need to monitor) and that monitoring efforts should be concentrated on the high-cost landowners. These are the landowners with high pre-contractual land-use intensities.

The impact on effectiveness of auctions compared to fixed-price PES schemes is hard to judge on this point, as auctions typically contract more high-cost, high environmental benefit landowners who also have a higher risk of non-compliance. If monitoring for these landowners is not increased, some of the additional environmental benefits may not be realized compared to a fixed-price PES scheme. However, as argued by several authors, the chance of achieving additionality should be higher overall with the use of an auction (Ferraro 2008). That is because paying low-cost landowners less through an auction frees up resources to pay high-cost landowners, who are much more likely to provide a

[25] Two well-known auction schemes are the conservation reserve program (CRP) in the US and the BushTender program in Australia.

(much) lower level of environmental services in the absence of a PES contract. This is an important point, given the low additionality observed in many PES schemes.

Auctions may also be more targeted to take account of the heterogeneity of biodiversity over the landscape, not just variations in opportunity costs. This may be done by separating auctions with groups of landowners that are relatively homogenous in the services they supply or by scoring environmental benefits using some form of index. This gives a problem of how to value or weigh environmental benefits. However, even some form of consideration or weighting of environmental benefits, may yield significant efficiency and environmental improvements over auctions that only consider the heterogeneity in costs (Claassen, Cattaneo et al. 2008; Connor, Ward et al. 2008). Auctions may also be designed to encourage bids (and higher payments) for land areas that are contiguous (e.g. some form of agglomeration bonuses), giving higher environmental benefits than similar-sized plots away from each other (Reeson 2011). However, auction design must carefully consider the risk of so-called collusion and strategic bidding among landowners which will reduce cost-effectiveness. Concentrating contracts in one geographic area may also reduce monitoring costs, and in some cases landowners may influence each other positively, reducing the likelihood of breaching contract obligations.

Whether contracts are based on inputs (e.g. prescribed management activities) or outcomes (i.e. some measureable part of the final ecosystem service or biodiversity change) – or a combination of the two – is important for effectiveness. If the contracts are based on input activities only with no reference to achieved outcomes, landowners will have no incentive to make sure the outcomes are achieved or for entrepreneurship, e.g. providing biodiversity habitat more cheaply.

The main issue analyzed in the auction literature is the potential cost savings of auctions compared to standard fixed-price PES schemes, i.e. ***cost effectiveness***. The general view in the literature based on actual experience and model simulations is that auctions may reduce costs of reaching environmental objectives substantially compared to fixed-price PES arrangements (Ferraro 2008; Rolfe and Windle 2008; Windle and Rolfe 2008). It varies whether these studies incorporate some measure of administrative or transaction costs. Auctions seem to work best when there are many bidders, contracts are fairly homogenous in the environmental services or input activities, and landowners are heterogeneous in their opportunity or compliance costs (Latacz-Lohmann and Schilizzi 2005).

Latacz-Lohmann and Schilizzi (2005) recommend using a discriminatory bidding rule rather than a uniform one for conservation auctions, if there are no clear reasons to think that bidders will grossly inflate their bids over opportunity costs. If the landowners are risk-averse and prefer a certain income from a PES contract over more uncertain alternatives, the discriminatory format may clearly preferable to the uniform format. This is because land owners would tend to bid less as they also value a more secure income. Note also that a uniform pricing is likely to give lower overall payments than a fixed-price scheme for the same environmental target.

Although many studies show large efficiency gains of auctions over fixed-price schemes, these studies have typically assessed one-shot auctions. More recent studies show that if landowners learn from previous auctions or get information for example about the specific preferences of the conservation agency or their maximum reserve price, these efficiency gains may be greatly reduced over time (and space) as landowners adjust their bids upwards (Schilizzi and Latacz-Lohmann 2007).

In this regard information sharing to achieve higher legitimacy may have to be traded off with increased cost-effectiveness (see below).

Regarding ***transaction costs*** of auctions, few studies investigate this issue explicitly. Auctions can be complex and difficult to implement and therefore imply transaction and administrative costs that are higher than fixed-price schemes (e.g. Connor et al., 2008). However, Ferraro (2008) argues that auctions may not be more complex than individually negotiating with landowners, which Norway and many other countries do. Different auction design issues (e.g. pricing rule, outcome-based contracting etc.) may have impacts on transaction. There are also transaction costs on the part of the participating landowners. As discussed briefly in the final section below, it may be possible to combine auctions with a fixed-price scheme to for the smaller forest owners who may think the transaction costs are too high compared to potential gains in participating in the auction.

No studies we have found investigate ***distributive impacts and legitimacy*** of auctions over fixed-price or bilaterally negotiated PES contract schemes. It is impossible to make general judgments of process legitimacy of auctions vs. standard PES schemes, as this is likely to depend very much on the local context and the specific type of auction design. It is difficult to tell how this would play out in the Norwegian context, except that the voluntary element of both auctions and the current voluntary forest conservation scheme would still be important for process legitimacy. Decisions of eligibility to participate, the information given to bidders, bid evaluation system and how environmental benefits are weighted and scored compared to costs, bidding rules and how many bidders are finally given contracts are all design elements that may be more or less transparent and judged as more or less fair and accountable by different stakeholder depending on the situation. This may influence their judgment of legitimacy. For example, the decision to differentiate bid prices using a discriminatory auction may be rendered suspect and prone to corruption compared to a uniform price auction, if the criteria under which price differentiation have been decided are not transparent. Another example of a design element of importance for process legitimacy is given by Cummings et al., (2004): If landowners are allowed to revise their bid during the auction process to reduce the chance of poor choices, the likelihood that landowners will be angry about the auction process may be reduced.

Many of the design elements we mention also have more or less clear implications for cost-effectiveness and efficiency of the auction, and it is likely here as in the choice of other policy instruments, that there will be trade-offs between different criteria. For example, although it may be desirable for process legitimacy to give as much information as possible about an auction process, this information may be used by landowners to extract information rents and thereby reduce the cost-effectiveness of the auction mechanism, especially in auction processes that are repeated (Latacz-Lohmann and Schilizzi 2005). Further, if sophisticated bid evaluation methods are used to combine environmental benefits and costs, this process may be perceived as a 'black box', is harder to explain to bidders and generally less transparent than other pricing schemes.

Another issue that Latacz-Lohmann and Schilizzi mention that may be potentially important for process legitimacy is whether the contract is based on input activities or environmental outcomes. If the contract is based on outcomes, land owners take all the risk to ensure such outcomes are achieved. If they are hard to observe or measure, there may be high risk of disputes (e.g. litigation) linked to unclear landowner responsibility.

Regarding ***distributional impacts and equity***, as we have seen, auctions may take many forms and the outcomes will depend on the specific design of the auction. Compared to a fixed-price PES scheme, payments will generally be made to fewer landowners, a larger percentage of who are high-cost (and high environmental benefit). This may have impacts of equity and incomes, if low-cost landowners are more likely to have low incomes. Further, in some countries it may be considered more equitable to make differentiated payments that reflect opportunity costs, rather than uniform payments to all landowners.

Can the instrument deliver on the challenges?

Conservation auctions are still in their infancy, even in industrial countries, though the interest and experience are growing fast. Auctions can potentially save substantial costs to reach environmental objectives compared to fixed-price PES schemes or individually negotiated PES-contracts when there are many bidding landowners (encouraging competition), contracts are fairly homogenous in the environmental services or input activities, and landowners are heterogeneous in their opportunity or compliance costs. Auctions could be tested and tried in Norway, practically perhaps best within the broad framework of the voluntary forest protection scheme. For auctions to save costs, it would be relevant to investigate if the current mechanism pays more than forest owner opportunity costs or not. Even if there is no “premium” paid over opportunity costs in the current scheme, the auction mechanism may still make sense, as many forest owners have preferences for amenities on their own land and may be willing to accept a lower bid than their actual opportunity costs (Lindhjem and Mitani 2012).

A particular concern related to the use of auctions (or other decentralized principles) for allocating forest management contracts is that many habitats cover multiple properties. This issue is particularly relevant in the Norway, where there is a large proportion of small forest properties. Two principally different ways of resolving this issue are pre-surveying to identify cases where conservation worthy habitats span multiple properties, and implementing a system of agglomeration bonuses when landowners succeed in incorporating such habitats in the auctions. A disadvantage with the pre-surveying approach is that it reduces competition in the bidding processes. For conservation purposes where the number of habitats meeting conservation objectives is low, this may limit competition and reduce the cost savings of using auctions. Agglomeration bonuses are not subject to the same collusion risks as landowners do not know how many other prospective bidders there are. However, they may be difficult to implement, in particular among landowners with small forest properties.

Entering an auction entails some extra semi-fixed costs in terms of formulating bids. For landowners with small properties the expected gains of getting a conservation contract may not justify these transaction costs, implying that small properties are likely to be underrepresented in such auctions. One benefit of the truthful revelation property of uniform price auctions is that the bids can be used to design other compensation mechanisms. Of particular relevance in our case is the use of flat rate payments for landowners who did not enter the auction. When such payments are set lower than the auction price, incentives for participating in the auctions are maintained for landowners where the extra expected revenues from the auction more than offset the transaction costs. Typically landowners with large properties will benefit more from the auction than landowners with small properties because transaction costs are divided on a larger acreage.

Moreover, when some of the conservation contracts are awarded by a fixed per unit payment, fewer contracts will be auctioned because some management contracts will be offered to landowners accepting the flat rate payment. This increases competition in the auction because fewer contracts will be awarded through the auction. Such post-auction payments also open for achieving spatial coordination among small properties.

4.5 Biodiversity offsets – potential

How the instrument is intended to work

Biodiversity off-sets can be defined as measures implemented after avoidance, minimization, and mitigation actions have been exhausted on-site in order to compensate for/offset residual on-site biodiversity impacts (Vatn, Barton et al. 2011). Biodiversity offsets have many practical requirements, but among the most important are (i) a spatially defined objective for biodiversity conservation (a cap) and (ii) a system for monitoring and evaluating the equivalence of biodiversity between forest sites.

To our knowledge neither biodiversity offsetting nor habitat banking have been practiced in Norway. Mitigation activities are carried out on-site by land and water users as part of their normal responsibilities of EIA under the Planning and Building Act, Forestry Act, Nature Diversity Act and the ‘Living Forest’ certification scheme.

Research on biodiversity offsets is also recent. In their study of incentives for management of biodiversity in forests and wetlands, Vatn and colleagues do not address this as a potential policy instrument (Vatn, Framstad et al. 2005). Bergseng and colleagues model cost differentials of a ‘high biodiversity’ forestry versus the ‘Living Forest’ forestry certification standard in a municipal forest (Bergseng, Ask et al. 2012), but do not discuss whether cost differentials between forests could be the basis for a biodiversity offset instrument.

Currently, Complementary Hotspot Inventory (CHI) of ‘woodland key habitats’ (WKH) as part of Living Forest certification is targeted at productive forest land. Low productivity forests have been considered to be ‘self-protected’ where there are negative net financial returns and have not been subject to CHI (with the partial exception of sites in the national forest monitoring system). The degree of ‘self-protection’ is however dependent on timber market conditions and subsidies of forestry activities (Bollandsås, Hoen et al. 2004).

At the level of forest associations and in the academic literature forest biodiversity in low forest productivity areas has explored in a handful of publications (Blom and Sætersdal 2003; Bollandsås, Hoen et al. 2004; Bollandsås, Hoen et al. 2004; Hals 2005; Sverdrup-Thygeson and Ims 2005). In general, higher biodiversity conservation values are expected in old high productivity forests than in low productive forests of a similar age. A hypothesis arising from these studies is that some ‘negative net return areas’ have a higher representation of forest characteristics of conservation value than forest plots that are more productive, but have been subject to repeated harvesting.

The implication for offsets of this hypothesis is that some form of off-setting could be carried out in order for forest owners to meet biodiversity conservation requirements on timber concessions. However, low productive forest areas cannot alone address the forest conservation gap (Framstad, Stokland et al. 2011). We discuss whether biodiversity offsetting measures on so-called 'negative net return areas' could be a complementary instrument to measures addressing high productive forest areas.

On the other hand, carbon offsetting effects of forestry conservation and management are actively debated in Norway. Framstad and colleagues carried out an analysis of the trade-offs between carbon storage, sequestration, opportunity costs to forestry of foregoing harvesting across different forest types prioritized for conservation under the nature types in Norway (NiN classification) (Framstad, Stokland et al. 2011). Using a national forest monitoring dataset they find an overall correlation between carbon sequestration and importance for biodiversity of different forest types. The national level of their analysis makes it possible to identify forest types where opportunity costs and conflicts of interest are expected to be highest (old pine and spruce forest) (Fig. 7 p.34), and forest types of high biodiversity value, but only intermediate productivity (old coastal forest, old boreal deciduous). However, at this level of analysis, there is no suggestion of cost-effective offsetting of biodiversity because their analysis looks across (non-equivalent) forest types. In their analysis impacts on forest biodiversity are the result of possible carbon-offsetting activities in Norwegian forestry, rather than the objective of offsetting itself.

Assessment of the instrument

Biodiversity offsets might take place at various spatial scales:

- a forest owner offsets requirements for setting aside WKH in productive forest by additional surveying activities in 'negative net return areas' on his property in order identify sites that are at least equivalent in terms of WKH elements, but at lower opportunity costs.
- forest associations act as a broker in locating WKH sites on 'zero areas' that may compensate for WKH in productive forests, but for different forest owners. Extra survey effort might still be funded using the forest owners Forest Trust Fund account. This would require that the opportunity cost and WKH differentials are great enough, when comparing across forest owners in a landscape, to finance a brokerage fee to the forest association.
- Within a forest region independent brokerage firms could conceivably operate a biodiversity offset scheme, across forest associations and/or individual forest owners. Scaling up an offset scheme to a regional level would be subject to a number of difficult trade-offs between conservation equivalence between offsets, opportunity and transaction/administration costs that would need detailed assessment (Vatn, Barton et al. 2011).

Forest associations currently play an important role in identifying and recruiting forest owner members who can potentially participate in voluntary forest conservation. It therefore seems appropriate in terms of minimizing set-up/transaction costs to focus potential further fine grained analysis on the potential interactions between biodiversity offsets and voluntary forest conservation (with auctions) on land within individual forest associations.

In the following we briefly discuss findings that could support biodiversity offsets at the local level as a new policy instrument in forest conservation, and raise a number of research questions that remain to be conducted as part of a fine grain feasibility study.

Conservation requirement(cap) on timber concessions. A minimum 5% of productive forests at property level for individual ceritification or at county level for group-based certification[26] are to be set aside for conservation as biological important areas (Søgaard, Eriksen et al. 2012), including key biotopes, buffer zones and forest fire areas in older forests. If 5% is not achieved through these areas, additional 'biologically important' areas are sought. 25% of biologically important areas can be on biologically unproductive areas with forest ('tresatt impediment'). Individually certified forest owners can cooperate in achieving the 5% target, indicating that some form offsetting across individual properties is already a mechanism in place as part of the certification scheme.

Complementary Hotspot Inventory CHI ('MiS', as noted in chapter 3) is the most common method for identifying WKHs, and for attaining the 5% target for biologically important areas. During forest planning potential WKHs are registered and then a subset is selected as set-asides.

Søgaard et al. (2012) simulated these requirements by selecting WKHs until 1.5% of productive forest area was selected for each forest region. They assumed that 2/3 of WKHs are totally protected while 1/3 of areas can be harvested to 50% of standing timber volume. A flat/common % area target might not be optimal in terms of biodiversity conservation because of regional variation in where hotspots are found. At property level, a fixed % area target for biodiversity conservation would be harder to justify because of the high variation in WKHs between properties.

A limitation for implementing a biodiversity offset scheme is therefore the justification that each property should be required to offset some productive forest area, regardless of what WKHs are actually found on the property. On the other hand, a justification for a conservation target at the level of each property, with the opportunity for offsetting, would be that all forest owners share the burden of achieving a regional conservation target.

These assumptions could constitute a starting point for an evaluation of cost-effective biodiversity off-setting schemes within individual forest regions, to be conducted in the fine grain analysis. One could argue whether such conservation target 'burden sharing' might be achieved in a more cost-efficient way through some form of forest user fee with redistribution to forest owners with larger conservation obligations. In the fine grain analysis one might evaluate to what extent the Forest Trust Fund achieves this type of redistribution.

Cost and biodiversity differentials between zero areas and productive areas.

Sverdrup-Thygeson and Ims (2005) showed that red list insects had favourable conditions on impediment areas in pine-dominated forests in southern Norway.

In a study of 'zero areas' on the Norwegian west coast (Luster, Sogn og Fjordane), Blom and Sætersdal found 63.6% of the area to include WKH characteristics, especially 'rich vegetation types'.

[26] §4. http://www.levendeskog.no/sider/tekst.asp?side=324&submeny=Levende%20Skog%20standarden&niv2=&menuid=239

Excluding this category, 25.9% of the area still included WKH characteristics, which is well above values expected for productive forests [27](Blom and Sætersdal 2003).

Using the national forest monitoring dataset (Landskogtakseringen) Bollandsås and colleagues evaluated 271 random plots with low or negative net revenues [-50,+50 NOK/daa] for the presence of WKH characteristics (Bollandsås, Hoen et al. 2004). They found a positive correlation for most elements with timber transport distance indicating that 'WKHs are more frequent the less accessible forest plots are to forestry (within the category of 'zero areas'). They did not evaluate the differential in WKH elements between zero areas and productive forest areas.

Large forest owners[28] have invested voluntarily in wide ranging survey of the forest landscape to identify key biotopes in 'negative net return areas'. Hals (2005) evaluated the effectiveness of such wide ranging inventories and the possibility of forest owner members of forest associations avoiding "full restrictions" in their productive forests. In the municipalities of Lom and Skjåk in Oppland , Prosjektet Mjøsen evaluated a total area of 124000 daa to detect WKH characteristics using remote sensing (Hals 2005). A preliminary filter narrowed the area down to a net study area of 36000 daa. A random system of plots in the preliminary and net study areas were used to check remote sensing predictions of WKH characteristics. Remote sensing could recognize all WKH characteristics, except 'red list species'. 76% of WKH characteristics identified in remote sensing were found on the ground. Identification costs were 20% of ground- based monitoring. These research findings indicate that an offset system could be established with lower inventorying costs than at present. Current inventorying costs are reported at 4-5 Euro/hectare for CHI in Norway (Timonen, Siitonen et al. 2007).

Can the instrument deliver on the challenges? – Research questions

For the fine grain analysis we will analyze whether the differentials between WKH characteristics are large enough between high net return forestry and negative net return forest areas to justify further evaluation of a more formalized biodiversity offset scheme for WKH as a complement to other measures and a means for smaller forest owners to participate more actively towards attaining the 5% conservation target in productive forests. These WKH-differentials are expected to vary considerably between the counties chosen for the fine grain analysis - Buskerud, Telemark and Vestfold counties – because of terrain and forestry history.

No biodiversity offset instrument has been proposed in forestry, so we can only indicate research questions that could be evaluated. Questions have been selected from a theoretical analysis of biodiversity offsets (Vatn, Barton et al. 2011):

[27] Statistics Norway statistics from the National Forest Inventory report a simple sum of 23.6% of productive forest areas with one or other 'complementary hotspot' characteristic http://www.ssb.no/emner/10/04/20/nos_skogstat/nos_d406/tab/2.6.html. However, a number of WKH characteristics are found in the same area so the sum is misleading. In the field a guesstimate might be that between 5-10% of productive forest area inventoried is expected to have at least one WHK characteristic (pers.com. Anne Sverdrup-Thygeson).

[28] e.g. Fritzøe Skoger

Like for like – quality and substitution.

How would an offset system be designed to avoid piecemeal selection of MiS elements versus selection based on functional conservation criteria?

Are MiS elements equivalent across forests of the same type within a forest region? Is it acceptable to conduct offsets across different 'red list species' (assuming that these cannot be identified using remote sensing approaches).

How could offset ratios be implemented to protect proportionally more MiS elements on 'zero areas' than are lost on forest productive areas? (trading up using favorable differentials in opportunity costs). Are there sufficient MiS element sites expected in 'zero areas' to meet demand for offset sites in productive forest area?

Opportunity costs

To what extent are opportunity costs and 'key biotope' density correlated?

Are opportunity costs differentials large enough between productive forest area and 'zero areas' to justify administration/transaction costs of a scheme?

What is the smallest area of biodiversity offset scheme with sufficient biodiversity and opportunity costs differentials to cover transaction costs?

What is the extent of area that provides 'additionality' in terms of conservation of 'key biotopes'? What low biological productivity areas are nevertheless at risk of future forestry? Can identification of MiS elements in these areas be considered additional?

Are there sufficient cost-differentials within productive forests to justify a biodiversity offset scheme (and achieve additionality if biologically impaired areas are not considered additional`).

Could biodiversity offsets be considered for forest habitat rehabilitation in order to ensure additionality at offset sites? Would rehabilitation sites be considered equivalent?

Motivation aspects

How can forest owners be encouraged to exhaust conservation options on-site before choosing an offset option?

Transaction costs

Can biodiversity offsets provide a private financing mechanism for wider surveying of key biotope sites? How could surveying be covered under allocations from the Forest Trust Fund?

What are the fixed and variable transaction costs of establishing a biodiversity offsets scheme?

What new brokerage functions would need to be established for different alternative biodiversity offset areas? (municipality , forest association, forest region etc.)

5 Interactions of economic instruments and the policymix

This chapter presents a coarse analysis of how existing and proposed/potential instruments interact, respectively.

5.1 Interactions within the existing policymix

Søgaard and colleagues conclude that about 25% of the standing timber volume of productive forest (>1 m3/ha yr) is affected by 'environmental considerations' that limit the amount of timber that can be extracted (Søgaard, Eriksen et al. 2012). The authors estimate that roughly 15% of this volume is economically attractive for forestry, in other words is an area with non-negative opportunity costs associated with the environmental considerations. This puts 10% of the productive volume as an estimate of 'zero net return areas' - areas that are financially unattractive for forestry. Prior studies have estimated the volume of 'zero areas' to be as low as 5.7% and as high as 18.7% depending on assumptions (Bollandsås, Hoen et al. 2004).

Søgaard et al. (2012) estimate that environmental considerations owing to regulation of forestry practices and protected areas affect about 31% of the productive forest area. Recent estimates by other sources of the area of productive forest considered to be 'zero areas' is as high as 27% for 2007 (SSB 2008 in Søgaard et al. 2012). Søgaard et al. (2012) calculated the percentage spatial overlap between individual environmental regulations (Figure 9). In our view their analysis is an excellent starting point for a discussion about the functional roles of each conservation instrument (regulation) in the policymix across the landscape (herewith called a 'policyscape') (Barton, Primmer et al. 2011).

	No overlap	National parks	Nature reserves	Protected landscape areas (LVO)	Key biotopes (MiS)	Buffer zones	Wilderess areas (INON class-ification)	Mountain forest	Recreation al area	Swamp forest
National parks	8 %		0 %	0 %	0 %	12 %	64 %	66 %	0 %	7 %
Nature reserves	59 %	0 %		0 %	0 %	7 %	7 %	26 %	5 %	3 %
Protected landscape areas (LVO)	24 %	0 %	0 %		1 %	13 %	28 %	61 %	4 %	1 %
Key biotopes (MiS)	73 %	0 %	0 %	1 %		2 %	3 %	19 %	3 %	3 %
Buffer zones	69 %	1 %	2 %	2 %	0 %		4 %	21 %	1 %	7 %
(INON classification)	24 %	14 %	4 %	10 %	1 %	10 %		64 %	0 %	1 %
Mountain forest	74 %	3 %	3 %	4 %	1 %	8 %	11 %		0 %	2 %
Recreational area	85 %	0 %	4 %	2 %	2 %	3 %	0 %	2 %		2 %
Swamp forest	72 %	1 %	1 %	0 %	1 %	16 %	1 %	9 %	1 %	

Figure 9 Spatial overlap between different 'environmental considerations' in forestry.

Source: Søgaard et al. (2012); color coding added. Note: the sum of each row exceeds 100% in some cases as only individual overlaps are considered, and some areas have overlaps of three or more environmental considerations in forestry. Only environmental constraints registered in the National Forest Inventory are included.

Spatial correlation between environmental regulation of forestry and 'zero areas'. Søgaard and colleagues suggest that there is an important spatial correlation between the area regulated by environmental considerations and 'zero areas'. This can be seen i.a. in the high overlap between protected area categories and 'mountain forests' (also discussed in chapter 6). They suggest that this is the case for example for 'wilderness areas' (INON) and 'key biotope areas' (MiS). There are only a few systematic studies to support this hypothesis (Blom and Sætersdal 2003; Bollandsås, Hoen et al. 2004). Focusing the fine grain analysis on policy interactions on and around 'zero areas' would therefore be a promising research strategy for a fine grain policymix analysis.

How would such a spatial overlay of environmental constraints on available forest area be used to discuss instruments' functional roles?

Instrument redundancy or synergy. A high degree of overlap could indicate either on-site instrument redundancy or synergy. A low degree of overlap, but spatial proximity could indicate functional complementarity of different regulations in a particular landscape.

Instrument complementarity. The spatial targeting of a protected area category such as protected landscape areas (LVO) could be discussed, considering its high degree of overlap with other features that regulate forestry.

Instrument sequencing. Some environmental constraints are in part results of other policy instruments. While INON wilderness areas have their own environmental regulations today, their current extent is partially the result of larger national parks, nature reserves and landscape protection areas excluding infrastructure development. This explains to some extent the overlap between protected areas and INON.

Targeting of incentives for complementarity. Targeting of new economic incentives might be most complementary when targeted at landscape characteristics whose use is regulated (MiS, INON, mountain forest), but that do not overlap with any formal protected area categories (national parks, nature reserves, landscape protection areas).

Targeting of incentives for synergy. Some of the area restrictions do not entail 100% conservation of productive forest (e.g. MiS, buffer zones). In these areas economic incentives could play a role in increasing effectiveness.

Targeting removal of perverse incentives. Similarly, removal of the use of subsidies to forestry could also be targeted to areas where they would be (i) in conflict with environmental regulations (INON wilderness areas), and (ii) are significant in tipping forestry from non-profitable to profitable.

Caveat - Spatial or timber volume excluded as indicators of complementarity or redundancy with relation to biodiversity? An approximate and theoretical indicator of conservation effectiveness of the environmental restrictions is the percentage volume timber that is assumed excluded from forestry. Søgaard et al. cite several cases where effectiveness is lower than what they assume in their analysis (i.a. for buffer zones and MiS). However, spatial overlap, or overlap in terms of percentage timber volume protected does not necessarily imply functional redundancy of the environmental considerations with respect to biodiversity. Aspects of biodiversity require strict area-based protection (reserves), other aspects require selective forestry practices depending on the landscape, and finally concerns are taken in normal forestry practices such leaving dead wood (Bollandsås, Hoen et al. 2004).

5.2 Potential interactions of proposed instruments

New instruments proposed in this report include auctions for voluntary forest conservation and biodiversity offsets. The discussion of ecological fiscal transfers discussed whether a more targeted fiscal transfers, in the form of local development trust funds, might be a more cost-effective incentive to the municipal level.

In this section we provide indications of how interactions of proposed instruments with the existing policymix may be analysed in the fine grain analysis. Interactions can be discussed in terms of a spatial location (as in the spatial overlay analysis above), or in relation to agents/stakeholders. Interactions are more easily evaluated in relation to a policy change, for example the introduction of a potential new instrument. For this reason we take a combined approach below dividing the discussion on interactions into agents at different spatial levels: (i) the interactions on the forest owner of auctions for forest conservation, (ii) the interactions for forest associations of biodiversity offsets, (iii) the interactions on municipal government of (ecological) fiscal transfers, and (iv) the interactions at county or regional level of national policy instruments.

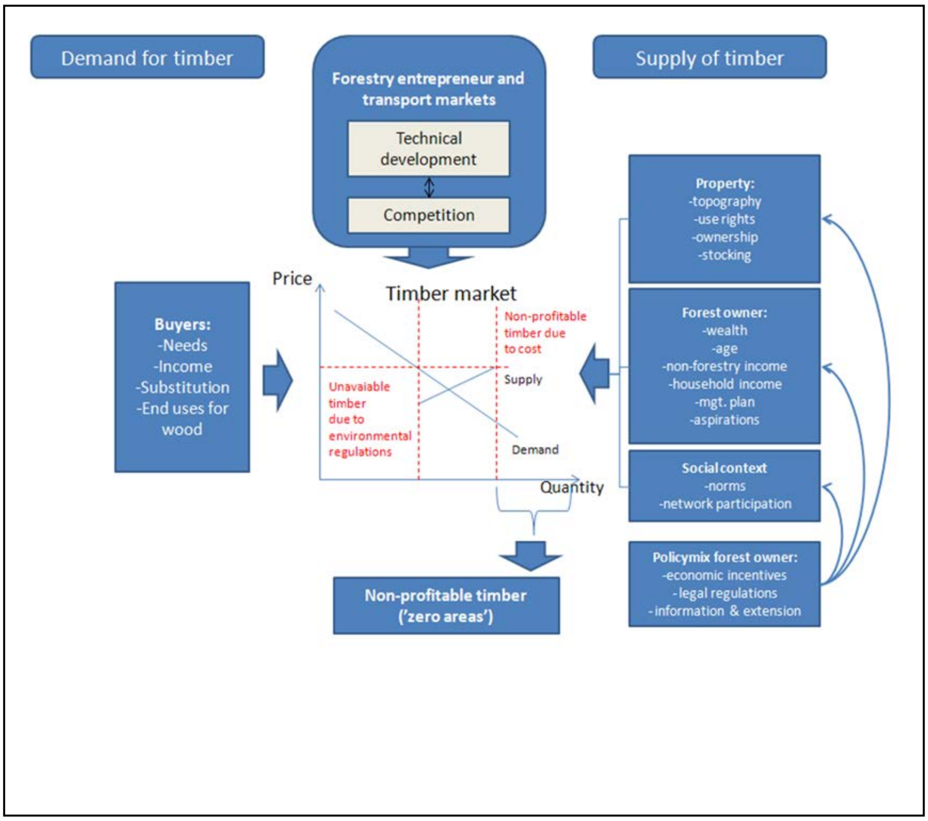


Figure 10: A policymix addressing the forest owner directly and affecting indirectly via the timber market . Source: adapted from (Bollandsås, Hoen et al. 2004).

How do current economic incentives interact with environmental concerns shown in Figure 9 and the proposed instruments?

Current economic incentives addressing the supply side of the forestry sector include:

- Forest user fee with tax exemption (for the Forest Trust Fund) (Bergseng and Solberg 2007).

- Regulation of activities that can be supported by the Forest Trust Fund (Bergseng and Solberg 2007).
- Support for building forest roads and upgrading of roads by the Agricultural Development Fund (Landbrukets Utviklingfond) (Bollandsås, Hoen et al. 2004; SABIMA 2011).
- Support for forestry in steep terrain (SABIMA 2011).
- Subsidies for environmental measures in forestry («tilskudd til nærings- og miljøtiltak I skogbruket- NMSK»). Compensation can be given for additional expenses for forestry measures to protect environmental values, as well as compensation for economic losses due to longer term measures that require reducing or stopping timber extraction. Compensation for additional expenses for forestry may also be given if these are due to avoided road construction which would otherwise have reduced wilderness areas (INON classification) (SLF 2011).
- Subsidies for surveying of environmental values before harvesting (key biotopes, MiS) (SLF 2011).

(i) Forest owner and auctions for voluntary forest conservation.

Bollandsås and colleagues discuss a number of property, forest owner, social and policy context variables that directly determine supply of timber (Bollandsås, Hoen et al. 2004) (Figure 10). Indirect effects determine supply costs through the forestry entrepreneur and transport markets. Policies affecting buyers, such as regulations regarding end uses of wood and substitutes, affect demand.

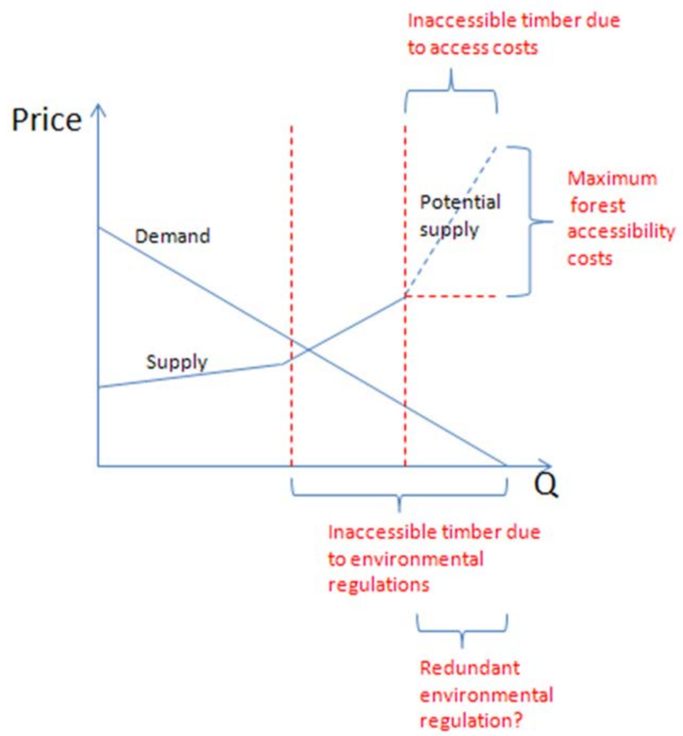


Figure 11: A hypothetical example of environmental regulation addressing forest land only in medium and high production cost areas. Are regulations (or conservation incentives) addressing non-profitable forest land functionally redundant in terms of conservation effectiveness?

In figure 11 the timber supply is illustrated with a hypothetical situation where it is constrained by environmental considerations targeting low cost forest, whereas a number of areas are inaccessible at current timber prices due to high extraction and transport costs. An opposite situation is illustrated in Figure 11, where environmental concerns cover the most inaccessible high cost forest areas. A policymix analysis would ask whether regulations (or conservation incentives) addressing non-profitable forest land are functionally redundant.

How would auctions for voluntary forest conservation interact with current incentives targeted at forest owners? How would auctions for voluntary forest conservation affect conservation of 'zero areas'? PES auctions are aimed at attracting offers from forest owners of land with a minimum set of conservation features at the lowest cost. Auctions also minimize the public cost of contracting the land for conservation. Based on the assumption that 'zero areas' may contain the 'minimum set ' of conservation features, forest owners would likely offer non-profitable 'zero areas' first. For such areas that are not currently under production there may be insufficient information also with the farmer regarding his opportunity costs. Some forest owners may have preferences for amenities on their own land and may be willing to accept a lower compensation that could be revealed through the auction process.

(ii) Forest association and biodiversity offsets

Biodiversity offsets might take place at various spatial scales:

- a forest owner offsets requirements for setting aside 'key biotopes'(MiS) in productive forest by additional surveying activities of 'zero areas' on his property in order identify sites that are at least equivalent in terms of MiS elements, but at lower opportunity costs. Extra survey effort might be funded using the forest owners Forest Trust Fund account.
- forest associations act as a broker in locating MiS sites on 'zero areas' that may compensate for MiS in productive forests, but for different forest owners. Extra survey effort might still be funded using the forest owners Forest Trust Fund account. This would require that the opportunity cost and MiS differentials are great enough, when comparing across forest owners in a landscape, to finance a brokerage fee to the forest association.
- Within a forest region independent brokerage firms could conceivably operate a biodiversity offset scheme, across forest associations and/or individual forest owners. Scaling up an offset scheme to a regional level would be subject to a number of difficult trade-offs between conservation equivalence between offsets, opportunity and transaction/administration costs that would need detailed assessment (Vatn, Barton et al. 2011).

Forest associations currently play an important role in identifying and recruiting forest owner members who can potentially participate in voluntary forest conservation. It therefore seems appropriate in terms of minimizing set-up/transaction costs to focus further fine grained analysis on the potential interactions between biodiversity offsets and voluntary forest conservation (with auctions) on land within individual forest associations.

(iii) Municipal administrative area

Håkonsen (2009) discuss the pros and cons of different instruments to promote environmental management practices at the municipal level. Different fiscal and regulatory instruments address different objectives at the municipal level. In many cases they play complementary roles in addressing expenditure equalization, income equalization, compensation for opportunity costs of involuntary conservation. Instruments such as local development trust funds have been deemed as a condition for involuntary protected area declaration. Incentives for voluntary creation of protected areas by municipalities have been less relevant because municipalities have not been (until the Nature Diversity Act) themselves initiators of nature protection. We have tried to summarize Håkonsen's findings in the Table below.

Table 8 A number of different fiscal transfer approaches for municipalities

	Earmarking fiscal transfers	**Discretionary transfers**	**Local development Trust Funds**	**Environmental expense equalization (fiscal transfer)**	**Regulation**
Pros	Correct externalities, tax competition, priority-setting errors in local democracy, public private competition, provision of new services	Targeted for exceptional circumstances	Compensation for foregone income Low transaction costs Conservation and development incentive	Correct systematic expenditure differences	Targeted, effective, general, national target achievement
Cons	Short term incentive effect Measurability Sector department conflicts	High transaction costs Unpredictability	Availability of funds	High administrative costs relative to Very small share of municipal budget No compensation for foregone tax income	Local legitimacy

Source: based on Håkonsen (2009)

Chapter 6 discusses the challenges of using the Nature Index (at its current spatial resolution) for evaluating conservation performance. The limited role municipalities have to play in protected area management, suggests that performance indicators must be tied to management of the landscape outside protected areas, as part of landuse regulation under the Planning and Building Act. Developing the nature index to be responsive at the sub-municipal level to pressures of infrastructure development etc. requires much further work. We think this falls outside the capabilities of the fine grain analysis for Norway at this stage.

(iv) Forest regions and county administration of national policy

The analysis would take place at landscape, county or regional level (e.g. Vestfold, Buskerud, Telemark combined). The analysis in figure 1 would be extended to look at the overlap between 'zero areas' and each of the environmental considerations/regulations of forestry. The analysis would discuss to what extent regulatory constraints that overlap with 'zero areas' are redundant or complementary. Interactions with economic incentives could be introduced by recalculating the extent and location of 'zero areas' when different subsidies for forestry or conversely PES for conservation activities are included in forest stand net present value calculations. The results of these scenario analyses could be summarized in a matrix outline in Table 9 below.

Where environmental regulations on forestry are 100% effective in terms of conservation effect, overlap between regulations may be considered "redundant". Where "zero areas" overlap with environmental considerations independently of the effects on incentives, environmental regulations are redundant. Where incentives to forestry reduce "zero areas" within areas with environmental restrictions, effectiveness of regulations are 'unilaterally reinforced' by the incentive (environmental restrictions are necessary conditions for conservation). Where regulations are less than 100% effective overlap may be considered 'mutually reinforcing' depending on the lack of effectiveness of each instrument.

Note that conclusions are similar, but with opposite sign when exchanging PES for forestry subsidies (PES is not relevant for the Norwegian case study). Note also that functional roles are defined relative to a specified forestry production or conservation objective (and will have opposite signs depending on which type of objective is chosen).

Table 9: Matrix of spatial functional roles of environmental regulation versus forestry subsidies on a specific forest location

Spatial overlap between row&column	Environmental regulation X is 100% effective	Environmental regulation X is <100% effective	"Zero area" only without current forestry subsidies	"Zero area" independently of current forestry subsidies
Environmental regulation Y is 100% effective	**Mutually redundant** (either X or Y)	Regulation X is **redundant**	Incentive is redundant and **unilaterally reinforcing** Y	Incentive is **redundant**
Environmental regulation Y is <100% effective	Regulation Y is **redundant**	**Mutually reinforcing**	Incentive is **conflicting** with Y	Incentive is **redundant**
"Zero area" only without current forestry subsidies	Incentive is redundant and **unilaterally reinforcing** X	Incentive is **conflicting** with X	The importance of the functional role will be measured by the area overlap as a % of productive forest area.	
"Zero area" independently of current forestry subsidies	Incentive is **redundant**	Incentive is **redundant**		

Note: Functional roles: 'conflicting (perverse)', 'redundant', 'unilaterally reinforcing' or 'mutually reinforcing' ? Functional roles defined relative to an objective of forest biodiversity conservation.

6 Scenario analysis – spatial analysis of Norwegian forest conservation policymix

The coarse grain analysis is specifically meant as a scoping exercise for the fine grain analysis. Chapter 6 provides further justification for what the Norwegian case study proposes to do in fine grain analysis.

6.1 Introduction

This section discusses the use of the Nature Index for Norway (NI) and forest productivity (N. ,'bonitet') as surrogate indicators for evaluating the quality of forest conservation and opportunity costs of different protected area categories. The NI is interpreted as a 'surrogate' for conservation value, while forest productivity is taken as a 'surrogate' for the opportunity costs of forest conservation. We briefly discuss the limitation of using these indicators as surrogates in a cost-effectiveness analysis. It finishes by discussing some potential ways forward for scenario analysis of cost-effective selection of future sites for conservation measures in forests.

6.2 Background

The Nature Index for Norway report and its chapter on forest analysed the relationship between timber production and the nature index for forest at county level for 2010 (Storaunet and Gjerde 2010). The authors found no relationship for 2010 data at the county level. A negative relationship was found between forestry activity in 1994-98 and the nature index indicators that are defined as affected by forestry (mainly for counties on the west coast that have experienced lower timber production and relatively higher nature index values). The authors found no relationship with timber production at county level for other types of indicators.

While the spatial resolution of the current NI data seems insufficient to use for spatial priority setting, the analysis in this section was carried out to generate discussion about the required characteristics of surrogate biodiversity and opportunity cost indicators for a fine grain spatial analysis.

6.3 Approach

Framstad et al. (2010a) evaluated Norwegian protected areas (PAs) using the following evaluation questions (Framstad, Blindheim et al. 2010). Framstad et al (2010b) evaluate 'voluntary forest conservation' using similar criteria. Using the NI to evaluate effectiveness of protected areas raises questions of which of the following conservation criteria used by Framstad and colleagues are more or less represented by the NI:

International obligations:

- Has Norway complied with its international obligations regarding protecting areas? This is a general criteria covering the CBD, Bern and Ramsar conventions requirements for effective protection of species and nature types.

Representation and coverage:

- Do PAs represent the variation in environmental conditions across a regional and national scale?
- Do PAs represent all the nature types in Norway?

Irreplaceability

- Do PAs sufficiently secure areas that are unique in terms of ecosystems, nature types or habitat for threatened species and species protected by the Nature Diversity Act?

Persistence and robustness

- Do PAs represent large connected areas where ecological processes can function undisturbed? (size, form)
- How do PAs contribute to functional connectivity in a network of ecosystems? (location)

Complementarity

- How has 'voluntary forest conservation' contributed to protecting areas with the highest 'conservation value' (as defined by the field evaluation criteria used in natural value assessment)?
- Are there additional areas that would contribute to the functional value of protected areas? DNs mapping of nature types in protected areas captures aspects of complementarity.

6.4 Method

None of the criteria cited above and used in the evaluation of the effectiveness of public protected areas address conservation risk or the quality/status of conservation efforts. In our example, we specifically address these issues. 'Surrogate indicators' are used in this coarse grain analysis to biodiversity conservation status and opportunity costs of conservation (Table 10).

Table 10: Coarse grain surrogate indicators

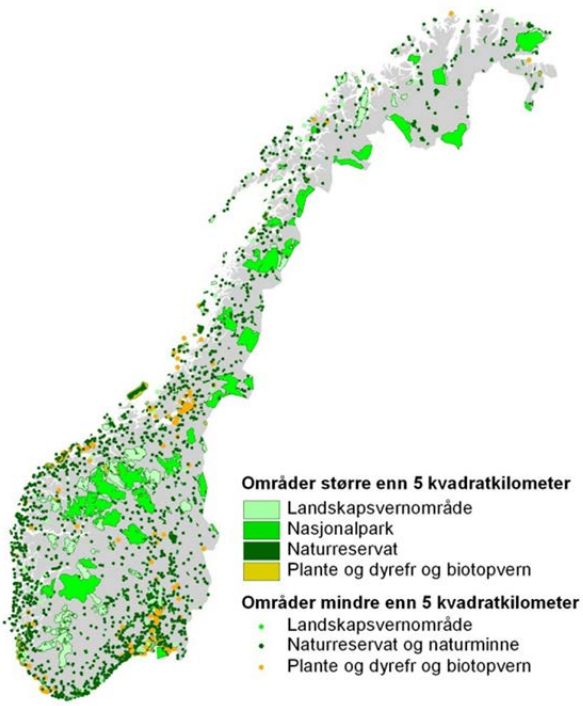
Criteria	Surrogate indicator
Biodiversity conservation status	Nature Index for forests composed of 74 forest specific species of a total N=310 species that compose the NI. The index is scaled to values 0-1
Opportunity cost of forest conservation	'Bonitet i skog' is an indicator of forest productivity, divided in 5 classes, and available as part of landuse maps for Norway.

The following paragraphs briefly describe how this information was used. We summarize critique to our use of the data after the results section.

Protected area categories coverage of forest

For purposes of the analysis protected areas are grouped as:

- National parks
- Nature Reserves (including voluntary forest conservation[29])
- Only voluntary forest conservation (established as nature reserves)
- Other conservation areas (including Landscape Protection Areas, Plant and Animal Reserves, Biotope Protection, Natural Heritage Sites)



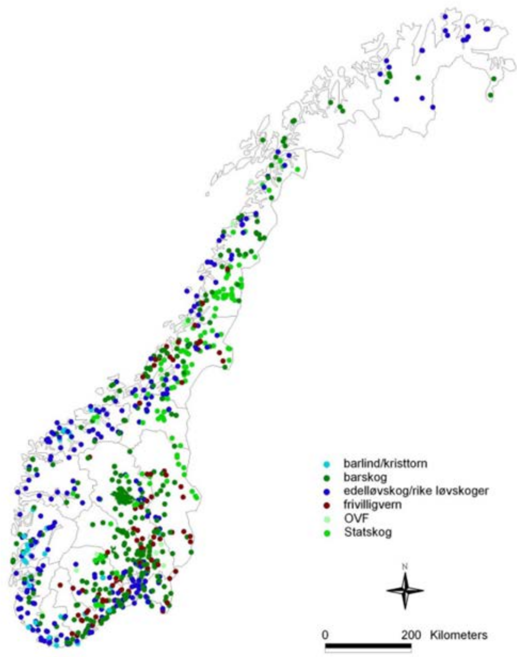


Figure 12

Overview of location of protected areas.

Small Pas (<5km2) are shown as points

Source: Framstad, Blindheim et al. 2010

Figure 13

Geographical location of different forest protection areas. Source : Framstad and Blindheim (2010)

The grouping is based on the specific interest in evaluating the cost-effectiveness of 'voluntary forest conservation' areas compared to nature reserves created through regulatory public protection process. The maps produced by Framstad et al. (2010a,b) also show that National Parks have a markedly different geographical coverage of forest than other protected area categories (Figures 12 and 13).

[29] Some voluntary nature resereces that are adjacent to previously existing PA, they are mapped together (but they have separate identifiers). Voluntary nature reserves that are not adjacent to other PA are mapped by themselves.

By 2010 voluntary forest conservation areas covered 84 areas (red dots in Figure 13) and a total 504,5 km^2 (Framstad and Blindheim 2010).

The analysis was carried out in a 1x1 km grid of Norway. The spatial resolution was chosen to represent a smaller scale than that used by the Nature Index in order to raise questions about the relevant resolution to be used in spatial priority-setting evaluations. An alternative 10x10 km grid is illustrated in Figure 14.

The number of forested grid cells containing forest and falling into different discretised intervals of the Nature Index and categories of forestry productivity were counted for each protected area category. Where grid cells contained a fraction of forest cover the NI and forest productivity indicator for that cell was multiplied by the forested % of the grid cell (area-weighted averaging) (Figure14).

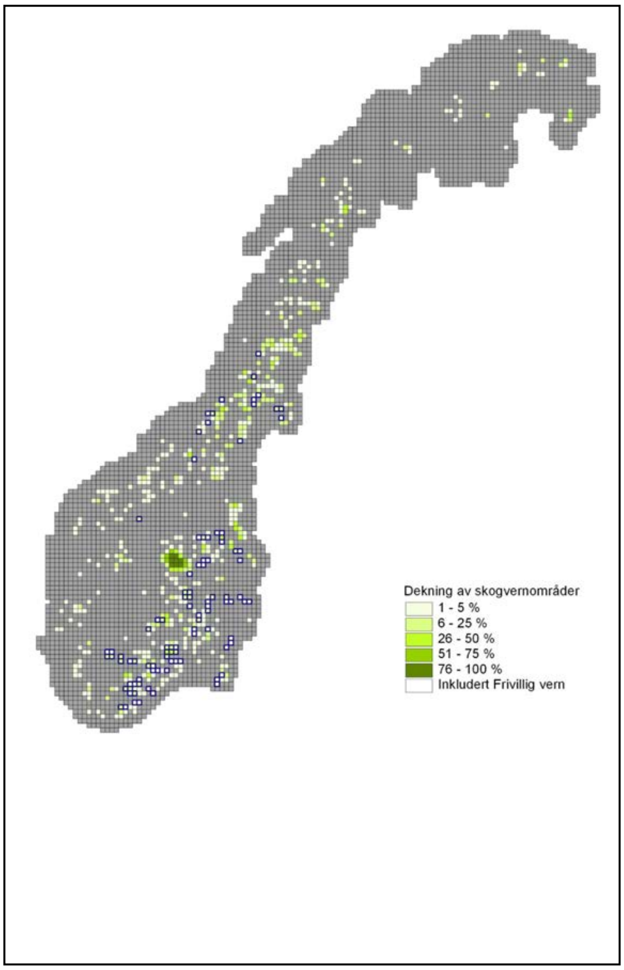


Figure 14: Percentage coverage of forest protection areas by grid cell (shown here for 10x10km2 grids). Source:(Framstad and Blindheim 2010)

The Nature Index as a biodiversity conservation status surrogate

The Nature Index was intended as an indicator for evaluating the status of biodiversity at the national level and over time. The NI for forest shows a 95% confidence decline from 1950 to 2000, followed by a stabilization or possible recovery between 2000 and 2010 (Figure 15).

A large part (n=74) of the total NI for Norway (N=310) is composed of forest species. 61 of these species (74%) are 100% specific to forest.

The NI is a normalized index between 0-1 as calculated for forests (Nybø(red) et al. 2010). The NI reference level of 1 in forests represents "old growth natural forest". Because of many centuries of years of forestry in most areas of Norway determination of a common reference value for forests is problematic(Storaunet and Gjerde 2010).

The forest NI has a municipal level resolution with values for 2010 ranging from 0.332674 to 0.539723 (Figure 16).

In our analysis this range was normalized linearly to a scale from 1 to 9 (Figure 17). This rescaling used was a chosen to match the scale used for forest productivity (also 1 to 9). The rescaled NI represents the area weighted average of the Nature index of Norway for forests in 2010 on municipality level, grouped by conservation area type.

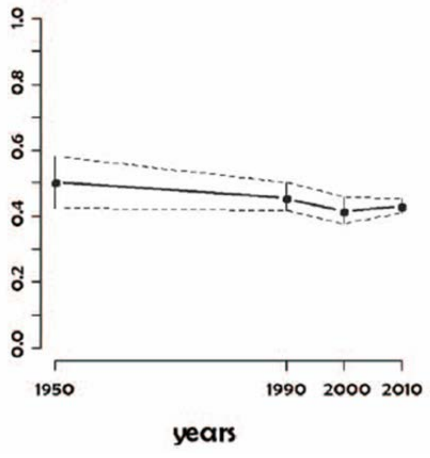


Figure 17: temporal state of the Nature Index for forests (Source: Certain et.al.2011)

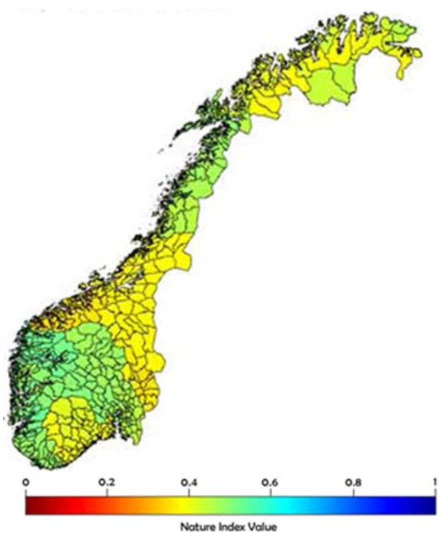


Figure 16: Spatial state of the Nature Index for Norway for forests (Source: Nybø S. (red.) 2010 and Certain et al.2011

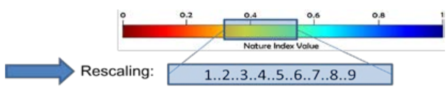


Figure 15: Rescaling the Nature Index

Forest productivity classes as a forest conservation opportunity cost surrogate

The surrogate indicator for the opportunity cost of forest conservation used here is the 'forest productivity' classification classified by the Norwegian Forest and Landscape Institute available in AR5 economic/landuse maps. The data is available at forest stand level, i.e. higher resolution than NI(Figure 18).

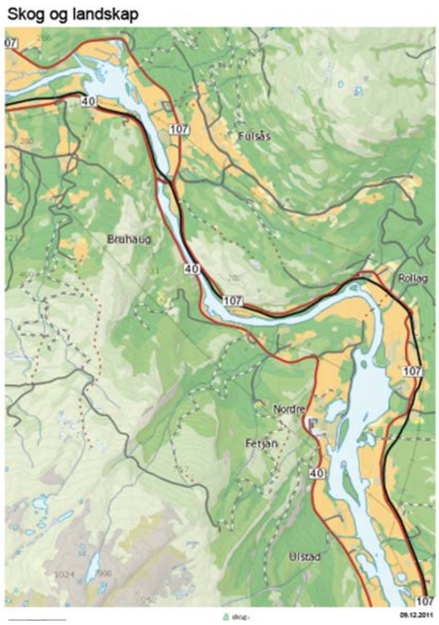


Figure 18: Spatial resolution of landuse classes map for Norway.(Source. Skog og Landskap)

Forest productivity – 'bonitet' in Norwegian - is divided into 5 classes (Figure 19):

1 – unproductive forest (<1 m3/ha yr)
2 - low productivity forest (1-3 m3/ha yr)
3 - medium productivity forest (3-5 m3/ha yr)
4 - high producticity forest (5-10 m3/ha yr)
5 - very high productivity forest (> 10 m3/ha yr)

Figure 19: Rescaling the forest productivity indicator from the land use classes for Norway.

The indicator represents the area weighted average of the forest productivity classes from AR5-data at the level of forest stands, grouped by protected area category. The range of values (from 1.0 to 5.0) was normalized linearly to values from 1 to 9.

The 'cost' of forest protection in Norway has historically been discussed in terms of units of 'productive forest' (categories 2-5 above) (Hågvar and Berntsen 2011). , as this best represent the lost income for the forest owner. Unproductive forest (yearly incremental growth of <1 m3 /ha of standing timber) is usually not considered for logging due to low outcome and slow recovery.

6.5 Results

The data plotted in Figure 8 are the result of the overlay of gridded (1x1km^2 resolution) versions of AR5-data for forest area characterized by its rescaled productivity (Skog og Landskap 2008), and the rescaled Nature index of Norway for forests in 2010 (Certain et al. 2011).

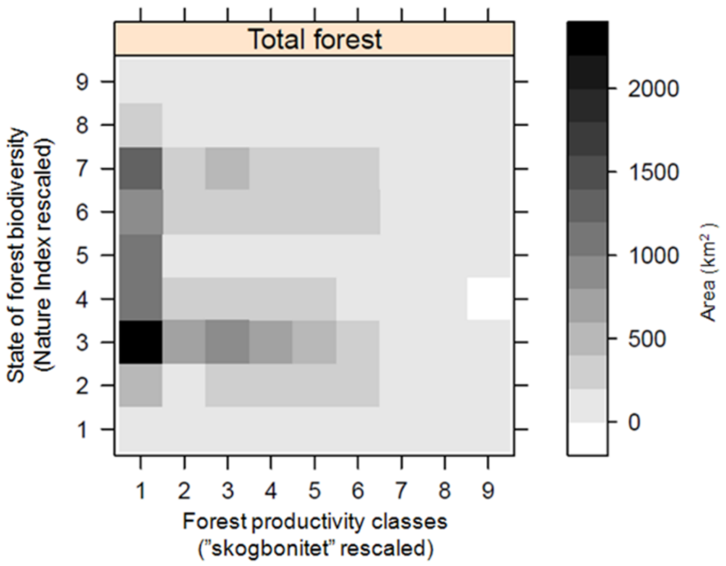


Figure 20: Distribution of forest area across rescaled indicators of forest productivity and the nature index

A large share of Norway's forest area of the country is located in unproductive forest, followed by forests of low-medium productivity.

Forest with low productivity have a distribution across the range of NI values(remembering that the scale is covering the original range of the NI [0.332674 , 0.539723]). The rescaled Nature Index for forest has a bimodal distribution for the higher forest productivity classes. This would match the regional distribution shown in Figure 15 of lower productive forests in the mountains and western coast of southern Norway, with a higher NI value, as compared to lower lying forests in South-Eastern Norway.

The data plotted in Figure 21 (below) are the result of the overlay of gridded (1x1km2 resolution) versions of AR5-data (Skog og Landskap 2008), the Nature index of Norway for forests in 2010 (Certain et al. 2011), and the protected areas of Norway (DN 2011). The plotted color indicates the amount of area protected by means of a certain conservation area type (in number of 1x1km grid cells) with regards to their Biodiversity and Production value'.

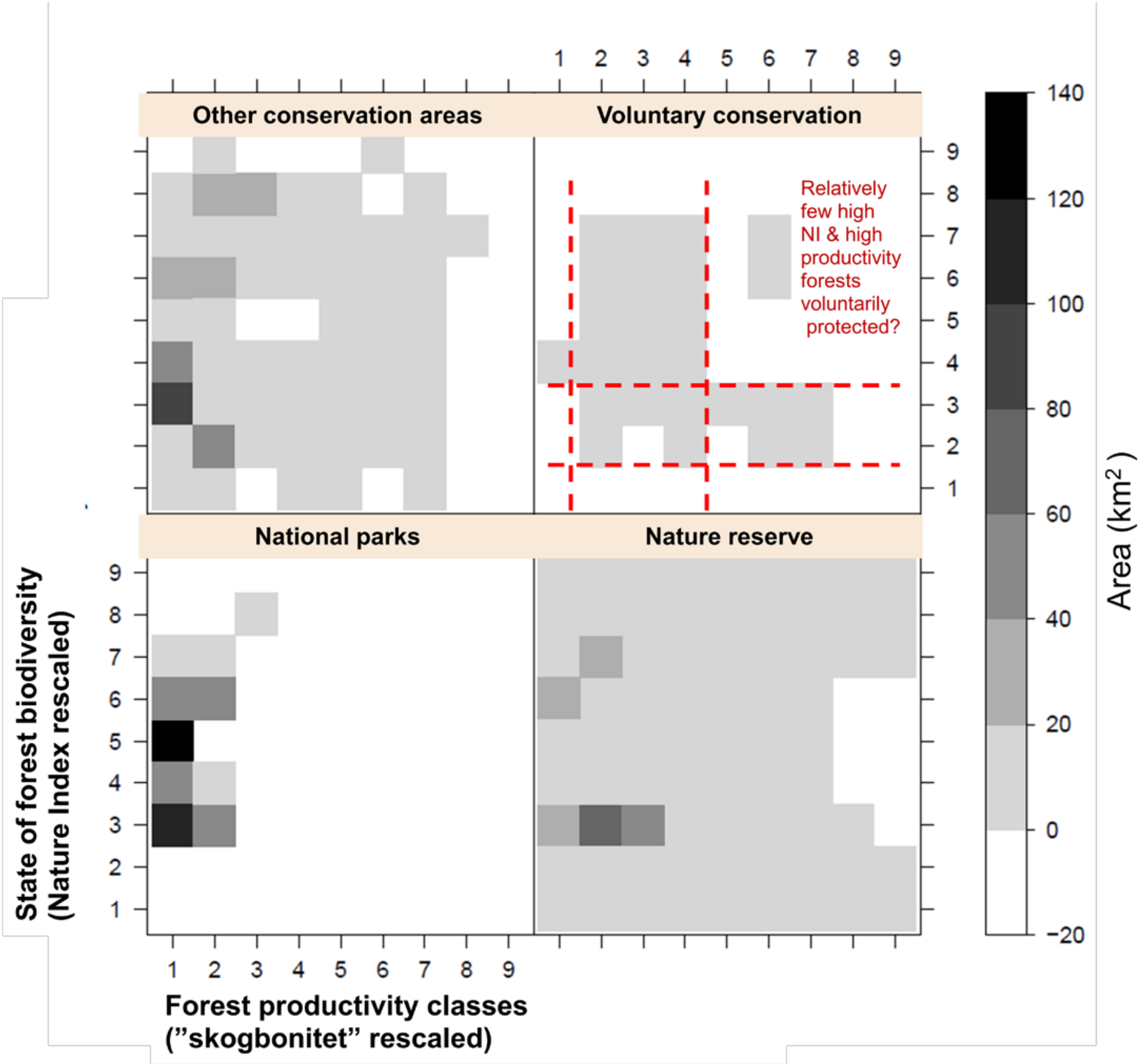


Figure 21: Distribution of different protected area categories across rescaled indicators of forest productivity and the nature index.

The spatial ordination of forest in protected areas across a biodiversity surrogate and an opportunity cost surrogate would indicate that National Parks cover a range of forests of different quality relative to a reference condition. National parks have largely been declared in areas of low forest productivity (the data includes premontane forests in large national parks in mountainous areas, for example). Nature reserves have been declared in areas of high forest productivity, but are predominantly in areas of low forest productivity, and low forest biodiversity quality status. Voluntary forest conservation, where forest owners present forest for enrollment into nature reserves, cover forests of low-high forest productivity.

It is notable that relatively few grid cells with voluntary conservation have higher NI value, while also in highly productive forests (N-E quadrant of the "voluntary conservation" graphic). Framstad et al. (2010a,b) conclude that forest in low lying, warm-loving vegetation zones, and rich nature types, particularly in Southern Norway are under-represented in the protected area network. Although Framstad and colleagues don't look specifically at forest productivity, these areas are likely to also be the higher productivity- high biodiversity status forests missing from the N-E quadrant of 'voluntary forest conservation' areas in figure 21. Further analysis should look into the relative areas under voluntary conservation in the different combinations of biodiversity status forest and forest productivity.

Other conservation areas – notably including plant and animal protected zones and biotope protected areas are not found in very high productive forest areas. They represent forests of higher biodiversity status. But notably they also represent a concentration of areas of lower nature index values. A possible explanation would be that these areas (which are generally small) are declared as a more direct response to risk and may be found in proximity to areas of high forest intervention.

6.6 Discussion

The analysis above has attempted to demonstrate how one could go about describing the complementarity of different conservation instruments in a landscape, in terms of represented ranges of forest productivity and nature index values achieved. In this section we summarise the critique of this simple analysis, as a basis for improving the "fine grain" spatial analysis of future site selection for conservation measures.

Limitations to the analysis of the cost-effectiveness of protected area categories.

Improve classification of protected areas. The classification of protected areas used in the analysis could better distinguish between nature reserves and landscape protection areas established for forest protection purposes, and other conservation objectives. DN is currently involved in a caracterisation of protected areas using Nature types for Norway (NiN).

Frequency versus area. Descriptive statistics. The figure showing the distribution of voluntary protected areas does not show the exact frequency or area in each combination of productivity and NI. The range in the figure is between 0-20 km2 making it hard to tell whether differences observed in the figure are significant. Further analysis should provide more detailed metrics of expected values and variance of each type of protected area.

Area weighted values. There is a question whether area based weighting of NI and productivity values implies that small protected areas, such as voluntary forest reserves, receive low scores. Protected areas are characterized based on the area weighted average of NI and productivity values for forested land falling within their boundaries (land without forest is excluded from the calculation). This means that size of protected areas should not bias the analysis against small areas.

It is not clear from Nybø (2010) to what extent expert evaluation of indicators that make up the forest NI in a municipality haves considered the size, form and functional connectivity of protected areas on the likelihood of long-term persistence of the populations (Bård Pedersen personal communication).

Limitations of surrogate indicator of conservation value

Forest biodiversity targets. The current Nature Index can respond to the policy target of 'no net loss' of biodiversity at a national and biome/ecosystem scale. Future work should discuss which other policy questions can be answered by just increasing spatial resolution of the underlying indicators, and which can be answered by increasing the underlying indicator set in different ways.

NI reference value. The reference situation is itself dynamic and based on expert judgement. Uncertainty regarding the reference value will have a significant effect on NI values that are close to the reference value. Confidence bounds for the reference value have thus far not been calculated for NI.

Indicator sets of NI vary between municipalities. Not all municipalities have data for the same set of indicators. Strictly speaking comparisons of NI between municipalities are inconsistent.

Spatial extrapolation when using expert judgement for NI. Experts characterized clusters of municipalities in the same region with the same values for a number of indicators. Calculation of NI using data from local expert in municipalities themselves may show higher NI values (pers. com. Per Arild Garnåsjordet, SSB[30]).

NI as a biodiversity conservation status versus a conservation value indicator. NI covers the variation in status between large biogeographical systems. The complementarity of characteristics at lower spatial scales is not addressed by NI. Some indicators used in NI are themselves integrating across the quality of larger landscapes, such as elk population.

NI is a forest quality indicator. The area of forest cover (nor presumably the forest areas spatial form) determines the level of individual indicators that make up the forest NI.

In future the NI might be used to assess the hypothesis of complementarity of instruments. For example, one could evaluate whether the forest NI of an area increases with the addition of different types of conservation. A hypothesis would be that the existence of both forest reserves and national parks in the same area increases the

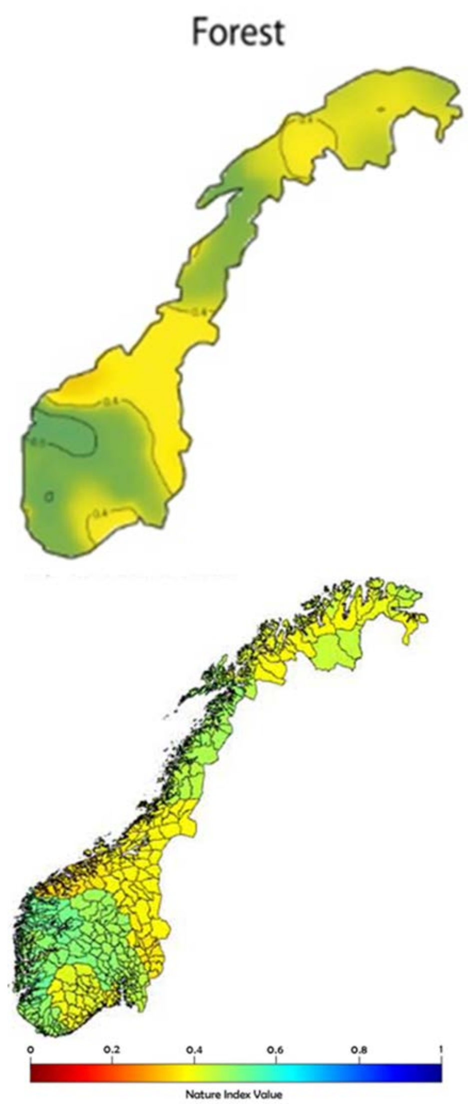


Figure 22: Alternative spatial resolutions if forest NI using municipal resolution data. Source: Certain et al. (2010) and Nybø (2010)

[30] A preliminary calculation for Tokke, Telemark, by SSB-NINA showed a locally estimated NI for forest of 0.67 versus a value of 0.34 estimated using the national database.

NI of the area compared with areas that only have forest reserves. A confounding issue for such an evaluation that national parks have other kinds of forests than voluntary reserves. Voluntary reserves are found in lowland forest land areas - it remains to be evaluated to what extent they are also productive forests. NI could in future be used to show how the different conservation types add 'robustness' in the sense that a mix of landuse management practices are adapted to the landscape and so increase NI values through this mixture. This 'mix' analysis could be carried out by county or regionally.
An extension of the analysis would characterize protected area coverage of forests of different NI and forest productivity for 1950 and 2000 in a similar fashion. Firstly, a spatial analysis could be carried out determine whether the deterioration 1950-2000 and improvement 2000-2010 are spatially clustered. If so there might be grounds to evaluate whether protected areas, and voluntary conservation in particular (since 2003) contributed significantly to this possible improvement in NI values since 2000.

Experts using landuse restrictions or protected areas as surrogates for forest quality. Species indicators based on expert judgement dominate the forest NI set (Certain, Skarpaas et al. 2011). A limiting factor in conducting the analysis outlined above would be the extent to which expert evaluations carried out in Nybø(2010) used the area and type of protected areas in each municipality as surrogate indicators for forest quality. In that case NI cannot be used to evaluate protected area effectiveness. In particular forest indicators that are associated with primary sectors such as forestry - 'pressure' indicators – should be determined by experts *without* using the presence of landuse restrictions as prior information. This is key to the future use of NI at finer scales for policy analysis.

Representation of natural variation in NI depends on the spatial scale. Representing natural variation is one of the principle objective of conservation. In general, classification schemes used in indicators remove variability by definition. Spatial data averaging and aggregation leads to a reduction in variation in nature quality at the level of the smallest spatial unit (municipalities) relative to variation at the sub-municipal property level.

The spatial resolution chosen for the analysis was arbitrary beyond the desire to exemplify a spatial analysis at sub-municipal level. Current NI data have resolution which can only pick up variation between biogeographical regions. Forest productivity / AR5 landcover data has a resolution at the level of forest stand (1:5000 scale). Here, forest productivity data variation is lost through spatial averaging to the 1x1km2 grid; municipal level NI data has little discriminatory power between 1x1km2 grids within a region, although it will still capture between region variation. Conducting a spatial priority setting analysis at a particular resolution will inevitably mean compromises in representing variation.

Different conservation features occur at different spatial scales. Terrain variability is an important determinant of local biodiversity value, but is not captured by NI. For example, stream canyons can contain old natural forest with red list species, but at a very small spatial scale; 'key biotope' MiS elements are sampled in at stations spaced at 3x3 km from each other, but with a high resolution at the plot level, and so on. As a rule the highest resolution of the data available and permitted by computing tasks required is often used, because aggregation is possible in post-processing results. However, spatial priority setting analyses multiple scales of analysis should also be considered for future work.

Limitations of surrogate indicator of conservation opportunity cost

Forest productivity as a biodiversity risk indicator. The analysis above asks to what extent PAs represent various levels of 'productive forest' as measured by 'bonitet'. In the original coniferous tree protection plan (DN 1988[31]) the cost of conservation objectives were calculated in terms of km2 of 'productive' forest. The costs of coniferous forest conservation have historically been estimated in terms of area of productive forest (> 1 m3/ha yr). Forest productivity is expected to be correlated with biodiversity value. High productivity forests are also less well represented in the protected area system.

Forest productivity classes may also be interpreted as a forestry probability indicator outside protected areas. Use of forest productivity or opportunity costs as a forestry probability indicator should be used with care, however. When multiplied by a conservation effectiveness indicator, this can be used as a forest biodiversity "risk" indicator. But this means that 'forest productivity' can end up being used as both numeraire and denominator in the cost-effectiveness ratio (probability x effect / cost).

Unproductive forest and 'zero net return' forest. Forest productivity classes is a simple surrogate for the opportunity costs to forestry of conservation. In future analysis the net income before tax from different forest stands – also accounting for accessibility costs - will be a more accurate indicator of opportunity costs to forestry of protected areas (Blom and Sætersdal 2003; Bollandsås, Hoen et al. 2004).

6.7 Fine grain analysis – cost-effectiveness of scenarios for the spatial targeting of different conservation instruments

This section is based on a planning document being developed in cooperation with the Norwegian Nature Management Institute (INA) and the Norwegian Institute for Forest and Landscape (Skog og Landskap). The section suggests (1) detailed research questions for the fine grain analysis and (2) outlines a methodology.

[31] Forslag til retningslinjer for barskovern. DN Rapport nr. 3 – 1988.

1. POLICYMIX research questions for the fine grain scenario analysis

How much of standing timber volume with environmental constraints are associated with forestry opportunity cost for the land owner?

Søgaard et al. (2012)[32] conclude that about 25% of the standing timber volume of productive forest (>1 m3/ha yr) is affected by 'environmental considerations' that limit the amount of timber that can be extracted. The authors estimate that roughly 15% of this volume is economically attractive for forestry, in other words is an area with opportunity costs associated with the environmental considerations (10% of productive volume as 'zero areas') . Prior studies have estimated the volume of 'zero areas' to be as low as 5,7% and as high as 18,7% depending on assumptions (Bollandsås et al. 2004)[33].

There is a need for spatially explicit analyses of "zero areas". Søgaard et al. (2012)[34] estimate that environmental considerations affect about 31% of the productive forest area. Recent estimates by other sources of the area of productive forest considered to 'zero areas' is as high as 27% for 2007(SSB2008 in Søgaard et al. 2012). The authors suggests that there is an important spatial overlap between the area regulated by environmental considerations and areas that are financially unattractive for forestry. They suggest that this is the case for example for 'wilderness areas' (INON) and 'key biotope areas' (MiS).

The Gaya model for calculating financial returns to forestry can be run with and without environmental constraints on forestry (Landseng et al. 2011)[35]. Landseng (unpublished) have used the Gaya model to estimate net present values of forestry without restrictions using data from National Forest Inventory (Landskogstaksering) plots.

Søgaard et al. (2012) have also calculated the % spatial overlap between individual environmental regulations (Table 6, p16).

- ⇨ POLICYMIX proposes to conduct a spatially representative analysis of the forest area and volume considered to be in 'zero areas' across the different categories of 'environmental considerations ' (% spatial overlap with each environmental regulation). The aim is to determine what % area of each the areas under particular 'environmental considerations' constitute opportunity costs for landowners. In this way we may identify the standing volume and area where regulations constitute real restrictions/constraints on production.

What areas are likely to be offered for voluntary forest conservation areas (VCA) in future? VCAs constitute the principle instrument for new forest conservation.

[32] Effekter av ulike miljøhensyn på tilgjengelig skogareal og volum i norske skoger. Norsk Institutt for Skog og Landskap. Rapport 02/2012. (Effects of different environmental considerations on available forest area and volum in Norwegian forests).

[33] Bollandsås O.M., H.F. Hoen, A. Lunnan (2004) Nullområdene betydning. Glimt fra skogforskning 3-2004.

[34] Effekter av ulike miljøhensyn på tilgjengelig skogareal og volum i norske skoger. Norsk Institutt for Skog og Landskap. Rapport 02/2012. (Effects of different environmental considerations on available forest area and volum in Norwegian forests).

[35]

- ⇨ POLICYMIX will evaluate to what extent nature reserves (protected area class FK1) that were created through VCA overlap with other environmental considerations and 'zero areas'.

What is the relative effectiveness on biodiversity conservation of the different individual types of environmental regulation on forests?

Søgaard et al.(2012) use % of standing volume that is 'environmentally restricted' as a surrogate indicator for the relative effectiveness of different environmental considerations (Table 7, p.16). For some types of restrictions, such as 'key biotopes' (MiS) and wilderness areas ('INON') the assumptions in the analysis have been criticised (SABIMA[36]). The effectiveness of the protected share of timber volume in conserving forest habitats has not been evaluated by Søgaard et al, and depends on the spatial configuration of the standing timber in the landscape relative to the environmental requirements of different species/habitats/nature types.

- ⇨ POLICYMIX will attempt to further classify the environmental considerations classes (FK1-FK4), in terms of conservation effectiveness of remaining standing timber (after unconstrained timber is removed).

What is the effect of current economic incentives for forestry on the extent and location of 'zero area' relative to a situation without incentives? How much of the additional area and volume made financially feasible by incentives is expected to lie within areas with environmental considerations?

- ⇨ POLICYMIX will evaluate the % of volume and area in the National Forest Inventory (Landskogstakseringen) that would currently eligible for financial support for forest roads and forestry in steep terrain.

To what extent are instruments (incentives and regulations) considered to be functionally 'conflicting' , 'redundant' , 'unilaterally reinforcing' or 'mutually reinforcing' ?

Søgaard et al. (2012) have also calculated the % spatial overlap between individual environmental regulations (Table 6, p16). An analysis of the functional roles of regulations and incentives in the landscape may be the basis for future recommendations regarding reform of the forest and conservation incentives (POLICYMIX Technical Brief 5 [37]).

- ⇨ POLICYMIX will carry out a characterisation of the functional roles of environmental regulations and economic incentives in forestry and conservation in the landscape, following the logic of the matrix below (Table 10).

[36] http://www.sabima.no/sider/tekst.asp?side=1009

[37] http://policymix.nina.no/Documents/Publicdocuments.aspx?Command=Core_Download&EntryId=869

Table 11 ***Matrix of spatial functional roles of environmental regulation versus forestry subsidies on a specific forest location***

<table>
<tr><th>Spatial overlap between row&column</th><th>Environmental regulation X is 100% effective</th><th>Environmental regulation X is <100% effective</th><th>“Zero area” only without current forestry subsidies</th><th>“Zero area” independently of current forestry subsidies</th></tr>
<tr><td>Environmental regulation Y is 100% effective</td><td>Mutually redundant (either X or Y)</td><td>Regulation X is redundant</td><td>Incentive is redundant and unilaterally reinforcing Y</td><td>Incentive is redundant</td></tr>
<tr><td>Environmental regulation Y is <100% effective</td><td>Regulation Y is redundant</td><td>Mutually reinforcing</td><td>Incentive is conflicting with Y</td><td>Incentive is redundant</td></tr>
<tr><td>“Zero area” only without current forestry subsidies</td><td>Incentive is redundant and unilaterally reinforcing X</td><td>Incentive is conflicting with X</td><td colspan="2" rowspan="2">The importance of the functional role will be measured by the area overlap as a % of productive forest area.</td></tr>
<tr><td>“Zero area” independently of current forestry subsidies</td><td>Incentive is redundant</td><td>Incentive is redundant</td></tr>
</table>

Note: Functional roles: ‘conflicting (perverse)’ , ‘redundant’ , ‘unilaterally reinforcing’ or ‘mutually reinforcing’ ? Functional roles defined relative to an objective of forest biodiversity conservation)

Which areas of productive forest are most cost-effective for future nature reserves offered through voluntary conservation?

This spatial analysis will be carried out using Marxan with Zones. We will evaluate modifications needed to use available timber volume calculations for different “Environmental consideration” categories (FK1-FK4) as defined by Søgaard et al. (2012) as parameters in “production zones” in Marxan.

To what extent are ‘zero areas’ sensitive to (short term) variance of timber prices, and to what extent does this sensitivity modify answers to the other research questions above?

- ⇨ POLICYMIX will conduct sensitivity analysis of net present value of forestry under assumptions about a credible range of timber prices (short term to be defined)

2. Methodology

Figure 1 shows the main steps required to generate representative spatial data for conservation features and opportunity costs to be used in Marxan with Zones.

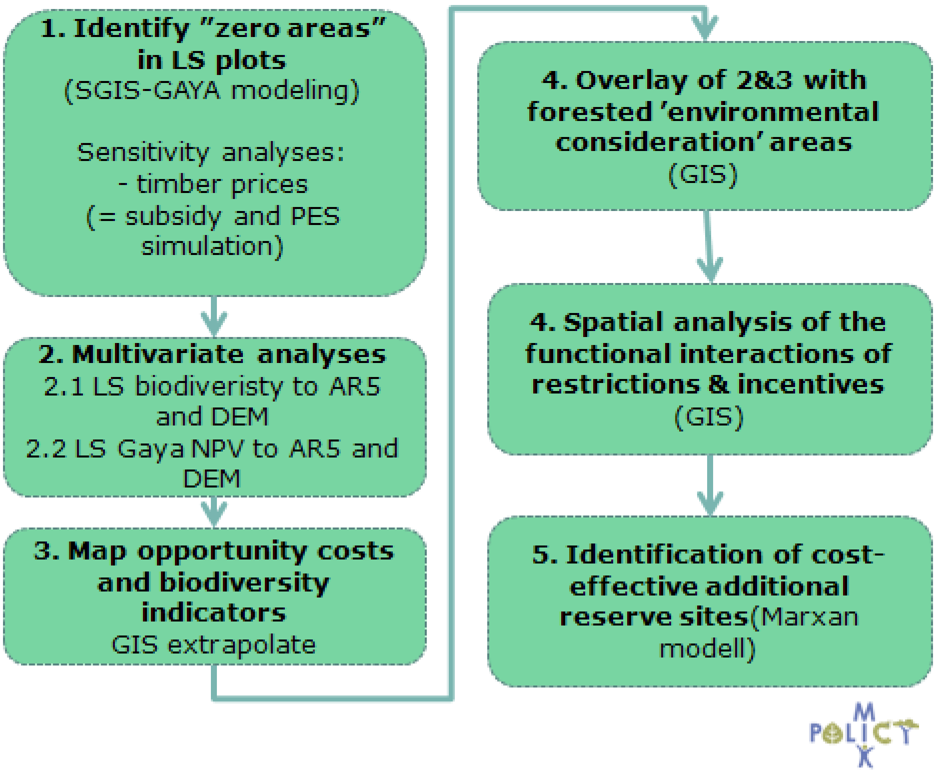


Figure 23 Scenario analysis steps

Step 1: INA calculation of NPV, annual income and costs per hectare for all LS-plots in study area: Telemark, Buskerud, Vestfold. Sensitivity analysis using timber price scenarios

Step 2.1: NINA , INA and Skog og Landskap identify LS parameters that are

- used in Gaya calculations of NPV (INA)
- are surrogate indicators of biodiversity/conservation features (NINA & INA)
- can be expected to correlate with AR5 and DEM25 features (Skog og Landskap, NINA, INA). See appendix.

Step 2.2 NINA rasterizes AR5 and DEM25 variables selected above to a 25x25 grid. Terrain variable definitions to be used as in the LS Instruction Manual.

Step 2.3 : **Skog og Landskap** overlay the rasterises AR5 and DEM25 with the National Forest Inventory (LS) plots. Generate a datafile with LS, AR5 and DEM25 columns/characteristics for each plot. . Delete geographical coordinates of each line/plot to make data anonymous. Keep FID id code.

Step 2.4 NINA carry out a multivariate analysis of NPV-LS-AR5-DEM25 correlation structure

Step 3.1 NINA maps opportunity cost and biodiversity themes to the whole study area using multivariate models from 2.4. Resulting maps shared with INA and Skog og Landskap (terms of use to be decided)

Step 3.2 Skog og Landskap shares map theme of 'environmental considerations' used in Søgaard et al. 2012. (terms of use to be decided)

Steps 4-5 NINA conducts overlay analyses and a functional role assessment of different regulations and incentives

Step 6.1 NINA uses opportunity cost layer and conservation feature map layer as input to Marxan analyses of cost-effective reserve site selection.

Step 6.2 Validation of analyses in steps 4-6 with stakeholders in the POLICYMIX Norway advisory board, in collaboration with NINA, INA and Skog og Landskap.

6.8 Fine grain analysis – forest owner and public preferences for voluntary forest conservation

This section describes a second stream of fine grain analysis that is under way, with particular emphasis on voluntary forest conservation.[38] This activity will investigate voluntary forest conservation ex post and ex ante. We will attempt to address some of the following research questions:

Ex post assessment:

- What are the experiences ("impacts") with voluntary forest conservation (VFC) in Norway? Main hurdles, challenges and opportunities?
- How do the actual compensations paid under the VFC compare with the government lead compensations?
- How do actual participation rates among forest owners compare with stated compensation rates?
- How can the VFC program be improved? Alone or in combination with other instruments? Is auctions an option?

- Ex ante assessment:
    - What would motivate forest owner participation and how can more cost-effective targeting of areas be achieved?
    - What would be the forest owners' stated levels of compensations, would they be willing to forego timber revenue for protection and how does the compensation depend on observable characteristics of forest owners and their forests?
    - What are people's preferences and willingness to pay for forest conservation – is more necessarily better?

[38] A POLICYMIX working paper has already been published from this activity. The paper is forthcoming in Journal of Forest Economics 4/2012. See also working paper: http://policymix.nina.no/News/Newsarticle/tabid/3574/ArticleId/1714/POLICYMIX-Working-Paper-Forest-owners-willingness-to-accept-compensation-for-voluntary-forest-conser.aspx

- Comparing costs and benefits, what is the “optimal level” of voluntary forest conservation, in terms of percentage protected?
- What are people’s and forest owners’ preferences regarding alternative instruments?

Methods and data - links WP guidelines and Norwegian case activities

Analyzing these questions, we will primarily utilize the WP4 guidelines on costs and benefits. There is some link with WP5 (social impacts) (e.g. forest owners’ opinions of the fairness of the conservation process and the compensation levels) and WP6 (institutions) (institutional/process hurdles for more effective VFC instrument/process). There is only a limited link with WP3 (main “indicator” in surveys of the public is percentage of productive forest protected in reserves (and some very limited descriptions of what would happen to main species groups depending on the sizes of forest protection).

Links with other Norwegian fine grain case activities: Data from Telemark/Buskerud (both forest and public preferences), which will also be the geographical area for activities described in chapter 6.7 and 6.9. There are links with social impact analysis (see chapter 6.9) through forest owner surveys. Links with site selection modelling/other forest conservation assessment (see chapter 6.7) through opportunity costs, knowledge of total willingness to pay for forest conservation, knowledge of how hard/easy/costly it will be to expand forest conservation and implement the Marxan solution(s), and forest owner motivation to participate.

Data: Large datasets from recent postal questionnaire surveys of forest owners, one large survey of the conservation preferences of the Norwegian general population. Actual compensation and participation figures from the Directorate of Nature Management have been collected.

Planned outputs: Several peer-review papers in addition to contributions to the fine grain case study report (deliverable 7.1.2) on ex post and ex ante assessment of voluntary forest conservation.

6.9 Fine grain analysis - distributive impacts and legitimacy

In this case study activity as part of the fine grain analysis, particularly drawing from the guideline in WP5, we apply a narrative analysis from sociology. This is a qualitative methodology to study the variety of ways that various actors tend to tell about a case (Svarstad 2009; Tumusiime and Svarstad 2011). We have selected a case area with three municipalities in which an intense conflict took place a few years ago about the establishment of a protected area. Trillemarka-Rollagsfjell Nature Reserve was established by the government in 2008. It is an area of about 148.000 da in Buskerud county in south-east Norway (see the map of figure 24). This constitutes the largest forest reserve in the country.

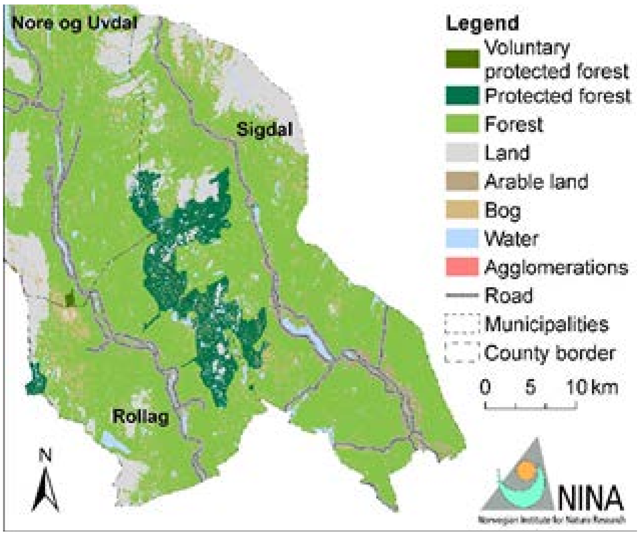


Figure 24: Map of the municipalities Nore og Uvdal, Rollag, and Sigdal, with Trillemarka-Rollagsfjell Nature Reserve.

Through analysis of written sources, such as newspaper coverage and opinion pieces, we look at varieties and patterns in ways that the planned protected area was narrated during the conflict. Furthermore, through qualitative interviews we reveal present narratives of the protected area. From the beginning, Trillemarka-Rollagsfjell must be seen as a more or less traditional case of “fortress conservation”. Later on, however, substantial funds were offered from the central government to the involved municipalities and forest owners. Thus, we ask whether there is a change in the local production of narratives that indicates a changing “sense of justice” and legitimacy of the conservation (Svarstad, Sletten et al. 2011). In the discussion of explanations of the findings, we will particularly look at the eventual roles of procedural and distributional justice (see figure 25).

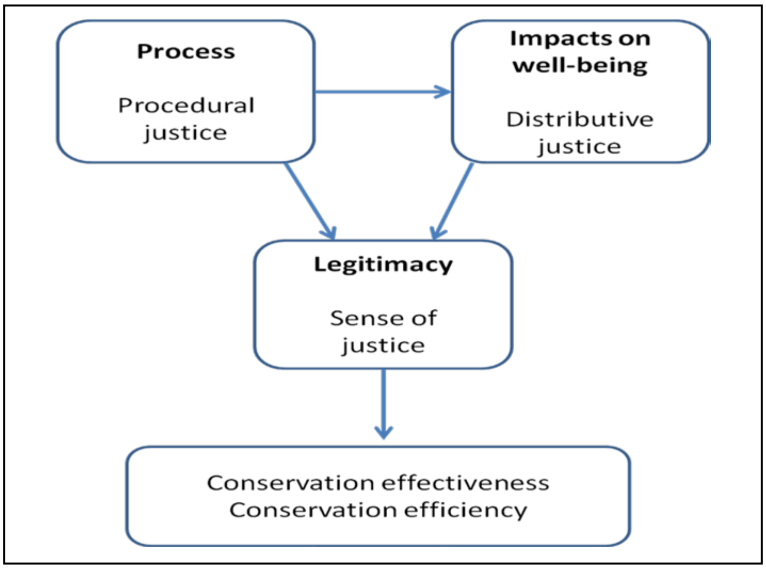


Figure 25: Framework for analysis of social impacts and legitimacy of policy instruments

Within the same area of Buskerud county, we will also carry out a narrative analysis on a case of voluntary conservation, and in a comparison to the case of protected area, we will discuss explanations of the sense of justice also in this case.

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