Low cost approaches for managing biological diversity in Nordic forests: The applicability of procurement auctions

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Executive summary

Biodiversity is lost at rates that worry. The scientific evidence for these concerns are strong for several reasons. First, biodiversity is important for maintaining ecosystem services. Second, biodiversity increases the resilience of ecosystems, i.e., their ability to withstand environmental shocks or changes. Global climate is an example. Third, loss of species, known or unknown, reduces our possibilities of finding gene materials that may be detrimental to solve problems related to diseases and pests. The arguments for pushing for biodiversity conservation or management policies are therefore many and strong.

According to conservation biologists the acreage of forests managed explicitly for biodiversity purposes is insufficient to meet stated policy objectives of halting the losses of biodiversity. Cost-effective policies for managing biodiversity in forests not only avoid waste of resources. They also make it easier to reach the stated policy objectives. Competition for the scarce public funds further augments the case for getting the most out of the funds allocated.

In this perspective successful forest biodiversity policies must meet two objectives: (i) reach conservation objectives, and (ii) allocate measures for conserving or enhancing biodiversity so that costs are minimized. Habitat conservation and management for biodiversity purposes mean changing forest management practices to halt biodiversity losses or even augment biodiversity. Habitat policies are increasingly seen as a viable way of reaching most of the biodiversity conservation targets. Such policies also constitute a strategy to deal with uncertainty and incomplete knowledge, for example on the existence of species and their ecosystem functions, as conserved habitats may cover more species than those we are currently aware of or know about. Protecting a selection of a wide variety of forest types in various regions is indeed consistent with the precautionary principle. Chapter 2 discusses these issues further.

Many biodiversity policy objectives will be met without protecting all forests. This opens for policies that select low cost forest plots for protection while still reaching conservation targets. Auctions, if properly designed, resolve the *double matching problem of implementing conservation policy measures on sites where the costs are the least* across forest types and regions. Double matching involves awarding conservation contracts to low-cost providers while meeting conservation objectives.

Landowners with low costs of changing their forest management practices are expected to require less compensation to change their operations. Well-functioning auctions allocate conservation contracts to least-cost providers and lowers the compensation payments needed for landowners to voluntarily accept changes in their forest management practices. We compare different auction mechanisms. Our conclusion is that uniform price auctions provide incentives for each landowner to equate his or her bid to the compensation just needed for him/her to be indifferent between the current and changed forest management practices, so-called *truthful revelation*.

The truthful revelation property of uniform price auctions does not come for free. In such auctions all who are awarded a contract are paid the same, the *uniform price*. Hence, some landowners are paid more than their bid and consequently more than their costs. In discriminatory price auctions each winning bidder is paid equal to his/her bid. It follows that the (budget) costs of uniform price auctions exceed those of discriminatory price auctions as long as the strategic bid adjustments in the discriminatory price auction are less than the information rents under the uniform price auction that reaches the same conservation target. Section 3.2 discusses these issues further.

A particular concern related to the use of auctions or other decentralized principles for allocating forest management contracts is that many habitats cover multiple estates or land holdings. This issue is particularly relevant in the Nordic countries, where there is a large pro-portion of small forest estates. Two principally different ways of resolving this issue are pre-surveying to identify cases where conservation worthy habitats span multiple plots or estates, and implementing a system of agglomeration bonuses when landowners succeed in incorporating such habitats in the auctions.

A potential effect of such a pre-surveying approach is that it reduces the number of qualified bidders, thereby lowering the competition in the bidding processes. For conservation purposes where the number of habitats meeting conservation objectives is low, competition may be reduced. As a result the cost savings of using auctions also declines. Auctions can also be designed to reduce risks by making conservation costs more visible. In turn, that opens for linking conservation costs to insurance and other financial instruments.

Agglomeration bonuses are not subject to the same collusion risks as landowners do not know how many other prospective bidders there are. However, such bonuses may be difficult to implement, in particular among landowners with small forest properties. Sections 2.4, and 4.2 address these issues further.

Entering an auction entails some extra 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. Hence, 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 with lower transaction costs for forest owners. Of particular relevance in our case is the use of flat rate payments for landowners who did not enter the auction. When such a payment is 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, owners of large properties benefit more from the auction than those 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. Section 5.3 addresses these issues in a Nordic context.

Conservation issues have been the source of many conflicts between landowners and the authorities. Resolving such conflicts without litigation or expropriation has a cost savings potential. By design, nobody enters a bid in a contract auction where the expected benefits of getting a contract makes him or her worse off. This also makes auctions interesting from a conflict resolution perspective – for one, auctions are voluntary compared to many current biodiversity measures. Reducing the tensions and conflicts between public agencies and landowners also opens for increased cooperation. Sections 3.1 and 5.4 address these issues further.

Conservation auctions have many desirable properties as this report shows. We have addressed the main issues that need to be in place for conservation auctions to be an interesting addition to biodiversity conservation policies in general, and in the Nordic countries in particular. The success of conservation auctions or any other conservation policies for biodiversity in forests hinges on one additional condition: that sufficient resources are provided for policy objectives to be met. This requirement is far from being fulfilled in the Nordic countries. A major advantage in this respect is that low cost policies like conservation auctions, increase net benefits of biodiversity policies. Thereby, an increase of the public funds available for biodiversity purposes becomes easier to justify.

Finally, we propose to test the applicability of uniform price procurement auctions to resolve some issues using focus groups, lab experiments, surveys, and finally a small scale implementation. These studies also aim at learning more on how information should be provided to potential providers of biodiversity.

If the test studies are promising, we propose a gradual implementation of uniform price auctions where separate auctions are held for various regions and forest types. A key premise in such a gradual implementation is that biodiversity research and management are “young activities”. Hence there is still a lot to learn. Balancing the needs to better manage conservation worthy habitats at risk with learning is a major challenge for biodiversity management in general and the conservation auctions in particular.

Sammanfattning

Biologisk mångfald går förlorad i en oroande takt. Det vetenskapliga underlaget för sådana farhågor är starka av flera skäl. För det första är biologisk mångfald viktig för människan genom att upprätthålla ekosystemtjänster. För det andra ökar den biologiska mångfalden ekosystemens resiliens, d.v.s. förmågan att motstå miljöchocker eller förändringar. Det globala klimatet är ett aktuellt exempel på detta. För det tredje minskar förlusten av arter – kända eller okända – våra möjligheter att hitta genetiskt material som kan vara värdefullt för att lösa problem kopplade till sjukdomar och skadegörare. Argumenten för bevarande av biologisk mångfald och förvaltning är därför många och starka.

Arealen skog som förvaltas särskilt med hänsyn till biologisk mångfald är enligt bevarande-biologer otillräcklig för att tillgodose de politiskt fastställda målen för att hejda förlusterna av biologisk mångfald. Kostnadseffektiva åtgärder för att hantera den biologiska mångfalden i skogarna gör mer än att undvika slöseri med knappa resurser. De gör det också lättare att nå de fastlagda målen. Konkurrensen om begränsade offentliga medel är ett ytterligare argument för att få ut mesta möjliga av de tillgängliga anslagen.

En framgångsrik förvaltning av skogens biologiska mångfald måste ur detta perspektiv uppfylla två syften: (i) uppnå bevarandemålen, och (ii) styra åtgärder för att bevara eller öka den biologiska mångfalden på ett sätt som minimerar kostnaderna. Bevarande av habitat och förvaltning för biologisk mångfald medför att skogsskötselmetoderna behöver anpassas för att stoppa förlusten av biologisk mångfald eller till och med öka den. Bevarande av habitat ses alltmer som en framkomlig väg för att uppnå de flesta målen när det gäller biologisk mångfald. Detta utgör också en strategi för att hantera osäkerhet och ofullständig kunskap, till exempel när det gäller arters existens och deras funktioner i ekosystemen, eftersom bevarade av habitat kan omfatta fler arter än de vi för närvarande känner till. Att skydda ett urval av en mängd olika skogstyper i olika områden är därmed förenligt med försiktighetsprincipen. Kapitel 2 diskuterar dessa frågeställningar närmare.

När det gäller biologisk mångfald kan många mål uppnås utan att skydda all skog. Detta möjliggör en strategi där skogsarealer som har en låg kostnad för skydd utnyttjas och bevarandemålen kan ändå nås. Auktioner som utformats på ett lämpligt sätt kan lösa matchningsproblemet för att genomföra åtgärder för bevarande på platser där kostnaderna är minst för olika skogstyper och regioner. Matchningen består i att bevarandekontrakt tilldelas dem som kan leverera till lägsta kostnad samtidigt som bevarandemålen uppnås.

Markägare som har låga kostnader för att ändra sina skogsskötselmetoder förväntas kräva mindre ersättning för att ställa om sin verksamhet. Väl fungerande auktioner fördelar bevarandekontrakt till dem som kan leverera till lägsta kostnad och sänker ersättningsutbetalningarna som krävs för att markägare frivilligt ska acceptera förändringar i sin skogsbruksverksamhet. Vi jämför olika auktionsmekanismer. Vår slutsats är att uniforma prisauktioner ger incitament för varje markägare att likställa sitt bud med den ersättning som precis behövs för att han/hon ska vara likgiltig mellan att behålla sin nuvarande verksamhet och att förändra den, så kallad «truthful revelation».

Denna avslöjande egenskap hos uniforma prisauktioner är inte gratis. Alla som tilldelas ett kontrakt erhåller samma betalning, det uniforma priset. Följaktligen kommer vissa markägare att få mer betalt än vad de har bjudit och därmed mer än sina kostnader. I diskriminerande prisauktioner får varje vinnande budgivare en betalning som motsvarar hennes/hans bud. Detta medför att kostnaderna för uniforma prisauktioner är högre än för diskriminerande prisauktioner så länge de strategiska anpassningarna av buden i diskriminerande prisauktioner är mindre än informationsräntan under uniforma prisauktioner som uppnår samma bevarandemål. Dessa frågor diskuteras utförligare i avsnitt 3.2.

Många områden omfattar flera fastigheter eller markägare, vilket utgör ett särskilt problem i samband med användningen av auktioner eller andra decentraliserade principer för att allokera skogsskötselkontrakt. Detta är särskilt relevant i de nordiska länderna, där det finns en stor andel små skogsfastigheter. Två principiellt olika sätt att lösa detta problem är dels en förberedande kartläggning för att identifiera områden där skyddsvärda områden omfattar flera ytor eller fastigheter, dels att tillämpa ett system för samordningsbonusar när markägarna lyckas införliva sådana områden i auktionerna. En potentiell effekt av en sådan kartläggning är att det minskar antalet kvalificerade anbudsgivare och därigenom minskas konkurrensen i budgivningsprocessen. Konkurrensen kan minska när det gäller bevarandeändamål, eftersom antalet områden som uppfyller bevarandemålen är lågt. I så fall minskar även kostnadsbesparingarna med att använda auktioner. Auktioner kan också utformas för att minska riskerna genom att göra bevarandekostnaderna mer synliga. Det möjliggör i sin tur att koppla bevarandekostnaderna till försäkringar och andra finansiella instrument.

Samordningsbonusar är inte relaterade till risker för oönskat samarbete eftersom markägarna inte vet hur många andra potentiella budgivare som finns. Emellertid kan sådan bonusar vara svåra att tillämpa, särskilt bland markägare med små skogsfastigheter. Avsnitten 2.4 och 4.2 diskuterar dessa frågor vidare.

Medverkan i en auktion medför extra kostnader för att komma fram till ett bud. De förväntade vinsterna med att få ett bevarandekontrakt kan för små markägare vara för små för att motivera sådana transaktionskostnader. Därför kommer troligen små fastigheter att bli underrepresenterade. En fördel med egenskapen av «truthful revelation» hos uniforma prisauktionerär att buden kan användas för att utforma andra kompensationsmekanismer med lägre transaktionskostnader för skogsägarna. I vårt fall är användningen av schabloniserade betalningar till markägare som inte deltog i auktionen av särskild betydelse. När en sådan betalning är lägre än auktionspriset så upprätthålls incitamentet för deltagande för de markägare där de extra förväntade intäkterna från auktionen mer än uppväger transaktionskostnaderna. Vanligtvis kan stora markägare dra större nytta av auktionen än de med små fastigheter eftersom transaktionskostnaderna fördelas på en större areal.

Om en del av bevarandekontrakten fördelas efter en fast betalning per enhet så kommer färre avtal att auktioneras ut, eftersom vissa kontrakt kommer att erbjudas de markägare accepterar ett schablonbelopp. Detta ökar konkurrensen i auktionen eftersom färre kontrakt kommer att fördelas genom auktionen. Sådana betalningar efter auktionen möjliggör också en rumslig samordning mellan små fastigheter. Avsnitt 5.3 behandlar dessa frågor i ett nordiskt sammanhang.

Bevarandefrågor har varit en källa till många konflikter mellan markägare och myndigheter. Om konflikterna kan lösas utan rättstvister eller expropriation så finns det en potential att göra besparingar. Genom auktionens konstruktion lägger ingen ett bud där de förväntade fördelarna med att få ett kontrakt är sådana att man hamnar i en sämre situation än tidigare. Detta gör också auktioner intressant ur ett konfliktlösningsperspektiv – auktioner är frivilliga till skillnad från många andra åtgärder för att bevara biologisk mångfald. Minskade spänningar och konflikter mellan myndigheter och markägare öppnar vägen för ökat samarbete. Avsnitt 3.1 och 5.4 diskuterar detta.

Denna rapport visar att bevarandeauktioner har många tilltalande egenskaper. Vi har lyft fram de viktigaste förutsättningarna för att bevarandeauktioner ska kunna vara ett intressant tillägg till bevarandepolitiken i allmänhet, och i de nordiska länderna i synnerhet. Framgången för bevarandeauktioner och andra strategier för bevarande av biologisk mångfald i skog är beroende av att ytterligare ett villkor är uppfyllt: att tillräckliga resurser skjuts till för att de politiska målen ska kunna uppnås. Detta villkor är långtifrån uppfyllt i Norden. Lågkostnadsstrategier som bevarandeauktioner ökar nettovinsterna av en politik för biologisk mångfald, vilket är en stor fördel i detta avseende. Därigenom blir en ökning av de offentliga medlen för bevarande av biologisk mångfald lättare att motivera.

Slutligen föreslås att användbarheten av uniforma upphandlingsauktioner testas för att lösa vissa frågor med hjälp fokusgrupper, laboratorieexperiment, enkäter och slutligen en tillämpning i liten skala. Dessa studier syftar också till att lära sig mer om hur information bör ges till dem som potentiellt ska tillhandahålla biologisk mångfald.

Om testundersökningarna visar sig lovande så föreslår vi en gradvis tillämpning av uniforma prisauktioner där separata auktioner hålls för olika regioner och skogstyper. En avgörande premiss i en sådan gradvis tillämpning är att forskning och förvaltning kring biologisk mångfald är "unga aktiviteter". Därför finns det fortfarande mycket att lära. Att balansera behovet av en bättre förvaltning av skyddsvärda habitat med lärande är en stor utmaning för förvaltning av biologisk mångfald i allmänhet, och bevarandeauktioner i synnerhet.

1 Introduction[1]

> "The variety of life on Earth, its biological diversity is commonly referred to as biodiversity. The number of species of plants, animals, and microorganisms, the enormous diversity of genes in these species, the different ecosystems on the planet, such as deserts, rainforests and coral reefs are all part of a biologically diverse Earth. Appropriate conservation and sustainable development strategies attempt to recognize this as being integral to any approach. Almost all cultures have in some way or form recognized the importance that nature, and its biological diversity has had upon them and the need to maintain it."

(Shah 2009, http://www.globalissues.org/issue/169/biodiversity).

The above quote summarizes how biodiversity conservation and management is matter about respect for nature and for ourselves. We find it an appropriate starting point to our treatment of a far more limited perspective – the costs of biodiversity policies.

Concerns about biodiversity loss have been growing for more than two decades. As our scientific knowledge on the importance of biodiversity has increased, our concerns about loosing biodiversity have grown. These developments are expected to continue for years to come. Scarcity of public funds and resources strengthen the need of finding the least cost ways of controlling biodiversity losses.

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[1] This report is the result of the project *Managing biological diversity in Nordic forest* that the Department of Economics and Resource Management at the Norwegian University of Life Sciences was awarded from the Expert group of environmental studies (Expertgruppen för Miljöstudier) under the Swedish Ministry of Finance.

Our summaries on the forest biodiversity policies of the Nordic countries have benefited from inputs and comments from Hans Nilsagård (Swedish Ministry of Agriculture in Stockholm), Niels Strange (University of Copenhagen, Denmark), and Paula Horne (Pellervo Economic Research Institute).

We have also benefited from an enthusiastic and lively reference group: Ann-Sophie Crépin, Göran Bostedt, Paula Horne, and Peter Frykblom. Björn Carlén and Magnus Allgulin at the Swedish Ministry of Finance have been our contact persons in the Expert group of environmental studies. Their comments and suggestions have helped shape this report. The usual disclaimers apply.

These concerns are also reflected in Swedish legislation on forestry and biodiversity issues: The forest policy adopted by the Swedish parliament in 1993 includes two objectives, one relating to forest production and the other to environmental protection. Both objectives were granted equal importance. The forest policy objectives together with the "Sustainable Forests" objective are given an operational interpretation in so-called interim targets for the forest sector (Skogsstyrelsen 2005). A major interim target pertaining mainly to biodiversity is that an additional 900 000 hectares of forest land with high conservation values are to be excluded from forest production by 2010 (Skogsstyrelsen ibid.). This has not taken place, which gives room for further concerns and suggest that current policies do not work as well as previously believed.

900 000 hectares is a sizable share of the total Swedish land area, and there could be substantial savings from implementing policies that focus on keeping costs down. Such savings should not entail sacrificing protection targets.

This report is about selecting least cost management regimes for reaching politically decided targets for biodiversity in Nordic forests with reasonable certainty. Forest biodiversity is characterized by regional and forest type specifics, implying that policy instruments must be designed for this variety of settings. This implies there must be regional or local targets for various dimension of biodiversity.

A cost-effective biodiversity policy then entails:

(1) Identifying which management strategies that are least cost. At first glance, this may seem a trivial task, but costs vary across regions, across forest types and states, and across owners in ways that the regulators are not (and should not) be fully informed about.

(2) Inducing forest owners to report to the regulator their true costs of various management strategies is part of a cost-effective biodiversity policy. This is difficult to achieve as forest owners have an interest to overstate their costs to to reap higher compensations from whoever pays for biodiversity management.

Many policy measures are able to address cost-effectiveness in more or less successful ways. Economists frequently suggest using environmental taxes or various forms of tradable permits to provide the proper incentives for reducing damages onto the environment. Managing biodiversity in Nordic forests does not quite fit the standard mold. It is difficult to measure biodiversity in meaningful ways, in particular given the quote by Shah (2009) at the start of this chapter. Moreover, many years of illdefined policies have raised the conflict level and distrust between forest owners and the authorities. Mechanisms that fully compensate forest owners for lost incomes from making biodiversity considerations is one way to reduce the conflict level and restore trust between the authorities and landowners. This will also lower administrative and litigation costs, and is therefore one of the reasons why we have chosen to study procurement auctions in more detail.

The basic idea of auctions is that forest owners submit bids for biodiversity conservation contracts in a public tender. The government can then contract with owners whose forest plots have the desired conservation attributes at the lowest cost (bids) given the budget available. Provided that the bids reflect costs, this approach will maximize biodiversity benefits for a given available budget. Promising results using auctions have been demonstrated by the US conservation reserve program (USDA Economic Research Service 2009) and the Australian Bush tender scheme (Stoneham *et al.* 2003), even if these and other applications have not been optimally designed to avoid landowners to inflate their bids.

Auctions, if properly designed, enable the regulators to identify low cost providers, and give incentives for these providers to bid the lowest compensation they need to voluntarily implement the desired management practices. Moreover, we link least cost biodiversity policies to the more complicated, but ultimate, objective of any benign policy maker – to maximize the contribution to human wellbeing from biodiversity. In addition to minimizing social costs of biodiversity regulations, this means that properly designed auctions will also capture conservation attributes that are perceived important by biologists and ecologists. This is done by specifying clear eligibility criteria in the auction call.

Finally, we note that the lack of trust between the forest sector, environmental non-govern-mental organizations and regulators is currently widespread in the Nordic countries (Bergseng and Vatn 2009).

The objectives of this report are:

(1) To identify and discuss the pros and cons of procurement auctions as a tool for biodiversity conservation and management in a forest context.
(2) To show that uniform price auctions is a particularly suitable auction format for biodiversity management because of its desirable truthtelling properties.
(3) To sketch a test program for procurement auctions for biodiversity conservation and management purposes for Swedish forests.

1.1 A brief introduction to biodiversity

Biodiversity spans a wide array of features as the UNEP (1992: article 2) definition shows:

> "Biological diversity" means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

Many other definitions of biodiversity exist. A majority of these definitions distinguish between genetic species and ecosystem levels of biodiversity (Cervigni 2001). The existence of different definitions of biodiversity has led to multiple ways of measuring biodiversity. However, almost regardless of how biodiversity is measured, it appears that we have been unable to halt biodiversity losses even after biodiversity has become an issue of public interest.

We believe that a key reason for this is the failure to identify and implement *cost effective policies* for managing habitats and protecting threatened species. The linkages between habitat management and species viability are central in this connection. One reason for this is that many species are yet not known. Therefore, their ecosystem functions are not known either. With this clear lack of knowledge on the role of single species, securing a wide variety of habitats becomes a plausible management strategy. Such a management strategy is also consistent with upholding ecosystem functions.

Habitat management is widely regarded as particularly important for promoting biodiversity in general (Hoekstra *et al.* 2004), and in forests in particular (Tabarelli *et al.* 2005). By *habitat management* we mean any management, including protection, that does not fall into the category of conventional forest management that is driven by owner objectives. Basically, habitat management or protection means changing forest management practices.

Dunster and Dunster (1996:137) define forest management as follows: "Forest management is the practice of applying scientific, economic, philosophical and social principles to the administration, utilization, and conservation of all aspects of forested landscapes to meet specified goals and objectives, while maintaining the productivity of the forest. Forest management includes the subset of activities known as timber management, but also involves planning and managing forested landscapes for fish and wildlife, biological diversity, conservation measures, parks, wilderness, recreation and aesthetic values. Forest management is an all-encompassing activity and is not to be confused with the more restrictive activities associated with timber management."

Dunster and Dunster (ibid.:156) operate with two definitions of habitat:

(1) "Those parts of the environment (aquatic, terrestrial, atmospheric), often typified by a dominant plant form or physical characteristic, on which an organism depends, directly or indirectly, in order to carry out its life processes.
(2) The specific environmental conditions in which organisms thrive in the wild."

How well are procurement auctions able to meet the criteria we presented at the start of this chapter – to identify the least cost solution to a given conservation target, and to reach this target with a reasonable degree of certainty? Related to biodiversity management in forests least cost solutions translate into breaking the information asymmetries that exist between landowners and regulators.

From the definition of biodiversity it follows that in order to reduce biodiversity loss or improve conditions for biodiversity to become higher, one needs to have a regional or forest type perspective on habitat management. One reason for this is that the acreage shares of apparently similar habitats may differ between regions and forest types. Successful use of auctions therefore implies that the auctions must be regional and forest type specific to capture variety in ecosystems and habitats. For particularly threatened (red listed) species separate or additional measures may be needed to secure their survival and viability.

1.2 Current biodiversity policies in a nutshell

US and Australian experiences, with direct incentives and targeted payment mechanisms suggests that biodiversity policies should be targeted, transparent and tractable. FAO's (2009) project on payment for environmental services point to similar experiences – those programs that had predictable, clear and focused incentives were far more successful than less focused programs.[2] Unfortunately, this is poorly reflected in most biodiversity legislation and policies to date. There are several reasons for this.

First, biodiversity management is a rather young policy and research area. However, when it comes to biodiversity, matters are further complicated by other historical factors. Second, the degree of conflict also appears to depend past and current resource use practices, and how compensation mechanisms are formulated. For example, a basic reason for higher conflict level in Norway relative terms to the other Nordic countries, is that landowners or titled users receive a smaller fraction of full compensation than in the other Nordic countries.

Sweden's compensation scheme to the reindeer herding Samí for predator damages (Swedish Ministry of the Environment 2007) is an example of a program where incentives for predator conservation are improved as compensations are paid up-front on expected losses. Still, there are conflicts in Sweden on this issue related to the size of the compensation. In turn, this threatens the effectiveness of the system (Svenska Samernas Riksförbund 2009). Moreover, poaching still takes place on, which demonstrates the complexities of predator conservation.

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[2] The general experiences from the environmental economics literature point in the same direction. The Kydland-Prescott article "Rules Rather than Discretion: The Inconsistency of Optimal Plans" (Kydland and Prescott 1977), that was awarded the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel in 2004, makes the same point that agents should know what to expect. In turn, that implies that the rules of the game should be changed infrequently, and if changed, changes should be predictable.

The failures of most past and current policies suggest biodiversity management is complicated. Avoiding that landowners inflate their costs to gain excess compensation lowers costs to society. On the other hand, full compensation is essential if landowners are to support conservation policies. It is therefore remarkable that no country to our knowledge has yet applied uniform price contract auctions to at least resolve some of the difficulties of biodiversity management. We find this quite odd, given that the theoretical results of this auction format on full compensation and low costs are so strong.

1.3 Some premises for and outline of the report

The overall objective of this report is to identify least cost policies for biodiversity management and ways to implement such policies. This entails to review and synthesize contemporary research in order to find cost effective policies for biodiversity management in Nordic forests.

It is widely accepted that landowners have better information than regulators on the costs of changing forest management practices from the current management regimes. A desirable property of auctions is that they are well suited for identifying least cost suppliers. With multiple habitats to be protected or managed to include biodiversity aspects, auctions that are able to assign several contracts in one auction round appear particularly relevant. Multi unit procurement auctions meet this criterion.

We also argue that some forest owners because of their local knowledge may know more about the occurrence of certain species and habitats on their property compared to regulators. While this may not always be the case, the ability of an instrument to identify such forest owners is also of interest to reduce costs. Here, we note that one may not *a priori* know who these forest owners are, nor how much they know. Reducing this knowledge gap may entail large gains to society in some settings.

We assume that society has determined policy targets for biodiversity which may or may not coincide with the efficient level of biodiversity protection[3]. Therefore, our analysis focuses on how

[3] In theory this is the level of biodiversity where the benefits to society of a further small, increase in bio-diversity equals the marginal costs of the protection or management required to achieve this level.

conservation targets may be achieved in a cost effective way. Even though benefit considerations are not the main focus of this report, reaching biodiversity targets at lower costs increases net benefits of biodiversity policy instruments. Or bluntly put: Economizing on scarce resources is a necessary condition for sustainable development.

Chapter 2 presents a wider background on biodiversity, and for our work on least cost instruments, and frames these instruments in a wider setting of maximizing the net benefits of policies.

Chapter 3 deals with the management issues pertaining to biodiversity in general with a special focus on compensation issues and procurement auctions. Chapter 4 takes a closer look at how procurement auctions can be designed to better utilize the informational advantage forest owners and managers have relative to regulators, the design of monitoring and enforcement regimes, and spatial coordination.

Chapter 5 looks more closely at how uniform price procurement auctions for biodiversity measures can be implemented in a Nordic setting when there is substantial knowledge gaps and hence room for learning the impacts management on biodiversity, and on how information to prospective providers should be provided for auctions to perform well.

Chapter 6 concludes this report on the use of procurement auctions to reduce the loss of biodiversity in Nordic forests more effectively and with lower costs to society than is the case for currently used policy instruments. Even at this stage we remark that current policies to avoid loss of biodiversity are unlikely to result in meeting publicly stated objectives on avoiding loss of biodiversity. Our auction approach is a way of reaching these objectives in a least cost fashion, with reasonable certainty, and with an eye to learning.

2 Further motivation and background

This report focuses mainly on least cost management strategies where regional and forest type variations are incorporated by having regional auctions that are further separated by forest types. Benefit considerations and the associated methodological aspects (Garrod and Willis 1999), are behind this choice.

2.1 The net benefits of biodiversity protection and management

The benefits of biodiversity are closely linked to ecosystem functions or services. Resilience, i.e., how robust an ecosystem is to external shocks like climate change, and the potential future benefits of genetic material from some species, are examples in this regard. In addition, there may be substantial non-use benefits related to the continued existence of forest species and ecosystems (Forest Encyclopedia Network, undated). A noteworthy feature of many of these future benefits is that we neither know what they are, nor their size. Moreover, our lack of knowledge on the dynamics of ecosystems may also have implications for how we manage biodiversity.

Ideally, we would have liked to devise policies that maximize the expected net benefits of biodiversity in Nordic forests. There are two reasons why such an orientation may be difficult to follow:

(1) *Concerns related to the applicability of current non-market valuation methods on biodiversity*. Since its inception more than thirty years ago, non-market valuation methods have become increasingly reliable and sophisticated. This methodological progress has been particularly strong in the

case of stated preference methods[4] (Bate-man *et al.* 2002), although there are still difficult issues related to the use of these methods.[5] Lindhjem's (2007) review of the valuation literature on non-timber benefits in the Nordic countries finds reasonably consistent results suggesting that stated preference methods broaden the knowledge base for managing biodiversity.

However, Bostedt (1997) notes that biodiversity and ecosystem functions benefits from not harvesting timber are uncertain and particularly difficult to value properly. Sjöström (2003) qualifies Bostedt's claim – most respondents know very little about biodiversity, and partly because biodiversity and ecosystem functions are complex and multidimensional. Forest type and regional specifics further augment the challenges of valuing benefits of (forest) biodiversity. Despite these concerns valuation more recent applications exist (for example Boman *et al.* 2008) that suggest reliable results on valuing biodiversity.

(2) *The (biological) knowledge about biodiversity is incomplete, and advances emerge frequently*. This implies rapid changes in benefit criteria and assessments. Over time, however, one would expect (the biological) information to become more accurate.

Our knowledge about biological systems is growing, particularly related to their complexity and connectedness. This implies that previous non-market valuation results may also have to be reassessed. In turn, this reduces the value of numerical applications using the quasioption value approaches[6] because the volatility in

[4] Stated preference methods try to derive people's willingness to pay (WTP) through surveys, either directly by asking about their WTP for environmental goods (so-called contingent valuation – CV) or indirectly through giving respondents choice sets describing different attributes of the environmental good coupled with a cost implication (so called choice modeling or choice experiments).

[5] The validity of the contingent valuation method (or other stated preference methods) is controversial in economics. For non-technical but excellent contributions to this debate, see Diamond and Hausmann (1994) and Hanemann (1994). Bergstrom (2006) is a more recent article on this controversy. Farber et al. (2006) and Martin-Lopez *et al.* (2008) are recent summary articles on using stated preference methods on ecosystem services.

[6] The quasi option value refers to the value of waiting to get more information before undertaking an action with irreversible (or costly to correct) impacts. For more details see Arrow and Fisher (1974) or Henry (1974). The quasi option value is a standard economic approach to deal with changes in the available information over time.

our estimates is not due to changes in the biodiversity conditions or preferences, but stem from methodological uncertainties.

However, the basic option value insight remains: be careful when undertaking actions that may lead to costly repairs later or irreversible losses.[7] In brief, it may make sense to restrict timber harvesting from a larger share of the Nordic forests while new biological knowledge is gained and the nature of the uncertainty becomes more amenable for numerical analysis. This is in line with the well-known precautionary principle in environmental policy (UNEP 1992). A key question is then how to maximize biodiversity benefits in such interim periods.

Least cost management for varying policy targets falls short of maximizing the (expected) net benefits, but is necessary to be able to maximize net benefits. To see this consider that the (policy) targets for biodiversity management were met, but that this was not done in a least cost fashion. By reducing biodiversity management costs while still meeting the targets, society's utility could be further increased.

Current forest biodiversity policy targets are often expressed in quantitative terms, like the Shannon diversity index, volume of dead wood or share of deciduous tree species, or protection of a certain share of forest acreage from activities that are perceived to negatively affect biodiversity. Our focus on identifying least cost management strategies (to reach a target) is therefore of immediate interest to policy makers.

Our policy recommendations must also be seen in light of the substantial changes that take place in the economy and concerns pertaining to the environment. Globally, the issue of climate change is highest on the agenda. Climate change may alter the growing conditions of the existing plants such that the composition of plants growing in an area also changes. In turn, this may have profound impacts on how well various animals thrive in the same area. For example, changes in vegetation may change the relative survival rates of moose relative to deer and wild boars, two species that have expanded in southern Sweden the last decades. However, other large scale issues like the impacts of pollution on how well different species cope, adds biological uncertainty. This

[7] For example, once a species is lost, it will not return again. On the other side, there are numerous examples of species that have been perceived as lost that have been found in other locations. This exemplifies the fundamental uncertainties related to biodiversity and its management.

calls for flexible policy instruments to adapt to changes in the natural environment, and motivates policies to preserve biodiversity even more.

On the economic side booms or recessions influence the pressure on forest resources. Therefore, policies for managing biodiversity also need to be dynamic (Costello and Polasky 2004; Strange and Thorsen 2008). Economic times may also alter the (relative) public emphasis on biodiversity. This calls for flexible policies to manage biodiversity. Changes in public perceptions that are expected to be of a more long term nature further strengthen the arguments in favor of flexible management.

Rapid land use changes pose a threat to biodiversity, and controlling land use or having sufficient areas without such changes may be a safeguard against biodiversity losses and ecosystem functioning degradation (Chapin *et al*. 1998). Continuity in vegetation cover or land use seem to be a significant factor for the performance of several species (see for example Ohlson *et al.* 1997, and Molinari et al. 2005). In brief, conservation biologists generally agree that habitat conservation and management are central to avoiding biodiversity losses or less functional forest ecosystems. Habitat measures may take many different forms. Some are costly (like reconstructing wetlands, national parks or nature reserves), but may be justified if conservation values are sufficiently high. Other measures cost less per hectare (like limiting the extent of thinning and clear cuts), and are hence more suitable if expected conservation values are lower. Which physical measures that are introduced depend largely on perceived benefits and costs, although benefits in many cases are uncertain.

Clear cuts and even-aged tree stand management were introduced in Nordic forestry in the early parts of the 20th century. These changes in forestry operations have yielded some obvious gains, foremost on the profitability of timber harvests and the ability to secure a stable and high volume of timber to the processing industry. Other benefits include an increased population of European moose (*Alces alces*), the most valuable game species in the Nordic countries[8], and less widespread disturbances on wildlife from forestry operations by limiting the acreage that is affected human activity at a given time. Increased road building has worked in the opposite direction by making

[8] Net benefits from a large moose population are reduced by browsing damages on young trees, and by traffic accidents.

forests more accessible not only to foresters, but also to the general public. Although the extent of forest road construction is less than it was fifty years ago, and timber harvesting has declined somewhat the last decades, it is reasonable to claim that the acreage share of Nordic forests that has not experienced recent changes in land use or vegetation cover is still declining.

The extent of damages from storms and extreme weather has increased the last few decades, exemplified by the storms *Gudrun* in 2005 and *Per* in 2007 that damaged forest stands in large parts of southern Sweden (Blennow 2008). This increases the challenges for biodiversity management because of increased risks for loosing valuable habitats or reducing the timber value of mature tree stands. The latter may actually increase pressures for logging trees at a younger age, which in turn is seen as a major threat to maintaining biodiversity.

Finding ways to manage make it profitable for forest owners allow tree stands mature and let some tree stands reach the old growth stage, therefore appears to be important. As tree stands mature there will be an increasing amount of dead wood (if not removed), and when stands grow old[9] more light will gradually reach the ground. Such forests typically have a high number of species. With their declining acreage share they become increasingly important.

The biological evidence on management impacts on biodiversity and ecosystem functioning is mixed. For example, Nielsen *et al.* (2007) found that some flowers and pollinating insects did better in younger forests. This variety in species performance is not unexpected given that biodiversity covers the entire specter of micro-organisms, plants and animals. Moreover, there is genetic variation between species and variation within and between ecosystems, adding complexity regarding the assessment of the biological criteria for forest management related to biodiversity and ecosystem functioning.

Broadly speaking there is substantial uncertainty about many of the biological performance criteria for managing biodiversity in forests. Resolving this uncertainty is part of a long term responsible management strategy. Securing what appears to be key habitats and sufficient forest areas with a continuous management

[9] The age at which more light hits the ground depends on the land productivity, and the firmness of the soil and wind exposure (smaller fraction of the tree stand overturned by wind). For typical Nordic spruce forests this age is from 120 years and upwards.

history while more knowledge is gained remain important and costs are kept low is a sound management principle under uncertain conditions (Polasky *et al.* 2001).

A striking feature on the biological side is the vast heterogeneity in Nordic forests. This relates to forest types spanning taiga forests in northern Finland, Norway and Sweden to temperate deciduous forests in parts of southern Norway and Sweden, and large parts of Denmark. A more subtle, but not less important division, is between various forest types within regions. Forests with a high timber production potential are of particular biological interest because the number of species per hectare is generally higher.

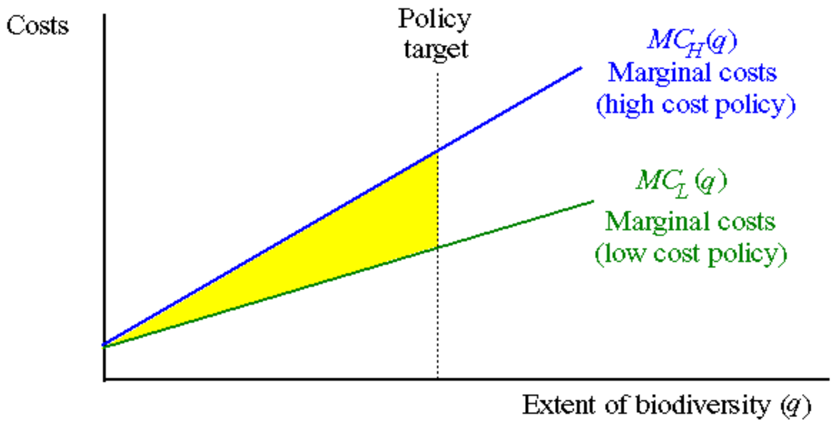
At the same time these areas usually are more intensively managed to increase the timber harvesting value, and are often more frequently clear cut. The higher economic value of current management practices implies that management for biodiversity purposes entail higher opportunity costs due to foregone timber revenues.

There are also other economic drivers at work. Usually, one associates high pressures of logging or forest operations with the more productive forests, or with forests in central regions. However, even remote areas with forests of low commercial timber values are under pressure. For example, as Norwegians become wealthier, there has been a strong growth in second homes being built in the mountain forest belt. The benefits to the local economies of this building activity are unquestioned, but concerns remain regarding the long run biodiversity impacts of this expansion.

2.2 The importance of low cost policies

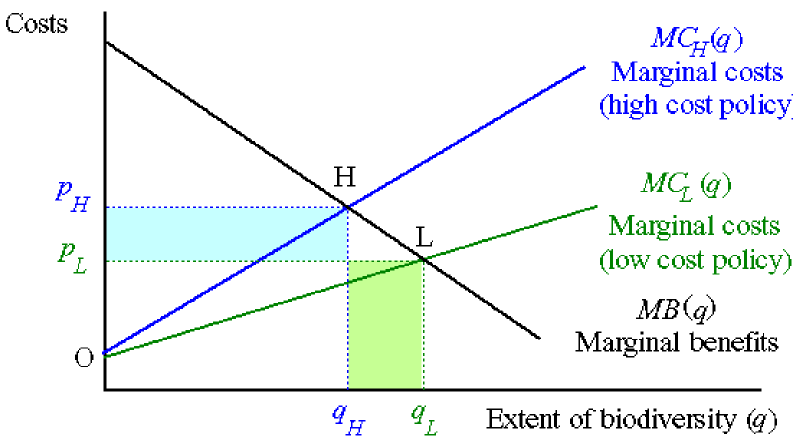
Society's means are limited, and the alternate value of resources may be high. Low cost policies reduce the strain on the overall economy. While there is a distinction between social and budget costs, keeping social policy costs low also benefits the budget, although some cost-effective policies may require increased public outlays. Figure 2.1 illustrates the cost savings of a low versus more costly policy for reaching a fixed target.

Figure 2.1 Cost savings of low cost policies



The yellow shaded area in Figure 2.1. shows the cost savings from applying the low cost rather than a higher cost policy. Suppose that the environmental target is not fixed but determined by what is economically efficient. This implies that the marginal costs should be set equal to the marginal benefits of the policy, providing q_H for the high cost policy, and q_L for the low cost policy as illustrated in Figure 2.2.

Figure 2.2 Low cost policies and optimal target setting.



If the policy agency is unable to undertake discriminatory pricing, and has to pay a uniform price to all suppliers, it may actually end up paying more for less services supplied, q_H, under the high cost policy than for more services provided, q_L, under the low cost policy. Whether this is the case depends on the relative sizes of the light blue and light green rectangles, which in turn depends on the relative elasticities of the marginal cost and marginal benefit schedules. Moreover, there are efficiency gains from applying the low cost policy given by the triangle OHL.

The ability to identify low cost policies may provide substantial efficiency cost savings depending on the distance between the marginal cost schedules and the slope of marginal benefit curve. In cases where government has to pay for securing these services, public expenditures from a least cost policy will always be lower compared to alternate (higher cost) policies if the policy target is fixed (as in Figure 2.1).

2.3 Identifying least cost policies

Biodiversity is to a large extent a public good with elements of non-rivalry and non-exclusiveness in consumption, in particular when biodiversity is considered at a regional or national scale. Non-rivalry means that someone's benefit from biodiversity is not affected by the benefits others derive from biodiversity. Non-excludability means that it is difficult to exclude others from enjoying the same benefits. Biodiversity is therefore denoted a public good, that cannot be efficiently provided by conventional markets.[10] This implies that if biodiversity in forests is to be supplied in the right quantities, it must either:

- be paid for by government or some other agency,
- be secured by some indirect regulation like a tax on timber harvesting,
- be mandated by direct (quantitative) regulation, or
- be supplied by controlling the forest management practices (procedural regulations).

[10] See Randall (1982) for a further discussion on the impacts of non-rivalry and non-excludability for allocation.

The latter three forms of regulations imply foregone profits or increased costs for forest owners. Apart from the obvious additional costs to forest owners of a logging tax, there may be negative profit impacts due to constraints on forest management practices that change current forest management practices. For forest owners where these constraints are not binding no such costs arise.

An inherent problem with any regulation that seeks to alter agent behavior is that affected agents seek to exaggerate their stated in order to influence the regulatory agency to reduce the stringency of the policy (i.e., regulatory capture; Stigler, 1971). In the case that government is to pay for biodiversity, experiences from public procurement in other sectors of the economy suggests that forest owners will overstate their costs of providing biodiversity. By not truthfully revealing their costs forest owners may increase the compensation paid. In turn, that augments the toll on public expenditures above what would have been necessary.

We therefore need some mechanism to induce forest owners to reveal their true costs of incorporating biodiversity in their management of forests. There exists many different truth revealing mechanisms. For example, an environmental tax or payment also truthfully reveals costs at the margin. Unfortunately, many environmental taxes and many of the other classical policy instruments give limited information on the costs to affected parties.

N-price procurement contract auctions[11] (after Vickrey, 1961) is one mechanism that achieves truthful revelation and discloses much information of interest to the regulator under certain conditions. Related to biodiversity in forests, such information is of particular interest because it can be used to design other complementary regulations at later stages. For example, the cost information provided by an N-price procurement auction is useful for designing flat rate payments to forest owners who have chosen not to participate in the auction for various reasons.

For auctions to work there needs to be some competition among bidders. This implies that not all bidders for biodiversity management contracts will get a contract, i.e., auctions will only

[11] In an *N-price procurement contract auction* contracts are given to the N bidders with the lowest bids in the auction whose bids also match the criteria set forth in the auction call. Each winning bid then receives a payment (compensation) equal to the size of the lowest rejected bid, the $N+1$ bid. N-price auctions is therefore also denoted $N+1$ - price auctions.

work as long as it suffices to undertake special management for biodiversity purposes on parts of the forest area (in each region and of each forest type). While conservation biologists disagree on how large acreage shares that need to be under special management, like set-a-side, they usually agree that it suffices that special management is limited to parts of the forest area in a region (Turner *et al.* 2007). The details of how such auctions could work and be implemented will be discussed further in Chapter 5.

2.4 Decentralized decision making and spatial considerations

One difficulty with auctions or any other decentralized decision making system is that the spatial coordination may be insufficient. This is clearly an issue for biodiversity in forests, where habitats for some species need to be quite large for the species to be viable. This implies that in many cases habitats will span over several land holdings or estates.

For auctions to work properly in this setting one also needs to give forest owners incentives to post bids including more than one property. Experiences on this issue is limited, but the experimental economics literature suggests that spatial coordination can be achieved without complicating the policy too much through agglomeration *bonuses* (Parkhurst and Shogren 2005; Warziniack *et al.* 2007).

The issues related to spatial coordination are not unique to decentralized decision making schemes like auctions. In the case of top-down management from an (environmental) agency, the distribution of the compensation paid to various forest owners may cause other problems of dissatisfied forest owners who are likely to sabotage the regulation, thereby reducing its intended impacts.

The spatial issues are among the most challenging in terms managing biodiversity in forests, and an area where we already at this stage can conclude that more research is needed despite the promising experimental results of Parkhurst and Shogren (ibid.) or Warziniack *et al.* (ibid.).

2.5 Scope of policies

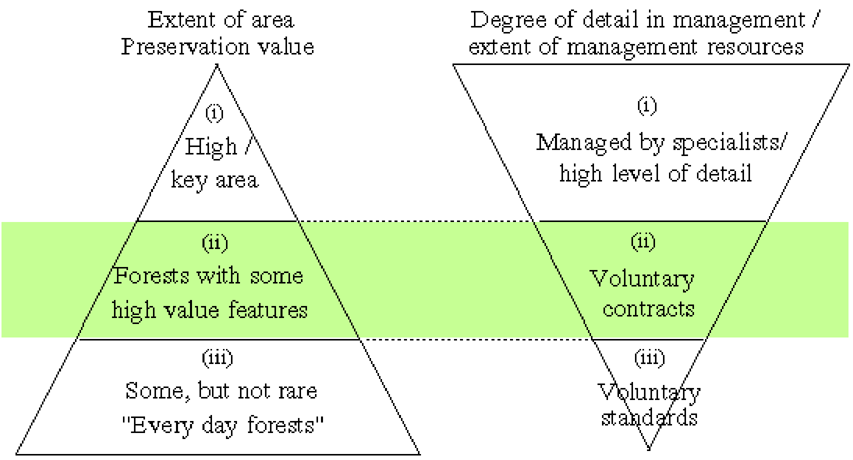
Two main elements of current Nordic policies for biodiversity management and ecosystem functions preservation are:

(1) The set-a-side of areas that are perceived to be highly important for preservation reasons at the national or international level into national parks and nature reserves. These areas are limited to only a few percent of the total forest acreage, and other aspects than biodiversity and ecosystem functions play a role in the selection of them.

(2) The legal framework related to forestry and the environment, with increased use of voluntary standards to restrict forest management practices on the remaining forest acreage.

Figure 2.3 illustrates the roles of various of environmental and preservation approaches.

Figure 2.3 Preservation values and management strategies (after Framstad *et al.* 2000)



The focus of the policy instruments discussed in this report are management in the light green shaded area. National parks and natural reserves cover a small fraction of the total Nordic forest acreage. Extensive work to identify preservation values and management strategies precede the decision to establish a national park or reserve. Setting up national parks and natural reserves usually involves multiple criteria, where economic considerations rarely play a strong role. We will not discuss national parks and natural reserves any further.

Voluntary standards are at the opposite end of the spectrum. They may take multiple forms, from set asides[12] and restrictions, like avoiding drainage of small marshes and wetlands that currently are not part of the forest producing acreage, to guidelines for forest management. "Everyday forests" is by far the largest category in terms of acreage, possibly covering more than 80 percent of the forest area. Certification schemes like the Forest Stewardship Council (FSC), may play an important role in avoiding the most damaging forest management practices as many large buyers of forest products require documentation or "soft evidence"[13] that forests are managed in ways that are environmentally desirable and without serious damages to habitat or fauna.

A key issue to the overall performance of voluntary standards is that the underlying agreement may be used by agents to prevent more stringent regulations in the future without giving much in return. One example of this is that technological change within a sector, of which agents in or representatives of the sector are more aware of than regulators, would have caused the same increases in environmental benefits as the agreement. In such cases agents make so-called informational rents which may reduce overall economic efficiency. We are not going to discuss the difficulties of such (weak) standards and guidelines any further. There is a vast literature in this field, where Segerson and Micheli (1998) is a seminal contribution. More recent works include Lyon and Maxwell (2003) and Blackman *et al.* (2006).

Our primary interest relates to the middle category, i.e., areas with some features of high value. This covers special habitats, like the mating grounds of the capercaillie (*Tetrao urogallus*), forests containing special features that are becoming rarer, like older tree

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[12] Nature reserves (in terms of area) are the most important form of protected forest in the Swedish voluntary standard "Living Forests"

[13] With multiple forest owners it may be too costly to require each forest owner to document his or her forest management practices. As forest sector companies rely on access to major markets, many buyers of forest products therefore accept the forest sector companies' own monitoring and enforcement programs as "soft evidence". These programs are usually developed in cooperation with the major buyers of forest products. For example the German publisher Springer has their own forest certification program that takes the form of an agreement with forest companies certified to deliver to Springer.

stands with little gain in volume and quality, and forests with high occurrences of dead wood. One anticipates that around 15-20 % of the total forest acreage may fall into this category.

There are particular concerns about biodiversity losses on areas with high biomass production potential. These areas are among the most profitable areas for ordinary forestry, and hence under more risk of being harvested. Under Faustmann or Hotelling rule forest management[14], such stands would normally be harvested to pave way for a new rotation since the value growth will be less than the costs of keeping the stand. Often we observe that forests are managed differently. Closer examinations of forest management practices suggest that there are other factors that play a role in such cases:

1. *Capital management*. For example, a forest owner may spread timber harvesting over several years to reduce tax payments, or the forest owner face interest rates that differ from the market rate because of high debt equity ratios.
2. *Special site or property attributes*, like difficult access, may make timber harvesting less profitable than under ordinary operating circumstances.
3. *Individual forest owner characteristics*, like forestry accounting for such a small share of total household incomes that the opportunity value of time leads to infrequent timber harvests and more passive forest management.

In particular, the last two categories may alter the biodiversity preservation value of a forest, for example through a higher share of the acreage being mature stands. Such individual variations make it harder to distinguish the areas in the middle from those in the bottom category of Figure 2.3.

Finding ways to identify these forest areas at the regional level and devising proper incentives for better management of biodiversity and maintenance of ecosystem functions is part of the focus point of this report. We claim that there are large efficiency gains to be made if the informational asymmetries can be resolved for such forest areas, as we will show in subsequent chapters of this report.

[14] Hotelling (1933) rule management involves comparing the (expected) growth of the value of timber stocks with the (expected) returns of harvesting the timber and collecting interest on the timber revenues. Faustmann (1858) also includes the alternate value of land, leading to shorter rotation periods.

2.6 More on the criteria for the choice of policy instruments

At the aggregate level it is desirable that policy instruments meet the following three criteria:

(1) They should protect species and target those areas of the most concern. Here, one usually thinks of areas that have some special features that are of public interest, i.e., the middle category of Figure 2.3.
(2) They should select the least cost providers of the desired management regime for a particular forest type or ecosystem in any given region.
(3) They should be flexible, i.e., allow for incorporating new information as this becomes available, and be suited for adapting to changing conditions, for example climate impacts.

In the conservation biology literature there are numerous indexes for measuring biodiversity. Weitzman (1992, 1998) extends this literature by devising strategies for which species to pre-serve. Brock and Xepapadeas (2003) go one step further, showing that management regimes that provide a diversity of systems enhance welfare compared to identical systems, even if the diversity within each system is rather low. This does not imply that biodiversity within an area is unimportant, but that one also needs to consider biodiversity in a meta perspective.

In this report we choose to focus on habitat management rather than species preservation *per se*. Our reasons for focusing on habitat management are:

- Species preservation in the wild also requires that the habitats are (reasonably) intact and of sufficient size. It also requires a certain spatial structure of the habitats. By securing suitable connected habitats one of the necessary conditions for a species' survival is met (Rosenzweig 1995).
- Habitat management is generally more flexible, and habitats can more easily be manipulated to facilitate learning.[15]

[15] *Adaptive resource management* differs from adjusting policy as new information is available, in the sense that the latter is passive when it comes to facilitate learning. In adaptive resource management one acts deliberately to promote learning, i.e., an active strategy for learning. For further reading on adaptive resource management, see Holling (1977) or Walters (1986).

- The costs of measuring the state of individual species may very high.
- By targeting habitat, one also easier preserves functional diversity of species, which may be economically more motivated.

Regarding the choice of policy instruments the following should be noted:

- How precise the instrument is in reaching the stated policy objectives, and what are the cost-precision trade-off. On the latter Romstad (1999) notes that this trade off depends on the importance of the environmental attribute. For a key attribute society may accept higher policy costs to gain the necessary certainty that the attribute is in an acceptable state, while for less important attributes cost considerations carry more weight.
- The general requirements for a (policy) mechanism to yield a predictable outcome must hold, that is the policy must be informationally viable, the participation constraint[16] must hold, and proper incentives must be in place (Campbell 1987).

Depending on the situation different policy instruments or mixes of policy instruments may fulfill these criteria. For example, Fredman and Boman (1996) concluded that endangered species close to a minimum viable population (MVP) display a vertical threshold in the marginal benefit function of the population, reflecting an existence value. A regulation that make sure that we do not fall below thresholds of sustainability and habitat viability will therefore be preferable relative to other instruments given uncertain marginal costs since it secures the existence of the species, even though the regulation is not the least cost solution. Existence value thresholds are however most likely found in area (i) of Figure 2.3, but not in area (ii), which is the main focus of this report. The scope for economic policy instruments is therefore greater here. Merlo and Paveri (1997) provide a typology, overview and evaluation of forest policy tools used in different countries.

[16] Meeting the *participation constraint* (individual rationality in the mechanism design literature) means that it must be in the agent's interest to take part in the desired activity. In our case this implies forest owners want to participate in programs directed towards managing biodiversity in forests.

3 Forest management, biological diversity and auctions

This chapter bridges some economic and biological management issues related to biodiversity in forests. It does not aim to present a complete overview, but rather focuses on some of the problems the regulator (the environmental protection agency) faces. In terms of biodiversity management in forest we think the main problematic issues relate to the following:

- The regulator does not have full knowledge of the compensations needed to make forest owners voluntarily manage parts of their forest to enhance biodiversity.
- The regulator has a limited budget that needs to be stretched as far as possible for two reasons: First, because it increases the net benefits of biodiversity management policies, thereby making such policies more legitimate under fierce competition for public funds, also known as tax payers' money. Second, because the biological evidence suggests that insufficient forest areas are managed for biodiversity purposes.
- Current biodiversity regulatory regimes cause unnecessary conflicts between forest owners and the authorities (Kvakkestad *et al.* 2005). This slows down contract acquisitions that may lead to considerable welfare losses, in particular when land use pressures are increasing.

This chapter proceeds as follows. We will start discussing the issue of how current regulatory regimes fail to promote cooperation between forest owners and the authorities, before we address impacts of knowledge and budgetary constraints on how policies should be formulated. Our discussion will be leading towards making a case for the use of (procurement) auctions for resolving these conflicts.

3.1 Conflicting interests

Including biodiversity considerations in the management of forests entails extra costs on most existing users of forests, in particular forestry related activities (Bergseng and Vatn 2009). It should not come as a surprise that forest owners are skeptical as long as they perceive they receive *incomplete compensation* in biodiversity matters. Incomplete compensation comes in two forms – that costs are not fully covered, and in cases where society for whatever reasons is unable to fully compensate, that some groups bear a larger share of costs than other groups. On the latter it appears that forest owners bear a larger share of the costs associated with biodiversity measures than the public at large.

Vatn *et al.* (2005:27) list four reasons for conflicts (when managing biodiversity in forests):

- *Conflict of value* – conflicts involving disagreement about which values are involved.
- *Conflict of facts or data* – conflicts that are characterized by disagreement about cause-effect relationships, technical questions.
- *Conflict of interest – conflicts that can be characterized by agreement with respect to facts and values involved, but disagreement with respect to allocation of costs and gains*.
- *Conflict of rights* – conflicts that involve different realizations of the prevailing legal rights or what rights that should prevail.

We see the latter two at the core of biodiversity management issue. *Conflict of interest* and *conflict of rights* may appear quite similar (as acknowledged by Vatn, ibid.), which also helps make our case for the need for *full compensation*.[17] A party who is not fully

[17] *Full compensation* implies that agents perceive they are made at least as *well off* as they were prior to the policy in question was implemented. This also coincides with the *participation constraint*.

compensated for damages or costs incurred is worse off than he was before.[18] This results in opposition to the proposed policy.

Full compensation involves that all losses and costs, including timber values and non-observable factors like recreational and aesthetic values or emotional stress, are compensated. Any person who is fully compensated will voluntarily accept the new allocation because he is better off than under the status quo. Therefore, full compensation also makes the two last reasons for conflicts – *conflicts of facts or data and conflicts of rights* – vanish because full compensation implicitly acknowledges that the party's point of view and rights are accepted.

It is difficult to assess if full compensation of a party has taken place as it is subjective, and sometimes involve aspects that are not directly observable to others. While stated (utility) losses may be real, they may also be a way of trying to increase the compensation offered. This parallels the discussion at the start of Chapter 2 on the skepticism among some economists to stated preference methods – a discussion that can be extended to the issue of stated versus revealed preference methods pertaining to non-market goods. In line with the gist of this debate, we point to the obvious fact that observing actual choices may work provided that relevant choice alternatives are available to the parties involved.

Emotional stress is a difficult aspect to deal with in these settings. While it is not always observable, the consequences of emotional stress may be. However, there is an additional side of emotional stress – agents may no longer act rationally. In negotiations it is difficult to separate claims made for emotional stress with strategic behavior of increasing the compensation to be paid by the state. Hence, claims of "emotional stress" should be viewed with some caution.

In the general matter of biodiversity management in forests, emotional stress is not likely to be as profound as in some other resource use conflicts like predation on domesticated grazing animals or the loss of hunting dogs. However, forest owners have expressed that patronizing attitudes of the authorities contribute to elevating the conflict level. In addition, we have issues related to losing control over land, like changes in hunting rights and other user rights that are associated with landownership as defined by legislation.

[18] Failure of *full compensation* is termed breach of the participation constraint in the mechanism design literature.

In the case of habitat management for biodiversity we argue that under any well designed voluntary program landowners will not be on the losing side in any of these conflicts. The reason for this is quite simple: Any landowner who feels he will be worse off will not sign up for the new situation, i.e., he will not accept the contract offered. Such voluntary deals are also *acceptable to the rest of society*[19] as long as:

- There exists a sufficiently large number of landowners who accept the contract offered so that the policy objectives are met without the rest of the society feeling they have been "black mailed" or coerced into an agreement.[20]

Taking the participation constraint seriously when managing biodiversity in forests therefore entails full compensation of landowners. It is also a key to resolving the conflict issues.

3.2 Procurement auctions managing biodiversity[21]

The main result from the previous section is that full compensation is needed for voluntary acceptance of biodiversity measures. In the beginning of this chapter we pointed out that regulators do not know landowners' full costs of undertaking measures to enhance biodiversity. Hence, regulators need some mechanism that induces landowners to participate, that selects the least cost providers, and that does not lead to gross overcompensation of landowners.

In this section we argue that a special format of auctions, the reverse $N+1$ price auctions meet these three requirements. Reverse price auctions are also called procurement auctions. They are commonly used to award contracts for building bridges, roads, buildings etc. The rationale for such procurement auctions is that building contracts will be given to the least cost provider. A troublesome feature connected to biodiversity management is that several contracts are to be awarded at the same time. To see the

[19] See the end of Section 3.2 for further discussions on splitting gains and fairness considerations under hidden information.
[20] Coercion could take place if a forest owner is reasonably certain he is the sole supplier of a specific type of habitat. The risk of coercion is reduced if information from auctions on similar habitats or forest management restrictions can be used to anchor an offer from the authorities to this forest owner. In situations where no agreement is made, information from auctions may be used to anchor court settlements.
[21] Latacz-Lohmann and Schilizzi (2005) constitute a nice review on auctions. Parts of this section draws heavily on their work.

relevance of this, consider that contracts were given out one by one. Then landowners may benefit from not participating in the first auction where one would perceive that bids would be lower, but wait for later auction rounds. We are therefore seeking auction formats that are conducive to awarding several contracts at once to avoid this kind of gaming behavior among potential providers.

Participating and bidding in auctions are voluntary actions. No agent would participate in an auction if his expected costs exceed his expected gains. Moreover, agents would place bids they expect would make them better off than they were in the status quo. This is both the curse and the blessing of auctions. A curse in the sense that bidders may seek to extract information rents, i.e., extra benefits beyond the compensation level needed for them to accept a contract. A blessing in the sense that if an auction is well designed, bidders will not seek excessive compensations, but bid what they need to be slightly better off than they were initially.

In our setting of full compensation schemes only the forest owner knows the true value of the compensation he needs in order to be indifferent between getting and not getting a contract, so-called *truth-telling*. That is, the forest owner is the best informed party, and society at large, paying the compensation for bio-diversity management, is the least informed party. Consequently, forest owners may capture information rents unless care is taken in designing policies.

There are three ways of inducing agents (landowners) to reveal their true costs, self-selection mechanisms, auctions, and the Becker-de Groot-Marschak (BDM) mechanism. BDM has many similarities with uniform price auctions.

In *self-selection mechanisms*, like menu pricing[22], the regulator offers a fixed payment for the contract. Forest owners who have lower costs than the payment would accept the contract, while high cost providers would refuse. Menu pricing schemes therefore satisfy the truth telling condition, but it provides little information on the distribution of the payment forest owners request to be indifferent between getting and not getting a contract. Latacz-Lohmann and Schilizzi (2005) discuss self-selection mechanisms in

[22] Menu pricing involves forest owners who are offered several choice alternatives. Each alternative has two attributes, a payment and a set of requirements the agent must satisfy to collect the payment. Through their choice of alternative (menu item) forest owners reveal their type.

more detail. They also note that such contracts have not been very widely used.

The *Becker-de Groot-Marschak* (1964) mechanism is an incentive-compatible procedure for truthful revelation of bidders' willingness-to-pay. It has been used quite frequently in experimental economics to elicit preferences under uncertainty. There are several variations of the BDM mechanism.[23]

Auctions have gained increased attention, recently also for allocating environmental management contracts. There are essentially four basic auction forms: English, Dutch, first-price sealed-bid and Vickrey (second-price sealed bid). All these auction formats were originally designed for sales of goods and items, but in principle there is no difference if they are run as procurement auctions, i.e., one seeks the lowest bidders for delivering a service. Appendix 1 provides a brief overview of the four auction formats and their properties.

In the case of auctioning of environmental management contracts, the regulator frequently would like to buy more than one contract. This implies that only the sealed-bid procurement auction formats – first-price and second-price sealed-bid auctions – are applicable. Moreover, when multiple contracts auctioned, the terminology changes:

- *First-price* auctions are referred to as *discriminatory price auctions*, where each winning bidder is paid an amount equal to his/her bid, i.e., the compensation is lower for low bidders who are selected first.
  By adjusting their bids upward in a *discriminatory price* contract procurement auction, bidders may extract information rents. However, this strategic adjustment entails some risk of not getting a contract the forest owner would have benefited from. To see this, consider some bidder who feels reasonably certain he is a low cost supplier. By overstating his requested compensation by bidding more, the risks of not getting one of the contracts is minor compared to the expected gains of strategic bidding. This is an essential weakness of all *discriminatory price auctions*.

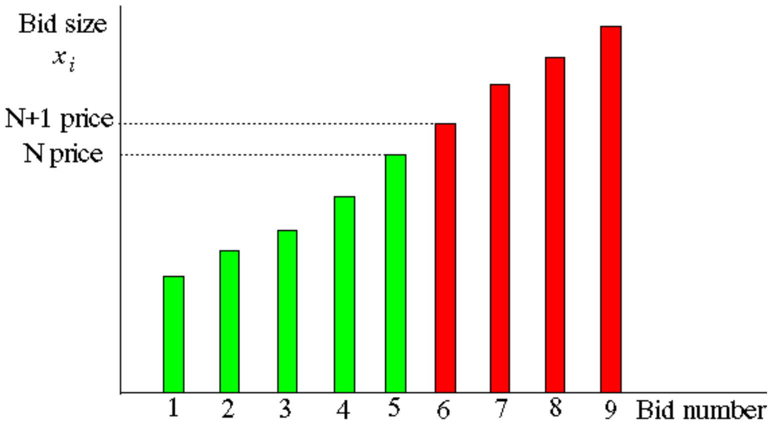
[23] Common features of BDM are that agents formulate their bids, and if an agent's bid exceeds or equals a randomly drawn cutoff price, the agent pays the price and receives the item being auctioned. Otherwise, the agent pays nothing and receives nothing. While the random nature of setting the price in the BDM limits its applicability, it verifies the desirable incentives for truthful revelation of N-price type auction mechanisms.

- *Second-price (Vickrey) auctions* are referred to as *uniform price auctions*, where each winning bidder is paid the same, the size of the first non-winning bid. When N contracts are awarded, the $N+1^{st}$ price is then paid. Uniform price auctions are therefore also often referred to as $N+1$ price auctions.
  A uniform price auction is the only auction format that induces truthful revelation of bidders' opportunity value. This separation of the bid size and the compensation paid is the driving force for truthful revelation – bidders gain nothing by bidding anything different from their opportunity costs: If they bid more, they risk to lose out on a contract that would have increased their profits, and by bidding less, they risk getting a contract where fulfilling contract terms implies losing money.

The Becker-de Groot-Marschak (BDM) mechanism and uniform price auctions share the property of separation of the bid size and the compensation paid, which makes it a weakly dominant strategy for bidders to equate their bids with their opportunity value or costs. BDM and uniform price auctions only differs in the way the price is determined: in BDM the price is randomly drawn, while in uniform price auctions the price is usually set by the highest non-winning bid.

Figure 3.1 provides an illustration of two versions of uniform price procurement auctions, an N and an $N+1$ uniform price auction involving nine forest owners and five management contracts that are auctioned off.

Figure 3.1 Multi-contract uniform price reverse procurement auctions



The green bars represent the five lowest bidders in the auction, whereas the red bars represent the four highest bidders. In the $N+1$ price version of the uniform price auction bidders 1-5 all get a contract, and they are each paid an amount equal to the bid of bidder number six. These five winners in the auction they enjoy rents equal to the distance between the price line and their truthful bid (their opportunity value)

To see that potential providers have incentives to bid their opportunity value, consider the following. Suppose that any of the five winners seek to adjust their bid upwards to capture extra rents. Under absence of knowledge about the size of bids of the other agents, this upwards adjustment entails some risk that one may not get a contract: this happens when the bid is is higher than the sixth bid. If the upward adjustment is that large, the agent will loose the rents guaranteed if one bids truthfully and were among those getting a contract under the $N+1$ price version of the uniform price auction.

Conversely, if any of the agents with costs exceeding the auction price, which is unknown by the time bids are placed, adjusts their bid downward to get a contract, they would be worse off than without the contract. Truthful bidding is therefore a weakly dominant strategy under the uniform price auction. It is the separation between the bid and the payment that produces this desirable property: the bid determines who should get a contract, and the price is determined by the first non-winning bid.

The *information rent* is the difference between the contract price and the landowner enjoys under a uniform price procurement auction. It is possible to reduce the information rents to bidders in uniform price auctions by using an N price setting rule as long as no bidder knows if he has the N^{th} ranked bid. In Figure 3.1 this corresponds to all agents being paid an amount equal to the 5$^{\text{th}}$ lowest bid.

We advise against using the N^{th} price version of uniform price auctions. In the N^{th} price auction the separation between the bid and the compensation paid no longer holds. Suppose a bidder has information about the size of bids of others. In theory, such an agent would be able to adjust his bid upwards and capture some extra rents. The maximum impact on the auction price from such an action is the difference between the N^{th} and $N+1^{th}$ bid, resulting in a maximum increase in the regulator's outlay of this difference times N, the number of contracts awarded. In a real life setting, the benefits to society of such cost savings to the regulator must be compared with the risk of losing truth telling if some bidders are well informed about the bidding behavior of others.

It should also be noted that the *Revenue Equivalence Theorem* does not hold in multiple unit (contract) auctions (Chan *et al.* 2003). Therefore one could expect the expenditures paid to bidders in uniform price procurement auctions to exceed those under discriminatory price procurement auctions.

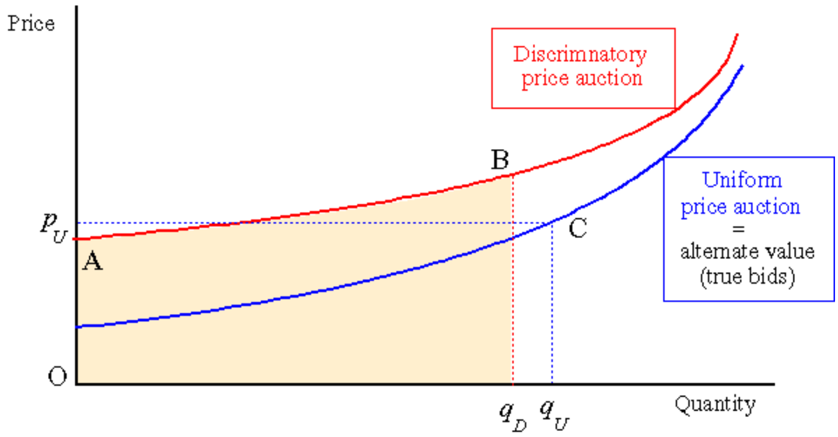
While truth telling is a desirable property of uniform price auctions, it does not come without costs. It is like the famous "there is no free lunch" saying, or put in mechanism design terms: "incentives (for securing truth telling) cost" (Campbell 1987). If truth telling is worth less than the information rents, it would be optimal for the regulator to sacrifice truth telling. However, this only holds when the size of the information rents, i.e., the extent of strategic bidding, is known. In our setting some strategic bidding will take place under discriminatory pricing, but one is unable *a priori* to know the magnitude of the upward strategic adjustments of the bids. Hence, the impacts of strategic bid adjustments may be smaller or larger than the size of the verifiable information rents given to bidders under a uniform price auction.

Understanding the nature of these bid adjustments is helpful to assess the size of the strategic bid adjustments under the discriminatory price. Recall that under the discriminatory price auction winners are paid according to their bid. Hence, providers who are reasonably certain they belong to the low cost segment may gain by adjusting their bid upwards. The expected size of this bid adjustment declines as bidders' provision costs increase. In figures 3.2 and 3.3 (next pages) this is reflected by the bid curve under discriminatory price auction (the red line) gradually coming closer to the bid curve under the uniform price auction (the blue line).

Now, consider a situation where the regulator has a certain budget at his disposal. This implies that once the sum of the contract payments offered reaches the budget limit, no further contracts are awarded. Then by construction the revenues (costs) of the two auction formats will be the same, and the only difference is the number of contracts awarded. Figure 3.2 provides an illustration.

Figure 3.2 Auction revenues under budget constraints

(after Latacz-Lohmann and Schilizzi 2005:24)

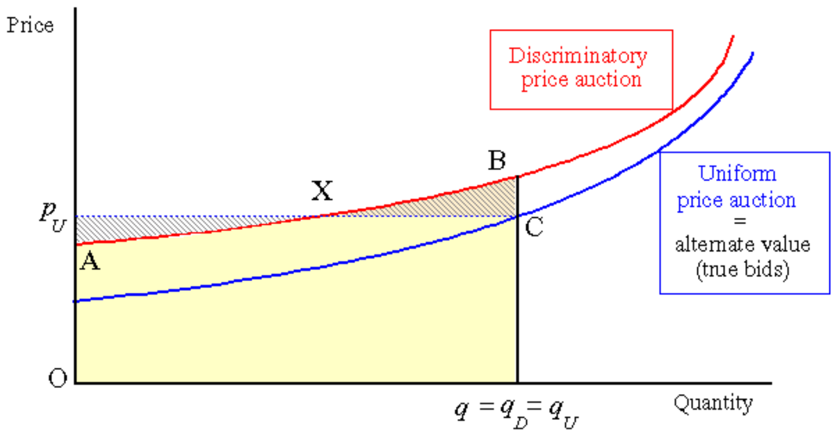


Under a multi-contract budget constrained procurement auction contracts would be awarded so that total outlays equal the budget. Under a uniform price auction, where all winning bids are paid the same price, p_U, total outlays would equal price times quantity, p_U q_U. In Figure 3.2 this corresponds to the rectangle Op_UCq_U. Due to the budget constraint, the total outlays under a discriminatory price auction must be the same. That implies that the area under the discriminatory price bid curve $OABq_D$ must equal the area Op_UCq_U.

In Figure 3.2 we see that the quantity awarded under the uniform price auction, q_U, exceeds the quantity under the discriminatory price auction, q_D. In this particular example this takes place because the size of the strategic adjustment in bids under the discriminatory price auction is quite large. If the strategic bid adjustment had been smaller, i.e., the discriminatory price auction bid curve (the red line) had been closer to the uniform price auction bid cure (the blue line), the opposite result may well have emerged.

Now, consider a situation where a fixed number of contracts is to be awarded. In our case that corresponds to the regulator saying a given percentage of some acreage category in a region must be conserved. This situation is depicted in Figure 3.3, where $q = q_U = q_D$.

Figure 3.3 Auction revenues under quantity targets



In Figure 3.3 the expenditures (i.e., the outlays of the regulatory agency) of the discriminatory price auction (the yellow shaded area OAB*q*) is slightly larger than the expenditures of the uniform price auction (the square $\mathrm{O}p_U\mathrm{C}_q$). This corresponds to comparing the sizes of the darker shaded areas $\mathrm{A}p_U\mathrm{X}$ and XBC.

If the size of the strategic adjustment of bids under the discriminatory price auction had been smaller in Figure 3.3, the opposite result would emerge, i.e., the discriminatory price auction would constitute a less expensive payment scheme that the uniform price auction.

Regarding figures 3.2 and 3.3 it should also be noted that the total costs (resources spent by bidders) are the area under the uniform price auction bid curve (blue line), which in both cases differ from the payments issued to the producers.

Latacz-Lohmann and Schilizzi (2005:41) *argue* that the discriminatory price auctions are preferable over uniform price auctions for the following reasons:

(1) Uniform price auctions expose bidders to more risk as the value of the bid is unknown.
(2) Owners of the least productive land would capture large rents compared to owners of more productive land and introduce a bias in who wins in the auction.
(3) For the same reasons as in (2) above, owners of the more productive land may be discouraged to participate. This

would augment the bias of the uniform price auction even more.[24]

(4) Uniform pricing is more complex and more difficult to comprehend than the discriminatory pricing rule. This may act as a barrier particularly to those who are not familiar with bidding situations. On the other hand, it may increase the risk of collusion from the few who do understand the rules and are able to spot loopholes.

We see things differently. Admittedly, the size of the compensation under uniform pricing is unknown at the time the bids are placed. However, truthful bidding under uniform price auctions secures some rents to all winners. Hence, there is less risk associated with the preauction unknown price from the perspective of bidders, making (1) above an empty claim.

In our case points (2) and (3) can partly be offset if the auction is made regional and/or forest type specific. For example, it is quite clear that biodiversity management contracts for a temperate deciduous forest require a different per hectare compensation payment than for a low productive taiga forest.

The fourth point on the additional complexity of uniform price auctions carries more merits, but we contend that the auction rules are one of the least complicated issues anyone who seriously considers bidding for a contract needs to understand. Specifically, getting an accurate estimate of own costs related to a contract is more difficult. Here, the information rents under uniform price procurement auctions serve to reduce barriers of participation.

[24] On this point Latacz-Lohmann and Schilizzi (2005) are quite vague, and we think there argument does not hold (as we will explain after presenting their view).

4 Further issues on auctions for managing biological diversity

In the previous chapter we argued in favor of using uniform price auctions as the main instrument for allocating habitat management contracts for biodiversity purposes. One of the main reasons for our position is that only uniform price auctions induce truthful bidding among potential providers. However, truthful revelation in the bidding process does not suffice.

First, once contracts have been awarded, one also needs to secure that contract terms are met. This is particularly important in settings where the costs of monitoring and enforcement of contract compliance could be large. This is addressed further in Section 4.1.

Next, there are issues related to the spatial distribution of habitats. Such concerns are particularly relevant for decentralized decision making schemes like auctions. This is the topic of Section 4.2.

A third issue relates to the fact that forest owners (or their managers) are likely to have superior – but not precise – information about the conservation values of their forests. Surveying of forests to identify conservation worthy habitat is both costly and time consuming. It therefore appears interesting to investigate the scope for using forest owners' private information on their own forests to reduce surveying costs and speed up the process of mapping conservation worthy habitats. This issue is dealt with in Section 4.3.

Finally, we round of this chapter addressing some additional issues we perceive are relevant for the applicability of procurement auctions in general, and uniform price auctions in particular, for managing biodiversity in forests.

4.1 Compliance issues related to biodiversity management

Compliance to (biodiversity management) contract terms is one source of moral hazard in our setting because it is costly for policy makers to completely monitor forest owners' actions in terms of meeting contract obligations. Moral hazard is a potential issue whenever the other party (here the regulator or environmental protection agency) cannot fully monitor the actions of agents (here forest owners). The agent may then have an incentive to act inappropriately (from the viewpoint of the principal) if the interests of the agent and the principal are not aligned.
This gives rise to two types of problems:

(1) Society may not get what it pays for in terms of changed forest management.
(2) If forest owners know that monitoring will be incomplete[25], they may be tempted to bid strategically to gain a contract where they do not intend to meet contract terms.

4.1.1 Compliance and contract performance: post contractual manipulation

The basic approach to securing compliance under incomplete and costly monitoring is to secure that the expected penalty exceeds the expected gains of noncompliance. Let U_i^c and U_i^n denote the respective payoffs of compliance and noncompliance for agent i, let S denote the penalty for being caught in noncompliance, and let p denote the composite probability of being monitored and caught in if in noncompliance. Compliance will then take place if the expected payoff of compliance is greater than or equal to the expected payoff of noncompliance:

$$pU_i^c+(1-p)U_i^c \geq p(U_i^n-S)+(1-p)U_i^n \qquad [4.1]$$

[25] Incomplete monitoring is optimal if it is costly for the regulator to monitor agent behavior.

which after some transformation leads to the basic equation for compliance:

$$p \geq \frac{U_i^n - U_i^c}{S} \qquad [4.2]$$

From [4.2] it is easy to see that if the penalty is increased, the probability of being caught in noncompliance can be decreased. Equation [4.2] has therefore been referred to as the "hang the prisoner with probability zero" proposition (after Becker 1968).

Increased effort by authorities increases on average the probability of being found guilty. As monitoring is costly, it is tempting to set penalties high to reduce resources that need to be devoted to law enforcement.

Under uncertainty about the accused being guilty, the applicability of strict sentences may be limited (Shavell 1987; Mitchell and Shavell 2000) for two connected reasons: First, the consequences of any errors made by the authorities increase with high penalties.[26] Second, in any democratic society, high penalties therefore increase the burden of proof on behalf of the prosecutor, which in turn has two undesirable effects: (i) it increases the litigation costs, and (ii) it becomes less likely that the accused will be found guilty. The probability of being found guilty and the size of the penalty are therefore both endogenous variables. Romstad (2006) summarizes further extensions on monitoring and compliance like reputation based models and how to deal with uncertainty about compliance performance.

These insights also carry over to contracts. Under uncertainty about compliance with contract terms, high penalties for failure to comply with these terms may increase the payment needed for the provider of goods and services under the contract (in our case forest owners) to accept contract terms. Most contracts therefore limits punishable damages *(S)*.

4.1.2 Expected compliance and bidding behavior

Truthful revelation of costs in the bidding process also depends on agents' expectations about having to deliver. If monitoring of

[26] For the ultimate sentence – the death penalty – the impacts of these errors are also impossible to correct at later stages if new information becomes available suggesting that the accused is not guilty.

contract compliance is lax or missing, low bids will result where bidders plan to violate contract terms.[27] A closer look at the basic condition for compliance demonstrates why this is the case.

An agent with a low bid from a uniform price contract auction signals low costs of meeting contract terms. This implies that the costs of complying with contract terms is low, which in turn means that the gains from not complying with contract terms, $\varphi_i = U_i^n - U_i^c$, are low. Using [4.2] this enables making the condition for compliance agent specific:

$$p_i \geq \frac{\varphi_i}{S} \qquad [4.3]$$

There is one problem about utilizing [4.3] to tailor agent specific monitoring probabilities: it removes the linkage between the bid and expected payoff that induces truthful revelation in uniform price contract auctions. It would be tempting not to inform agents about this linkage to preserve truthful revelation in the bidding process, but most likely news would leak about this connection. This could reduce the public's trust of the environmental regulatory agency, and damages related to conflict resolutions could be quite harmful. Moreover, such behavior is not conducive with what the public has the right to expect from public agencies.

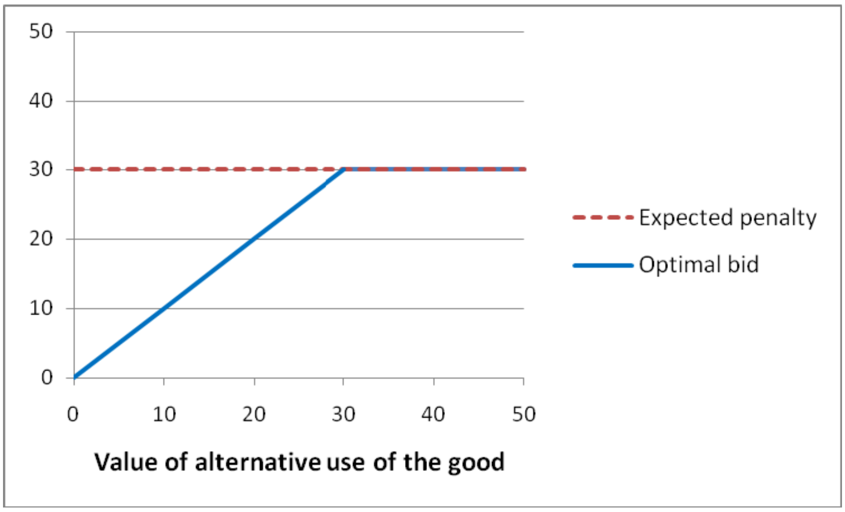
One insight that can be used from [4.3] is to signal to bidders that while there is a maximum fine for noncompliance, the size of the expected penalty will be set so that among all agents receiving a contract, the expected payoffs of compliance will exceed the expected payoffs of noncompliance. Utilizing the truthtelling property of uniform price auctions, setting the penalty, S, higher than the contract price divided by the common monitoring probability, p, secures expected compliance.

Failure to do this (or *ex ante* to set the penalty so high that [4.3] holds for all agents awarded a contract)[28] may lead to strategic bidding (Romstad and Alfnes 2009). Figure 4.1 provides a

[27] A similar result is seen on prices generated in tradable permit markets (Malik 1990), where the permit prices generated under expected noncompliance are grossly deflated because nobody expects to meet his or her allowed emission level. In the extreme case the permit price will be zero because nobody buys any permits.
[28] One disadvantage with setting the penalty before the auction is that it may provide an anchor for bidders when they decide the size of their bid.

numerical illustration of the perceived behavior when the expected penalty, γS, is ex ante fixed to 30.

Figure 4.1 The expected penalty and bidding behavior (Romstad and Alfnes 2009)



The above numerical illustration captures the theoretical result that agents with alternative values above the expected penalty of 30, will bid exactly 30. This corresponds to experimental valuation results for marketed goods – if a chocolate bar is sold that people know have a market price of 30 in the experiment, nobody will bid above 30 for it. The known penalty provides the forest owners with information about society's implicit valuation of the contract. Hence, if awarded a contract, agents with higher costs of complying than the expected penalty will not comply to contract terms.

As long as the regulator does not know what the cutoff price will be, it cannot set the size of the expected penalty without running into the risks of the outside option. On the other hand, an unknown penalty may make biodiversity management contracts less desirable from the viewpoint of forest owners because it introduces uncertainty regarding the expected value of the contract. Before the bidding starts, the regulator must therefore inform potential bidders that the size of the expected penalty, γS, will exceed the (yet unknown) auction price, but that it will not be unreasonably higher. One way of securing this is to fix the ratio of the expected penalty, for example by setting γS = 1.25 p, where *p* is the auction price.

Another way to partially correct for this failure is to apply reputation based monitoring schemes along the lines of Greenberg (1984), where the monitoring probability is adjusted based on past compliance history, but damages to the reliability of parts of the bid curve has then already been made.

However, reputation based models for monitoring and enforcement can be used once the system is implemented to gradually make monitoring probabilities agent specific as illustrated in [4.3]. As a matter of fact, [4.3] provides an important yardstick to how far down the monitoring probabilities can be adjusted for habitual compliers.

4.2 Spatial considerations when using procurement auctions for managing biodiversity

It is already well established that different species have different requirements in terms of habitat size or distance between habitats. By making policies forest type and region specific, some of these differences will be captured as the species composition varies across forest types and climate regions. Moreover, our focus on the need for forest type and region specific policies implicitly acknowledges that least cost is a relative term that needs to be seen in relation to perceived benefits and opportunity costs. On the other side, to preserve the price taking behavior needed for uniform price contract auctions to work as intended, one cannot make regions too small or forest type too specific. This implies that it may be necessary to add extra elements into any policy to capture spatial issues.

Decentralized policies have been criticized for not being able to capture the need for spatial coordination (Vatn *et al.* 2006). Nelson *et al.* (2008) show that voluntary payments programs that pay a uniform rate generate far fewer environmental benefits for a given size budget than does the full information solution, both because the “wrong landowners” are enrolled and because of the inability to price discriminate. The Nelson *et al.* (ibid.) finding also holds for spatially coordinated policies as long as these involve separate properties. Under coordinated policies among individual property owners, the idea is that deliberations will result in better coordination (Vatn *et al.* 2006). Such negotiations can be viewed as a game, which involves many of the same asymmetric information issues as in the regulator-landowner game. To sum up, deliberative processes do not guarantee that information asymmetries between landowners will be fully resolved.

Moreover, if a collection of landowners reach an agreement, their negotiation power vis-a-vis the regulator may be stronger (for example if few other collections of coordinated landowners exist). This increases the risk that such a collection of landowners will seek to utilize their oligopoly powers.

The experimental economics literature provides some indications that spatial coordination may be achieved even when the spatial distribution of plots meeting conservation criteria is quite complex through the so-called agglomeration *bonuses*[29] (Parkhurst and Shogren 2005; War-ziniack *et al.* 2007). However, this remains an untested issue in terms of practical implementation.

Some applied works point in favor of more centralized approaches. For example, Strange *et al.* (2006) found that independent regional planning for biodiversity conservation in Denmark can be twenty times more costly than nationally coordinated planning. Moreover, Bladt *et al.* (2009) arrive at similar conclusions with respect to coordinated biodiversity management within the whole of EU.

Concerns related to decentralized approaches, like procurement auctions, have also been raised by ecologists on more theoretical grounds. In a comment to a report by Swedish Environmental Protection Agency (Naturvårdsverket 2008) ecologists at the Swedish University of Agricultural Sciences write:

> One consequence of the introduction of the Metso framework with for example trades on natural values is that the planning of protected areas at the landscape level becomes more difficult. There is an obvious risk that protected areas are not included based on conservation biological criteria, because some landowners' interests of signing (forest management, *our addition*) contracts and the associated costs of these. Landscape planning of protected areas is highly important for the long term protection of biodiversity in forest landscapes. An application of Metso in Sweden may lead to protected areas becoming dispersed and (that each protected plot, *our addition*) with limited

[29] An agglomeration bonus is an extra payment given when landowners are able to coordinate the habitats in conservation programs so that a desired/better spatial pattern of habitats is achieved.

> acreage. That may increase the risk of stochastic extinction, and that the movement (of threatened species, *our addition*) between protected areas becomes more difficult.
> (Swedish University of Agricultural Sciences 2008, *our translation*).

There are two reasons that the above arguments are not directly transferable to our case using procurement auctions for conserving or protecting biodiversity in forests. First, from a biological perspective we have argued that conservation auctions need to be regional and forest type specific. While it is still possible to coordinate regional and forest type specific management schemes by adjusting the regional and forest type targets for acreage under special management, more finetuned targets rapidly reduce the cost savings of auctions. Here, it should also be noted that one justification for more finetuned protection and conservation targets is the intrinsic uncertainty associated with biodiversity management.

Second, mandating spatial coordination prior to biodiversity management procurement auctions may reduce the competitive nature of the bidding process. Again, this relates to previous discussions that pre-auction coordination opens for collections of landowners knowing that few others are likely to compete for the contracts. In turn, this provides these landowners with more negotiation power vis-a-vis the regulator (if few other collections of coordinated landowners exist), which increases the risk that such teams of landowners will seek to utilize their oligopoly powers or collude.

The literature on procurement auctions (see Milgrom 2004) – for example on bus services, or how comprehensive packages public agencies – point to several issues that should be considered when making auction calls. There are clear parallels between the general literature and our case of biodiversity management contracts. This relates to the fact that as more acreage for a particular type of habitats is secured beyond some (biological) threshold, the marginal value of additional acreage under contract declines.

Empirical studies and simulations show that using biological information to target incentives can improve performance (for example Connor *et al.* 2008, Lewis *et al.* 2008). A series of papers, have investigated improving conservation solutions by making payments to an individual property a function of the responses of neighboring properties (Drechsler *et al.* 2007, Lewis and Plantinga 2007, Lewis *et al.* 2008, Parkhurst *et al.* 2002, Parkhurst and Shogren 2007, 2008, Warziniack *et al.* 2007). This literature shows that it is possible to coordinate decentralized landowner decisions by making payoffs contingent on neighbors' decisions.

The basic conclusion on spatial coordination is, however, that coordinating across multiple landowners with private information to get an optimal pattern of conservation is a difficult, and yet not fully solved problem. This holds for decentralized as well as centralized policies due to the inherent information asymmetries involved.

A related biodiversity issue that will not be resolved through policies for habitat management for highly mobile species like birds, large plant eating animals like moose, or large predators like wolves, lynx or wolverines. In particular, large predators involve special challenges because they inflict negative externalities on certain groups, like the reindeer herding Samí and farmers who use forest for grazing areas for their livestock, and for the hunting value of predated animals. Swedish experiences with *ex ante* compensations paid to the reindeer herding Samí on expected damages from predators are promising (Zabel and Holm-Müller 2008), and also provide reasonable incentives for accepting these damages. Nevertheless, the forest bio-diversity policies currently in place in the Nordic countries do not primarily focus on highly mobile species,(like wolves or other predators) but rather on features like dead wood, mature and old forest and deciduous trees, which are considered to be beneficial for rare flora and fauna (see Chapter 4; Naturvårdsverket 2008).

4.3 Utilizing landowners' private information to identify conservation worthy habitat

Earlier in this report we have shown that uniform price auctions are particularly helpful to induce landowners to truthfully reveal their opportunity costs (foregone profits) of changing forest management practices. The applicability of auctions, however, also hinges on finding ways of making land parcels or areas offered in an auction setting comparable. This is a challenge with a multifaceted concept like biodiversity because all biodiversity qualities can never be completely surveyed or mapped. Under such settings one cannot rule out that land-owners or forest managers may possess better local information than public agencies about biodiversity attributes. One example of this from the Nordic countries is the location of the mating grounds for the capercaille (*Tetrao urogallus*), where foresters and other locals go and watch this spectacular event in the spring.

Polasky and Romstad (2010) propose a solution to this double asymmetric information problem when in addition to having superior private cost information, agents (landowners) also have better information about (some) environmental attributes on their land than the agency. On the other hand, the environmental agency has better information than landowners about what is to be conserved or managed. Maximizing net benefits for society under these settings corresponds to solving the matching problem of attracting low cost providers with the desired (high) conservation values on their land.

Polasky and Romstad (ibid.) introduce a survey fee to create a separating equilibrium between high and low quality habitats that has to be paid if a site is surveyed. This fee creates a separating equilibrium (Rothschild and Stiglitz 1976) between landowners who have more secure information about having high quality habitat and those with less secure priors, as the bid must also cover the landowners' uncertainty about the site meeting the biodiversity eli-gibility criteria.

Following Polasky and Romstad (ibid.), let c_i denote the costs (foregone profits) of meeting contract terms, and *bi* the bid for landowner *i* being indifferent between getting and not getting a contract, let α_i^h be the subjective probability agent *i* has for habitat *i* satisfying contract eligibility criteria, let *y* be the contract price, and let φ denote the survey fee any landowners pay per habitat that is surveyed. Because landowners are uncertain about the biodiversity quality of the pre-survey signal of biodiversity quality (a low α_i^h), indifference between bidding and not bidding creates a markup in the bid that implies that the bid is given by:

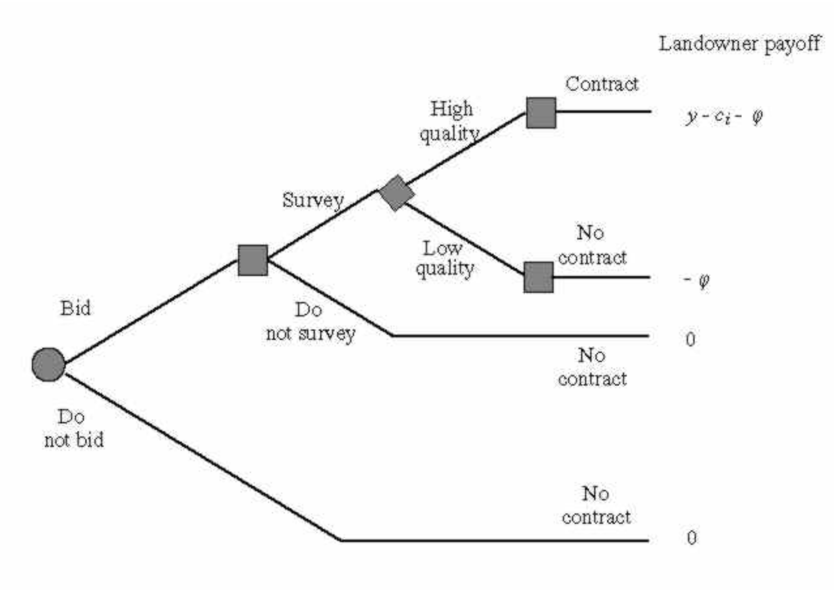
$$b_i = c_i + \frac{\varphi}{\alpha_i^h} \quad \text{where} \quad \frac{\varphi}{\alpha_i^i} \quad \text{is the markup fee} \qquad [4.4]$$

Consequently, agents with low priors, i.e., a low α_i^h, will be "underrepresented" among the low bidders. This creates the before mentioned separating equilibrium that enables reducing surveying costs by surveying the lowest bids first.

It is easy to see the practical implications of this as environmental regulators are looking for attributes that are positively related to biodiversity like old stands, large share of deciduous trees, dead wood with different stages of decay, standing or fallen trees, dead or dying trees, or diversity in dimensions and height. These are attributes the landowner or -manager is likely to be better informed about than regulators located elsewhere.

Returning to Polasky and Romstad (ibid.) landowners are endowed with resources that also determine their costs of conservation or environmental management. The order of the moves are as follows: (1) the landowners receive an imperfect (high or low) signal about the conservation quality of their habitat, (2) landowners decide to bid or not, and if they bid they decide on the size of their bid(s), (3) bids are sorted in an ascending order and surveyed sequentially, starting with the lowest bid, (4) surveyed habitats are charged with the survey fee, φ, (5) landowners with habitats that pass the survey are informed they will get a contract, (6) surveying continues until the conservation target is met or the agency's budget for this conservation program is exerted, and (7) the price, y, is set by the $N+1^{th}$ bid. Figure 4.2 explains the order of the moves.

Figure 4.2 The decision tree summarizing the order of moves and landowner payoffs.



A circle indicates landowner choice, a square indicates conservation agency choice, and a diamond indicates the outcome is due to chance. The initial move of nature that generates a high or low signal to the landowner is not shown (after Polasky and Romstad 2010).

An intriguing property of the Polasky and Romstad (ibid.) mechanism is that it – compared to a standard uniform price auction – is not manipulation free under some restrictive, but unlikely conditions. Suppose:

- an agent j has extra knowledge about the distribution of costs and hence the bid structure[30],
- the same agent j adjusts his bid so $b_{N+1} < b_j < b_{N+2}$, and
- that the $N+1$ bid does not pass the survey eligibility criteria.

Then the *equilibrium price*[31], $y' = b_{N+2}$, differs from $y = b_{N+1}$, i.e., the compensation paid price has been manipulated and landowners get an extra rent equal to b_{N+2} - b_{N+1}. How likely is this to happen? It depends on how accurate is the information landowners have about the bid distribution which involves two elements, the costs, c_i, and the markup, φ/α_j^k, of the other bidders.

The Polasky and Romstad scheme solves the *matching problem*, i.e., assigning biodiversity protection or special management to forest parcels with low cost of changing or restricting current forestry practices that meet the biological eligibility criteria for such management. It also produces considerable cost savings on the surveying side because only low cost sites (ie., a selection of the sites, not all sites) are surveyed. The size of these cost savings depends on the relative accuracy of landowner vs. conservation agency pre-survey knowledge of biodiversity attributes. This relationship is likely to differ from one conservation objective to another as different forms of biodiversity are viewed been unequally interesting or not easily observable for landowners and other locals.

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[30] While there is a distinction between social and budget costs, keeping social policy costs low also benefits the budget, although some cost-effective policies may require increased public outlays. While there is a distinction between social and budget costs, keeping social policy costs low also benefits the budget, although some cost-effective policies may require increased public outlays. Available to some agents, cfr. Seabright's (1993) work on local commons.

[31] The *equilibrium price* is defined as a price that is such that no agent can be better off by changing his or her behavior. In our context this means adjusting his bid so it differs from his or her opportunity costs.

A potentially troublesome feature on the applicability of auctions for allocating biodiversity management contracts is that habitats already under a specific biodiversity conservation contract may qualify for other biodiversity conservation contracts. There are two principally different ways of relating to this issue. One approach is to formulate conservation contract requirements more stringent than current knowledge suggests from using a precautionary principles thinking. The disadvantage of such an approach is that the costs of current conservation schemes increase as bidders would require extra compensation for not being able to participate in future auctions for other conservation purposes. This corresponds to payment needed to liquidate an option.

An alternate approach is to say that areas already under conservation contracts are likely to be low cost if they also qualify for new contracts. One disadvantage of this is that the regulator may have outlays that would not lead to more conservation. Taking the truthtelling properties of uniform price auctions seriously, however, the bids from entering areas already in a conservation scheme would be small if no changes in conservation management practices were needed. Hence, while little is gained from having already conserved areas enter a new auction, the costs of such entries should also be small.

This additionally issue can also be seen in another perspective. Suppose that the regulator has a long ”wish-list” of criteria. Adding one more attribute a habitat is likely to increase landowner uncertainty about meeting eligibility criteria. This would increase the markup, and hence public outlays. Again, there is a tradeoff that needs to be considered. One benefit of pre-surveying for some attributes is that it most likely also will increase the knowledge about the habitat in general, and hence also about the benefits of staging an auction for additional attributes.

4.4 Other issues to be considered when choosing auction formats

4.4.1 The winners' curse

Until now, we have worked with the assumption that forest owners fully know their own costs associated with a forest management contract. Most likely, that is not going to be the case for all forest owners because the contract requires changing practice to something they have limited experience with. Under these conditions those getting the contract (the winners in the auction) may end up in the so-called *winners' curse* (Milgrom 2004). In our setting the *winners' curse* occurs when those getting the contract consistently have underestimated their own costs.

To see this consider the following: Under uniform price auctions the winners are secured some extra rent (the difference between the price paid and the individual bids which are assumed to equal the costs of the contract). Hence, even under truthful revelation (of expected costs) the risk of ending up losing on the contract is lower under uniform price auctions than discriminatory price auctions. The uncertainty of own costs is therefore likely to result in a larger upward adjustment of own bids under a discriminatory price auction than a uniform price auction.

Fairness considerations and fears of being conned may also influence biodiversity management contracts in the sense that policy makers will be reluctant to engage in deals that grossly overcompensate forest owners. Uniform price contract auctions leave some information rents to the forest owner, but the size of these rents are revealed to the policy makers once the aucion is completed. This knowledge and the observation that other procurement approaches hide the information rents to policy makers, make it easier to politically accept outcomes – at least for those trained in economics who are well aware of the fact that society-at-large also gains as long as perceived benefits exceed costs (an extended *consumer surplus* argument).

4.4.2 Formulating regulations subject to international agreements

The International Biodiversity Convention (UNEP 1992:article 6) is vague on which concrete measures or policies that can be implemented, as illustrated by the following text from the agreement:

(a) Develop national strategies, plans or programs for the conservation and sustainable use of biological diversity or adapt for this purpose existing strategies, plans or programs, which shall reflect, inter alia, the measures set out in this Convention relevant to the Contracting Party concerned; and

(b) Integrate, as far as possible and as appropriate, the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programs and policies.

Quantitative targets for biodiversity are scheduled for 2010 (see also national Nordic policies described in Appendix 2). There is a large collection of background papers for this work (see the web site of the Convention on Biological Diversity, general: *http://www.cbd.int/*, targets at: http://www.cbd.int/2010-target/).
The absence of international (quantitative) targets for biodiversity in general, and for biodiversity in forests in particular have triggered some countries to set their own national targets. Some of these are governed by special international agreements. A common feature of these agreements is a current focus on definitions of what biodiversity is, and a future (but yet unknown) specification of quantitative targets for various species and habitats.

5 A practical guide for using auctions in forest biodiversity management

This chapter looks at how one could implement procurement auctions as an instrument for assigning biodiversity conservation contracts to forest owners in the Nordic countries. As there are limited practical experiences[32] with the use of procurement auctions, such an "implementation cookbook" needs to be based on what we know from related economic theory and the nature of the good to be managed – habitat.

From the natural scientific side we already know that biodiversity is site specific, and strongly related to the type of habitat and region. It is also a well-established fact that the opportunity costs to landowners from undertaking measures to enhance biodiversity vary across regions and with the commercial value of timber harvests. Hence, auctions need to be region and forest type specific. However, there is a limit to how fine-tuned such divisions can be before the competitive element of the auctions are lost.

In Chapter 3 we concluded that the desirable auction format was uniform price auctions due to its desirable truth telling properties. With these premises we proceed on how to implement (uniform price) auctions for improved management of biodiversity. This chapter is organized as follows: Given the limited practical experiences with conservation contracts we think pilot studies are needed. This is dealt with in Section 5.1. Next we propose a gradual implementation scheme (Section 5.2). Due to the fixity of transaction costs landowners with small acreages may choose not to participate in the initial auction. This implies that there may be a

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[32] A notable exception is Australia, where the experiences are summarized in Connor *et al.* (2008). See also section A2.6 of this report.

self-selection bias in landowner participation, and hence a failure to identify the least cost providers. Section 5.3 addresses this issue in more detail.

5.1 Pilot studies

Uniform price auctions may at first come across as a bit difficult for agents not familiar with auctions. Clear communication of contract terms and how contracts are awarded are hence particularly needed when forest management contracts are to be auctioned. A first step is therefore focus group studies to work improve the clarity of information provided on the auction format and contract terms. With today's low costs of conducting WEB based surveys, such a survey may be a natural follow to test the clarity of the information to be provided to landowners.

One weakness of surveys is that respondents often do not put in the effort needed to provide meaningful answers. Even though such a survey would be targeted to landowners, who at the outset would benefit from an auction scheme put in place, one has no guarantee that they see this and hence exert the necessary effort. On the other hand, this is a low cost activity that reaches many in the policy target group.

Following the focus study and a possible WEB survey the next step is further testing: (1) lab experiments to further improve the clarity in the information provided and to check if landowners understand the bidding strategy in a uniform price auction, and (2) in real on a small scale (like two to three selected regions for a forest type that covers limited acreage) to further identify ambiguities and to see if conservation objectives are met. Well-designed experiments and test cases would provide valuable information for policy makers on the details of how to formulate policies at a larger scale and for a wider variety of cases.

Before we proceed, it should be noted that all pilot studies need to be followed up with an evaluation on behalf of participants to further enhance policy developers' understanding of participant perceptions. The research dimension of the pilot studies does not end here. We see four additional issues that need to be given particular attention in the pilot studies: (i) the applicability of the Polasky-Romstad (2010) auction sign-on fee, (ii) the impacts of option values on bidding behavior, (iii) the indexing of payments, and (iv) how to treat additionally, i.e., if areas already under one conservation scheme should be eligible to participate in new conservation auctions. Points (ii) to (iv) are related.

(i) *The Polasky-Romstad sign-on fee*

If one chooses to go for the Polasky-Romstad (2010) scheme with a sign-on fee in the auction, one of the key issues to test is participant reactions to such a fee. While its theoretical properties are sound, it may result in too many potential providers opting out. Some investigations of survey data of Norwegian forest owners as part of a recent study by Lind-hjem and Mitani (2012) cast some doubt about the Polasky-Romstad sign-on fee.

Conservation biologists and society at large rely on field studies to increase their knowledge on the state and development of biodiversity in forests. The Polasky-Romstad sign-on fee helps to utilize forest owners' knowledge on potentially conservation worthy habitats. This enables the biologists to focus their field studies on habitats that are likely to be more conservation worthy. There are two benefits from this: (i) the extent of costly field studies can be reduced, and (ii) conservation efforts can be concentrated on the most potentially conservation worthy habitats.

At first sight this may render the perceived benefits of the Polasky-Romstad scheme smaller over time. A more economic perspective is to allocate resources to surveying so that the expected marginal value of such surveys equals the expected marginal value of other activities to promote or manage biodiversity in Nordic forests. That means one should still refrain from surveying all Nordic forests for biodiversity purposes.

(ii) *Option value impacts on bidding behavior*

Another key issue to be tested is the impact of the duration of contracts on bidding behavior. From a conservation perspective one would like contracts to be longlasting, like at least 20-30 years (one generation of owners). A disadvantage with contracts of such long duration is that option values (Arrow and Fisher 1974, Henry 1974, Fisher and Hanemann 1987) are likely to be embedded into the bids, increasing bids and making the scheme more costly than what otherwise would be the case.

As time progresses conservation biologists will learn more about which species and habitats that need special management or protection based on biodiversity grounds. This means that what forest practices that constitute sound biodiversity management will also change, and hence that the forests under special biodiversity management schemes should change over time. One implication of this is that habitat management and conservation contracts should be flexible and limited in time to allow the incorporation of new scientific knowledge. This could reduce the impacts of option values on bidding behavior.

(iii) *Indexing of conservation payments*

An option value related issue is the form of the payment. Should it be a fixed yearly payment or should it be indexed? The consumer price index is one candidate for an indexed payment, but in our setting it suffers from two potential weaknesses. First, it does not reflect the basic principle of opportunity costs behind the auction scheme. Second, since the 1970s the consumer price index has been growing at a substantially higher rate than timber prices. Land prices appear as an interesting index base as it reflects both timber prices and landowners' the long term expectations on opportunity costs of conservation contracts. A land price based index appears particularly relevant in the case of long-lasting conservation contracts as it is expected to capture some of the option value concerns already discussed. Impacts of bidding behavior from various index regimes hence constitute another concern we see need to be addressed in the pilot studies.

(iv) *Additionality*

Should someone who has acquired one management contract be allowed to bid for additional contracts on the same area as long as the management practices of two contracts do not conflict with each other? The argument against such a permission is that the environmental gains are small, while the argument for is that while marginal environmental gains are minor, marginal costs will also be small.

We enter another argument in favor permitting participation in future conservation auctions. Suppose that participation in the initial auction makes it impossible to enter into future auctions.

Then the bids in the initial auction will include an additional option value component equal to the possible foregone income of not being able to participate in subsequent auctions. Although this adjustment is likely to be small, it may alter the bids for some bidders such that the initial contracts are not awarded to the least cost providers. Furthermore, this reduces the learning of costs associated with the initial conservation objective.

Allowing participation in the case future conservation auctions as long as conservation measures are consistent will yield very low (and in some cases zero) bids from existing contract holders. Hence, the costs of the new program will be lower. Admittedly, the environmental gains will also be minor. However, future (conservation) policies will be assessed based on where we are at the time such policies are implemented. By that time we most likely will have gained additional knowledge on expected conservation benefits that should be accounted for then, not at an earlier point in time (when knowledge is less).

Economic experiments and the pilot studies should reveal if landowners see option value point when placing their bids in initial auctions.

5.2 Gradual implementation of conservation auctions

Once pilot testing is completed and ambiguities are reduced it is time to put the scheme to work. From a conservation perspective one would like conservation policies to first be implemented in areas at risk. In our case that would imply that early use conservation auction schemes should take place in areas with simultaneous high conservation and commercial values. We are uncertain on the wisdom of such an approach. Areas at risk also tend to be areas where controversies exist. A gradual implementation may instead suggest that one runs initial conservation auctions for a variety of settings – forest areas with low commercial value and conflict as well as for some areas with higher commercial values and conflict – to learn more about the impacts of controversies on the bidding behavior.

Here, we note that in controversial areas one is likely to observe a larger spread in bids than in less controversial areas, which implies that the potential gains from auctions in controversial areas are higher. Differences in bidding behavior between high and low conflict areas will shed more light on this issue, and hence constitute an argument in favor of gradual implementation.

Scientific progress on the biological aspects of biodiversity pulls in the same direction for two reasons: (i) As our knowledge of biological systems and their functions increase, conservation objectives are likely to change. (ii) Having a variety of areas of under different biodiversity management regimes could facilitate faster learning. An implication of the latter could be that gradual implementation also entails a variety in management contracts offered in auctions.

5.3 Taking account of the transaction cost of bidding[33]

Preparing bids may be costly for agents. For forest owners with small forests that only contribute with a fraction of the total income of the forest owner (Mattsson *et al.* 2004), the costs of preparing the bid may not be worth the possible extra payoff. Moreover, small forest properties may not be as intensively managed for forestry purposes as larger forest properties (Eriksson 2008). This suggests that there could be interesting habitats on such properties, and that trees on small properties on average may be older than trees on larger properties.[34] As old growth forest is scarce in the Nordic countries, restricting timber harvests in mature tree stands or tree stands that are close to reaching maturity may be a fast way to increase the acreage share of older forests. With low opportunity costs of protecting these forests from the perspective of the owners, biodiversity management restrictions may also come quite cheap to the regulator. This implies that an auction system could result in a loss of net benefits if interesting

[33] This section builds on Paulsrud's (2008) MSc thesis at the Norwegian University of Life Sciences.

[34] We define "old" forest as forest over 120 years of age. In total for all Sweden both more area and volume of old forest are found on small privately owned properties, which constitutes 50% of the Swedish forest acreage. Looking at the share of old forest out of the total area and total volume owned by small private owners, this share is 11% of the area and 16% of the volume. The corresponding shares for the other two owner categories (private companies and other owners) are 13%/16% and 21%/22%, respectively. Hence it is generally not true that small forest owners on average have older forests, at least not that they have more of the old forest that is most valuable for biodiversity. (Underlying statistics from Skogstyrelsen 2009b).

habitats and older forests on smaller properties do not enter the system due to the associated transaction costs.

There are three possible solutions to this problem:

(1) The regulator could run an additional auction specifically tailored to small estates and land holdings. We advise against an additional auction because it reduces competition in the initial auction for a particular conservation objective as fewer landowners will participate. This would particularly be a problem for forest types and regions where the number of potential providers is low. Moreover, it sends a signal to potential bidders that they are given more than one opportunity to bid. This could render the truth revealing properties of the initial auction dubious, and provide an erroneous price anchor for subsequent auctions.
(2) Brokers could emerge, who have experience in specifying bids and are familiar with the auction formats. We see no problems with this as the truth revealing properties of the proposed auction approach is not hampered by this, and it would lower transaction costs.
(3) The information gained from the auction can be used to design other payment mechanisms to capture landowners who did not participate in the auction. This avenue will be further addressed below.

Even under these settings auctions are not irrelevant because the truth telling properties of uniform price auctions can be used to set the compensation for agents not participating in the auction schemes. The fixed rate compensations offered for nonparticipants in the auctions must be lower than the price determined by the auction for two reasons: First, one would like the rents to be larger on average for those participating in the auction schemes than for non-participants to maintain incentives to participate. Second, the auction price must also cover the markup fee in equilibrium, cfr. Equation [4.4].

Such fixed rate or menu payment schemes for voluntary participation in conservation programs will otherwise mimic auctions in the sense that programs would be region and forest type specific. An additional benefit of complementing auctions with such schemes is that fewer contracts would be awarded in the auction, lowering the auction price somewhat, and help maintaining competitive bidding even in settings where there are rather few potential participants in the auctions. This could be the case in small regions and rather special forest types.

5.4 Conflict resolution in practice

The existence of policies where participation is voluntary and where by design, participants are secured some rents, provide landowners with options that make them at least as well off as they otherwise would be. Under the assumption that the rest of society also are at least as well of under the proposed biodiversity policy, a potential Pareto improvement takes place. Pareto improvements augment social welfare without making anyone worse off. Therefore, they by definition reduce the conflict level in society. This is also one theoretical rationale for the use of contracts.

A voluntary approach like this with lower transaction costs to landowners (for example a problem in the "traditional voluntary" conservation arrangements in Norway) is seen as constructive and cooperative towards forest owners. Salanie (2005) and Binmore (2007) provide further theory details.

At the outset a procurement contract auction on forest management for biodiversity meet the above criteria as no landowner will submit a bid that makes him or her worse off than before, and society at large, represented by some environmental agency, is not going to accept bids that make it worse of.

The Polasky-Romstad (2010) auction scheme does not meet these criteria fully since some landowner may enter a bid that does not meet the biological eligibility criteria, but is low enough to be surveyed. In such a case, the landowner ends up losing the survey fee, φ, in addition to her costs associated with preparing the bid. However, landowners who submit bids expect to run a surplus. Otherwise, they would not have entered the auction. Therefore, in terms of expectations, landowners are at least as well off as they were initially, and the Polasky-Romstad auction scheme reduces conflicts. This conflict reducing perspective of auctions was shared by the landowners in the Paulsrud (2008) study discussed in the previous section.

The Swedish compensation system for the Samí for losses of reindeer to large predators also operates with expected positive net payoffs compared to the old system of documented losses to predation. Under the current Swedish scheme the reindeer herding Samí are compensated on expected losses (which again is based on the regularity and density of large predators) rather than on documented losses, i.e., a reindeer herder who experiences losses that exceed the expected losses that form the basis for the compensation is worse off. This compensation scheme has been developed in a dialogue with the reindeer herding Samí (Swedish Ministry of the Environment 2007).

Offering fixed compensation or menu schemes as a follow up to forest biodiversity auctions (Paulsrud 2008) meet the Pareto improvement conditions in actual payments, and is therefore conflict reducing as long as some landowners accept the offer. This was also reflected in landowners' reactions in the Paulsrud (ibid.) study.

6 Conclusions

6.1 Background and justification for policy proposals

Our focus has been on selecting least cost management regimes for reaching politically decided targets for biodiversity in Nordic forests, and to meet these targets with reasonable certainty. A basic premise for our work is that this can only be achieved if landowners and the regulatory agencies cooperate. Full compensation is a corner stone criterion in this respect, which leads us to uniform price conservation auctions that have two desirable properties:

- Landowners have incentives for truthful revelation of their perceived opportunity costs.
- It allocates management contracts to the least cost providers.

Forest biodiversity typically vary between regions and forest type, implying that policy instruments must be designed to capture attributes that are specific to regions or forest types. Least cost management strategies for biodiversity management then entails also entails identifying which management strategies that are least cost, keeping in mind that costs vary across regions, forest types and states, and across owner characteristics.

Uniform price auctions for forest management contracts can be designed to meet these criteria. Such auctions also facilitate the design of menu and fixed payment systems for those not entering the auctions.

Choosing low cost management strategies is important because it is an integral part of an extended policy perspective of maximizing the net expected benefits of forest biodiversity. With highly uncertain benefits of biodiversity, let alone the estimated monetary value of these benefits, low costs become even more relevant, and possibly for the moment the only operational economic performance criterion.

Still, the proposed auction scheme may not lead to lower public expenditures. One reason for this is of course the full compensation requirement that is needed to make forest owners wanting to participate in the auction. The second reason is that the least cost nature, which may make it optimal to increase acreage under special conservation contracts, which may exceed the savings of the least cost management regime. This is, however, unproblematic as such an enlargement of acreage under conservation management contracts is optimal.

The uncertainties about forest biodiversity benefits themselves and their monetary value are also part of the reason why current forest biodiversity policies in the Nordic countries are to a large extent formulated in acreage terms, i.e., the acreage share of various forest types under special management or in national parks or nature reserves, or in other quantifiable terms like volume of dead wood.

From the biological sciences (see Section 2.1) we know that ecosystem functions and species composition differ by region and forest type, and this needs to be reflected in the formulation of forest biodiversity policies. In our case this implies that the ensuing menu and fixed payment systems also are differentiated by forest type and regions.

Low cost policies that meet the biological conservation criteria need to resolve the following issues:

(1) Sufficiently many landowners must see it in their own interest to participate in the schemes that a policy mandates. This requires that landowners are at least as well off after the policy is implemented as they were before, i.e., the participation constraint is met. One implication of this is that full compensation (including timber values and non-observable factors like recreational and aesthetic values) must be offered to landowners for costs (forgone profits) arising from necessary changes in forest management practices. These non-observable aspects will enter into the landowner bids to make them indifferent between the current situation and the contract.
Here, it should be noted that Norway and Sweden currently do not offer full compensation to landowners.

(2) The policy must provide explicit incentives to participate for landowners who have low costs of meeting forest management requirements. In practice, this implies that a sufficiently large share of low cost providers choose to participate, while high cost providers are more likely not to participate. This corresponds to the matching problem in economic terms.

6.2 Conditions for the policy proposals to work in practice

Our main policy instrument is uniform price auctions. Separate auctions are to be performed for major forest types at the regional level where multiple contracts are auctioned in each round. To preserve the truthful revelation properties of uniform price auctions the following conditions must hold:

(1) There must be sufficient competition for the contracts to preserve the incentives for truthful bidding, i.e., landowner bids equal opportunity costs of changed forest management on forest sites or plots entered into the auction. This requires that there are more bidders than plots or habitats to be offered a contract, and that the total number of bidders is large enough for them to see themselves as price takers (i.e. collusion is prohibitively costly). In practice this sets a minimum limit to how region and forest type specific each auction round can be.

(2) Prospective bidders must be certain that for a particular biodiversity conservation or enhancement purpose, there will only be one auction held for each region and forest type. If this condition is not met, there may be an opportunity for bidders to influence their payoffs by holding out for subsequent auction rounds.

Competition in the bidding process is enhanced if the fraction of winning bids is low. Combining the procurement contract auction with a fixed payment scheme where the fixed payment price is set at a fraction less than one (for example 80 %) of the auction price is one way of awarding contracts to fewer bids (see Section 5.4). There are, however, limits to how few bids that are to be offered a contract before landowners deem chances of winning too small to justify the effort of formulating bids and entering the auction.

Parts of the Nordic countries are characterized by many small forest estates. Hence, in some cases the desired habitats will span multiple properties. This raises the issue of how to ensure that the conservation objective is met. Spatially coordinated bids or multiple landowners with joint bids that involve habitats from several properties open for larger conservation areas even in areas with many small properties. Such coordination need not to involve the action of the conservation agency if agglomeration bonuses are used. One advantage of the agglomeration bonuses is that it better preserves the competitive nature of the auction compared to agency involvement in identifying habitats to be protected. In this connection it should be noted that landowners of small forest parcels are more likely not to enter the auction at the outset. That implies that the small property issue may be better handled by the ensuing fixed price/menu price schemes discussed in Section 5.4.

6.3 Implementation

Chapter 5 addressed some central implementation issues. Biodiversity research and management are both young activities. This is also the case for the use of conservation auctions. We therefore think new knowledge will be gained as our experiences with various management regimes and auctions increase. This is an important factor in motivating our implementation scheme:

- Pilot studies where one seeks to gain knowledge on the performance of conservation auctions where special attention is paid to the four knowledge gaps we point to: (i) the impact of the Polasky-Romstad sign-on fee, (ii) option value impacts on bidding behavior, (iii) indexing of conservation payments, and (iv) additionally.
- A gradual implementation in terms of areas and forest types where conservation auctions are used and a variety of contracts offered. Again, we advocate a strong focus on learning.

As mentioned in Chapter 5, the fixed costs and information barriers may cause some potential providers not to participate in the auctions. Here, we propose that the auction prices are used to set the flat rate compensations to be offered to forest owners who chose not to participate in the auctions. These compensation levels are lower than the auction prices to induce sufficient high participation rates in the auctions.

We strongly believe that the experiences gained from a carefully designed test scheme and gradual and differentiated implementation would be valuable not only for Sweden, but also for other countries where biodiversity in forests is an important issue.

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Appendix 1: A breif overwiew of auction formats

This brief overview builds on Chan *et al*. (2003). The four major auction formats are English auctions, Dutch auctions, first-price sealed-bid auctions, and (4) second-price sealed-bid auctions.

All these auction formats were originally designed for sales of goods and items, but in principle there is no difference if they are run as procurement auctions, i.e., one seeks the lowest bidders for delivering a service. A brief summary of these four auction formats follows:

(1) *English auctions* are open auctions with an ascending outcry format, where the price is successively increased until only one bidder remains. A bidder bids as long as the current price remains below his own valuation of the auctioned good. As bids increase, bidders successively withdraw from the auction in order of their relative valuations. The good is sold to the bidder with the highest valuation who is the last remaining person in the auction for a price above what makes the second last bidder withdraw from the auction. The dominant strategy is to stop bidding once the bid price exceeds one's own valuation. Bidding more than the subjective valuation involves the risk of winning the auction and having to pay more than one's subjective valuation. Bidding below the subjective valuation reduces the chance of winning. Bids in the English auction therefore reveal bidders' valuations.

(2) In *Dutch auctions* bids are announced in a descending order. A bidder wins by being the first to accept an announced bid and pays that price. The term "Dutch auction" originates from the use of this auction format in the Netherlands' flower markets.

(3) *First-price sealed-bid* auctions require bidders to submit confidential bids to the seller. As the name reveals, bidders cannot observe the size of the competing bids when placing his bid. This is in contrast to the English auction where other bids are observable. The bidder with the highest bid wins and pays that bid.
(4) *Second-price sealed-bid auctions* (Vickrey 1961), also denoted Vickrey auctions, differs from the first-price sealed-bid auctions as the highest bidder wins the auction, but only pays the price of the second-highest bidder. This separation between the bid and the price paid makes it a dominant strategy to bid the subjective valuation. Bid-ding above the subjective valuation increases the risk of having to pay more for the auctioned item than what the bidder perceives it is worth. Contrary, bidding below the subjective valuation increases the risk of losing out on a good where one would have been willing to pay more.

All these four commonly used auction formats have two desirable properties under rational bidding behavior. First, the winner is the person with the highest subjective valuation. However, only the sealed bid formats provide incentives that bidders will bid their maximum willingness-to-pay. Second, auctions produce on the average the same payments when the following conditions are met (Chan et al. 2003 for full details, summarized by Latacz-Lohmann and Schillzi 2005:18):

- *The auction sells a single item.*
- *Independent private values*: Each bidder has a valuation of the traded good that is unknown to the seller and rival bidders and that is not influenced by others' views (in particular, no resale value). The seller does not know each bidder's exact valuation and perceives this valuation to be drawn randomly from some probability distribution. Likewise, bidders have prior knowledge about the probability distribution of rival bidders' valuations, but not about competitors' exact valuations.
- *Symmetric bidding*: The probability distribution of valuations is identical for all bidders.
- *Competitive bidding*: All bidders enter the auction with the intent to win and know the number of rival bidders. There is

no collusion and bidders do not have the ability to influence market demand.

The ability of these auctions to generate the same revenues is known as the *Revenue equivalence theorem* that Vickrey (1961) also pointed to. It should be noted that this result also holds for procurement auctions.

Appendix 2: Overwiew of existing forest biodiversity policies

This appendix reviews current biodiversity policies, starting with the EU regulations as they are binding for all the Nordic countries. The following subsections address the national regulations in the Nordic countries, starting with Sweden. Next the international experiences are summarized and lessons for Sweden are presented.

According to the European Commission (2009) EU policies related to biodiversity have the following main elements:

They are in line with the United Nations biodiversity convention (UNEP 1992). The primary objective of EU biodiversity policies is to halt biodiversity losses by 2010.

The *Habitats directive*, which aims at protecting the loss of key habitat for biodiversity.

The *Birds directive*, which is explicitly directed towards protecting threatened bird species and maintain the viability of Europe's bird fauna.

The *Natura 2000 scheme*, which is targeted towards the protection and management of selected nature types.

Only *Natura 2000* contains explicit economic instruments in the form of payments to areas that meet its requirements.

A2.1 Sweden

Swedish environmental policy has been summarized in 16 national environmental objectives (Naturvårdsverket 2008) decided by the Swedish parliament. Biodiversity conservation is an integral part of several of these objectives. Of particular relevance for forest biodiversity are “Sustainable Forests” and “A Rich Diversity of Plant and Animal Life”, but ”Thriving wetlands”, “Flourishing Lakes and Streams”, and ” A Magnificent Mountain Landscape” also have connections to forest biodiversity. The “Sustainable Forests” objective deals explicitly with forest land, and is made up of four interim targets focusing on long-term protection of forest land, enhanced biological diversity, protection of cultural heritage and action programmes for threatened species. International conventions and EU directives are also part of the foundation of Swedish national policy with respect to biological diversity in forests (KSLA 2002, Molander 2008).

The forest policy adopted by the Swedish parliament in 1993 includes two objectives, one relating to forest production and the other to environmental protection. Both objectives were granted equal importance. The forest policy objectives together with the “Sustainable Forests” objective are given an operational interpretation in so-called interim targets for the forest sector (Skogsstyrelsen 2005). A major interim target pertaining mainly to biodiversity is that an additional 900 000 hectares of forest land with high conservation values are to be excluded from forest production by 2010 (Skogsstyrelsen ibid.).

The “Swedish model” emphasizes the shared responsibility between the state and the landowners to achieve production and biodiversity targets through voluntary measures by landowners and protection measures by the state (Skogsstyrelsen 2006). This means that the bio-diversity targets shall be achieved through a combination of set aside areas financed by the state, areas voluntarily set aside by forest owners (without financial compensation), and general conservation consideration in all forestry operations (e.g. leave habitats favouring red-listed species and biodiversity in general) (Skogstyrelsen 2005).

Nature reserves, legal habitat protection and general conservation consideration can be characterized as command-and-control style approaches to biodiversity protection in Sweden. Nature reserves are areas protected by the state that usually are larger than 20 hectares, and are either bought by the state or the landowner is compensated in other ways. Key habitats can be turned into legal habitat protection (average size 3 hectares, Skogsstyrelsen 2008b) by the state, but the ownership is retained by the landowner, who gets financially compensated (Kindstrand 2008, Perhans 2008). General conservation consideration is the lowest legal level in all forestry operations in the production forest, and involves setting aside smaller areas (less than 0.5 hectares), so called “retention patches” (Perhans ibid.).

According to Swedish forest conservation legislation voluntary set asides should be larger than 0.5 hectares and decided by the landowner (e.g. a key biotope as part of a certification commitment) (Skogsstyrelsen 2008a). Nature conservation agreements constitute a type of economic policy instrument where the landowner makes an agreement with the state to refrain from e.g. forestry operations in an area for a specified time period (often 50 years), against an economic compensation (Kindstrand 2008).

Our summary of Swedish policies pertaining to biodiversity in forests consists of the following main points:

- There are clear quantitative targets in terms of acreage to be under conservation schemes, and the biological qualities of that acreage (cfr. Skogsstyrelsen 2005a).
- However, the policy appears fragmented and with an unclear division of responsibilities between the state and landowners.
- Matters are complicated by what appears to be insufficient incentives despite the existence of instruments like voluntary conservation agreements, because the issue of full compensation to landowners is not clarified.

A2.2 Denmark

The Danish forest sector is under the jurisdiction of the Ministry of Environment, but the responsibility has been delegated to the Danish Forest and Nature Agency. As is the case for Sweden, Denmark participates in a number of international processes that set an additional frame for the national forest management planning. Regarding biodiversity Denmark has adopted international conventions, including the United Nations Forest Declaration, and the Convention on Biological Diversity (CBD). Denmark has adopted an expanded work programme on forest biological diversity under the CBD (Danish Forest and Nature Agency 2009a, Agency for Spatial and Environmental Planning 2009).

The national legislation frames the main administrative tools for protecting and restoring bio-diversity. The most important laws concerning biodiversity in Denmark are: the Nature Protection Act, the Environmental Protection Act, the Environmental Goals Act, the Environ-mental Protection of Streams Act, the Forest

Act, and the Planning Act (Danish Law Information 2009). None of these laws explicitly address the issues of incentives and compensation schemes for protected or specially managed forest areas.

The Danish government has revised the Nature Protection Act and the Forest Act to cover the implementation of the EU Habitat Directive and the Water Framework Directive. The Nature Protection Act is the most important legislative tool to protect nature and public access on private and public land. In addition, 254 Natura 2000 Sites of Community Importance (SCI) have been designated according to the Habitats Directive and the Special Protection Areas designated according to the Birds Directive.

The Environmental Goals Act of 2003 frames the administration and procedures of nature protection and water protection planning. It outlines the responsibilities of the municipalities and the action plans which must be implemented. The Forest Act describes the responsibility of the Ministry of Environment to prepare action plans on Natura 2000 areas located on forest land. In addition, the Law on Danish National parks (2007) promotes biodiversity and landscape protection in larger reserves.

Based on the UN Forest Declaration and the resolution from the Helsinki Conference on bio-diversity in 1993, Denmark developed a National Strategy for Sustainable Forest Management in 1994. The strategy was updated and extended into a National Forest Program in 2002. Its objective is full implementation of sustainable forest management, including economic, ecological and social considerations. The overarching goal of the Danish forest policy is "a combination of nature, production and recreational opportunities, which at the same time increases biodiversity protection, consolidates the possibilities for outdoor recreation, and ensures the future production potential of the forests." (Danish Ministry of the Environment 2002, Danish Forest and Nature Agency 2002). There is an overall vision of long term conversion to near-to-nature forest management principles, but it is unclear what this will cost, and who will bear these costs.

According to the Danish Ministry of the Environment (2002) the vision and the legal framework is accompanied by quantitative targets for forest biodiversity where the main points are that:

- 10% of the forest area shall have biodiversity as the main management objective by 2040,
- natural forests shall be conserved,
- 20-25% of Denmark shall be covered by forest landscapes in 80-100 years (11% cover today), thus strengthening the scope and potential for natural habitats and processes.

Forest owners can apply for subsidies for: preparing 'green' forest plans, transforming coniferous forest stands into stands of local tree species; untouched forest areas, and protection of forest areas of special interest (Danish Forest and Nature Agency 2009b). A general overview of subsidies for enhancing the protection of biodiversity in Denmark is found in Danish Forest and Nature Agency (2009c).

Our summary of the Danish policy on forest biodiversity is that it appears to have many of the same problems as in Sweden, including less clear priorities on biodiversity. A noteworthy difference between Denmark and Sweden is the large emphasis on enlarging forest coverage in Denmark.

A2.3 Finland

The Finnish Ministry of the Environment (2008) summarizes Finnish biodiversity concerns as follows:

> "Forest management is, along with the changes in agricultural practices, the most important factor affecting biodiversity in Finland. Threats to biodiversity result also from road construction and building of holiday residences on the lakeshores. According to the latest assessment of threatened species carried out in 2000, about ten per cent of the species in Finland are threatened."
> *(http://www.ymparisto.fi/default.asp?node=5340&lan=en)*.

The Finnish policy on biodiversity is divided into three area categories: nature conservation areas, biosphere, and habitats. In addition, there is a special species protection program. The UN Biodiversity Convention (UNEP 1992) establishes the basic foundation for Finnish policy measures, that are mirrored in the Finnish Environmental Policy act (2001) with the following main principles:

- the prevention or reduction of harmful impacts (principle of preventing and minimizing harmful impact),
- the exercise of proper care and caution to prevent pollution (principle of caution and care),
- the use of the best available technique (BAT principle),
- the use of best practices to prevent pollution (principle of environmentally best use), and
- parties engaged in activities that pose a risk of pollution have a duty to prevent or minimize harmful impacts (polluter-responsibility principle).

The above list emphasizes best available techniques and management principles while economic policy instruments are not mentioned. The scope for (economic) policy instruments were studied in the METSO research program (http://wwwb.mmm.fi/metso/international/), where the main policy instruments are acquisition of areas to increase protection of bio-diversity, voluntary contracts and information. Horne *et al.* (2009) found that three out of four Finns are in favor of the above instruments with particular support to voluntary contracts and information.

Our summary of the Finnish forest biodiversity policies contain the following main points:

- The strong focus on protection and the use of best available techniques and practices in the management of forests.
- A clear normative imperative of the responsibilities of agents to take proper care, most clearly stated related to pollution.
- Regarding land acquisition the principle of full compensation is soundly rooted, which therefore makes the Finnish forest biodiversity policy more clear in economic terms than in the other Nordic countries.

A2.4 Norway

Norwegian legislation related to forests and biodiversity are undergoing substantial changes. The first result of this work is the Forestry act of 2005 (Norwegian Ministry of Food and Agriculture 2005), which has a strong focus on timber production, hunting and fishing rights, but where a central stated policy objective is to “...

run a forestry adapted to local conditions, and that the forest sector is to contribute to important environmental issues".

The second phase in this process is the new biodiversity law (Norwegian Ministry of the Environment 2009)[35]. Key features of the new law are (our condensation):

Environmental principles: The Act will build on the precautionary principle, the eco-system approach and the polluter pays principle, extending beyond the scope of pollution. Moreover, the act will codify the principle that decisions affecting the environment are to be built on scientific knowledge, as well as traditional knowledge.

Selected habitat types is a new and important tool in Norwegian nature management. Examples of habitat types include deltas, bogs, coastal heaths, farm ponds or scree. Many such habitat types, though threatened, are located outside protected areas. For these there is a lack of common goals and guidelines enabling municipalities and other authorities to take appropriate action. This issue is addressed through the new instrument in the Nature Management Act: the selected habitat types.

Priority species and their natural habitats: "Priority species" is an updating of the sanctuary concept in current conservation legislation seeking to deal with species and their habitats in context. Functional ecologic areas for species is a new step in the proposed biodiversity legislation, and cover sites that are important to species for nesting, hibernating, spawning, residing or resting.

Protected areas: Regulations in the Nature Conservation Act of 1970 concerning the protection of national parks, protected landscapes and nature reserves will be updated to enhance protection efforts and to ensure greater consistency and clarity for landowners and local communities involved: establishing, among other things, clear goals for protected areas, obligatory management plans for large protected areas and increased funding for management (italics added). Substantially improved compensation provisions for landowners and stakeholders in protected areas will be introduced.

(... further items not directly relevant to biodiversity in forestry removed, the full text is found at:
http://www.regjeringen.no/en/dep/md/press-centre/Press-

[35] Kvakkestad *et al.* (2005) contains a detailed summary of the past legislation on forest biodiversity in Norway.

releases/2009/new-nature-diversity-act-will-secure-nor.html?id=553630).

The details of the new law is yet not fully worked out (in Norwegian legislation these are added in separate supporting documents by the relevant ministries), but concerns have already been voiced among land and forest owners that the funding will be inadequate to meet the high ambitions of the proposal (Norges Skogeierforbund 2009 – comment on the national budget proposal for 2010). Similar comments have been made by nature conservation NGOs (see Norges Naturvernforbund 2009).

Land and forest owner sentiments on biodiversity and acreage protection are still influenced by the 1974 High court decision (Rettstidende 1976:5-6) that landowners are only to receive compensation for restrictions in land use or public land acquisitions based on current landuse, i.e., likely more profitable land uses shall not play a role in the size of the compensation). The controversies surrounding recent Trillemarka nature reserve have reinforced these sentiments. (Dagbladet 2008).

Norway is an early signatory of international treaties related to the environment and bio-diversity, but is still the Nordic country with the lowest acreage share in protected areas. Voluntary management contracts are an integral part of Norwegian biodiversity policies through the "Levende skog" ("Living forests") program that was implemented in 1998 and last revised in 2006 (Levende skog 2009) and covers twenty five requirements on forest management practices for forest owners to be able to sell timber to firms that take part in the agreement. Many consider the agreement rather weak, but it may have contributed to reducing the extent of the most harmful practices for biodiversity.

Our summary of the Norwegian forest biodiversity policies contain the following main points:

- Full compensation is rarely awarded. There is a law presedence in these matters dating back to High court ruling in 1974.
- The existence of many other resource use conflicts, in particular related to grazing sheep and large predators, and to the recent Trillemarka nature reserve, have contributed to a climate of mistrust between environmental regulators and landowners.

- Increased interest and focus in voluntary agreements, with the “Levende skog” (“Living forests”) program playing an important role.

A2.5 Summary interpretation of forest biodiversity policies in the Nordic countries

All of the Nordic countries are affected by the EU biodiversity policies. With the exception of Natura 2000 (that does not apply in Norway), EU biodiversity policies are weak on the use of economic instruments.

The Nordic countries have generally been quite early in adopting biodiversity legislation and measures, but the policies are generally not well focused, and are also strongly influenced by other objectives. Moreover, the extent of economic instruments is quite limited in all the Nordic countries. On the issue of full compensation Finland appears to be the Nordic country accepting this principle this to the highest extent, with Norway at the other end of the spectrum.

A2.6 Experiences from other countries

Outside the Nordic countries the experiences with economic instruments for biodiversity conservation is more widespread. The FAO Roles of agriculture project provides a nice overview on payment for environmental services (PES) in developing countries (FAO 2009). Most of these payment schemes include some compensation offers for landowners or other users to agree to restrictions on their current use of an area or on their harvest of wood or game the land in question produces. These compensation offers are voluntary in the sense that involved parties can accept the compensation offered and hence the ensuing use restrictions, or decline the offer.

Other noteworthy experiences are the US conservation reserve program (USDA Economic Research Service 2009) that was started in 1985, and the Australian Bush tender scheme (Stoneham et al. 2003). Connor et al. (2008) provide an evaluation of the Australian experiences. The latter two programs have used auctions or menu pricing to induce landowners to undertake some desired management practices. Like the PES schemes participation in these programs is voluntary. These programs have also partly succeeded in resolving some of the information asymmetries on costs, although the auctions have not been of the uniform price kind that theory suggests for truthful revelation to take place (see next chapter). However, the direct incentives of these two programs have contributed to making the programs targeted, transparent and tractable, that according to Batie (1996) are key parameters for successful policies.

Recent developments in Australia include a new offsetting scheme, where conversion of areas of biodiversity interest to other purposes like road construction roads or housing, require that unprotected areas of similar or better quality from a biodiversity perspective are protected. To match suppliers of unprotected areas of various biodiversity classifications with land developed for these other uniform procurement auctions (purposes; a double auction system is being put in place (Plott *et al.* 2008). This double auction system mimics a market, and is made possible as all acreage of relevance has been pre-surveyed for their biodiversity qualities.