Private forest owners' willingness to accept contracts for ecosystem service provision

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Abstract
Provision of ecosystem services from Danish forests relies to a great extent on voluntary engagement by forest owners. This can be through voluntary participation in environmental contracts promoting ecosystem services or forest owners' own initiatives. Another way is through changes in the legal setting demanding specific changes on private land, with or without compensation, such as Natura2000 policies.
We have investigated Danish forest owners' preferences for voluntary participation in the provision of specific ecosystem services closely related to the contemporary Natura2000 framework. This involves leaving old trees for natural aging and decay, setting aside untouched forest areas, accepting a fixed percentage of broadleaves in the forest and increased access on foot for the public. The study adds a new element to the literature by investigating the link between current forest management on individual properties and the WTA for ecosystem services. Analyses based on a Choice Experiment show, that among the investigated attributes, granting the public increased rights of access is by far the most expensive element; the average respondent requires 121 DKK/ha and year for accepting access up to 15 meters from roads and paths and 242 DKK/ha and year for accepting access everywhere in forest. Forest owners also require compensation for leaving untouched forest areas (3.6 DKK/ha and year for 1% of their forest area). Accepting a broadleaves restriction only involves compensation when it is on 75% of the forest area (53 DKK/ha and year), whereas they do not require compensation for the lower levels investigated here (25%, 50%). Preserving dead trees stands out as the attribute respondents are willing to accept the lowest amount of compensation for - if they already do this on their property (approximately -75 DKK/ha and year for preserving 5 trees). Results also show that forest owners' attitude towards their role as 'ecosystem service providers' for the community has a significant effect on their compensation requirements for increased access. Respondents who find it important that subsidy schemes are beneficial for the local community require approximately 81 DKK/ha and year less in compensation for providing access up to 15 meter from roads and paths. As opposed to this, respondents who use the forest for hunting require approximately 47 DKK/ha and year additional to the 121 DKK/ha and year for granting access up to 15 meters from roads and paths. Policy-wise, these analyses add information regarding to which extent we can expect forest owners to provide some of these ecosystem services voluntarily and without compensation. Moreover, it also points out which types of services draw more heavily on both the good-will, alignment with personal interests and the compensation requirements, when forest owners take on the role as providers of these ecosystem services.

Keywords: Payment for environmental services, biodiversity, groundwater, recreational access.
JEL codes: Q50, Q57, Q23.

Introduction

Provision of ecosystem services from forests relies to a great extent on voluntary participation by forest owners. Changes in management can be achieved through voluntary participation in environmental contracts promoting ecosystem services or through changes in the legal setting demanding specific changes on private land, with or without compensation, such as Natura2000 policies. In many European countries a large percentage of the forest area is privately owned. Therefore the willingness of private forest owners to engage in the provision is essential for reaching national and international goals for nature protection and recreational services for the public at large.

We have investigated forest owners' willingness to provide specific ecosystem services, with or without payments, on their property based on a questionnaire including a Choice Experiment (CE) replication of contract choices. The ecosystem services chosen here, and the related forest management measures, are based on on-going policy debates in Denmark regarding access, biodiversity protection, e.g. in relation to NATURA 2000 initiatives, and the provision of clean groundwater for drinking water purposes. This paper provides a new approach where the willingness to provide these services (and the related WTA) is analysed in connection with forest owners actual current land use and forest management on their individual forest properties. This enables us to analyse the impact of current land use on the required amount of compensation for specific ecosystem services. Moreover, we also investigate to what extent the forest owners' attitude towards doing something beneficial for the local community affects their WTA for ecosystem services. The impact of attitude is explicitly investigated in relation to allowing increased access on the property. Increased access constitutes a public good which is well-known for both forest owners and society, since it is comparable with the current access rights for the public on all publicly owned forest areas.

The CE method has previously been applied for eliciting landowners' preferences for policy initiatives regarding nature conservation on private land. Although the CE method has been applied in a vast amount of environmental valuation studies, its application in eliciting landowners preferences for contracts are more limited (Hudson and Lusk 2004; Horne 2006; Ruto and Garrod 2009; Espinosa-Goded et al. 2010; Broch and Vedel 2012). Horne (2006) was, to our knowledge, the first to apply a CE study on forest owners preferences for contracts regarding forest conservation focusing on specific contractual elements such as on whose initiate the contract was established and the duration of the contract. Later studies on farmers' contracts preferences have also applied the CE method for analysing the effect on WTA of different types of ecosystem services and monitoring by the government (Broch and Vedel 2012).

A number of studies have previously shown heterogeneity in landowners' preferences, highlighting the scope for potential targeting of contracts (Wilson and Hart 2000; Vanslembrouck et al. 2002; Hudson and Lusk 2004; Hackl et al. 2007; Ruto and Garrod 2009; Broch and Vedel 2012). The present paper also investigates the relevance of heterogeneity, however, it also adds a close link to the various current management situations on the individual owner's property and assesses the impact of the current management situation on the owners willingness to provide different types of ecosystem services.

The paper is structured as follows: first the econometric method and data collection is presented. The presentation of results includes both a model with and without interactions related to the current management in the forest. Afterwards the discussion and conclusion is presented.

Econometric method

Choice experiments are based on the random utility model, assuming that a respondent will choose an alternative *k* over another *j*, given its utility is larger (see e.g. Train, 2003 for details). To allow for heterogeneity between respondents, we model the choices by a random parameter logit model allowing for multiple choices of each respondent. Thus the probability that the *i*'th respondent will choose the *k*'th sequence of choices, $k = \{k_1,\ldots,k_N\}$ is

$$\Pr_{ik} = \int \left(\prod_{n=1}^{N} \left[\frac{\exp^{\beta_i' x_{ik_n n}}}{\sum_j^J \exp^{\beta_i' x_{ijn}}} \right] \right) \phi(\beta | b, W) d\beta$$

Where we assume a constant scale and $\phi(\beta | b, W)$ is a normal distribution function for *β*, with mean *b* and covariance *W.*

Furthermore we allow for an error component (Sigma) capturing the uncertainty associated with choosing status quo as opposed to one of the contracts (Greene and Hensher 2007; Ferrini and Scarpa 2007).

We calculate the marginal rate of substitution (WTA) using the Delta method (Greene, 2002), assuming no distribution around the price parameter.

Data collection

The data were collected through a national, online survey of Danish forest owners. The survey was carried out using the software SurveyXact in the period from June-August 2012. The forest owners were contacted through a letter including a leaflet with brief information on the survey and the name of the website, where they could log-on to fill out the questionnaire online. The leaflet also included information on the possibility to win a prize. Since the number of owners with large forest areas is small in Denmark, we decided to offer this part of the sample a greater opportunity to win a gift voucher (one in ten would win), than owners with smaller forest areas (7 gift vouchers would be randomly distributed between all completed questionnaires for this part sample). The gift vouchers each amounted to 3.000 DKK which could be spent in grocery stores across the country.

A total of 1429 forest owners were contacted by letter and three-four weeks after, owners who had not filled out the questionnaire in the preceding period received a reminder by letter. The letter included an invitation to participate in the survey and a brief explanation as to how respondents had been identified. The letter also included statements of support for the survey from the director of the Danish Forest Owners' Association and the director of the Danish Forest Extension services.

Forest owners were sampled based on contact details obtained from the Danish National Forest Inventory during the previous years. This approach was used to obtain names and addresses of forest owners in order to send out the invitation to fill out the questionnaire. This method allowed us to contact a random set of forest owners rather than relying on membership of forestry or agricultural organisations, or previous participation in subsidy schemes. Based on the total sample of contact details, a random set of forest owners were selected across a systematic stratification based on forest area within different size classes. The aim was to gather data on forest owners who are representative with regard to both region and size classes. In our case, this meant that we had to use all contacts available for owners in the largest size classes since the total number of these owners is relatively small.

The design of the questionnaire was based on experience from earlier studies on forest owners and other types of landowners (Boon et al. 2004, Broch and Vedel 2012). We tested the questionnaire among a focus group of forest owners resulting in a redesign of parts of the questionnaire. The change especially targeted the questions related to costs and income variables of the forest where we sought to make this section less burdensome to answer for the owners.

The questionnaire was structured as follows: First it presented questions regarding the forest and property of the respondent including harvest, administration and decision-making related to the management. After this followed questions regarding previous experiences with subsidy schemes and issues which may affect their motivation for participating. Then the CE was introduced and each forest owner was presented with 6 choice sets including 2 alternatives and a status quo option (see example of choice set in appendix 1). The final part of the questionnaire consisted of socio-economic questions regarding the respondent, their household and membership of organizations. Throughout the questionnaire the respondent had the opportunity to go back to previously answered pages in the questionnaire. This was chosen because some of the questions e.g. regarding harvest and cost/revenue for the forest were cumbersome to answer for the forest owners, and we did not want to prevent them from seeing previously answered pages if they felt a need to.

Table 1: Attributes investigated in the Choice Experiment

Attributes	**Variable name**	**Coded levels**	**Levels**			
Set aside an area as untouched forest	UNTOUCH	0,7,15	No change	7% of the forest	15% of the forest	
Leave 5 old trees for natural decay	DEAD	0,5	No change	Leave 5 old trees for natural decay		
Agree to an area with broadleaves of at least	BLEAVE25 BLEAVE50 BLEAVE75	3 dummies (0,1)	0% broadleaves	25% broadleaves of total forest area	50% broadleaves of total forest area	75% broadleaves of total forest area
Increase the public's access	ACC	0,1,2	No change	Access for the public on foot up to 15 meters from	Access for the public on foot everywhere	

				roads and paths						
Lower property tax	PRICE	0,25,50	0 DKK	25 DKK	50 DKK	75 DKK	100 DKK	125 DKK	150 DKK	175 DKK

The attributes and levels were described in detail just prior to the choice experiment. All attributes were presented along with the various levels associated with them – except for 'Lower income tax' where the levels were omitted in order to prevent an anchoring effect at the highest level. The payment vehicle, lower property tax, is described as a permanent reduction in the property tax per ha/year for the whole property. This will be registered in the deed and persist in perpetuity (along with the other elements in the contract).

Design

The design for the CE was optimised in NGene 1.0.2 for D_B-efficiency. A model in WTA-space was assumed for the design using zero priors and no interactions. The attributes access and broadleaves were dummy-coded whereas untouched forest area, leaving old trees for natural decay and price were continuously coded. The final design had 24 choice sets divided into 4 blocks, resulting in 6 tasks to be answered by each respondent. One level in one choice set (0 to 5 for old trees for natural decay) was changed manually to avoid having an alternative exactly identical to the status quo. Within the same block, a 5 was changed to 0 (old trees for natural decay) in order to maintain the balance within the block. The D-error at the generation stage was 0.00124.

Response rate

In total 1429 people received the letter inviting them to participate in the questionnaire. In the final sample used for the data analyses we have chosen to eliminate respondents who have not answered all six choice sets. The final sample constitutes of 283 respondents and provides a response rate of 19.8 %.

Results

Main effects model

Table 2 shows the results of a main effect RPL model along with WTA estimates. Note that the compensation requirements are per hectare for the entire forest, even if the restriction (like untouched forest) only applies to a part of the forest. As shown in table 2, forest owners require 3.6 DKK per ha (for the entire property) in compensation for each percentage set aside for untouched forest. Thus setting aside 7% as suggested costs 2520 DKK and setting aside 15% costs 5400 DKK if the total forest property is 100 ha. Leaving trees for natural decay is interestingly an aspect which forest owners are willing to accept a reduced compensation for, namely 45 DKK/ha/year for the entire forest. Having a restriction on the broadleaved percentage on the forest area has no implication until it reaches a threshold. Thus for a requirement of minimum 75% cover by broadleaved tree species, forest owners require 53 DKK/ha/year for the entire property. For allowing the public access up to 15 meter outside road and path, forest owners require 121 DKK/ha/year for the entire forest, and 142 DKK for allowing access everywhere on the forest floor. Even though the access levels conceptually are not linear, they are modelled as such

here as a linear tendency was found in earlier models. For all the parameters, except compensation for 75% broadleaves cover and leaving 5 trees for natural decay per ha, we see considerable heterogeneity in the population.

Table 2: RPL model of main effects (based on 1000 Halton draws); WTA based on the Delta method. 1 € equals approximately 7.5 DKK.

	Coefficient	Standard error	Z	WTA (DKK/ha/year)	WTA 95% confidence interval
Random parameters in utility functions					
UNTOUCH	-.05173**	.02460	-2.10	3.6**	(0.41 - -6.8)
DEAD	.12837**	.05252	2.44	-9.0**	(-16 - -1.6)
BLEAVE25	-.38207	.34735	-1.10	27	(-20 - 73)
BLEAVE50	-.22934	.36878	-.62	16	(-35 - 68)
BLEAVE75	-.75759**	.35188	-2.15	53**	(9.0 - 97)
ACC	-1.73080***	.25251	-6.85	121***	(84 - 159)
Non-random parameters in utility functions					
ASC	4.84554***	.66793	7.25	-340***	(-432 - -248)
PRICE	.01426***	.00189	7.56		
Standard deviations of normal distributed random parameters					
UNTOUCH	.13039***	.02774	4.70		
DEAD	.18802*	.10907	1.72		
BLEAVE25	1.35748**	.63102	2.15		
BLLEAVE50	1.01828**	.51765	1.97		
BLEAVE75	.73181	.74658	.98		
ACC	1.45746***	.30167	4.83		
|Standard deviations of error component					
Sigma*10	5.24778***	.74911	7.01		
Number of respondents / Pseudo R^2	283/0.5782				
Log-likelihood / R^2 adjusted	-786.8/0.5763				
Restricted LL / χ^2	-1865.4/2157.2				

***, **, * ==> Significance at 1%, 5%, 10% level

A model with interactions

To identify some of the heterogeneity, an RPL model of the results including interaction effects is shown in Table 3. There is the same pattern for the main effects as in the previous main model, though the levels of WTA changes slightly. The most distinguished difference is that leaving trees for natural decay (DEAD) becomes insignificant. The interaction effects analysed relates to the actual management situation in the forest/property and also to the forest owner's stated attitude towards provision of public goods, see Table 4. Table 4 shows the presence of these characteristics and management levels among the respondents.

Including attitudinal questions such as positive attitude towards creating benefits for the local community may cause an endogeneity bias. Therefore we have shown a model in appendix 2,

similar to the one in Table 3, but excluding the attitudinal question. In the following we look at each of the elements of the contract, together with the interaction effects.

Table 3: RPL model including interaction effects (based on 1000 Halton draws); WTA based on the Delta method. 1 € equals approximately 7.5 DKK.

	Coefficient	Standard error	Z	WTA	95% confidence interval
	Random parameters in utility functions				
UNTOUCH	-.12831***	.03843	-3.34	8.3***	(3.5 - 13)
DEAD	-.01345	.07688	-.17	.87	(-8.8 - 11)
BLEAVE25	-.42471	.35469	-1.20	274	(-17 - 72)
BLEAVE50	-.06619	.56173	-.12	427	(-67 - 75)
BLEAVE75	-1.03211**	.43762	-2.36	67**	(13 - 120)
ACC	-2.13885***	.41657	-5.13	138***	(80 - 196)
Non-random parameters in utility functions					
ASC	5.02759***	.66266	7.59	-324***	(-410 – -239)
PRICE	.01550***	.00186	8.32		
HAVEUNTOUCH*UNTOUCH	.12350***	.04292	2.88	-8.0***	(-13 - -2.5)
HAVEDEAD*DEAD	.23213**	.10223	2.27	-15**	(-28 - -2.0)
HAVE50%B*BLEAVE50	-.29468	.68692	-.43	190	(-68 - 106)
HAVE75%B*BLEAVE75	.27988	.52430	.53	-181	(-84 - 48)
HAVEACC*ACC	1.79302**	.75053	2.39	-116**	(-214 - -18)
POS*ACC	1.26332***	.40209	3.14	-81***	(-134 - -30)
HUNT*ACC	-.72268*	.40671	-1.78	47*	(-4.2 - -97)
Standard deviation of normal distributed random parameters					
UNTOUCH	.12685***	.02904	4.37		
DEAD	.28454***	.09635	2.95		
BLEAVE25	1.34095*	.70483	1.90		
BLEAVE50	1.02257*	.61317	1.67		
BLEAVE75	.89612	.63405	1.41		
ACC	1.26434***	.30872	4.10		
Standard deviations of error component					
Sigma*10	5.21697***	.69586	7.50		
Number of respondents / Pseudo R^2	283/0.5906				
Log-likelihood / R^2 adjusted	-763.7/0.5879				
Restricted LL / χ^2	-1865.4/2203.4				

***, **, * ==> Significance at 1%, 5%, 10% level

Access

Out of the investigated ecosystem services, allowing access either up to 15 meters from roads and paths (level 1) or access everywhere on the forest floor (level 2), is by far the most expensive management change to get the forest owners to accept. On average they require 138 DKK/year and hectare (app. 18.4 €) for accepting each of these levels. To identify what kind of owners require more in compensation, access is interacted with three characteristics related to the owner and the management: the current access level in the forest stated by the forest owner, the

hunting interest on the property according to the owner and the forest owner's attitude towards providing ecosystem services which benefits the local community. The current access level is a dummy variable taking the value of one if the owner has stated, that he already allows the public access everywhere in the forest.

Table 4: Percentage of owners who currently provide/partly provide the investigated ecosystem services.

Ecosystem services	Variable name	Percentage owners who provide the service
Has min. 5% of untouched forest	HAVEUNTOUCH	60.1%
Leave 5 trees per ha for natural decay	HAVEDEAD	49.5%
Have > 50% broadleaves in the forest	HAVE50%B	71.7%
Have > 75% broadleaves in the forest	HAVE75%B	59.4%
Allows access everywhere	HAVEACC	9%
Attitude/interests		
Positive attitude towards benefits for the local community	Pos	45.3%
Hunting interests on the property	Hunt	73.5%

Positive attitude is a dummy coded variable describing the respondent's attitude towards subsidy schemes that also benefit the local community. The variable takes the value 1 if the respondent has stated that his/her motivation for entering a subsidy scheme is affected very positively/a little positively if the scheme is beneficial for the local community. Hunting interests is also a dummy variable, which takes the value 1 if the respondent or his/her family uses the forest for hunting or the hunting rights are let out to hunters.
The forest owners who already allow access everywhere in the forest require significantly less compensation for this service (approximately 116 DKK less). Owners who are positively motivated by providing services which benefit the local community require approximately 81 DKK less for granting access (per level). As opposed to this, owners with hunting interests on their property require approximately 47 DKK more in compensation. However, this latter parameter is influenced by the stated positive attitude - thus when that is left out, the interaction effect with hunting interests becomes insignificant (see Appendix 2).

Untouched forest areas
Allowing an interaction between setting aside forest as untouched with whether owners already provide this service, interestingly shows that it almost fully offsets the compensation requirement. 60% of the respondents state that they have minimum 5% untouched forest area on their property. This is far more than the average untouched forest area in the country which today constitutes 1.6% of the total forest area (Ejrnæs, 2009), indicating that the sample may be biased towards the ones already providing the services.

Leaving trees for natural decay
Similarly we see that owners who already leave trees for natural decay in their forest, have a positive parameter estimate for the interaction effect, causing a reduction in the required compensation. This is probably the reason why the main effect model shows a significant and negative compensation requirement for leaving trees for natural decay – sufficiently many

respondents are already doing it, namely 50%, cf. Table 4. Consequently, leaving *new* dead trees for natural decay is not something forest owners require compensation for.

Minimum percentage of broadleaves

One would expect that the actual broadleaved area on a property would have an impact on the compensation requirement for a broadleaved percentage restriction, as it would imply actual changes in the forest. However, as Table 3 shows that is not the case indicating that it is the restriction per se that matters. Although forest owners require compensation for the main effect of a broadleaves restriction of minimum 75%, the interaction with regard to already fulfilling the broadleaves requirement is neither significant for 50% nor 75%.

Discussion

The forest area in Denmark is characterized by being fragmented and owned by a large number of people who each owns a very small area. This implies that policy initiatives regarding enhanced biodiversity measures or recreational opportunities for the public, often will involve a large number of forest owners if they are to be successful. Attracting forest owners to take specific initiatives on their property through participation in voluntary schemes is therefore a prerequisite for reaching many of the national and international goals for biodiversity protection and conservation. The Danish forests serve as key habitats for more than 50% of the red-listed species in Denmark (Stolze and Pihl, 1998) and these forests are therefore of great importance for halting the decline in biodiversity.

Furthermore, in a landscape such as the Danish, characterized by intensive agricultural production, the forests play an important role in providing areas for recreation and leisure time activities for the public. With 75 million forest visits on average per year, forests are important for the public when they seek to be in peaceful and quiet surroundings, experience nature and get a break from everyday life (Jensen and Koch 2004). In a historical perspective, the interests of the public for pursuing recreational opportunities and leisure time activities has given rise to conflicts with landowners and their wish to maintain private property rights unaltered. To a great extent the interests of the public regarding recreational opportunities have been provided through public provision based on state ownership of forest – especially close to urban areas. However, with a private share of approximately 70% of the forest area in Denmark recreational use of private forest areas remains an important issue for a large share of the Danish population.

The provision of enhanced access

Our results here show that the issue of increased access is by far the most dis-motivating ecosystem service for forests owners among the policy issues investigated here. Owners require on average approximately 242 DKK per hectare for allowing access for walking everywhere in the forest for the public. Many of the viewpoints on this topic expressed in the open-ended statements in the questionnaire also reflect a strong aversion regarding increased public access. Forest owners with relatively small forest areas state that they do not want people to trespass close to their home and express concerns about maintaining privacy. The issue of enhanced public access rights in private forests has been part of environmental policy debates for several decades,

and our results illustrate that forest owners remain largely opposed to such initiatives and that to a significant degree compared to other potential initiatives. Interestingly, recent analyses of the willingness-to-pay for such enhanced access revealed that the general public is in fact divided on the value of such enhanced access (Campbell et al. 2013).

For many forest owners hunting plays an important role for both the economy and the personal interest of the owner. However, hunting interests only affected the WTA for access significantly when positive attitude also was included as an interaction, so this requires further investigations outside the scope of the present paper. Owners who had expressed strong or moderate motivation for creating benefits for the local community were willing to accept a significantly lower amount of compensation for granting the same rights of access to the public. However, the greatest impact reducing compensation for access was among the approximately 9% of forest owners who stated that they already do this; for this group the compensation dropped to approximately 5 DKK/ha for each level of access.

The enhanced provisioning of biodiversity protection

Turning to attributes related to enhancing biodiversity, we found that on average the forest owners require (3.6 DKK/ha/year for the entire forest per percentage set aside as untouched). Thus if 7 ha are set aside as untouched in a 100 ha large forest, the compensation is (3.6*7*100) 2520 DKK/year in total for the owner. Setting aside an area as untouched is a comprehensive management change which may entail large opportunity costs for some owners, depending on the characteristics of the forest area in question, so the required compensation appears low for this change. It should however be noted that there is considerable heterogeneity in these WTA measures within the sample of forest owners. One reason for that, is the fact that some forest owners already have set aside parts of their land as 'untouched' and hence may be able to deliver at virtually no cost. In fact, using an interaction dummy for owners who claim to already do this, we find that this group does in total not require compensation.

Finally, it remains a key issue for policies to investigate if the areas forest owners are willing to set-aside as untouched at a given compensation level (or maybe already have set aside) are also areas of interest for biodiversity protection purposes.

Leaving 5 trees/ha to grow old and for natural decay following final harvests is considered a small-scale management change, and the main effects model shows that they actually require less compensation for a policy when this is part of it. Looking at the model with interaction, it however reveals that the positive attitude is caused by respondents already doing this, resulting in an insignificant parameter estimate for this attribute per se. Thus leaving 5 trees/ha to natural decay is something forest owners, on average, are willing to do without receiving compensation.

Broadleaves restrictions

On several forest lands conifer stands have higher volume productivity and can be established at lower costs, and for these reasons species like Norway spruce (*Picea abies* L,) and Sitka spruce (*Picea sitchensis* Bong. (Carr.)) are quite widely used in monocultures. Therefore, the percentage of broadleaves varies significantly across the country. During the 1990s and 2000s various policies targeted increases in the area of broadleaves for several reasons, including concerns for forest stability (in particular risks of wind throw), but also concerns regarding groundwater quality and

quantity. Groundwater recharge under broadleaved forests is considerably higher and of better quality (lower nutrient loading) than under coniferous forests (Raulund-Rasmussen and Hansen 2003), and again the public has significant willingness-to-pay for such enhanced groundwater provision (Campbell et al. 2013).

Thus, we expect that on average forest owners will demand compensation for restrictions regarding species choice (broadleaves restrictions), but the compensation may vary a lot depending on current levels of broadleaves, soil type etc. In fact we find that owners are on average willing to accept a broadleaves restriction of up to 50% without significant compensation, and require only 53 DKK/ha and year for the entire forest for accepting a minimum 75% broadleaves restriction on their forest land. It should be noted, though, that there is significant variation among forest owners for the 50 % restriction level, whereas owners seem more united in requiring compensation for a 75 % restriction. Interestingly, the existing percentage of broadleaves on the property does not influence the compensation requirement. Thus it seems like the compensation requirement is due to the restriction per se rather than the actual required management changes.

Caveats and limitations

Our study here relies on the voluntary responses of a random sample of forest owners and therefore may suffer from significant selection biases relative to a fully representative sample. Although our final sample consists of only 283 forest owners, these forest owners in total have 55,228 hectares. This makes up approximately 14.4% of the Danish private forest land. Thus, despite the issue of self-selection bias, the forest properties investigated here makes up a large proportion of the privately owned Danish forest area. However, looking at the number of owners that provide untouched forest areas, it indicates that the sample may be biased towards respondents with some interest in providing these ecosystem services.

As the study relies on stated preferences techniques we cannot rule out that some owners may have found incentives for strategic answering perhaps. However, overall compensation levels are not high compared to estimated costs of these and related initiatives, e.g. for leaving single trees or undertaking environmentally friendly reforestation measures (see e.g. Jacobsen et al 2013), and this suggest that strategic answering may not have driven up WTA measures beyond ranges which must be considered realistic.

Conclusion

Enhancing the provision of biodiversity and recreational opportunities in forests relies to a great extent on private forest owners' own initiatives or their willingness to voluntarily accept contracts for the provision of specific ecosystem services. This study shows that forest owners do have differentiated requirements for providing different types of ecosystem services related to the Natura2000 framework. Moreover, in relation to most of these types of services, they differentiate their WTA according to the present management situation on their property.

Despite potential self-selection bias, the study is based on a sample of forest owners, who altogether own 14.4% of the Danish private forest area. This highlights the scope for targeting the

provision of ecosystem services and improving cost efficiency when combined with analyses of the value created on the benefits side.

Allowing increased access rights for the public stands out as the ecosystem service, which owners require the highest level of WTA for. On average the owners require 242 DKK per ha for allowing access everywhere on the forest floor, and half for allowing access up to 15 meters from roads and paths. The WTA for access is affected by owners' personal motivations for providing ecosystem services for the local community. 9% of the owners report that they already allow access everywhere, and for this group the WTA is close to zero. Initiatives to enhance biodiversity were also investigated, and analyses showed that for leaving forest areas untouched and preserving dead wood for natural decay, the WTA is closely aligned with the current management situation on the property. Accepting a restriction regarding minimum percentage of broadleaves is the only exception. Here owners on average do not require compensation for a restriction of up to 75%, and the level of compensation is unaffected by whether or not owners already fulfil this requirement on their property – indicating a requirement for compensation for the restriction itself.

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Appendix 1

Figure 1 shows an example of a choice set as it was presented to the respondents on screen where icons are used in the left hand column together with text to describe the attributes. Changes which are referred to in exact figures or percentages are in bold.

Valg mellem tilskudsordninger (1 ud af 6)
Hvis tilskudsordningen f.eks. indeholder en lavere ejendomsskat på 75 kroner per ha, og din største skov udgør 100 ha, så vil din kompensation i alt udgøre 7500 kroner hvert år (udbetalt efter skat) for hele skoven.

Hvilken af disse tilskudsordninger foretrækker du for hele din største skov?

Elementer i ordningen:	Tilskudsordning A	Tilskudsordning B	C - Ingen af disse tilskudsordninger
Krav om urørt skov:	**15 %** udlægges som urørt skov	Ingen ændring	Ingen ændring
Krav om træer der efterlades til naturligt henfald:	Ingen ændring	**5** træer/ha efterlades til naturligt henfald	Ingen ændring
Krav om andel af løvtræer i skoven:	Ingen ændring	**50 %** løvskov	Ingen ændring
Krav om adgang for offentligheden:	Adgang for offentligheden til fods **over alt**	Nuværende adgangsregler: Adgang til fods på vej og sti	Nuværende adgangsregler: Adgang til fods på vej og sti
Lavere ejendomsskat per hektar for din skov, der svarer til (udbetalt efter skat):	**25** kr/ha/år	**150** kr/ha/år	Ingen kompensation
Sæt ét kryds:	☐	☐	☐

Forige Næste

Figure 1: Example of a choice set as it was displayed to respondents. Choice between subsidy schemes (1 out of 6) If the subsidy scheme for example includes a lower property tax of 75 DKK per hectare, and your largest forest is 100 hectares, then your compensation will amount to 7.500 DKK every year (in cash after tax) for the whole forest. Which of these subsidy schemes do you prefer for your (whole) largest forest?

Appendix 2:

Table 5: RPL model with interactions - but excluding effect of attitude (based on 1000 Halton draws); WTA based on the Delta method. 1 € equals approximately 7.5 DKK.

	Coefficient	Z	WTA	95% confidence interval
Random parameters in utility functions				
UNTOUCH	-.13990***	-3.28	9.03343***	(4.1 - 14)
DEAD	-.00550	-.08	.35526	(-8.9 - 9.6)
BLEAVE25	-.39360	-1.19	25.4152	(-16 - 66)
BLEAVE50	-.11286	-.20	7.28749	(-65 - 80)
BLEAVE75	-1.03709**	-2.22	66.9661**	(12 - 121)
ACC	-1.57380***	-4.18	101.622***	(51 - 152)
Non-random parameters in utility functions				
ASC	5.10001***	6.78	-329.312***	(-420 - -239)
PRICE	.01549***	7.15		
HAVEUNTOUCH*UNTOUCH	.13029***	2.83	-8.41309***	(-14 - -2.8)
HAVEDEAD*DEAD	.19985*	1.90	-12.9042*	(-26 - 0.20)
HAVE50%B*BLEAVE50	-.32689	-.47	21.1079	(-67 - 109)
HAVE75%B*BLEAVE75	.43154	.84	-27.8647	(-92 - 36)
HAVEACC*ACC	1.63090**	2.25	-105.308**	(-201 - -9.5)
HUNT*ACC	-.49606	-1.23	32.0312	(-18 - 82)
Standard deviation of normal distributed random parameters				
UNTOUCH	.12614***	4.35		
DEAD	.28640***	3.15		
BLEAVE25	1.00909	1.47		
BLEAVE50	1.27435**	2.07		
BLEAVE75	.82543	1.03		
ACC	1.33405***	4.32		
Standard deviations of error component				
Sigma*10	5.18046***	7.39		
Number of respondents / Pseudo R^2	283/0.5865			
Log-likelihood / R^2 adjusted	-771.3/0.5840			
Restricted LL / χ^2	-1865.4/2188.3			

***, **, * ==> Significance at 1%, 5%, 10% level.

A model excluding hunting interest, but including positive attitude, shows that the interaction effect of attitude is significant in both case, and not brought forth by the presence of the variable for hunting interests.