A report summarizing examples from case studies on the application of cost of provision assessments and the relations to the main finding from the forest owner surveys

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1 INTRODUCTION

Assessing the cost of provision of positive forest externalities is important for policy-making. By combining these estimations with information about the demand side, it is possible to estimate the social optimal supply of forest externalities. Furthermore, knowledge about forest owners' additional costs associated with an increase in their supply of ecosystem services provides useful information for the design of policy instrument. This includes the development of programs for payment of ecosystem services (D4.3). An assessment of the cost determinants such as forest type, forest owner type and management measures, is particularly important for policy design.

Europe is characterized by large regional differences in the natural conditions, e.g. various climates, institutional contexts, and public demands for forests ecosystem services. The large diversity of the methods applied for the cost assessment reflects this diversity. It is one of the reasons why the same methodological approach was not applied in all case studies. The choice of the survey approach was influenced, among others, by forest owner characteristics, the possibility of having access to forest owner databases and the ecosystem services considered.

The variety of contexts and the applied methods imply that this study has limited meaning to compare the costs estimates between different case studies or to calculate one unique value of cost. The work package should be seen instead as a tool box where the different tools for costs assessment have been tested. The acquired experiences will be an important starting point for other researchers and practitioners who will make regional and context-specific costs assessments in the future. Even though the surveys and cost assessments of this report are different, it has been possible to compare some results between case studies. In the synthesis of the case study analyses below, the comparison is initiated; however, it is still at a preliminary stage. In the forthcoming analyses of the collected data several aspects will be considered, such as the relation between current management practice, forest management objectives, forest owner characteristics, and perceived costs of providing ecosystem services. The results of these analyses will be relevant to draw a comparison among the case studies.

The survey strategy, the data collection as well as the questionnaires developed for each case study were presented in detail in deliverable D3.2. This deliverable focuses on data analysis. In the Atlantic, Central European, Boreal case studies as well as in the French pilot study, data from quantitative survey as well non-survey data were analysed and results reported. Similarly, in the Mediterranean case study, both qualitative survey and non-survey data were investigated and results reported. In the Mountainous region case study, quantitative data private forest owners, public forests and community forest were investigated. In the German and Amazon study, the focus was on survey data.

In the following section a synthesis of the analyses carried out in each of the case study regions is presented. The objectives, methods and main results of the analyses are structured according to the type of data used, in order to facilitate comparisons across case studies. In particular, three main groups were considered: quantitative survey; qualitative survey and non-survey analyses. Then, we conclude the synthesis with some lessons learned. Finally, the reports of the analyses of each case study are included.

2 A SYNTHESIS BASED ON CSP

The survey strategy, the data collection as well as the questionnaires developed for each case study were presented in detail in deliverable D3.2. This deliverable focuses on data analysis. In the Atlantic, Boreal, Central European, Mountainous case studies as well as in the French pilot study, data from quantitative survey were analysed and results reported. In addition, for most of these case studies, methodologies not based on survey data (i.e. engineering methods, production possibility frontier methods) were applied to shed more light of the cost of provision of forest externalities issue. Similarly, in the Mediterranean case study, both qualitative survey and non-survey data were investigated and results reported.

In this section a synthesis of the cases' analyses is presented. The objectives, methods and main results of the analyses are structures according to the type of data used, in order to facilitate comparisons across case studies. In particular, three main groups were considered: quantitative survey; qualitative survey and non-survey analyses.

2.1 *Descriptive data of the private forest owners samples*

In this sub-section, a cross-case-study comparison of the keys variables describing the forest owners' samples is presented. Due to the peculiarities of each case study survey, this comparison was not always possible. A comparison was possible only between the Atlantic case study (Denmark), the Central European case study (Poland), the Mountainous region case study (Italy), the French pilot study and the German case. For the age structure and the income of respondents, descriptive statistics were also available for the Boreal case study (Finland).

Nevertheless, we believe that an overview of similarities and differences between forest owners' samples across countries can offer a better understanding of the framework of cost of provision estimates. Moreover, it can possibly contribute to stimulate further research questions.

2.1.1 Representativeness of the sample and sample size

The data collected in the case studies presented different spatial scales. The Boreal, the Mediterranean and the Mountainous case studies had a regional scale. The French pilot study sample referred to five different administrative regions. The Atlantic case study, the Central European case study and to some extent the German study were carried out at a national level.

The Boreal case study focussed on the private forest owners in the Kuusamo municipality, who owned at least 7 hectare of forest. The final number of completed responses was 471 (response rate 35.3%). The representativeness was not directly addressed.

The Mediterranean and the Mountainous case studies targeted respectively the Catalonia region (Spain) and Veneto region (Italy). In the Mediterranean case study, due to the difficulties in conducting a quantitative survey, a qualitative face to face recorded interview was conducted through a selected purposive sampling (see deliverable D3.2). The sample was not representative of forest owner in Catalonia. In the Mountainous case study, overall 197 forest owners were interviewed by trained interviewers. Two main strata were used for sampling: the distribution of forest area amongst the 4 mountainous provinces of the Veneto region; and, inside each province, the distribution of type of ownership amongst public (municipality or region) property, common propriety (the so called “regole”) and private property. Since there is not an official record of private forest owners in Italy, the sampling was based on the forest surface represented, independently to the reference population. The surface target has been reached for the 80%.

The French pilot studied focussed on five administrative regions scattered across France: Lorraine in the North-east, Pays de la Loire in the North-west, Bourgogne and Auvergne in the centre, and Provence-Alpes-Côte d’Azur in the south. Although the sample refers to only five different administrative regions, it was rather reasonable to compare its representativeness to the national private forest owner population characteristics. The sample did not represent the forest owner population in terms of property size and gender. In particular, small forest owners were underrepresented. A higher degree of representativeness was found regarding the age structure and the professional situation. Overall 590 questionnaires were returned (response rate 3.9%). Due to the presence of incomplete questionnaires, 241 observations could be used in the cost of provision estimation.

The Atlantic case study sample included 308 respondents (response rate 32.6%). Given the lack of socio-demographic data on the population of private forest owner, it was not possible to compare the representativeness of the sample. However, comparisons were made with previous Danish studies on private forest owner and with the general population (see the Atlantic case study report for more details). In contrast to the French study, in the Atlantic case study it was harder to obtain data on owners of larger properties.

The Central European case study surveyed 100 forest owners possessing forests which size was equal at least to 5 hectares through a pooling agency (the survey was carried out as a part of the POLFOREX project funded by the EEA Financial Mechanism Norwegian Financial Mechanism and the Polish Ministry of Science and Higher Education). The representativeness of this sample could not be tested since in Poland there is no private forest owner association at the national level and there are no socio-demographic data available on the total population of forest owners.

As far as the German study is regard, 209 forest owners answered the questionnaire. No census data of forest owners are available for Germany; therefore, it was not possible to compare the representativeness of the sample.

2.1.2 **The forest property**

On average, the Central European and Mountainous case studies, private forest properties were smaller than in the other case studies, about 6 ha and 16 ha respectively (in the Polish case properties smaller than 5 ha were excluded from the analysis). In the Mountainous case study, public and common properties were 240-280 times larger than private properties.

The average private forest property in the Danish and German sample (191 ha and 148 ha, respectively) was larger than in French sample (99 ha, see Table 2.1). This was due to a presence of very large estate in the Atlantic case study (the largest property was 7167 ha) and in the German study (11000 ha). As a matter of fact the 25-50-75% quartiles of the forest property size distribution from the France sample were larger than in the Danish and German sample.

The majority of the forest properties investigated in the Atlantic, Central European, and Mountainous case studies as well as in the French pilot study was served by an access road. Forests without a road with public access were about 34% in the Atlantic case study, 33% in the Mountainous, 28% in the Central European, and 22% in the French pilot study.

Table 2.1: Size of total forest area owned in hectare (non-private forest in grey)

Study	Mean	St. Dev.	25% quartile	50% quartile	75% quartile	min	max
Atlantic case study	191.1	763.80	3	10	39.75	0	7167
Central European case study	15.7	23.67	6	9	15	5	180
French pilot study	99	240.46	5.3	22	80	0.2	2800
German study	148.3	838.67	2.65	10	56	0.3	11000
Mountainous region case study (private n=132)	5.9	10.57	1	2.05	4.1	0	72
Mountainous region case study (common n=18)	1425.8	2716.94	330	689	1016	175	12000
Mountainous region case study (public=42)	1196.8	1240.93	320	725	1444	8	4860

2.1.3 **The forest owner**[1]

As far as the age of the respondent is regarded, differences were found between the case studies. Danish, Polish and German forest owners were mostly middle aged (47% of Danish respondents was in the 30-60 age class, 66% of German respondent in the 40-60 age class, 75% of the Polish forest owners were younger than 60). In contrast, 63% of French respondent, about 57% of the Italian (only private forest owner considered) and almost 55% of the Finnish respondents were over 60.

In the Mountainous and Central European case studies only respectively 10% and 13% of the respondents have a higher education (at least two years of education after the high school). In contrast, in both the French and the Atlantic samples, there seemed to be a significant higher share of highly educated people. In the former, over 50% of the respondents had at least two years of higher education after the high school diploma. In the

[1] In this section, only private forest owners are considered in the discussion for the Mountainous region case study.

latter, 49.5% of the forest owner had some type of higher education. Given that the French and Danish surveys were done by mail and internet, it may well be that higher educated individuals had a higher willingness to participate and express their opinions. This may led to an overrepresentation of these individuals in the samples, as found in other survey studies. However, since there are no national censuses of forest owners, it is not possible to draw more precise conclusions.

The total income distribution of forest owners (presented in income classes) in the Atlantic, Nordic, French and German case studies were not directly comparable, because the Atlantic and French data referred to the gross income (before taxes), whereas German, Central European and Boreal data referred to the net income. The income class with the higher frequency in the Atlantic case (about 14%) included all gross monthly incomes higher than 13,423 € (100,000 DKK); in the French pilot study, the most frequent gross monthly household income class (about 24%) ranged from 2,917 € to 4,167 € (equivalent to 35,000 to 50,000 € on an annual basis); in the German sample, two net monthly income classes had the highest frequency (circa 20%), namely the 2,000-2,499 € class and the 2500-2999 € income class. In the Nordic sample, the net monthly income class 3,000-4,000 € had the highest frequency (15.5%). In the Central European case the average income was approximately 640 € per month (2553 zloty in June 2011), and the most frequent income class was the one ranging from 250 € to 500 € (about 1001-2000 zloty in June 2011). The no response rate for this question was rather high, ranging from about 19% in Denmark to 37.4% in Finland. In the Mountainous case , the household income was not asked.

2.1.4 The forest management

The majority of private forest owners in the Atlantic case study and French pilot study did not have a management plan. In particular, the percentage of respondents without a management plan was rather high in the Danish sample (75%) compared to the French sample (approximately 54%). Not surprisingly, in these case studies, forest owners were highly independent in their forest management. The largest part of the management decisions, specifically 48.38%, in the Atlantic case study sample was made by the forest owner. Similarly, about 69% of the forest owners in the French sample managed their forest directly.

However, in other case studies such as in the Italian and Polish cases, the management plan is regulated by law. In the Polish case, forest management, either in state forests or in private ones is based on 10 year forest management plans. Private forest owners have a right to harvest trees according to their local forest management plans, which are drawn up by the Forest Management and Geodesy Bureau, which is subordinated to the Minister for Treasury. In Italy, public and common forests (regole) must have a management plan by law. Due to the tiny average size of the forest property, management plan is not required to private forest land. However, private forest owners have to make a cut declaration in case they intend to harvest timber.

Differences across the case studies were found regarding the implementation of forest operations. In the Atlantic case study, roughly 57% of the harvesting operations were carried out by the forest owner or a member of his/her family; external contractors conducted the felling operations in around 30% of the cases. Similar results were found in the German sample, where nearly 60% of forest owners directly executed forestry work, whereas external consultants were contracted in about 17% of the cases. Different results emerged from the French survey. Only 19% of French forest owners interviewed were responsible of the logging operation directly (or through a member of his family). The largest part of the harvesting operations (approximately 58%) was actually carried out by the timber buyer. In the remaining 21%, contractors were hired. Contrastingly, in Poland the largest part of the forest operations (about 85%) were carried out by the forest owner or a member of his family.

Regarding forest certification, only a small share of the private forest properties in the Atlantic case study and French pilot study had a certificate of sustainable management, such as FSC or PEFC. As a matter of fact, about 87% of the forest properties in the Danish sample and 64% in the French sample were not certified. In the Mountainous region case and in the Central European case, none of the private forest owner had a certificate for sustainable management practices (PEFC or FSC).

2.1.5 Wood supply and economy of the forest

Data on revenues, costs and volume of timber production were collected in the Atlantic, Central European, Mountainous region case studies and in the French pilot study. The percentage of no response relatively to these questions was rather high, with exception of the Polish study. Roughly 60% of the Danish respondents and 80% of the French respondents did not answer these questions. In the Italian case, the non-response rate among private forest owners was about 90% for questions regarding revenues (this value may be overestimated due to a high rate of passive forest owner in the sample who may not have responded because they did not do any activity) and around 40% for the cost related questions. Therefore, results must be treated with caution and would not be compared here. The interested reader may find more information in the case study sections.

2.1.6 Services provided by the forest

In both the Atlantic, Central European and French studies, the average respondent visited his/her forest both for recreational purposes (i.e. walking, picking berries, wildlife watching) and for work related purposes. In Italy the presence in the forest of the owners was mostly for forestry work (53%) or control activities (33%). Recreational activities and hunting were seldom practiced by the owners in their own forests. Circa one third of the respondents in France and slightly more than half of the respondents in Denmark used their forest for hunting. In Poland and Italy, hunting was done by a small share of the sample.

Results relating to leisure activities were not directly comparable: However some general indications could be extracted. It seemed that the possibility of leisure activities was offered more in the forest properties analysed in the Mountainous and Danish survey compared to the French situation. In particular, in less than 50% of the forests in the French sample, it was possible to practice leisure activities. In contrast, the largest majority of respondents in the Atlantic case study survey (approximately 84%) affirmed that he/she visited his forest for recreational purposes. This may suggest that in 84% of the Danish properties, leisure activities were possible, at least for the owner. In the Mountainous case, at least one facility for recreational activities (such as marked walking paths, mountain shelter or hotel, picnic areas, forest road, climbing sites. adventure parks) was present in 68% of the private forests (and 95% of the public ones). In contrast, in the Polish sample instead, touristic facilities (educational path, benches, indication tables, camping site, litter bins) were not present in 95% of the properties.

In the Atlantic case study, it emerged that 10.71% of the forest in sample was partially or totally within a Natura 2000 site; this percentage was close to 8% in the French sample, 7% in the Central European sample, 27% in the Mountainous region sample (but this percentage drop to 7% if only private forest property is considered). National parks touched slightly more than 2% of the properties in the Danish sample, against 1% in the French one. In the latter, regional parks included partially or totally nearly 9.5% of the studied forests, which on average had a share of 20% of their areas under conservation measures. In the Mountainous region case a large share of the forest property sampled were protected. About 16% of the private property was under some form of protected area.

2.2 *Quantitative survey analysis: Choice experiment*

2.2.1 **Boreal and Atlantic case studies**

In four case studies stated preference (cost) methods were used to estimate the cost of provision of forest externalities. In the Boreal and the Atlantic case studies choice experiments (CE) was used to estimate the cost of provision. In the central European case study an experimental approach was also used but here the main objective was not to derive quantitative estimates of the cost of provision but to investigate more generic behaviour related to provision of positive externalities. The basic description of the CE approach is given in D3.2. This Deliverable also discusses basic issues related to implementation of a CE in the context of cost assessment. In this section, the application of the two case studies where CE is applied and the respective results are presented. Detailed descriptions of the results are found in the respective sections (n. 4 and 5) reporting the case study results.

2.2.1.1 ***Objectives, context and questionnaires***

The two CE are not directly comparable. The two case study areas differ with respect to the ecological and socio-economic context. The ecological conditions constrain the potential provision of externalities and the socio-economic conditions determine which externalities are demanded. In the Boreal case study, located in the Ruka-Kuusamo area, nature-based tourism plays an increasing role. Therefore, the focus in this study was on the estimation of the costs of provision of forest landscapes which meet the preferences of tourists visiting the region. In the Atlantic case the focus was on the externalities demanded by the general public. However, in both cases the objectives were to estimate the costs of provision of externalities considered in Work package 2 (WP2). In WP2 the demand for main externalities was estimated.

2.2.1.2 ***Design and implementation of the choice experiment***

The applied empirical approach (the CE) is based on choices between scenarios described by a number of characteristics (attributes). In the two applications the scenarios were described as potential contracts which a forest owner could choose between. The contracts described different constraints on forest management and an associated compensation. Table 2.2 summarizes the attributes which were considered in the two choice experiments. In the Atlantic case study, the compensation was in the form of a reduction in the property tax, whereas in the Boreal case it was a subsidy associated with the contract. In both cases, the forest owner could choose a status quo option, i.e. no contract. In the Boreal experiment, there was also included a contract attribute describing the length of the contract. The Atlantic experiment did not include attributes related to contract administration.

Table 2.2: Scenario attributes and levels in the Boreal and Atlantic case study

Boreal Attributes	**Boreal Levels**	**Atlantic Attributes**	**Atlantic Levels**
Harvesting restrictions	No restrictions No clear-cutting No regeneration cuttings No harvesting at all	Set aside an area as untouched forest	No change 7% 15%
Size of restrictions	0, 5, 10 or 20% of the forest area of the property	Leave 5 old trees for natural decay	No change Leave 5 old trees for natural decay
Length of new hiking and skiing routes	0, 500 or 1000 meters	Increase the area with broadleaves	0%, 25%, 50%, 75%
Duration of contract	5, 10 or 20 years	Increase the public's access	No change Access for the public on foot up to 15 meters from roads and paths Access for the public on foot everywhere
Amount of compensation (€/hectare/year)	30, 60, 120, 180, 240 or 300	Lower property tax (per DKK/year)	0, 25, 50, 75, 100, 125, 150, 175

The questionnaire and the survey strategy were described in D3.2. Here, an overview of the realized implementation of the questionnaire is briefly presented. The Boreal survey was implemented as a postal survey, whereas in the Atlantic case study a letter with an invitation to complete the questionnaire on the internet was sent to the forest owners.

In the Boreal case study, forest owners with more than seven hectares where considered and one third of the 3,900 forest owners in Ruka Kuusamo were in the sample. The sample was stratified with respect to the core areas and the rest of the Ruka Kuusamo municipality. The number of completed questionnaires was 471.

Table 2.3 Summary of survey and choice experiment design

	Boreal	**Atlantic**
Implementation period	June-August 2012	March-April 2012
Survey mode	Postal survey	Postal/internet
Minimum forest size	>7 ha	
Sample	1355	1429
Number of responses	471	308
Stratification	Location (over representation in core area)	Forest size (over representation of large forests)
Contact to Forest owners	Kuusamo Forest Management Association	Addresses from National forest inventory
CE design: D_B-efficiency	D-error= 0.000231	D-error= 0.000124
Blocks	4	4
Choices tasks total	24	24
Choice task per questionnaire	6	6

2.2.1.3 *The CE results*

The results of the preliminary analyses of the data from the choice experiments are reported and discussed in more detail under each case study area. Generally, it emerged that the results depended on the design of the contract and that the compensation required by a forest owner to accept a contract increased with number of constraints included in the contracts. In the Boreal case study, the likelihood of participating in contracts, where harvest was not allowed and where the size of forest under restriction was high, was relatively low. With a short duration of the contract and with high compensations, owners were more likely to enter into a contract. The harvest restrictions defined by no clear-cutting and no regeneration cuttings as well as the length of new hiking and skiing routes had no impact on the choice of participating in a contract. In Table 2.4, estimates of the willingness to accept are reported for the Boreal case study. The estimates represent the additional compensation a forest owner demands to accept a contract with the constraints reported in the table. For example, on average, a forest owner required at least 310 € (124.6+10*47+139.6) to accept a 10-year contract with the constraint that there would be no harvest on 10% of the land.

The results also showed that there is significant heterogeneity in forest owners' willingness to accept a contract. In the Boreal case study, the interaction terms between income group and the demand for compensation were significant and they indicate that high-income forest owners demanded less compensation.

Table 2.4 Summary of compensation demand for contract attributes in the Boreal case study. Conditional model without interaction terms

Boreal **Attributes**	**Boreal** **Compensation (€/ha/year)**
Status quo (no contract)	30.5
No clear-cutting	n.s.
No regeneration cuttings	n.s.
No harvesting at all	123.6
Size of restrictions (%)	4.7
Length of new hiking and skiing routes (meters)	n.s.
Duration of contract 5 years	114.6
Duration of contract 10 years	139.6
Duration of contract 20 years	277.4

n.s.: The attribute or attribute level are not significant

Table 2.5 shows the average compensation (in tax reductions) demanded by forest owners to enter a contract given the different contract attributes in the Atlantic case study. Here, the results are based on a random parameter logit model which takes into account the heterogeneity in forest owners' willingness to accept a contract. The results showed that all contract attributes were significant except for the restriction of minimum 50% broadleaves. Respondents required additional compensation for leaving an area as untouched forest, for accepting a broadleaves restriction of 75%, and for granting the public increased rights of access. On average, forest owners were willing to accept a lower compensation if the contract included preservation of old trees for natural decay. In the Atlantic case study, interaction terms were included. According to the results from the random parameter logit model, forest owners who had declared that they were positively motivated to enter subsidy schemes which were beneficial for the local community required approximately 70 DKK less in compensation for providing access up to 15 meter from roads and paths. On the other hand, respondents using their own forest for hunting required approximately 42 DKK additional to the 138 DKK for granting access up to 15 meters from roads and paths.

Table 2.5 Summary of compensation demand for contract attributes in the Atlantic case study. Random parameter logit with interaction terms

Variable	**Compensation (DKK/ha/year)**
Set aside an area as untouched forest in %	3.8
1 old tree preserved for natural decay	-8.1
Accept a broadleaves restriction on 50 % of the area	n.s
Accept a broadleaves restriction on 75 % of the area	50.9
Increase the public's access (0: no change, 1: Access for the public on foot up to 15 m from roads and paths, 2: Access for the public on foot everywhere)	138.6
Increase the public's access interacted with positive attitude to schemes being beneficial for the local population)	-70.8
Increase the public's access interacted with forest owners own use of the forest for hunting	41.7
Status quo (no contract)	-341.6

n.s.: The attribute or attribute level is not significant

2.2.1.4 *Discussion of the results*

The results showed that, in general, forest owners required compensation for restrictions on forest management. However, the demanded compensation depended on the characteristics, attitudes, and their own use of forest (e.g. hunting use). Forthcoming analyses will address more in detail the cost heterogeneity in both case study areas. The Boreal study also showed that the administrative design of the contracts (length of contract) could have an important impact on the perceived costs of participation. The two choice experiments are not directly comparable. However, we find that in the Atlantic study the demand for compensation was high when it concerned increased public access to forests; whereas in the Boreal study, increasing the length of hiking and skiing routes did not have a significant effect on the demand for compensation. It should here be mentioned that the Boreal case dealt with increasing length of (existing) routes in the forest, whereas the Atlantic case dealt with allowing a new type of access, namely access outside established road and paths. In both cases, restrictions on harvest (Atlantic: Set aside an area as untouched forest; Boreal: no harvesting at all) were considered as costly restrictions. However, in the Atlantic case study the preservation of old trees for natural decay was not considered an important cost factor and in the Boreal study the restrictions "no clear cutting" and "no regeneration harvest" had no significant impact on the demand for compensation.

2.3 *Quantitative survey analysis: Other methods*

2.3.1 Amazon case study

2.3.1.1 *Objectives and context*

In the Amazon case study, the main objectives are to investigate the causes of deforestation and forest degradation and to estimate the opportunity costs of protection the forest. The survey was carried out in February – April 2011. The results have been analysed and a paper is currently submitted and is under revision in an economic journal. Therefore, below only a few summary statistics on the implementation of the survey is reported. Early 2013, when the journal review has been completed, this present report will be supplemented with the main results. Note that a more detailed description of the survey approach and hypotheses can be found in D3.2.

The case study applied semi-structured questionnaires at the village and farm-household level, covering approximately 30% of the population of the two studied intervention areas: the protected areas Juma and Uatuma, both so called Sustainable Development Reserves (SDR) with large, and often well conserved forest areas, relatively scarcely populated by forest-dwelling people with variable degrees of agricultural versus hunter-gatherer type of economic activities. We also interviewed a small number of households outside of the intervention areas, for comparison.

2.3.1.2 *Implementation*

In the Brazilian case study, stated cost methods and qualitative surveys were combined. The stated cost methods included a contingent valuation approach and an auction approach. In both approaches, the objective was to estimate the opportunity cost of restricting current forest use of the respondents.

The case study applied semi-structured questionnaires at the village and farm-household level, covering approximately 30% of the population of the two studied intervention areas: the protected areas Juma and Uatuma, both so called Sustainable Development Reserves (SDR) with large, and often well conserved forest areas, relatively scarcely populated by forest-dwelling people with variable degrees of agricultural versus hunter-gatherer type of economic activities. A small number of households outside of the intervention areas was also interviewed for comparison.

Table 2.6 provides a summary of survey implementation and Table 2.7 the stratification of the sample. Note that the sample was split into two groups: One group received contingent valuation (CV) questions and the second participated in the auction.

Table 2.6:. Summary of the implementation of the survey in Amazonas, Brazil.

Implementation period	February – April 2011
Survey mode	Household survey (face-to-face)
Sample	340
Number of responses	340
Stratification	Location (inside and outside PES area which were two Sustainable Development Reserves) See table below
Contact to Forest owners	FAS (Sustainable Amazon Foundation: local agency responsible for PES area), and CEUC (State Centre for Conservation Divisions)

Table 2.7:. Distribution of sample on the two areas and empirical approach.

Area	Standard CV # of households	Auction CV # of households	Total number of households	Total number of villages
Inside Uatumã SDR	69	53	122	11
Outside Uatumã SDR	28	22	50	4
Inside Juma SDR	58	64	122	24
Outside Juma SDR	24	22	46	3
Total	179	161	340	42

2.3.2 Central European case study

2.3.2.1 *Objectives and context*

The aim of the survey was to investigate the potential compensations for forest owners for introducing changes in the management in order to enhance the provision of environmental services into their forests. The focus was on two distinct forest environmental services: recreation and biodiversity protection.

The private Forest Owner Survey presented in this chapter was carried out as a part of the POLFOREX project “Forest as a public good. Evaluation of social and environmental benefits of forests in Poland to improve management efficiency”; PL0257; (2008-2011) funded by EEA Financial Mechanism, Norwegian Financial Mechanism and Polish Ministry of Science and Higher Education.

2.3.2.2 *Methods*

The private Forest Owner Survey was conducted in June 2011 by a professional polling agency, through face to face interviews. A total of 100 forest owners were interviewed. Only forest owners with at least five hectare of forest were considered; five hectare was considered the minimum size above which forest owners start to actively choose between different management regimes.

The survey was designed as a contingent valuation with the outcomes of two different management regimes. The first one concerned the enhancement of biodiversity by limiting logging and leaving fallen trees in the forest for a period of 10 years. The second regime concerned improvements of the recreational (touristic) conditions for a period of 10 years. In the first case, as a payment vehicle an annual compensation per hectare was used, in the other an annual compensation per forest. The applied elicitation format proposed to the interviewees was a payment ladder with four possible answers to proposed bids: “definitely no” “rather no” “rather yes”, “definitely yes”. It was furthermore specified that if the compensation amount stated by the respondent resulted higher than the average indicated by the other respondents, he/she would not take part in the program.

Interval regression models were eventually run to investigate the variation in the willingness to accept (WTA) of the compensations for two different management regimes based on “rather no” and “rather yes” responses. The Kaplan–Maier non-parametric technique was used to estimate the willingness to accept these schemes.

2.3.2.3 *Main results*

The results of conducted survey indicate that the majority of the respondents would be interested in participation in voluntary schemes regarding enhanced biodiversity measures or recreational opportunities for the public. About 53% of the respondents stated that the programs focusing on maintaining the high level of biodiversity in some private forests in Poland were needed, and 61 % of them declared they would like to take part in such a program. The average WTA to participate in this program for those who agreed was equal to 305 zł (76 Euro) per hectare. However, more than half of the respondents noticed that such a program would increase the risk of tree disease and expansion of insects. Concerning recreation, 69% of respondents agreed with the statement that the public should be allowed to enter private forests in the recreational purposes. The participation rate in such a program corresponded to 79% of the sample. The average WTA to participate in this program for those who agreed was equal to 7013 zł (1753 Euro) per year. More than the half of respondents agreed with the statement that the nature is a public good and everybody should benefit from it.

The results from the interval regression models used to investigate willingness to accept the compensations for introducing two different management regimes show rather poor fit. That can be explained by a few factors. Firstly, Polish forest owners have no experience with voluntary schemes; secondly, their economic activities in the forests are constrained by the law. Additionally, from the methodological point of view, the analyzed sample was quite small. Only in the model concerning the recreational scenario two coefficients appeared to be significant. The younger respondents and those with the smaller forest sites were willing to accept the lower compensation for improving recreational conditions in their forests. The first case can be explained by the fact that younger people in Poland are more familiar with the market mechanisms and they are more rational in their expectations concerning payments for ecosystem services. In the second case, since the compensation was defined in zł per year unit, a wish to receive higher compensation for the larger forest seems to be reasonable.

2.3.3 German case study

2.3.3.1 *Objectives and context*

In addition to the studies on forest owners originally planned in NEWFOREX a survey was conducted nationwide on forest owners in Germany. The focus of this study was forest cooperatives and their members. Moreover, the questionnaire focused primarily on issues related to policy measures for externality provision (results are reported in D4.3). However, here is reported the main results on forest owner priorities.

2.3.3.2 *Results*

In two mailing campaigns, 1479 paper questionnaires were sent to forest owner management cooperatives. In the questionnaire, an internet link was included (printed) and the forest owner management cooperatives should forward this link to their members by email. Thereby, it was possible to reach forest owners as well. Overall, 209 forest owners answered the online questionnaire.

Table 2.8 shows how forest owners assessed different types of values associated with owning a forest. It appeared that the first priorities for forest owners in Germany were to keep the forest in family ownership, cover their own demand of services (firewood and recreation services) and to obtain a profit. Amenities provision (e.g. nature protection and aesthetics landscapes) was considered as important. For further discussion of results could be found in the German study section.

Table 2.8: How important are the following forest values for you? (0 = unimportant, + a bit important; ++ important, +++ very important)

Forest values	**0**	**+**	**++**	**+++**	**Sum**
	Total/ Percent	Total/ Percent	Total/ Percent	Total/ Percent	Total/ Percent
Covering own Requirements (Firewood, Hunting, Fishing, Mushrooms)	29 14.36	33 16.34	56 27.72	84 41.58	202 100
NATURE PROTECTION (Animal protection, Biodiversity preservation)	13 6.37	47 23.04	98 48.04	46 22.55	204 100
EXPERIENCE VALUE (Recreation, aesthetics, privacy)	34 17.00	69 34.50	68 34.00	29 14.50	200 100
ENTERPRENEURIAL USE (Timber sales, Hunting leases)	16 7.88	36 17.73	65 32.02	86 42.36	203 100
INVESTMENT (Savings for large purchases)	48 24.12	60 30.15	57 28.64	34 17.09	199 100
TRADITIONAL VALUE (Continuing family heritage)	15 7.50	19 9.50	72 36.00	94 47.00	200 100

2.3.4 French pilot study

2.3.4.1 *Objective and context*

In the French pilot study, the main focus of the questionnaire was the willingness to harvest timber. Therefore, the quantification of the costs of provision of forest externalities could not be directly determined. A heuristic method was therefore implemented. This method compared the expected monetary outcome per hectare across individual with different management objective. In this sub-section, the methodology and the results are briefly described. Detailed descriptions are found in section 7 reporting the case study results.

2.3.4.2 *Data and methods*

Out 15000 forest owners selected by stratified random sampling, only 590 replied to the questionnaire (response rate 3.9%). Due to the high number of incomplete questionnaires, 241 could eventually be used in the analysis.

In the questionnaire, respondents were asked to rank their management objectives from a given list (wood production; leisure activities, hunting; participation in the climate change mitigation, preservation of biodiversity; preservation of water quality, risk prevention). From this question a four level ordinal variable was created in order to measure the relevance of amenities (considered in general) in the management objective of each respondent.

Respondents were then divided in four groups according to this variable: "mostly production" (wood production is the primary management objective; amenities provision might be considered as a secondary objective); "production & amenities" (wood production and provision of some amenities are both primary objectives); "mostly amenities" (amenities provision is the priority, but wood production is considered as a secondary objective); "no production" (amenities provision is the only priority; wood production is not considered).

Successively, three measures of forest monetary income were computed for each respondent: the expected mean timber revenue per hectare of productive private forest (EMTRH); the forest income per hectare of owned forest (FIH); the expected forest income per hectare of owned forest (EFIH). The first and third measures were expected monetary outcomes because they considered the likelihood that a specific respondent would harvest timber in his property. This probability was estimated by a logistic model which considered the characteristics of the owned forest, the type of management, his/her socio-demographic characteristics and his/her management objectives.

After the three measures of forest income were computed, they were averaged among respondents within similar management objective group. For each monetary outcome measure, the difference in the average monetary outcome per hectare between the group of respondents with "only production" objective (considered as the traditional and most diffused paradigm) and the groups with greatest interest for amenities provision served as proxies for the opportunity costs.

2.3.4.3 *Main results and discussion*

Results from this analysis confirmed the presence of opportunity costs in terms of reduced timber revenue (or income) related to the amenities provision. The three monetary outcome measures showed a rather similar pattern. The trade-off between timber production and amenities provision seemed to be confirmed. However, whenever timber production plays a primary role (as for mostly production group) or a co-primary role (as for the production & amenities), there seemed to be no difference in the opportunity costs. This may be explained by the existence of a threshold level of services production below which the join production of timber and services is somehow complementary.

On average, respondents with a management objectives giving priority to amenities (still considering wood production as secondary objective) would face a reduction of their forest monetary outcomes ranging from 9.3 to 33.6 €/ha/year compared to respondents focussing primarily on timber production. The loss would increase to 26.6 to 60.9 €/ha/year for respondents giving priority only to amenities (not considering wood production in their management objective). These losses could be considered as proxies of the opportunities cost of amenities provision.

The ranges in the loss estimation are explained by the choice of the reference variable. The revenue measure generated higher differences across group compared to the income measures. This is because the income measures are net of the costs of timber production. The proxies of opportunity cost of amenities provision are expected to be an underestimation due to the underrepresentation of small forest owners in the sample.

2.3.5 **Mountainous region case study**

2.3.5.1 *Objectives and context*

This study was carried out in 4 mountainous provinces Belluno, Vincenza, Treviso, and Verona in the Veneto region (northern part of Italy). The first objective of the survey was to collect detailed information on the characteristics of the forest estates, the features of its owner/owners and the forest management practices in place. These are the basic pre-requisites to understand the potentialities of forest areas in the region to provide ecosystem services. The second objective was to collect information on revenues and costs of the forest management practices in place. The third objective of the survey was to explore more in detail the causal-effect relationships between the forest management practices in place and the provision of the four NEWFOREX externalities, namely Recreation, Biodiversity, Water (including also aspects linked to erosion control, very important in a mountainous context, where the slopes are steep) and Carbon sequestration. Finally, the survey wanted to collect information on forest owners' awareness (and knowledge) of the 'externality' concept, attitudes and expectations towards possible changes on his/her forest management objectives in the view of shifting towards producing forest ecosystems. Note that a more detailed description of the questionnaire can be found in D3.2 and in the annex of this report (Section 10).

2.3.5.2 *Implementation*

The sampling of forest owners through face-to-face interviews took into account the distribution of forest area amongst the four mountainous provinces analysed and as well the ownership types (municipality, common property and private property). Based on the applied stratification, the Regional Administration identified the owners to be interviewed and sent them a letter introducing the purpose of the research and announcing the interview. Then each selected forest owner was contacted by phone for an appointment. The interview took place at the forest owner's place of residence. Two interviewers were trained to carry out the interviews. The interviews have been completed November 2012. Overall, 200 forest owners were interviewed. At the time this report was written, data were being analysed. The present report will be updated with the results early 2013.

2.3.5.3 *Main results*

From the survey it emerged that the extreme fragmentation of the forest property in the Mountainous region is the main limiting factor for active forest management and hence for the forest sector. The private forest is rarely a source of income but rather a cost for the households. On the contrary, public forest owners should be considered as active economic players, achieving several targets, among which, the provision of environmental services. However, private forest owners are crucial for the provision of forest environmental services because they hold more than 60% of the total forest surface. Due to the small size of the property and the difficulties in the decision process generated by multiple ownerships, private forest owners are unable to achieve both better environmental services provision and active forest management for traditional market goods production. The first important message for the policy makers that emerged from this survey is the need to cluster up private forest in order to facilitate a homogenous management. By doing so, costs reduction may be achieved as well as more constant output supply.

2.4 *Qualitative survey analysis*

2.4.1 **Mediterranean case study**

2.4.1.1 *Objectives and context*

A qualitative survey was implemented in the Mediterranean case study. In the Amazon, Central European, and Mountainous case regions qualitative and quantitative approaches were combined, i.e. semi-structured interviews were complemented with quantitative elements. In this report, only the qualitative results from the Mediterranean case study are reported. In the other case study regions, the qualitative elements, among others, served the development of appropriate interview guides for the quantitative analysis and the interpretation of the quantitative results, including identification of causes.

2.4.1.2 *Methods*

The qualitative approach and the interview guide used in the Mediterranean case study were described in the Deliverable 3.2. The Grounded theory was the basis for the qualitative approach in this project. It constitutes an inductive type of research, by which the analysis and interpretation of the data collected by the researcher elaborate certain hypothesis on the observed phenomenon. Sampling was based on non-probability sampling techniques (snowball or purposive sampling). Some of the core questions with respect to provision of externalities addressed forest owners' knowledge of externalities, the management measures which have an impact on the provision of externalities, and the forest owners' demand for compensation if they would have to change behaviour.

2.4.1.3 *Results*

There were relatively few questions on the cost of provision since in this region forest owners were not intensively managing their forest. Moreover, the qualitative survey concentrated on forest owners' preferences and experiences with respect to incentive programmes (reported in D4.3).

The analysis of the interviews identified five different categories of forest owners with respect to their perception of forest externalities. They were explained in the case study report (Section 9) and a brief description is given below in Table 2.9. The demanded compensation for providing externalities was lowest for the "the synergic" owner and increases down through the table to "the business seeker" owner who demand the most in compensation. The last category "the incompatible" included owners who were not even interested in participating, even in presence of an incentive program.

Table 2.9: Categories of Forest owners based on the perception of externalities

Category	Statement	Why? (cause)
the synergic	"*it's* fine"	Because I also get benefited, because I go walking, or I like biodiversity, or I have a rural tourism business where clients appreciate that, or because It also implies a lower fire risk...
the indifferent	"it doesn't influence me"	Because I won't benefit in any case; I am used to see people here around; I have accepted this social use; they don't disturb me...

the annoyed	"behaviours associated to their benefit bother me"	Because they leave litter; because they pass through places where they shouldn't; they are impolite/rude; they don't know that the forest is private; they break some infrastructure; they frighten away the animals...
the business-seeker	"I get upset because I cannot get profit from it"	Because I am used to extract some economic revenues from other forest products and if there is some people willing to pay for it, why shouldn't I get some proceeds? They are just another asset of my forest capital!
the incompatible	"the benefit interferes with my main forest objective"	Because I want to devote my forest to XX and people valuing that externality is against my objective

2.5 *Non-survey analysis*

2.5.1 Boreal and Mediterranean case studies: engineering costs approach

2.5.1.1 *Objectives*

As discussed in the deliverable D3.1 several approaches could be used to estimate the opportunity cost of forest externalities. In this section, the engineering approach is presented. This approach is not based on survey data. Rather, it is based on forest inventory data, economic data (prices, operational costs, etc.), silvicultural treatment types and timber growth models. In the Boreal and Mediterranean case study, an engineering approach was implemented as a complement of the analyses of the surveys.

The results from this approach refer to representative forest in a particular geographical area. Therefore, they are case-specific and they cannot be directly compared across case studies.

2.5.1.2 *Methods*

In the engineering approach, the opportunity costs of forest externalities were computed as the difference in the present value of net income from timber harvesting between the management regime enhancing the provision of forest externalities (management alternative) and the conventional regime (business as usual).

In the Boreal case studies, two different scenarios were simulated. In the business-as-usual (BAU) management, the stand was managed according to the prevailing silvicultural recommendations (Hyvän metsänhoidon 2006). In the alternative, the stand was left unmanaged for 10 more years (till clear-cutting took place), in order to enhance the landscape and recreational values.

In the Mediterranean case study, the baseline scenario (BAU) was characterized by a pre-commercial thinning and a final harvest (assuming an intensive extraction of 2/3 volume harvested) preceded by a preparatory thinning to increase stand accessibility (about 10 years before the final cut). Five management alternatives were considered: intensive management for timber production (pre-commercial thinning, a low thinning, two mixed thinning cuts and a final harvest leaving 250 seed trees); subsidized intensive management (as intensive management with regional subsidies for management operations); fire prevention enhancement (pre-commercial thinning, three low thinning, a selective shrub cleaning, a final harvest leaving 250 seed trees); biodiversity improving management (converting the initial even stand into an uneven stand through several light thinnings and eventually leaving 800 stems/ha); mushroom production improvement (series of thinning aiming at keeping the basal area which maximize mushroom production).

Table 2.10: Synthesis of the input data and simulation tools in the Boreal, Mediterranean and French engineering approach.

Characteristics	**Boreal CS**	**Mediterranean CS**
Region	Ruka-Kuusamo (FI)	Catalonia (E)
Reference forest	One private forest holding, with altogether ca. 35 individual stands	3 standard forest stands of 1ha, representing different site quality between coastal and continental Aleppo pine forests
Input forest data	Traditional inventoried field data	Data from the national forest inventory
Main characteristics of the reference forest (stem density, basal area, dominant high, soil type, etc.)	Spruce-dominated mixed stands with admixture of pine and birch (both less than 30%).	Pure site Aleppo pine (*Pinus halepensis*) forests
	556 stems per hectare (average) Mean basal area 13.1 m^2/ha, dominant height 14.1 m. Mesic forests on mineral soils.	Initial stem density 3.000 stems/ha 3 standard forest have different mean annual growths: 5 m^3/ha/year (quality A) 3 m^3/ha/year (quality B) 2 m^3/ha/year (quality C)
Economic data	Average stumpage prices and silvicultural costs for private forests of the Ruka-Kuusamo area in 2011 (Forest Management Association Kuusamo, database inquiry).	Timber prices from autumn 2012 (Centre de la Propietat Forestal 2012). Forest road maintenance costs (from the bulleting of the Diputació de Barcelona, 2011). Silvicultural costs (Forestal Catalana 2007; Beltrán et al. 2011).
Discount rate	3%, 4%	2%
Growth simulator	MOTTI stand simulator	Growth table
Simulation period	10 years (focus on plots ready for harvesting at year 0)	Between forest stand age 10 (t=0) to 75 (t=66)

In Table 2.10, the input data and the simulation method are presented for the two studies

2.5.1.3 *Main results*

In the Boreal case study, the computed opportunity cost of enhancing landscape benefit resulted on average 27 € per hectare for a reference period of 10 years and at a 3% interest rate. The highest income loss in a single plot was 129 €/ha/10 years. An increase of the interest rate of one percentage point drove the average opportunity cost up to 143 € per hectare for a reference period of 10 years. Consequently, in this analysis taking landscape into account in forestry planning would not lead to any substantial financial losses. However, these results are rather preliminary and further studying should be carried out with a considerably larger amount of individual stands.

From the Mediterranean case study computations, it emerged that all scenarios produced a negative net present value. In other words, there seemed to be no financial gains form managing Aleppo pine forests. This was in line with the indications of the qualitative survey according to which there was a lack of interest in investing in the forest properties. However, the combination of timber production and mushroom production could decrease the net financial loss, providing an incentive to shift towards a conjoint production of timber and non-timber products without public subsidies.

2.5.2 French study

2.5.2.1 *Objectives*

The purpose of this study was to investigate the joint production of timber and non-timber, biodiversity and recreation, using a simulation approach.

2.5.2.2 *Methods*

Focusing on the stand level, the methodology was structured in three main steps. Firstly, a methodology based on growth and yield simulators was used to model the production set. Then, the production possibility set for the modelled forest was determined. Last, the envelope of the simulated production set in terms of possible progress in management was analysed to estimate the opportunity costs of preserving biodiversity and recreation. The analysis focussed on high forest of oak in France.

2.5.2.3 *Results*

The trade-offs between timber profit and bird diversity, on one hand, and between timber profit and the attractiveness for recreation, on the other hand, were high. It was noted that the preservation of bird species was a stronger substitute to the profit than the attractiveness for recreation: the maximum profit is closer to the maximum attractiveness than to the maximum biodiversity. Starting from the Faustmann (1849) profit optimum, increasing the bird diversity by 10% (two more species) would cost 330 euros per hectare. An increase in the attractiveness by 10% would cost 140 euros per hectare. These two results however did not take into account that the increase in the service was done at a low cost because the level of provision of the second service was not constrained. Still, starting from the Faustmann optimum, the opportunity cost of increasing the biodiversity by 10% subject to constant level of attractiveness for recreation would not be feasible (the corresponding point would be outside the production possibility frontier). An increase in the diversity indicator by 0.5 was possible at constant attractiveness and would cost 214 euros/ha compared to 43 euros/ha for the same increase without constraints on the attractiveness. These results showed the relevance of a multidimensional analysis over two-output estimations of the production possibility frontier.

2.5.3 **Central European study: experimental economics**

2.5.3.1 *Objectives*

In addition to the original methods proposed to analyse the costs of provision, it has been decided to include an experimental study in the NEWFOREX project. It is carried out by the Polish and French partners.

The objective of the study is to test mechanisms of selecting privately-owned forest areas that would provide ecosystem services (ES). The specific context addresses the creation of a buffer zone in hitherto unprotected private forests surrounding an already existing national park. The cost faced by a forest owner related to the provision of ES (in this case nature protection) at a particular plot may well be her private knowledge and not always be revealed. The external benefit, on the other hand, will typically depend on the location of the plot and location of other plots providing ES. In particular, it may be important to have ES plots clustered together, adjacent to the NP and providing wildlife “corridors”. Because of the nature of the problem, it appears natural to use multi-unit procurement auctions to select the plots (Latacz-Lohmann and Schillizi 2005, Ferraro 2008). However, little is known about their empirical properties, which calls for experimental tests.

The first research question addresses the issue of testing different auction formats: on one hand, the discriminatory auctions (conceptually analogous to the first-price sealed-bid auction for sinlge object); and the uniform auctions (conceptually analogous to the second-price auction for sinlge object), on the other. Discriminatory auctions have the advantage of simplicity: the highest accepted offer determines the winner of the auction as well as the transaction price. The uniform actions offer to the auctioneer the possibility to capture information on the sellers’ reservation price.

The second research question aims to investigate the influence of communication among participants during auctions. Actually, in auctions for the provision of ecosystem services, owners of specific lots will often know each other, and in complex, multi-round auctions they will often have enough time to communicate and possibly coordinate their strategies.

2.5.3.2 *Implementation*

The experimental design was developed starting from the work of Reeson et al. (2011). A detailed description of the experiment is presented in Section 6. The computerised experiment was conducted at the Laboratory of Experimental Economics at the University of Warsaw. The participants were mostly students (84%), some with previous experience in lab experiments.

In each repetition of the experiment, a group of six individuals was involved. A property consisting of 16 different forest stands (*cells*) was assigned to each participant. Each cell had specific *production value* expressed in experimental dollars (ED) drawn independently from an uniform distribution. Each participant could either offer one or more of his/her cells at any price he/she wished (in a multi-round auction run by an automated *government*), or alternatively, the participant could retain his/her cells. This shall reflect the choice faced by a private forest owner deciding which stands should be used for wood production and which stands should be auctioned (if any). The final payoff for each participant was computed by the sum of the production values of the retained cells and the sum of the transaction prices of the sold cells.

The automated government provissionally purchased the combination of cells offered by some or all the sellers (participants) that would maximize *environmental value* per experimental dollar, subject to a budget constraint ranging betweeen 4000 and 5000 ED. Actually, each cell had a specific environmental value which depended on the spatial proximity of the cell with the national park (core zone): the lower the distance of a cell from the core zone, the higer its environmental value. Moreover, the environmental value of a cell increaseed depending whether the neighbouring cells were also purchased (corridor effect).

The following four experimental treatments were tested: discriminatory auction without the possibility to communicate via chat (7 groups), discriminatory auction with chat (6 groups), uniform auction without chat (7 groups), and uniform auction with chat (6 groups). Each group operated under one of two auction formats.

It is planned to run a similar experiment at INRA/LEF in Nancy with student subjects. This experience will serve as a pilot for possible implementation with forest owners.

2.5.3.3 *Main results*

Out of 16 cells componing the property, a typical bidder in the discriminatory condition would offer 13.86 cells at a value above the relevant production value, just 0.21 and 0.41 cells at a value respectively equal or below the production value, and the remaining 1.52 cells would not be offered at all. In contrast, for the uniform treatment, the typical participant would offer 10.69 cells for a value above the cell's production value, 1.98 at the same value, 1.03 below and 2.30 cells would not be put into auction. Note that, in line with expectations, offers at or below the production value were much more common under the uniform auction format.

As expected, cells with higher environmental value (closest to the natural parck area) were offered at significantly higher values than other cells. This was found under both auction formats. This may reglect the participants' intention to to seize the opportunity and require higher profit margin.

No significant diffrences were observed between offers in "chat" and "no chat versions. The uniform sessions lasted longer and were characterized by more rounds.

3 LESSONS LEARNED

From the case studies experiences, it emerged that several methodologies were available to estimate the cost of provision of forest externalities. Methodologies and results differed firstly across qualitative and quantitative surveys, secondly across analysis focussing on objective costs or perceived costs.

In the choice experiments and the contingent valuation, it emerged that there are difference in the demanded compensation for enhancing environmental services depending on socio-demographic characteristics as the income of the forest owners (high-income forest owners demanded less compensation). In many case studies, it emerged that environmental services are recognised as important by the private forest owners and in some cases they are directly included in the management objective. This seemed to indicate that forest owners' attitudes, characteristics and forest management objectives were important determinants of opportunity costs of measures enhancing externality provision. However, the quantification of the exact increment in cost due to an extra effort for providing environmental services is a challenging task and further research is required. In particular, it has to be considered that the national and regional context such as the development of the forest sector, the structure of the private ownership, the presence of forest owners cooperatives and association have an impact of the cost of provision of environmental services. Similarly, the role of the public forest in providing forest externalities is highly significant in some case studies (i.e. Mountainous region, Central European).

In four case studies (Atlantic, Boreal, French and Mediterranean), the costs estimations and qualitative analysis based on surveys methods were complemented with cost of provision estimates based on engineering approaches. The engineering approach is typical based on net present value estimations. It focuses only on the financial cost, not considering transaction costs, uncertainty, and forest owners' preferences for forest externalities provided in their forest. However, the engineering approach does not suffer from potential biases originating from the hypothetical nature of stated cost methods. In the Boreal case study, for example, a comparison of the results showed that the cost estimates based on the choice experiment were significant higher than the calculated cost using a stand simulator and net present value calculation. This suggested both the potential role of transaction costs which is typically ignored when using the engineering approach, as well as the own utility that a forest owner derives from the non-marked goods and services provided by his/her forest.

Cross country comparisons of the costs estimates were hardly possible. This was mainly due to different priorities and perspectives in the setting up of the research objectives at the national level. Even though similar externalities were considered in the case studies' surveys, often they were not directly comparable due to different definitions of the variables. Nevertheless, survey analyses had a higher degree of comparability across countries than non-survey analysis. In fact; very often non-survey analyses strongly depend on the site specific forest characteristics.

The choice of the methodology to estimate costs of provision of environmental services was strongly influenced by the several factors. A first crucial factor referred to survey data's availability and quality, especially for individual level data. In some case studies, forest owners' individual data were difficult to obtain due to, inter alia, a lack of public registry or obsolete public information, low interest to participate in surveys.

Moreover, crucial information on forest owners such as income, timber revenues and costs generally presented a high rate of no response (see the Atlantic, Mountainous, French and German case). There may be several explanations, for example privacy related reasons, difficulties to provide specific information like timber revenues or costs of particular forest operations, and laziness, among others. Very long and detailed questionnaire resulted in a low response rate and high percentage of incomplete questions. Face to face interview helped to some extent in reducing the number of incomplete questions.

A second main limitation was the scarcity of data directly linked to environmental services and the difficulties to obtain them (biodiversity, recreation, carbon or water quality indicators). As for the valuation of forest externalities demand, the level of externality provision could only be quantified indirectly by measuring management actions. For example, the increment of cost and benefit related to enhancing biodiversity (number of species present or likelihood that some rare species would survey) was not possible to be directly estimated; therefore, proxies had to be used, such as the estimated cost of an increased number of retained old trees or the cost of setting aside part of the forest.

4 THE ATLANTIC CASE STUDY

4.1 *Introduction: Survey content*

The study of forest owners' attitudes and willingness to accept contracts regarding the provision of forest externalities is closely linked to the key externalities of Danish forests described in Deliverable 2.1 and 3.2 (Tyrväinen and Mäntymaa (Eds.) 2010; authors), whereas the demand-side of these externalities were the pivotal point in WP2, this investigation focuses on the supply-side of these externalities seen from the forest owners point of view. The forest areas in the Atlantic case study are geographically fragmented and the ownership of these areas is also distributed on a large number of owners. Policy wise, the implementation of a politically desired change in management will therefore often involve a large number of forest owners, each with their view on e.g. nature management policies and management objectives for their land.

Danish forest areas are of great importance for recreational activities for the general public, but they also make up essential habitats which are foundations for the survival of many species. Approximately 50% of the endangered red-listed species rely on forest areas for survival.

The key management changes investigated here range from small-scale to comprehensive changes regarding protection/promotion of biodiversity, groundwater protection and recreational opportunities. The changes relate to near-natural forestry and the comprehensive changes include setting aside areas as untouched forest, change in trees species from coniferous to broadleaves and increased access rights for the general public. The small-scale management change evaluated here is leaving a number of trees per hectare for natural decay. In addition to this, a comprehensive study on a sample of forest owners regarding their characteristics of property, management and personal attitudes have been conducted. A detailed description of the selection of management changes and their expected effects on forest externalities can be found in Deliverable 3.2.

The present study takes as departure point knowledge gained from other studies on landowners' preferences for contracts, heterogeneity in management objectives and attitudes for provision of environmental goods and services (Broch and Vedel 2012, Boon and Meilby 2007, Wilson and Hart 2000, Vanslembrouck et al. 2002, Hudson and Lusk 2004, Hackl et al. 2007, Ruto and Garrod 2009).

4.2 *Data and Methods*

4.2.1 **Summary of data collection**

The data was 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 amount to 3.000 DKK which can be spent in grocery stores across the country. (See more details about the two samples below).

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 (Dansk Skovforening) and the director of the Forest cultivators' Association (Skovdyrkerne).

Forest owners were sampled based on contact details obtained from the National Forest Inventory during the previous years. This approach was used because we needed 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 and not have to rely 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. In total

The design of the questionnaire has been 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 and add a few more simple questions regarding their total costs/revenue in order to at least get an overview of this type of information from the forest owners if they could not provide more detailed information.

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 Choice Experiment was introduced and each forest owner was presented with 6 choice sets including 2 alternatives and a status quo option. 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. In case they had uncertainties about some answers we did not want to prevent them from seeing previously answered pages if they felt a need to.

Table 2-1 provides an overview of the attributes used in the CE. As stated in the previous reports for WP2 and WP3, the attributes were selected to cover both the demand-side as well as the supply-side of forest externalities. The attributes in the CE targeted forest owners are therefore chosen to investigate the supply-side of the attributes also investigated in WP2 but moreover, they have also been chosen to provide information on current policy issues such as Natura2000 and other policy issues regarding the future management of forest and nature areas in Denmark.

Table 4.1: Attributes investigated in the Choice Experiment

Attributes	Levels							
Set aside an area as untouched forest	No change	7%	15%					
Leave 5 old trees for natural decay	No change	Leave 5 old trees for natural decay						
Increase the area with broadleaves	0% broadleaves	25% broadleaves	50% broadleaves	75% broadleaves				
Increase the public's access	No change	Access for the public on foot up to 15 meters from roads and paths	Access for the public on foot everywhere					
Lower property tax	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. Moreover, the respondent could go back to previous pages if he/she felt a need to read the descriptions of the attributes again. The following description of attributes was presented to respondents:

Choice between different subsidy schemes

In the following questions we would like you to consider some subsidy schemes which deal with creating more biodiversity and recreational goods. We put forth two subsidy schemes at a time and ask you to choose between them. It is a hypothetical question, but we would still like your honest answer – as if you were making the actual decision. If you do not want any of the schemes you may choose 'I do not want any of these subsidy schemes'.

We ask you to think of the largest forest you own, and state your answers according to whether or not you could imagine accepting one of these subsidy schemes for this forest.

Each subsidy scheme entails some restrictions or management changes for the forest which will be registered in the deed of the property and be binding in the future. As compensation for these changes the property tax will be lowered for the whole forest. The lower property tax will also be registered in the deed. Both will therefore be binding in the future. The subsidy scheme entails the following 5 elements:

1) Set aside an area as untouched forest:

The purpose is to enhance the area of forest where natural processes may take place undisturbed and create new habitats for animals and plants. If you accept to leave a small part of the forest as untouched, the area will be selected in consultation with experts considering that there is a good potential for increasing biodiversity. The area will be registered in the deed and cannot be included as productive forest again. The subsidy scheme may include suggestions to set aside 0% (nothing), 7% or 15% of your forest as untouched forest.

2) Leave 5 old trees for natural decay:

The purpose of leaving 5 old trees per hectare is to increase the biodiversity. If this is a part of the subsidy scheme, 5 dominating trees have to be left for natural decay per hectare every time an area is clear-cut or regenerated naturally. These trees may not be removed when they are overthrown, but have to rot.

3) Increase the area with broadleaves:

The purpose of ensuring a large area of broadleaves in the Danish forests is both to increase the amount of groundwater and to ensure stabile forests with high biodiversity in the long run. If the subsidy scheme has a requirement of a minimum share of broadleaves in the forest (either 0%, 25%, 50% or 75%), then it may entail that some of the conifer areas have to be converted to broadleaved areas when the have reached their age of harvesting – this conversion has to take place until the forest fulfil the requirement regarding area of broadleaves. Areas with a mixture of conifers and broadleaves are also included in the percentage (according to the weighted average).

4) Increase the public's access (from 6 am to sunset):

Today there is access to all forests (over 5 ha) on foot from 6 am to sunset, but only on roads and paths. The scheme may include an opportunity to allow the public also to have access on foot in the immediate vicinity of roads and paths (up to 15 meters). Another option is to allow the public access on foot everywhere in the forest.

5) Lower property tax:

As compensation for entering into the subsidy scheme, the total area of your largest forest will have a lower property tax per hectare per year. This lower property tax will be registered in the deed and will be permanent (also for a potential new owner). The value of the lower property tax is stated in DKK (in cash after tax) per hectare per year for all the elements included in the scheme. Note that it is the whole forest area you will receive tax compensation for, regardless that some of the initiatives only involve a small part of the forest.

This means, that if you have a forest of 100 hectares and you are offered a tax reduction of 75 DKK/hectare and year, then you will receive an annual tax reduction of 7.500 DKK (in cash after tax).

On the following pages there are 6 questions regarding choice between subsidy schemes. Here we ask you to choose which contract you would prefer for your forest. You may choose scheme A, scheme B or 'I do not want any of these subsidy schemes' (for my forest).

As seen from the text above, 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.

Figure 2.1 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:	☐	☐	☐

Forrige Næste

Figure 4.1: 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?

4.2.1.1 *Design*

The design for the CE was optimised in NGene 1.0.2 for D_B-efficiency. A model in WTP-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.

4.2.1.2 *Final sample and response rate*

In total 1429 people received the letter inviting them to participate in the questionnaire. In the final sample used for the present data analyses we have chosen to eliminate respondent who have not stated how many hectares of forest they have and how many hectares the largest forest they own constitute (both questions at page 1 in the survey). In addition to this, respondents who have not answered any of the questions regarding their current/prior participation in subsidy schemes were also removed from the sample. This group of questions were selected as they were simple to answer and it was a straight forward way of eliminating respondents who had merely completed the first few pages in the questionnaire. The final sample constitutes of 308 respondents and provides a response rate of 21.6%.

4.2.2 Descriptive data of the sample of respondents

Since there are no socio-demographic data available on the total population of forest owners in Denmark, we are unable to compare the representativeness of our sample to the general population of forest owners in Denmark. When it is considered relevant, the sample is compared with data for the Danish population in general.

Even though we cannot make comparisons with the total population of Danish forest owners, we know from other studies that the Danish private forest owner on average is a male (86% of all owners) in his fifties. He has the forest as part of a farm (84% of forest owners own farmland, 75 % grew up on a farm). He considers himself a farmer rather than a forest owner, but he also has a feeling of attachment to the forest, and likes to keep the forest as a legacy (59 %). Three out of four forest owners consider that aesthetic and environmental values are important or very important to forest ownership (Boon, 2003).

Forest area

Table 4.2: Size of total forest area in hectares

	mean	**sd**	**25% quartile**	**50% quartile**	**75% quartile**	**minimum**	**maximum**
Sample	191.09	763.80	3	10	39.75	0	7167
Danish forest owners							

One respondent has stated ‘zero’ in this question which is interpreted as a mistake, since he has stated in the question below, that the largest coherent forest he owns is 1400 hectares.

Table 4.3: Size of your largest coherent forest area (referred to as ‘this’/’your’ forest)

	mean	**sd**	**25% quartile**	**50% quartile**	**75% quartile**	**minimum**	**maximum**
Hectares	171.82	684.93	3	8.82	40	.1	7167

Income

Table 4.4: The monthly income of the household before taxes (incl. pension etc.)

Income per month (kr.)	**Income per month (Euro)**	**Total**	**Percent**
0 - 7.999	0-1074	6	1.95
8.000 - 14.999	1074-2013	7	2.27
15.000 - 19.999	2013-2685	12	3.90
20.000 - 24.999	2685-3356	15	4.87
25.000 - 29.999	3356-4027	22	7.14
30.000 - 39.999	4027-5369	25	8.12
40.000 - 49.999	5369-6711	30	9.74
50.000 - 59.999	6711-8054	33	10.71
60.000 - 69.999	8054-9396	15	4.87
70.000 - 79.999	9396-10738	23	7.47
80.000 - 99.999	10738-13423	19	6.17
More than 100.000	More than 13423	43	13.96
No reply		58	18.83
Total		308	100.00

Education and gender

Table 4.5: Longest completed education compared with the Danish population (Danmarks statistik, 2012: Longest completed education for the Danish public (age 15-69 years old) in 2010).

	Men	**Women**	**Total**	**Expected total**	**Percent (sample)**	**Percent (population)**
Elementary school up to 10th grade	30	2	33	94	10.71	30.44
High school	5	2	7	19	2.27	6.11
Vocational high school or skilled craftsman	60	10	72	107	23.38	34.67
Higher education (Short)	15	2	17	13	5.52	4.24
Higher education (intermediate, bachelor)	37	9	46	44	14.94	14.35
Higher education (MSc, Ph.D.)	63	10	75	21	24.35	6.81
Unknown/Other	22		11	10	18.83	3.39
Total	232	35	308	308	100	100
Chi-test	3,82465E-40					

With regard to the educational level, we find that people with long educations are over represented compared with population at large. We find a higher representation of both people with MSc./long term educations as well as people who have stated 'other' in the response for this question. Regardless of the actual distribution of education levels among the population of forest owner, other similar studies also tend to find an overrepresentation of people with high levels of education. The table also shows that the vast majority of respondents are male (75.32%) – as would be expected from the population of forest owners, where 86% are male.

Geographic location of the forest and residence of the owner

Table 4.6: Geographic location of the forest and residence of the owner

Region	Freq. - forest	Percent - forest	Freq. - owner	Percent - owner	Percent – distributed to
Zealand	4	1.30	12	3.90	17.14
Fyen	27	8.77	23	7.47	7.56
Jutland	227	73.70	189	61.36	73.76
Bornholm	6	1.95	5	1.62	1.54
No reply	44	14.29	79	25.65	0.00
Total	308	100.00	308	100.00	100.00

The majority of the respondents live in Jutland and that is also where their forest areas are located. When we compare the location of the respondents with the total sample which we distributed the letters to, there have been a higher response rate from people who live on Fyen, Bornholm and in Jutland as opposed to people who live on Zealand.

Rural versus urban population

We have divided respondents into rural and urban population based on two relatively rough categories based on the postal coded of the four largest cities in Denmark. Based on this division, merely 14 respondents have their residence in an urban area and only 10 respondents have forest areas which are located in an urban area.

Age distribution in sample and population

Table 4.7: Distribution of ages in the population and the respondent sample

Age	18-30 years	31-40 years	41-50 years	51-60 years	61-70 years	>70 years	No reply	Total
Number	2	13	57	75	80	36	45	308
Percent	0.65	4.22	18.51	24.35	25.97	11.69	14.61	100.00

The age distribution of respondents reflects that, as previously mentioned, the typical Danish forest owner is middle aged. In this study we therefore have a large fraction of respondents in the upper age classes and very few respondents in the younger age classes. Similar studies show an underrepresentation of people in the younger age classes, possibly enhancing this underrepresentation.

4.3 *Survey Results*

On the first page in the survey, respondents were asked to state the total size in hectares of the forest area(s) they own and afterwards they were asked to specify the size of the largest coherent forest area they own. This i.e. largest forest was afterwards referred to as 'your' forest or 'this' forest, and respondents were asked to answer all questions in the questionnaire with this forest in mind.

4.3.1 Fact about the forest property

267 respondents (86.69%) have stated that they themselves are owners/co-owners of the forest property whereas only 33 (10.71%) have stated that they have filled out the questionnaire on behalf of the owner. Most of the respondents only own one forest property (73.38%) whereas 23.70% have indicated that they own more than one forest property. As seen below, the majority of respondents live in the immediate vicinity of the forest. And more than 75% of the respondents have forests where there is public access through asphalt or dirt roads.

Table 4.8: Do you live in the immediate vicinity of the forest?

	Percent
Yes, all year	66.88
No, but I have a house/summer cottage/cabin near the forest	10.39
No, there is some distance from the forest to my home/summer cottage (please state the distance in kilometres)	17.86

Table 4.9: Access: Which types of roads provide access to your forest? (multiple options could be selected)

	Percent
Asphalt roads with public access	35.39
Unpaved roads/dirt roads with public access	41.88
There are no roads with public access to the forest	34.74

Table 4.10: Buildings and machinery

	Percent
The forest property has one or more residential houses	61.04
The forest property has buildings for machines, management etc. or a hunting cabin	37.01
There are no buildings connected with the forest property	22.73
I do not own large machines (tractors etc.) which mainly are used in the forest	28.90
I do not own large machines which mainly are used in the forest	43.83

4.3.2 **Characteristics and economy of the forest**

More than 30% of respondents have forest areas which are affected by some kind of conservation measure (national park, Natura 2000, other protected areas such as heath land, bog etc.). Approximately 20% of the respondents have a management plan for the forest and 60% state that important management decisions are made by themselves or in unison with their spouse. Approximately 20% makes important management decisions jointly with employees or external forest consultants.

Table 4.11: How large a part of your forest is used for the following? (means, quartiles, min, max)

	Hectares					
	mean(sd)	25%	50%	75%	min	max
Productive coniferous forest	98.67(524)	2	8	33.75	0	7167
Productive deciduous forest	81.04(265)	1.5	5.5	31.7	0	2500
Non-productive forest (conservation, wetland area etc.)	62.05(424)	1	3.2	13.13	0	5516

Table 4.12: Age class distribution (means, quartiles, min, max)

Conifers						
	Hectares					
	mean(sd)	25%	50%	75%	min	max
Young (1-20 years)	22.39(64)	1	4	10.1	0	600
Middle-aged (20-50 years)	81.92(557)	1.5	5.5	22	0	7167
Mature (50-80 years)	21.25(37)	1	5	24.48	0	180
Old (>80 years)	15.22(36)	0	1	5	0	230.52
Deciduous						
	Hectares					
	mean(sd)	25%	50%	75%	min	max
Young (1-40 years)	29.89(86)	1	4	18.4	0	750
Middle-aged (40-90 years)	40.14(134)	1	3	25	0	1250
Mature (90-130 years)	34.80(76)	1	5	34	0	453
Old (>130 years)	28.71(60)	0.5	4.6	17.5	0	273

(2 respondents have been removed from the descriptive statistics here for having stated errors i.e. areas much larger than their total forest area; respondent id= 81366521 and 83098367)

Table 4.13: Conservation measures in the forest

	Percent
Natura 2000 area(s)	10.71
Part of national park	2.27
§3 areas (e.g. heath land, raised bog)	15.26
Other	11.36

Table 4.14: Is the forest certified according to FSC or PEFC?

	Percent
Yes	4.87
No	86.69
No reply	8.44
Total	100.00

Table 4.15: Do you have a management plan for the forest?

	Percent
Yes	20.45
No	75.65
No reply	3.90
Total	100.00

Table 4.16: Decision-making: Who makes the decisions regarding selection of tree species, harvest, thinning and larger investments?

	Percent
Myself	48.38
My family/ my spouse and I	12.66
I do, jointly with the other owners of the forest	5.19
I do, jointly with employees or an external forest consultant	20.45
An employee or external forest consultant	6.49
My spouse/family	2.27
A co-owner, board or similar	1.62
Others	0.32
No reply	2.60

Table 4.17: Forest work: Who normally carries out the following types of work related to the forest?

	I do	**Family**	**Employee**	**External consultant**	**Not done in the forest**
Harvest and hauling	43.18	14.29	11.04	30.19	10.39
Christmas trees/greenery	16.56	8.12	8.12	11.69	34.09
Planting	36.36	13.64	12.34	20.78	15.26
Maintenance of roads	44.48	7.47	9.74	11.04	15.91
Wildlife management	44.16	10.39	8.12	8.12	19.48
Prepare the management plan	17.53	2.92	1.95	21.75	35.39
Keep accounts and administrative work	41.56	7.14	5.52	14.61	18.51
Contact buyers, handle sales	30.19	3.90	5.52	25.00	24.03

4.3.3 Harvest volume and income from the forest

Approximately 42-45% of the respondents have stated their gross income and costs (different from zero). 20% of the respondents receive some income from hunting on their property and 12% also have experience with renting out buildings.

Table 4.18: Approximate gross income, costs and harvest volume for the forest <u>during the last year</u>

Gross income from your largest forest area (in DKK)						
Number who has replied something different from zero	124					
	Less than 1000	100-10000	10000-50000	50000-100000	100000-500000	500000-
Number	15	17	26	20	21	30
	mean(sd)	25%	50%	75%	min	max
Overview	351649.4(1455478)	0	0	51,200	0	15,000,000
Gross costs/expenditures (incl. costs of harvest, administration and taxes) in DKK						
Number who has replied something different from zero	137					
	<0 (i.e. -30000)	0-1000	1000-10000	10000-100000	100000-500000	500000-
Number	1	21	35	35	21	2
	mean(sd)	25%	50%	75%	min	max
Overview	316845.9(1194718)	0	1,000	40,000	-30000	1,2000,000
Harvest volume in m3						
Number who has replied different from zero	135					
	mean(sd)	25%	50%	75%	min	max
Overview	316845.9(1194718)	0	1,000	40,000	-30000	1,2000,000

Table 4.19: Alternative sources of income

Hunting						
Number who has replied different from zero	65					
	mean(sd)	25%	50%	75%	min	max
DKK/year	76581.67(304204)	0	0	5500	0	2,500,000
Horseback riding and other recreational activities						
Number who has replied different from zero	17					
	mean(sd)	25%	50%	75%	min	max
DKK/year	5549.22(32366)	0	0	0	0	300,000
Letting of houses/buildings in connection with the forest						
Number who has replied different from zero	37					
	mean(sd)	25%	50%	75%	min	max
DKK/year	72340.56(360292)	0	0	0	0	4,200,000

4.3.4 Subsidy schemes: Experiences and motivation

Table 4.20: Experience with existing subsidy schemes

	I do not know this scheme	**I know this scheme but have never participated in it**	**I am currently participating in this scheme or have participated earlier**	**No reply**
Subsidy for special management initiatives	61.04	24.68	6.17	8.12
Subsidy for replanting after windthrow	43.83	32.47	15.91	7.79
Afforestation subsidies	31.49	47.40	12.99	8.12
Subsidy for production and sales of Christmas greenery	56.49	17.53	15.58	10.39
Practical forest management experiments	72.08	15.58	1.30	11.04
Recreation and outdoor facilities	63.96	22.73	2.27	11.04
Sustainable management Counselling visit	61.04	22.08	6.82	10.06
Oak woodlands and coppice	65.26	20.45	3.25	11.04
Subsidy for setting aside areas as untouched forest	63.64	24.35	2.27	9.74
Single tree contracts for aging and natural decay	68.18	19.16	1.95	10.71
Sustainable management	57.79	21.75	11.36	9.09
Contracts related to groundwater or wetland areas	61.04	25.65	1.95	11.36

Table 4.21: What affects motivation for participating in subsidy schemes

The environmental good which the subsidy scheme focus on…

The subsidy scheme…

	Affects my motivation/inclination…					
	Very negatively	**A little negatively**	**Has no effect**	**A little positively**	**Very positively**	**No reply**
… improves the conditions (habitats) for animals and plants	1.95	0.97	15.26	17.86	51.30	12.66
… increases the public's access for walking in the forest	31.49	18.51	20.78	7.14	5.84	16.23
… increases the public's access for sport activities in the forest	42.21	15.91	19.48	5.52	3.25	13.64
… enhances the groundwater quality	1.95	0.65	15.58	22.73	44.48	14.61
… increases the amount of dead wood/old trees in your forest	5.19	8.77	36.04	20.13	13.64	16.23
… increases the share of deciduous trees in your forest	3.57	0.97	30.52	22.73	28.90	13.31

Table 4.22: What affects motivation for participating in subsidy schemes: Formal requirements in the subsidy scheme. The subsidy scheme.....

	Affects my motivation/inclination...					
	Very negatively	**A little negatively**	**Has no effect**	**A little positively**	**Very positively**	**No reply**
... compensates you partly for the effort requested	4.22	1.62	28.90	28.90	19.48	16.88
... involves that the Government monitors that you comply with terms	17.21	15.26	35.71	9.42	4.87	17.53
... allows you to withdraw within 5 years (against returning any compensations received)	8.12	6.17	40.58	21.10	7.14	16.88
... compensates you fully for the effort requested	4.22	1.95	27.27	21.10	27.27	18.18
... restricts your actions as an owner	46.10	20.13	14.29	2.27	0.32	16.88
...gives you an opportunity to get free advice from a professional	2.92	0.65	33.12	25.97	20.78	16.56

Table 4.23: What affects motivation for participating in subsidy schemes: Your personal interests as owner. The subsidy scheme

	Affects my motivation/inclination…					
	Very negatively	**A little negatively**	**Has no effect**	**A little positively**	**Very positively**	**No reply**
…implies a benefit to the local community	2.60	2.60	40.91	24.68	12.66	16.56
…means that my fellow citizens acknowledge what I do	1.30	1.30	48.38	20.78	9.09	19.16
… enhances the nature value of my property	0.65	0.65	15.91	23.70	42.53	16.56
… means that I receive public acknowledgment from society	1.95	1.62	53.90	15.58	8.44	18.51
… enhances the aesthetic joy (smukkere) of my property	0.65	0.00	15.58	26.30	41.88	15.58
…encourages sustainable management of the forest	0.65	0.65	28.57	25.97	26.30	17.86

Table 4.24: What affects motivation for participating in subsidy schemes: How is your motivation to enter into a subsidy scheme affected by.....?

	Affects my motivation/inclination…					
	Very negatively	**A little negatively**	**Has no effect**	**A little positively**	**Very positively**	**No reply**
…other forest owners acceptance (of schemes) in the local area	1.30	0.97	62.34	14.29	3.90	17.21
…other forest owners acceptance outside the local area	1.30	1.30	67.53	8.44	2.92	18.51
…other forest owners experiences with subsidy schemes in the local area	0.97	0.65	44.48	29.55	6.49	17.86
… other forest owners experiences with subsidy schemes outside the local area	0.97	0.65	53.25	22.40	4.22	18.51
…on-going nature initiatives in forests close by your own forest	1.62	0.65	50.32	22.73	6.82	17.86

Table 4.25: Willingness to enter into subsidy schemes without compensation:

Would you consider offering any of the following environmental goods from the largest forest you own without compensation?

	I do this already	**Yes**	**No**	**I don't know**	**No reply**
Set aside a fraction, e.g. 5% of the forest area as untouched to increase the biodiversity	39.94	14.94	27.60	8.44	9.09
Leave 5 trees per ha for natural decay to increase the biodiversity	31.49	25.65	24.03	9.09	9.74
Restore small wetland areas	25.32	32.47	20.13	11.04	11.04
Allow a new walking route/trail	7.14	10.71	64.61	7.47	10.06
Allow a new mountain bike trail	0.65	3.57	79.87	5.84	10.06
Allow public access outside paths and roads in your forest	6.49	3.57	75.00	4.87	10.06
Increase the area covered by broadleaves in your forest	27.60	32.79	19.16	10.06	10.39

Table 4.26: Willingness to enter into subsidy schemes with compensation:

If you received an appropriate compensation, do you then believe that you would like to offer any of these goods from the largest forest you own?

	I do this already	**Yes**	**No**	**I don't know**	**No reply**
Set aside a fraction, e.g. 5% of the forest area as untouched to increase the biodiversity	32.47	30.19	21.43	4.87	11.04
Leave 5 trees per ha for natural decay to increase the biodiversity	27.60	37.34	15.58	6.17	13.31
Restore small wetland areas	22.08	40.91	16.56	7.14	13.31
Allow a new walking route/trail	4.22	16.56	59.42	6.49	13.31
Allow a new mountain bike trail	0.97	6.49	74.03	6.17	12.34
Allow public access outside paths and roads in your forest	4.55	8.44	69.16	5.52	12.34
Increase the area covered by broadleaves in your forest	22.73	39.94	17.21	7.14	12.99

Forest owners' views on regulation

With regard to biodiversity measures, forest owners prefer voluntary contracts offered by the state. Regulation regarding the use of pesticides to ensure clean groundwater is the single issue where forest owners are most in favour of regulation by law which would entail the same restrictions for all owners and no compensation (17.53% prefers this). With regard to regulation of access, the majority of forest owners prefer to negotiate these regulations themselves with the users/organisations and secondly, they prefer voluntary contracts offered by the state.

Table 4.27: Which type of agreement or way of regulation do you prefer for the following types of environmental goods?

	By law (the same for all owners and no compensation)	**Compulsory contracts for management changes (all owners compensated by the state)**	**Voluntary contracts for management changes offered by the state (like subsidy schemes)**	**I negotiate contracts myself with users/organisations/firms (like selling licenses for horse riding, hunting**	**I do not know**	**No reply**
Access on foot	14.29	6.82	20.78	24.35	21.75	12.01
Access in relation to sport activities (biking, orienteering, climbing)	6.17	4.87	19.81	30.19	25.65	13.31
Leave old trees for natural decay	9.09	7.14	30.84	17.21	22.40	13.31
Leave an area in the forest as untouched	8.12	8.77	33.77	15.58	20.78	12.99
Increase the area of broadleaved forest	7.47	8.44	31.17	15.26	24.35	13.31
Avoid using pesticides to ensure clean groundwater	17.53	7.79	28.25	12.01	21.10	13.31

4.3.5 Your own and other people's use of the forest

The average respondent visits his/her forest both for recreational purposes and for work related purposes and approximately 57% also use their forest area for hunting.

Table 4.28: Forest visits for work or recreation

	Almost every day	1-3 times a week	1-3 times a month	Less than once a month	I hardly ever go there	No reply
How often do you visit your forest for work related purposes?	13.96	16.23	27.92	26.62	8.77	6.49
How often do you visit your forest for recreational purposes (go for a walk, relax, watching animals etc.)?	25.97	21.75	28.57	13.96	4.55	5.19

Table 4.29: Use of forest for hunting purposes: Do you or your family use your forest for hunting?

	Percent
Yes	57.47
No	37.99
No reply	4.55

Table 4.30: Recreational use of the forest: Compared to other forests in your neighbourhood, would you consider that your forest is visited more often/seldom by the general public?

	Percent
Yes	36.36
No	41.56
I don't know	13.96
No reply	8.12

4.3.6 Choice Experiment and follow-up questions

4.3.6.1 *How many answered at least some of the choice sets?*

Due to the online set-up of the questionnaire, it was mandatory to answer the 6 choice sets. However, some of the respondents have dropped out of the questionnaire before the CE part which is why the number of respondents in this part is lower than 308. They have all been kept in the analyses which are unrelated to the CE since they have provided much information of their property, expenditures and attitudes etc.

Altogether, 287 respondents have answered all or almost all of the questions in the CE. They are used as data foundation for the clogit models. The RPL models are based on 283 respondents since 4 respondents have been removed as they have not answered all 6 choice sets.

4.3.6.2 *Follow-up on the CE*

The tables in this section describe responses to the follow-up questions on the CE and potential identification of protest-bidders. 163 respondents chose status quo in all 6 choice sets. Only respondents who have chosen status quo 6 times in a row received the question below, so a few of these have chosen not to answer below question. However, removal of any of the respondents based on this question would only have an effect on size of the ASC.

Table 4.31: In the previous questions you have chosen that you did not want any of the subsidy schemes. Why did you not choose one of the schemes?

(Question contingent on having answered status quo in all 6 choice sets)

	Percent
The compensation was not high enough compared with the requirements	5.19
I do not want any restrictions in my forest – regardless the size of the compensation	34.09
I think that forest owners should fulfil the requirements without compensation	3.57
I do not think it is the right way to do something for the environment/citizens	1.62
Other	6.17
No reply (contingent question)	49.35

4.3.6.3 *Conditional logit with the main attributes*

Table 4.32: Attributes used in the CE with definition of levels for the ASC:

Attributes	**Levels (ASC and status quo levels marked in grey)**								**Coding**
Set aside an area as untouched forest	No change	7%	15%						0, 7, 15
Leave 5 old trees for natural decay	No change	Leave 5 old trees for natural decay							0, 5
Increase the area with broadleaves	0% broadleaves	25% broadleaves	50% broadleaves	75% broadleaves					0, 25, 50, 75
Increase the public's access	No change	Access for the public on foot up to 15 meters from roads and paths	Access for the public on foot everywhere						0, 1, 2
Lower property tax	0 DKK	25 DKK	50 DKK	75 DKK	100 DKK	125 DKK	150 DKK	175 DKK	0, 25, 50, 75, 100, 125, 150, 175

The table below shows the output of a conditional logit model with the main attributes where the attribute 'percentage of broad leaves' has been dummy coded. The other attributes are included as linear variables. For 'Leaving an area as untouched' and 'access', it has been investigated that these show a linear trend and are therefore not dummy coded in the present example. So the internal scope sensitivity seems to hold for all attributes. The properties of the model are as follows:

Table 4.33: Conditional logit model with the main attributes

Attributes	**Coef.**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Asc	2.01945	.1831352	11.03	0.000	1.660512	2.378389
Untouched	-.0044965	.0081146	-0.55	0.579	-.0204009	.0114079
Dead trees	.0668398	.0216199	3.09	0.002	.0244655	.1092141
Broadleave25%	-.0429753	.1460196	-0.29	0.769	-.3291684	.2432178
Broadleave50%	-.1762371	.1534208	-1.15	0.251	-.4769363	.1244621
Broadleave75%	-.3170015	.1451999	-2.18	0.029	-.6015881	-.0324149
Access	-.626401	.0680163	-9.21	0.000	-.7597105	-.4930916
Price	.0080122	.0009474	8.46	0.000	.0061554	.009869
Number of observations			5142			
LR chi2/ Prob > chi2			1350.89/0.0000			
Log likelihood/ Pseudo R2			0.3587			

Table 4.34: Willingness to accept in the CL (based on the Krinsky-Robb procedure in Stata with 1000 draws)

	Asc	Dead trees	Broadleave75%	Access
wta	-252,0479	-8,3423	39,5650	78,1812
ll	-303,6328	-13,8879	2,3944	55,0470
ul	-200,4630	-2,7966	76,7356	101,3154

The results of the conditional logit model shows that respondents on average have a positive attitude towards initiatives to promote biodiversity when this is based on leaving old trees for natural decay in the forest and thereby keeping some amount of dead wood. They are willing to accept a lower amount of compensation when this is a part of the subsidy scheme.

If the subsidy scheme involves leaving 7% or 15% of the forest as untouched, the respondents on average do not require additional compensation for this. This result is somewhat surprising, since this could involve a substantial cost for a forest owner if the total forest area is used for production currently. Almost 40 % of respondent has stated that they already have 5% of the forest set aside as untouched, and as we cannot rule out a certain amount of self-selection in the sample of respondents who have chosen to answer the questionnaire, it is likely that forest owners more prone to take initiatives regarding biodiversity protection are overrepresented in the sample.

If the subsidy scheme involves a restriction regarding how large a percentage of broadleaves there has to be on the forest area, then respondent would like compensation for this, however, only for the highest level (75% of the forest). Compared with programmes for forest certification schemes, forest owners are willing to agree to a remarkably high percentage of broadleaved tree species on their property without demanding compensation for this.

Out of the attributes selected here, forest owners are most adverse towards increased access in the forest. On average they require 78 DKK per hectare for allowing access in the proximity of roads and paths, and approximately 155 DKK for allowing access everywhere in the forest. This is also reflected very clearly in the results regarding attitudes toward what they would be willing to allow in their forest with or without compensation. 75% of the respondents have stated that they would not be willing to allow access everywhere without compensation, and 69% have stated that even if they received an appropriate amount of compensation they would still not be willing to allow access everywhere in the forest. Even though the sample of forest owners analysed here is too small for detailed information of many subgroups, an RPL model is, however, expected to show a more varied picture of the heterogeneity of the population.

4.3.6.4 *Interaction effects in the CE – Conditional Logit model*

The fact of living close to the forest all year has been dummy coded and interacted with all attributes in the CE. This only showed to have an effect on respondents' willingness to accept for conserving dead trees and having a restriction regarding percentage of broadleaves in the forest. However, in a conditional logit model these interactions showed correlation, so only the interaction between living close to the forest and a broadleaves restriction of 75%

are showed here. If respondents live in the immediate vicinity of the forest all year, then they are willing to accept a broadleaves restriction in their forest at a much lower cost – approximately 20 DKK on average per hectare as opposed to 84 DKK, however, with a relatively broad confidence interval tied to these averages.

Table 4.35: Conditional logit model with interaction effects, year round residence close to the forest.

Attributes	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
Asc	2.017906	.1832391	11.01	0.000	1.6588	2.3770
Untouched	-.0043164	.0081207	-0.53	0.595	-0.0202	0.01160
Dead trees	.0663201	.0216382	3.06	0.002	0.0239	0.1087
Broadleave25%	-.0438446	.1460605	-0.30	0.764	-0.3301	0.2424
Broadleave50%	-.178568	.1534962	-1.16	0.245	-0.4794	0.1222
Broadleave75%	-.6755297	.2395518	-2.82	0.005	-1.1450	-0.2060
Residence*Broadleave75%	.510293	.2562625	1.99	0.046	0.0080	-1.0126
Access	-.6287378	.0681186	-9.23	0.000	-0.7622	-0.4952
Price	.008026	.0009483	8.46	0.000	.006168	0.009885
Number of observations			5139			
LR chi2/ Prob > chi2			1353.25/0.0000			
Log likelihood/ Pseudo R2			0.3595			

Table 4.36: Willingness to accept in the CL (based on the Krinsky-Robb procedure in Stata with 1000 draws) with interaction effects

	Asc	Dead trees	Broadleave75%	Residence*Broadleave75%	Access
wta	-251.42087	-8.2631441	84.167564	-63.579915	78.337529
ll	-302.85933	-13.799433	22.042236	-127.69891	55.20504
ul	-199.9824	-2.7268548	146.29289	.53907758	101.47002

4.3.6.5 *Random Parameter Logit model*

The random parameter logit model is based on 283 respondents' choices who all have answered all 6 choice sets. This model includes two interaction effects referred to as attitude and hunting. Attitude is a dummy coded variable describing the respondent's attitude towards subsidy schemes and their benefits for 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/a little positively if the scheme is beneficial for the local community. The second interaction effect applied here is hunting, which takes the value 1 if the respondent or his/her family uses the forest for hunting themselves.

Table 4.37: RPL model of main attributes and interactions with access

Variable	Coeff.	Standard Error	z	P>z
Random parameters in utility functions				
Untouched	-.05381**	.02602	-2.07	.0386
Dead trees	.11422**	.05617	2.03	.0420
Broadleave50	-.12779	.33064	-.39	.6991
Broadleave75	-.71588**	.33723	-2.12	.0338
Access	-1.94806***	.38975	-5.00	.0000
Attitude*Access	.99516***	.38544	2.58	.0098
Hunting*Access	-.58660*	.34541	-1.70	.0895
Non-random parameters in utility functions				
ASC	4.79980***	.64757	7.41	.0000
Price	.01405***	.00218	6.45	.0000
Standard deviations of parameter distributions				
NsUntouched	.13677***	.02891	4.73	.0000
NsDead trees	.23289***	.08981	2.59	.0095
NsBroadleave50	1.06558*	.60474	1.76	.0781
NsBroadleave75	.55573	.76689	.72	.4687
NsAccess	1.31423***	.32431	4.05	.0001
NsAttitude*Access	.31350	1.21314	.26	.7961
NsHunting*Access	.30378	.94033	.32	.7466
Standard deviations of latent random effects				
Sigma	4.89864	.66251	7.39	.0000
Number of obs/groups in panel		5094/283		
LR chi2/ Prob > chi2		2170/0.0000		
Log likelihood/ R2-Adj		-1865/0.5796		

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

Table 4.38: Table: Willingness to accept in the RPL (based on the Wald procedure in NLogit)

Variable	Coeff.	Standard Error	z	P>z
Untouched	3.82985**	1.76125	2.17	.0297
Dead trees	-8.12874**	4.10799	-1.98	.0478
Broadleave50	9.09434	23.35167	.39	.6969
Broadleave75	50.9475**	22.47525	2.27	.0234
Access	138.638***	28.85895	4.80	.0000
Attitude*Access	-70.8232**	27.84648	-2.54	.0110
Hunting*Access	41.7471*	25.10861	1.66	.0964
ASC	-341.590***	50.27142	-6.79	.0000

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

The RPL model shows that all attributes are significant except for the restriction of minimum 50% broadleaves (the 25% level omitted here). Respondents require additional compensation for leaving an area as untouched forest approximately 3.8 DKK per hectare and approximately 50 DKK per hectare for accepting a broadleaves restriction of 75%. Granting the public increased rights of access is by far the most expensive element for the state; the average respondent requires 138 DKK for accepting access up to 15 meters from roads and paths and 276 DKK for accepting access everywhere in forest (per hectare). Preserving dead trees stands out as the single attribute where respondents are willing to accept a lower amount of compensation if this is a part of the subsidy scheme (approximately -40 DKK/ha for preserving 5 trees). Respondents who find it important that subsidy schemes are beneficial for the local community require approximately 70 DKK less in compensation for providing access up to 15 meter from roads and paths. On the other hand, respondents who themselves (or their family) use the forest for hunting require approximately 42 DKK additional to the 138 DKK for granting access up to 15 meters from roads and paths.

There is significant heterogeneity in the population with regard to the preferences for untouched forest, conserving dead trees, accepting a 50% broadleaves restriction and providing increased access for the public.

4.4 *Other methods: Models and estimations*

Specific management restrictions or voluntary subsidy schemes may be applied to promote the diversity of species in forest, secure endangered habitats or create new and better recreational opportunities for the Danish public. One method for observing forest owners' willingness to engage in these activities against a monetary compensation is of course to survey the actual responsiveness when implemented – or conduct a hypothetical study to assess this as described in earlier sections.

Another method used for assessing the cost of provision of forest ecosystem services is to investigate the direct opportunity cost a forest owner faces when met with specific restrictions on the property. A contemporary example is the implementation of restrictions related to increased conservation in Natura2000 areas.

4.4.1 **Cost of conservation initiatives related to Natura2000 policies**

When dealing with specific management restrictions e.g. as those connected with Natura2000 initiatives, another method could be to investigate the actual costs a forest owner faces if a given restriction is imposed on the property. When the desired forest externalities can be achieved through very specific management changes, then it is possible to evaluate the direct costs for the forest owner. Examples of how this may be carried out are shown below for contemporary management changes related to Natura2000 policies in

Denmark. The examples cover management changes in productive beech stands, setting aside areas as untouched forest and leaving single trees for old growth and decay.

4.4.1.1 *Conservation initiatives in beech forests*

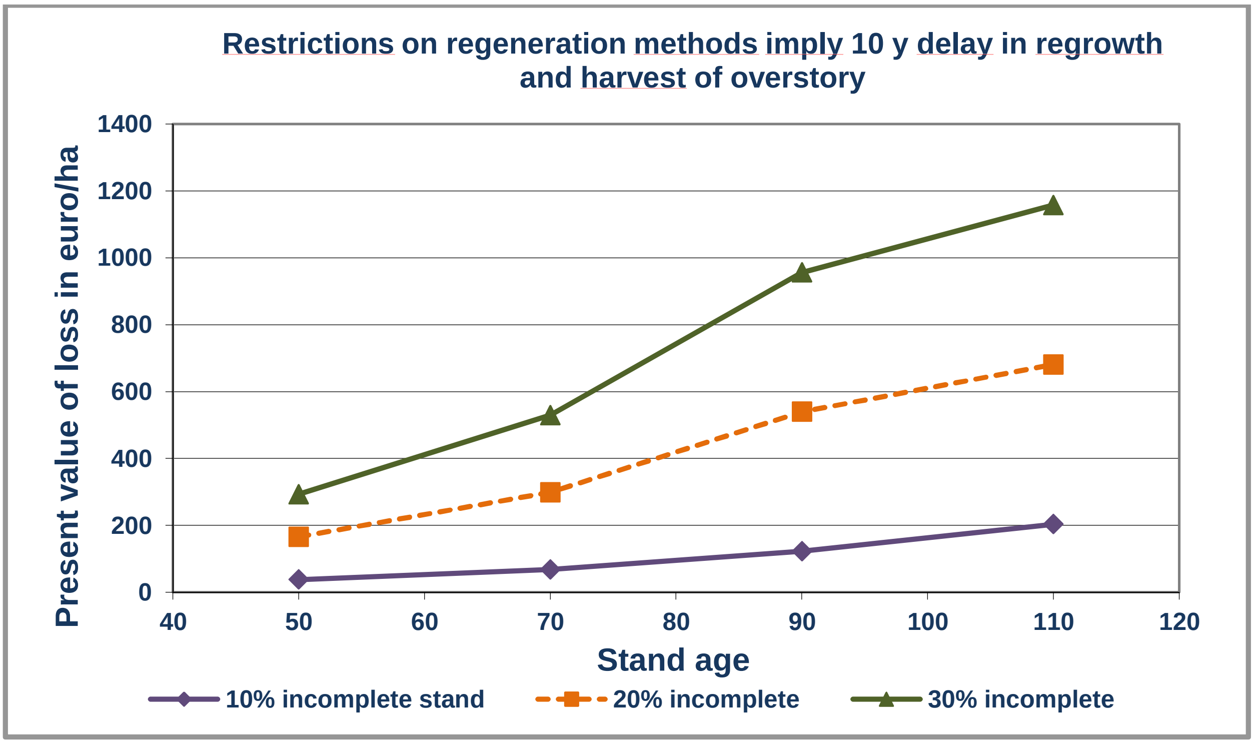
The cost of a specific management restriction may be estimated based on the change in the net present value of the area before and after the restriction is imposed. Ideally, one would like to assess the change in net present value due to the restriction if the forest is sold; however, the method described here cannot capture any additional value change based on e.g. people's perceptions/reluctance to buy a forest with management restrictions on specific areas.

Formally the costs for a specific scenario can be calculated as:

$$T = K^{UR} - K^{R} = \sum_{t=0}^{\infty} \frac{I_t^{UR} - U_t^{UR}}{(1+r)^t} - \sum_{t=0}^{\infty} \frac{I_t^{R} - U_t^{R}}{(1+r)^t}$$

Where K is the capital value without restrictions (UR) and with restrictions (R). Revenue (I) and costs (U), may vary between the two scenarios. The interest rate applied here is r.

In beech Danish stands it is possible to carry out a more close-to nature regeneration process with reduced soil preparation and ensuring that the land is not bare between two generations of beech stands on the same area. This is carried out to minimize the leakage of nutrients to the groundwater and preserve the soil microclimate in order promote the existence of fungi, insects and larger species that are dependent on these for survival/existence in the forest. Scenarios of the costs can be calculated for different site qualities. The expected cost of a management restriction entailing natural regeneration with reduced soil preparation and a prolonged harvest period for the overstorey, due to a longer establishment period for the new generation, is shown in the figure below for site quality 1. The figure shows three different cost functions depending on how large the gaps in the regeneration may be due to the management change.



(Vedel, Jacobsen and Thorsen, 2009)

4.4.1.2 *Untouched forest areas*

Some forest areas may have unique characteristics which can only be protected by avoiding any management initiatives in the future and letting it be set aside as untouched forest land. When evaluating the potential cost of this seen from the forest owners point of view, the calculation should be based on compensating the current lost production as well as the lost value of not being able to utilize the area in perpetuity. For a given forest area this may be calculated as the soil expectation value (loss in net present value) of the area at a given age of the stand. However, this type of conservation initiative is most likely to be relevant for forested areas which are currently not being managed as production forest and therefore do not resemble growth and wood quality functions connected with traditionally managed production forest. Traditional and well-known net present value calculations are therefore not applicable. Relevant areas could be old-growth forest areas where trees have not been harvested when they were mature or forest areas with special characteristics due to water level, soil type or rare composition of the micro climate. Common for the areas it may be relevant to set aside as untouched, is that the implicit costs will in most cases have to be evaluated individually for each specific area in question. Cost calculation may be based on an assessment of the standing timber volume and value and adding the lost value of the imposed restriction in the future – i.e. that current and new owners cannot use the area in the future.

4.4.1.3 *Preservation of single trees for decay*

Due to the lack of dead wood in forests managed for production, one of the initiatives in Natura2000 seeks to promote the amount of old growth trees and dead wood in forests across the country.

Site Class 1 Beech:		
Diameter	Quality J/W	Quality C
55	173	201
50	162	184
45	124	141
40	95	108
35	71	80
30	53	60

Present value of cost (euro/tree) of setting a side single trees for natural aging and decay

When preserving single standing trees in the forest, a similar net present value calculation can be made for each single tree left for old growth and natural decay in the forest. An example of the cost of implementing this for site class 1 in beech is shown above for different diameter sizes. From a conservation point of view, it will often have the greatest value to preserve old, large and perhaps already 'uneven' trees – trees which do not have the largest economic value. In most cases, an estimation of the cost for a preserving a single tree should rely on an individual assessment, however, average costs estimates based on site class and diameter may be applied as guidelines.

4.5 *Discussion*

As discussed in earlier deliverables, 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.

Moreover, forests close to urban areas also plays an important role in the provision of recreational areas for the general 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. 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 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. This WP provides views on the forest owners' attitudes towards key issues in the current policy debate regarding increased access in the proximity of roads and paths – or – everywhere, in private forests for the public.

The CE study (RPL model) shows that the issue of increased access is by far the most dis-motivating one for forests owners among the policy issues investigated here. Owners on average require approximately 276 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. On average the forest owners requires a small amount of compensation for leaving small areas as untouched (3.8 DKK/ha) and 50 DKK/ha for accepting a minimum 75% broadleaves restriction in the forest. Setting aside an area as untouched is a comprehensive management change which may entail large costs for some owner, depending on the characteristics of their forest areas, 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. Leaving 5 trees/ha for old growth and natural decay is considered a small-scale management change, which is also reflected in the positive attitude owners have for this initiative; this is something they, on average, are not only willing to do without compensation but even for a slightly reduced amount of compensation.

Based on hypotheses regarding forest owners attitudes and forest use characteristics, living close to the forest all year was found to have an effect on forest owners choices in the CE – these owners required much less compensation for accepting a 75% broadleaves restriction on their property. For many forest owners hunting plays an important role for both the economy and the personal interest of the owner. Personal use of the forest for hunting had a significant effect on owners' preferences for increased access – making them much more expensive to compensate with regard to granting the public increased access. Owners who had expressed strong or moderate motivation for creating benefits for the local community were on the other hand willing to accept a significantly lower amount of compensation for granting the same rights of access to the public.

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5 THE BOREAL CASE STUDY

5.1 *Introduction*

In Finland, the rapid growth of nature-based tourism has expanded outdoor recreation activities from protected areas into timber production forests both in private and public lands; this is particularly so in northern Finland. In turn, this has created a growing demand to modify current forest management regimes, in particular regeneration practices, focused currently on timber production. As landscape and recreational benefits are mainly based on direct and indirect use values of forests, it is relevant to study possibilities to create a direct compensation mechanism between the users (tourists or tourism entrepreneurs) and providers (forest owners).

In order to integrate the interests of tourism entrepreneurs and forest owners, the Landscape and Recreational Values Trading (LRVT) approach has been proposed. Under this scheme, forest owners would make contracts for enhancing the provision of landscape and recreational values in their own forests and receive monetary compensations. Forest ownership would stay unchanged, and the use of the forest for purposes other than those restricted in the contracts would be free.

A joint body of the local Forest Management Association and the local Tourism Association, for example, could be established as executor and intermediary of the scheme. The contracts between the body and the forest owners would be voluntary and temporary, and the funds for the compensations would be collected from tourists as payments in connection with prices of accommodation or other tourism services.

The contract would define specific areas important for recreation and tourism, in which the preservation or enhancement of the key characteristics of the scenic and recreational quality would be secured. These areas are typically located along outdoor recreation routes and roads as well as along shores and in the surroundings of resting places. The emphasis would be in mitigating the landscape effects of final fellings, in particular those of clear-cuttings. This can imply temporarily delaying the final felling, using selective harvesting methods or regeneration through small forest patches only, or temporarily leaving a restricted area aside from cuttings.

An important piece of information for assessing the viability of the LRVT scheme is to assess the future costs of the system, e.g. the costs of collecting payments from the visitors, transaction costs between the executor and forest owners, as well as the opportunity costs of forest owners for producing landscape and recreational values. In addition to forgone revenue due to reduced harvesting, the latter may include the costs of using specific environmentally friendly harvesting and regeneration methods instead of traditional practices that aims to focus solely on timber production.

This paper will analyse these costs using two approaches. First, based on what can be called the engineering approach, we provide estimated opportunity costs for forest management practices that aim to enhance landscape and recreational benefits using computational, objective methods. More specifically the stand-level simulation software Motti developed at Metla (Hynynen et al. 2005, Salminen et al. 2005) is used. In this case, the opportunity costs are represented by the difference in the present value of net income from timber harvesting between the adjusted management regime enhancing the forest's suitability for recreation and a conventional cutting regime. The average implementation costs of typical forest management operations are available in a database gathered by regional forest authorities.

Second, following the perceived cost approach, we provide results from a forest owner survey in which the choice experiment (CE) approach was applied to reveal the minimum compensation that the owners would be willing to accept for making a temporary LRTV contract. In addition, the survey evaluates forest owners' interest to enhance the production of non-timber amenities on their own lands, and in particular their attitudes towards safeguarding the landscape and recreational values of forests. The analysis of the survey data produces indirect information about the costs of provision as subjectively assessed by forest owners. The estimated monetary value from the CE study describes the compensation claimed by the forest owners for producing these benefits by participating in the LRVT scheme. The compensation claims, or forest owners' perceived costs, can be seen as an indication of purchaser costs within the market-based mechanism.

The aim of the study is to compare the computational opportunity costs and the perceived purchaser costs of provision of enhanced landscape and recreational amenities. The case study targets the Ruka-Kuusamo area, which is a nationally as well as internationally well-known nature tourism area and one of the most important ski resorts in Finland, and an area characterised by a very high share of private forest ownership. As forestry traditionally is an important source of livelihood in this region, there is an obvious potential for conflicts between these two industries.

In what follows, section 5.2 describes the methods and material for each approach. Section 5.3 presents the estimated computational costs, estimation results and scenario analysis from the CE models, and a comparison of the results. Section 5.4 concludes.

5.2 *Methods and material*

5.2.1 Growth predictions for the engineering approach

Growth predictions were made with the MOTTI stand simulator, which is a stand-level growth simulator including specific distance-independent tree-level models for predicting such variables as natural regeneration, growth, and mortality, as well as effects of management on tree growth (Hynynen et al. 2002, Salminen et al. 2005). It is designed to simulate stand development under alternative management regimes and in Finnish growth conditions (Hynynen et al. 2002, Matala et al. 2003, Salminen et al. 2005), with specific models for peatland trees (Hökkä 1997, Hynynen et al. 2002, Hökkä and Salminen 2006).

Basically, Motti stand simulator produces stand projections under various management schedules which are determined by specific user-defined parameters (Hynynen et al. 2002, Salminen et al. 2005). Such parameters include e.g. thinning intensity and timing, stumpage prices, unit costs for silvicultural measures and the discount rate. The performance of the MOTTI simulator has been assessed in young Scots pine stands by Ahtikoski et al. (2004), Huuskonen and Ahtikoski (2005) and Huuskonen (2008), and in mixed stands by Hynynen et al. (2002). Mäkinen et al. (2005) evaluated the reliability of the growth predictions in intensively managed Scots pine stands.

Recently, Motti stand simulator has been applied at the landscape level (Ahtikoski et al. 2011) as well as in stand-level optimization (Ahtikoski et al. 2012). In general, previous results indicate that the MOTTI simulator can be applied as a tool to compare stand management alternatives in Finnish conditions. The basic assumptions behind the growth and yield models incorporated into the MOTTI stand simulator are consistent with the generally accepted principles in empirical modelling of tree growth as described by Wykoff (1990).

In the case of the Ruka-Kuusamo area the private forests' data consisted of traditionally inventoried field data with stand-level forest variables such as basal area, dominant height and stem number assessed. Further, the growing stock was described by tree species and by tree layers (see Mäkelä et al. 2011 for technical details on traditional field assessments). Finally, the measured field data were processed by specific stand-level models which generated the actual tree list to describe growing stock for Motti stand projections (Siipilehto 2006, 2009).

Average tree characteristics of the field measurements were 556 stems per hectare, basal area 13.1 m^2/ha, dominant height 14.1 m, average volume 75 m^3/ha and all stands were classified as old-growth stands (described only by biological age which exceeded 140 years). Most of the stands were spruce-dominated mixed stands with admixture of pine and birch (both less than 30%), and they represented mesic forests on mineral soils, i.e. national fertility classes *Myrtillus type* (e.g. Hotanen et al. 2008). The stands can be considered to be well-representative of stands in the region on average with respect to site type as well as to growing stocking (Statistical Yearbook of Forestry 2011, p. 56 and p. 72). With respect to average stand age in the region (Statistical Yearbook of Forestry 2011, p. 65) the stands in this study were slightly older. The economic data were based on average stumpage prices and silvicultural costs for private forests of the Ruka-Kuusamo area in 2011 (Forest Management Association Kuusamo, database inquiry). For instance, stumpage price for pine sawlogs was 51 €/m^3 (at final cut) and the cost of precommercial thinning was 272.2 €/hectare.

At this juncture the results of one private forest holding, with altogether ca. 35 individual stands, are presented. Even though this somewhat restricts the generalizability of the results, these results from a pilot forest holding still provide solid information on the calculated costs of provision for forest amenities, in this case the landscape. The smaller amount of private forest holdings than originally planned is due to the major technical delays in gathering the data from private forest holdings in the Ruka-Kuusamo area.

5.2.2 Application of choice experiment

The basic premise in valuing nonmarket forest goods with the choice experiment (CE) method is that people have preferences over goods and any good can be described through it characteristics, i.e., as a bundle of specific attributes. In economic valuation, it is assumed that people are willing and able to trade-off money for these attributes, so a monetary attribute is also included. In the CE, different attributes are traded of in the process of value elicitation so that a decrease in one attribute may be compensated by an increase in another attribute. The CE method aims at estimating the relative importance of each attribute and from there the economic values of the environmental good can be estimated. The CE acts as a tool for revealing the respondents' valuations of defined environmental goods, the quality of which may vary as described through levels of attributes. The analysis of respondents' choices provides resource managers and policy makers with detailed information about public preferences for various levels of, for example, forest goods and services produced. As a multi-attribute method, allowing the simultaneous valuation of several attributes, the CE is particularly suitable for the purpose of an integrated valuation of several key forest externalities.

In this case study, the questionnaire of the CE survey consisted of six sections. The first section dealt with the main features of the forest property, including information about the size of the forest area, availability of up-to-date forest management plan, timber sales, and recent harvesting or other forest management activities. The second section inquired forest owners' attitudes in general towards different forest and environmental management goals in the Ruka-Kuusamo tourism area. The third section dealt with the general objectives of forest ownership and the management targets for the owner, including management goals benefiting other users such as local residents or tourists. The fourth section investigated forest owners' experiences, especially familiarity of and participation in different national policy programmes enhancing environmental values of forests. The fifth section asked specific questions about the content and terms of the LRVT scheme that the forest owners would be willing to accept.

The core section of the questionnaire asked respondents to imagine that the LRVT would be started in the Ruka-Kuusamo area. They were shown tables where the attributes of a trading contract, i.e. type and size of harvesting restrictions, length of outdoor routes, duration of contract, and compensation (€/hectare/year), varied randomly (Table 5.1). From the alternatives, the respondents were asked to select the kind of contract they prefer. Finally, the questionnaire inquired socio-economic information of the respondents. The questionnaire was developed through several versions and commented by both researchers and stakeholders in the target area, e.g. Forest Management Association Kuusamo.

Table 5.1: Attributes and attribute levels used in the choice experiment

Attributes	Levels
Harvesting restrictions	No restrictions No clear-cutting No regeneration cuttings No harvesting at all
Size of restrictions	0, 5, 10 or 20% of the forest area of the property
Length of new hiking and skiing routes	0, 500 or 1000 meters
Duration of contract	5, 10 or 20 years
Amount of compensation: €/hectare/year	30, 60, 120, 180, 240 or 300 €

A full factorial design would require 864 choice sets, so a design optimised by NGene 1.0.2. (ChoiceMetrics 2010) for D_B efficiency was used. The final design had 24 choices tasks divided into 4 blocks, resulting in six choice tasks to be answered by each respondent. The D-error at the generation stage was 0.000231.

The population of the survey consisted of private people owning forest within the borders of Kuusamo municipality. The sample of owners has been drawn from the register administered by the Kuusamo Forest Management Association, in which information of all people owning more than 7 ha of forest in the municipality is recorded.

The total sample of the survey was 1355 persons divided into two sub-samples. First, in the core of the Ruka-Kuusamo tourism area where most of the outdoor activities and accommodation possibilities, like hotels, apartments and cottages, are located, all forest owners, about 1000 persons, were included in the sample. Second, in the rest of the municipality there is several single tourism firms located far away from each other. A sub-sample of people owning forest around these firms, about 350 individuals, was selected into the survey. As the number of owners in the register is about 3900, our total sample comprised one third of this. This kind of sampling is not random in the statistical sense but will most likely give a representative picture of forest owners' interests in the enhancement of quality of landscape and the use of the LRVT mechanism.

The survey was implemented as a mailed survey. The main reason for not conducting an internet survey was that the average age of forest owners in Finland is rather high, in this case 62 years. In addition, many of the owners live in rural areas where internet connections are not so usual as in towns and cities. In March 2012, questionnaires were sent to the forest owners chosen into the sample, following request cards after two weeks and other full questionnaires after additional three weeks for those who had not been responded yet. The final number of completed responses was 471, meaning that the response rate was 35.3%.

5.3 *Results*

5.3.1 Computational opportunity costs

In the calculation of opportunity costs for each stand relevant for landscape (classified as visually sensitive during a field trip by an expert), two different scenarios were projected by Motti stand simulator: first, business-as-usual (BAU) management in which the stand was managed according to the prevailing silvicultural recommendations (Hyvän metsänhoidon… 2006), and second, an adjusted management regime in which the stand was left unmanaged for the next 10 years. In most of the stands, the BAU scenario indicated immediate clear-cutting (in year 0), while the adjusted scenario resulted in growing the stand for the next 10 years, till clear-cutting took place (in year 10). The net present values (NPVs) were calculated for both scenarios, the difference between the NPVs being the income loss associated with taking landscape into account. The income losses with two different discount rates are presented in Table 5.2.

Table 5.2: Opportunity costs of enhancing landscape benefits for study stands (NPV of income losses due to adjusted management), €/hectare/10 years.

	Discount rate 3%	**Discount rate 4%**
Average income loss, €/hectare/10 years	27	143
Highest income loss, €/hectare/10 years	129	308

As can be seen from the results, the income losses were quite reasonable (Table 5.2), implying that at least in this case study taking landscape into account in forestry planning would not lead to any substantial financial losses. However, the subject merits further studying with a considerably larger amount of individual stands. This case study only demonstrates that in the given circumstances taking landscape also into account in forestry planning would not lead to any substantial financial distortions compared to business-as-usual management.

5.3.2 Perceived or purchaser's costs

Table 5.3 lists the attributes, with their levels and variable names, used in the analyses of CE data to be presented below.

Table 5.3: Attributes used in the CE with definition of levels for the ASC

Attributes	Levels	Variable name
Alternative specific constant	(…)	ASC
Harvesting restrictions	No restrictions No clear-cutting No regeneration cuttings No harvesting at all	CUT2 CUT3 CUT4
Size of restrictions	0, 5, 10 or 20% of the forest area of the property	SIZEC (continuous, (€/% point/y)
Length of new hiking and skiing routes	0, 500 or 1000 meters	ROUTC (continuous, €/m/y)
Duration of contract	5 years 10 years 20 years	DUR5 DUR10 DUR20
Amount of compensation: €/hectare/year	30, 60, 120, 180, 240 or 300 €	COMP (continuous)

Table 5.4 shows the estimation results for a Conditional Logit (CL) model with the main attributes only. The signs of the significant parameters are logical. All parameters (except for “no clear-cutting” CUT2, “no regeneration cuttings” CUT3 and “length of new hiking and skiing routes” ROUTC) are significant at the 5% level. The most restrictive harvesting restrictions (“no harvesting at all” CUT4), “size of restrictions” (SIZEC), and all levels of the duration of contract (DUR5, DUR10, DUR20) reduce the probability of choosing an alternative and imply a welfare loss. The higher the compensation (COMP) the higher is the probability of choosing an alternative.

The alternative specific constant (ASC) reflects the utility associated with the status quo alternative and factors not described by the considered attributes. Thus, a negative and significant estimate of ASC indicates that the respondents do not have a preference for choosing the status quo but are willing to have a change from the present state.

Table 5.4. Conditional logit (CL) model with main attributes only and compensation claims for significant attributes, €/hectare/year

Variable	Coefficient	Std. Error	*t* statistic	P value	Compensation claim €/ha/year
ASC	-0.115	0.0623	-1.840	0.066	30.5
CUT2	0.147	0.1707	0.858	0.391	
CUT3	-0.223	0.1696	-1.318	0.188	
CUT4	-0.465	0.1538	-3.021	0.003	123.6
SIZEC	-0.018	0.0066	-2.669	0.008	4.7[a]
ROUTC	0.000	0.0001	-0.406	0.685	
DUR5	-0.430	0.1637	-2.630	0.009	114.6
DUR10	-0.525	0.1773	-2.959	0.003	139.6
DUR20	-1.042	0.1539	-6.771	0.000	277.4
COMP	0.004	0.0003	10.953	0.000	
Number of observations		2038			
Log likelihood / R2-Adj		-2200.1823 / 0.05595			

[a] €/percentage point/year

The last column in Table 5.4 shows the monetary measures for welfare changes related to marginal changes in the levels of various attributes, i.e., compensation claims due to the implied restrictions. These can be calculated using the formula $WTA_j = -\beta_j/\beta_{COMP}$, where β_j is the parameter on the attribute j and β_{COMP} is the parameter on the compensation attribute. The respondents claimed the highest compensation for 10 (DUR10, 139.6 €) and 20 years' (DUR20, 277.4 €) duration of a contract and "no harvesting at all" (CUT4, 123.6 €). Note that as "size of restrictions" (SIZEC) is a continuous variable, the related compensation claim is measured in euro per one percentage point increase per year. Thus average compensation for the 5% share of restrictions, for example, should be 23.5 € per year. The negative coefficient of ASC implies that not having a proposed change causes a welfare loss, and the respondents would claim a compensation of 30.5 € in order to be as well off in the status quo as at the changed level.

We also calculated interaction effects between the amount of compensation (COMP) and several variables related to forest property, forest management operations as well as socio-economic and demographic characteristics. As an example, Table 5.5 shows the estimation results for a CL model with main attributes and CO_PIN58, an interaction term between COMP and respondents with net personal income higher than 4000 € per month the rest of the sample being left to a reference group. In comparison to Table 5.4, three of the variables become insignificant. One reason for this may be the loss of observations as part of the respondents refused to reveal their income. The signs of the significant parameters remain the same as in Table 5.4.

The last two columns in Table 5.5 show compensation claims related to marginal changes in the levels of significant attributes. In this model including an interaction term, the compensation claims for the basic case (reference group) and the special group depicted by the interaction term can be calculated using the formulae $WTA_j^B = -\beta_j/\beta_{COMP}$ and $WTA_j^S = -\frac{\beta_j}{\beta_{COMP}+\beta_{COMP\times D_S}}$, respectively. Here B refers to the basic case and S to a specific group marked with the dummy coded variable D_S. The formula implies that where the interaction term $\beta_{COMP\times D_S}$ gets a positive (negative) coefficient, the respondents belonging to the group with the characteristic in question would claim less (more) compensation than those in the reference group or the rest of the sample.

Table 5.5: CL model with main attributes and positive interaction between the compensation attribute and high net personal income

Variable	Coefficient	Std. Error	*t* statistic	P value	Compensation claim €/ha/year	
					Reference	High income
ASC	-0.119	0.0644	-1.842	.0654		
CUT2	0.043	0.1803	0.237	.8129		
CUT3	-0.237	0.1777	-1.332	.1828		
CUT4	-0.564	0.1612	-3.499	.0005	169.5	85.4
SIZEC	-0.020	0.0070	-2.826	.0047	5.9	3.0[a]
ROUTC	-0.000	0.0000	-0.575	.5653		
DUR5	-0.218	0.1706	-1.277	.2017		
DUR10	-0.296	0.1863	-1.588	.1122		
DUR20	-0.830	0.1608	-5.164	.0000	249.4	125.6
COMP	0.003	0.0004	9.118	.0000		
CO_PIN58	0.003	0.0006	5.297	.0000		
Number of observations			1847			
Log likelihood / R2-Adj			-2012.0762 / 0.06701			

[a] €/percentage point/year

The compensation claims of the high-income respondents are substantially lower than those for the reference group. Their compensation claim for a 20-year contract (DUR20) is 125.6 €/ha/yr as opposed to the reference group's claim of 249.4 €/ha/yr, and for "no harvesting at all" (CUT4) 85.4 €/ha/yr as opposed to 169.5 €/ha/yr. Other significant positive interactions were associated with male owners, those who made thinnings in their property during the last five years, those residing in the countryside, or owners of forest properties with sites of special scenic importance, among others.

Table 5.6 presents a CL model with negative interaction between COMP and CO_PIN1, denoting net personal income of less than 1000 € per month. The model indicates that respondents belonging to the low-income group claim a higher compensation than the rest of the sample. Their claim for a 20-year contract (DUR20) is 633.5 €/ha/yr as opposed to 203.1 €/ha/yr for the reference groups, and for "no harvesting at all" (CUT4) 441.3 €/ha/yr as opposed to 141.5 €/ha/yr. In addition, significant negative interactions were associated with the forest owner's old age, lower education, residence in Kuusamo municipality, or properties received through inheritance.

Table 5.6. CL model with main attributes and negative interaction between the compensation attribute and low net personal income

Variable	Coefficient	Std. Error	t statistic	P value	Compensation claim €/ha/year	
					Reference	Low income
ASC	-0.123	0.0643	-1.919	0.0550	30.6	95.3
CUT2	0.038	0.1800	0.212	0.8322		
CUT3	-0.243	0.1774	-1.367	0.1716		
CUT4	-0.571	0.1609	-3.550	0.0004	141.5	441.3
SIZEC	-0.020	0.0069	-2.816	0.0049	4.9	15.1[a]
ROUTC	-0.000	0.0000	-0.544	0.5866		
DUR5	-0.215	0.1702	-1.264	0.2062		
DUR10	-0.285	0.1859	-1.532	0.1255		
DUR20	-0.820	0.1604	-5.112	0.0000	203.1	633.5
COMP	0.004	0.0003	11.215	0.0000		
CO_PIN1	-0.003	0.0007	-3.770	0.0002		
Number of observations			1847			
Log likelihood / R2-Adj			-2012.0762 / 0.06345			

[a] €/percentage point/year

By adding up the compensation claims for specified changes in the levels of individual attributes we can calculate an overall compensation claim for a policy scenario involving changes in several attributes in combination (see Juutinen et al. 2011). In our case, the result of this kind of welfare analysis can be interpreted as an estimate of the forest owner's perceived or subjective costs for a potential LRVT contract in the Ruka-Kuusamo area. As an illustration, we construct three scenarios (Table 5.7). For the *least restrictive* scenario we add up the compensation claims given in Table 5.4 for the attribute levels "no harvesting at all"[2] (123.6 €), "restrictions on 5% of the forest area" (23.5 €) and "5-year contract" (114.6 €). For the *middle* and the *most restrictive* scenarios corresponding levels and values are shown in the table. If we sum the values of the attribute levels the perceived costs of an LRVT contract range from 261.7 €/ha/year for the least restrictive to 495.0 €/ha/year for the most restrictive scenario, the middle scenario getting the value 310.2 € per hectare per year.

[2] A problem here is that the only significant level of the "harvesting restrictions" attribute is the most restrictive level "no harvesting at all". For this attribute to apply to the scenario analysis this level must be used for the calculation of the values of the least and the most restrictive scenarios as well.

Table 5.7: Estimates of forest owners' overall compensation claims for three different scenarios, €/hectare/year

Variable name	**Level**	**Compensation claim**	**Scenario**		
			Least restrictive	**Middle**	**Most restrictive**
CUT4	No harvesting at all	123.6	123.6	123.6	123.6
SIZEC	€/5%/year	4.7	23.5		
	€/10%/year			47.0	
	€/20%/year				94.0
DUR5	5 years	114.6	114.6		
DUR10	10 years	139.6		139.6	
DUR20	20 years	277.4			277.4
Overall claim			261.7	310.2	495.0

5.3.3 Comparison of the results

Based on the calculations of average income losses in Table 5.2 in Section 3.1, the computational costs of provision of enhanced landscape benefits with two discount rates (3% and 4%) were 27 and 143 € per hectare per 10 years, the highest loss within the study stands being 129 € and 308 € per hectare per 10 years, respectively. As shown in Table 5.7 above, the order of magnitude of the perceived costs per year calculated from the CE data set is at least 10 times larger. Especially, the middle scenario that might be the most comparable one with the computational costs gives an annual value (310.2 €/ha/yr) almost exactly 10 times the highest income loss with 4% discount rate, 30.8 € per hectare per year.

5.4 *Conclusions and discussion*

This chapter compares two approaches to the costs of providing enhanced landscape values in the Ruka-Kuusamo nature tourism area. The first one is the engineering or computational approach providing estimated opportunity costs, or lost income due to restricted forest management practices, using the stand-level simulation software Motti. In this case, the opportunity costs are represented by the difference in the present value of net income between the changed management regime enhancing forest suitability for recreation and a conventional cutting regime. In the present analysis, a limitation of the calculations is that they are based on one private forest holding only, restricting some generalizability of the results.

The second type of analysis follows the perceived or purchaser cost approach providing results from the CE survey revealing the minimum monetary compensation that the owners would be willing to accept for making a temporary LRTV contract. Based on this analysis, we found that the perceived costs derived from the CE data set exceeded the computational opportunity costs by a factor of ten.

While comparing the results from the two approaches, it is worth noting that the perceived costs, or forest owners' overall compensation claims for entering a voluntary LRVT contract, include at least three components. First, they contain the opportunity costs or the loss of income for restricting forest management practices. This should reflect the costs that we got from the Motti simulations. Second, they include planning and transaction costs, i.e., the costs of information search, bargaining process and contract making, for example. Third, they include extra costs from specific forest management practices, such as environmentally friendly harvesting and regeneration methods, which forest owners may face if they decide to make a LRVT contract. Given the much wider contents of the perceived or purchaser's cost concept, the difference of the orders of magnitude is natural.

The analyses made with interaction variables of the CE data set indicated that there might be substantial heterogeneity in preferences of the respondents. The compensation claims, for example, may reflect owners' own preferences with respect to landscape and recreational values (see Mäntymaa et al. 2009) as well as their attitudes towards tourists and tourism business. In the future, we will analyse this topic more deeply using factor analysis, random parameter logit models and latent class models, for example.

6 THE CENTRAL EUROPEAN CASE STUDY

This chapter is organized in two main sections. In the first section, the aim is to present the main results from the forest owner survey in Poland. It is carried out in framework of POLFOREX described in D3.2. The aim of the survey was to investigate the potential compensations for forest owners for introducing those programs into their forests. This was carried out through a contingent valuation surveys (CV) focusing on two management plans: (1) improving recreational (touristic) conditions in forests and (2) increasing biodiversity (naturalness).

In addition to the original methods proposed to analyse the costs of provision it has been decided to include an experimental study in the NEWFOREX project. This is presented in the second main section of this chapter. It is carried out by the Polish and French partners. The objective of the study is to test mechanisms of selecting privately-owned forest areas that would provide ecosystem services (ES).

6.1 *Forest owner survey in Poland*

6.1.1 Introduction

Around 18% of Polish forests (1.6 million hectares) are private; 17% belongs to individuals, 0.8% to land communities, less than 0.1% to cooperatives. The sites smaller than 5 ha account for 73% of the private-owned forests. On average, a single forest owner in Poland has 1.3 ha of a forest. 5% of a Polish timber production comes from private forests. In private forest the efficiency of timber production is 4 times less (75 m3/100 ha) than in forests managed by the State Forests National Forest Holding (SF NFH) (337 m3/100 ha). Mostly, timber from private forests is used for owners own purposes.

Forest management, either in state forests or in private ones, is based on 10 year forest management plans. The main goal of the forest management is to conduct the forest economy according to the principles of common preservation in terms of durability of the maintenance, continuity and balanced usage of all forest functions and expending forest resources (the Forest Act from 1991). Management plans are drawn up by administrative services outside the SF NFH named the Forest Management and Geodesy Bureau, which is subordinated to the Minister for Treasury. Plans are approved by the Minister of Environment. However, the work of preparing the management plan is regulated by a special document, "Instruction for preparation of forest management plan for forest districts", which is elaborated by a team of specialists supervised by the SF NFH.

Private forest owners have a right to harvest trees according to their local forest management plans. They have a right to receive public subsidies to cover the costs of development and conservation related to rebuilding stands, which were damaged by industrial gases or dust. They have a right to get subsidies for an afforestation planed on their lands. According to the Forest Act from 1991, private forest owners have the right to forbid access to a forest by posting an adequate information table.

The private Forest Owner Survey presented in this chapter was carried out as a part of the POLFOREX project "Forest as a public good. Evaluation of social and environmental benefits of forests in Poland to improve management efficiency"; PL0257; (2008-2011) funded by EEA Financial Mechanism, Norwegian Financial Mechanism and Polish Ministry of Science and Higher Education. As this had similar objectives and a time framework to forest owner surveys planed under the NEWOFOREX project we decided to not repeated it, but just present the results obtained in the POLFOREX survey. Saved funds we used for the experiment described in the section 6.2.

We conducted a contingent valuation surveys (CV) focusing on two management plans: (1) improving recreational (touristic) conditions in forests and (2) increasing biodiversity (naturalness). The aim of the survey was to investigate the potential compensations for forest owners for introducing those programs into their forests.

6.1.2 **Data and Method**

6.1.2.1 ***Summary of data collection***

The private Forest Owner Survey was conducted in June 2011 by a professional polling agency (Centrum Badania Opinii Społecznej). The approach chosen was face to face interviews. A total of 100 forest owners were interviewed. These were selected and contacted with help from Polish local forest owner associations. We deliberately chose forest owners with more than 5 ha forest in order as we assume a minimum size of forest needed before owners actively decide to choose between different management regimes.

6.1.2.2 ***Method***

The survey was designed as a contingent valuation with the outcomes of two different management regimes. Below there are presented scenarios describing the hypothetical changes in the forests management.

<u>The scenario concerning the enhancement of biodiversity measures:</u>

"Let's assume that the government has offered compensation to private forest owners to increase biodiversity in their forests. Such compensation would be set depending on the level chosen by the majority of private forest owners who are willing to participate in this program. What minimum compensation would you expect for limiting logging and leaving fallen trees, for a period of 10 years? If your stated amount of compensation is higher than the average amount declared by other private forest owners, you will not be allowed to participate in this program."

<u>The scenario concerning improvements of the recreational (touristic) conditions:</u>

"Let's assume that the government would propose compensation for private owners for sharing their forests with visitors and improving recreational conditions. This compensation would be set at a level chosen by the majority of private owners who are willing to participate in this program. What would the minimum yearly compensation requested be for participation in this program for 10 years? If the amount you propose is higher than the average indicated by the other owners, you would not take part in this program."

In the first case, as a payment vehicle an annual compensation per hectare was used, in the other an annual compensation per forest. Both were designed for the 10 years period. The applied elicitation format was the payment ladder with four possible answers to proposed bids: "definitely no" "rather no" "rather yes", "definitely yes".

We run the interval regression models to investigate the variation in the willingness to accept of the compensations for two different management regimes based on "rather no" and "rather yes" responses. To estimate the mean WTA we used the Kaplan–Maier non-parametric technique.

6.1.2.3 *Descriptive data of the sample of respondents*

There is no private forest owner association at the national level in Poland and there are no socio-demographic data available on the total population of forest owners. Because of that we were unable to use a representative sample for private forest owners in Poland. We asked the polling agency to choose respondents from forest owners possessing forests which size was equal at least to 5 hectares.

In the analysed sample 25% of the respondents were women, and the average age of a respondent was 52 years. Around 63% had a lower education (primary or vocational) and the average net monthly household income was 2553zł (638 €). 24% of the respondents did not declare their income. Most of the respondents inherited their forests. Half of the respondents lived in the distance equal shorter than 2 km from their forests. Tables below refer to forest sides owned by the average respondent in our survey.

Age

Table 6.1: Age distribution

	mean	sd	25% quartile	50% quartile	75% quartile	minimum	maximum
Age	51.53	12.38071	43	51	59.5	22	88

Education and gender

Table 6.2: Completed education by gender

	Men	Women	Total
Primary	12	5	17
vocational	37	7	44
incomplete secondary	0	1	1
secondary (comprehensive school)	3	1	4
secondary vocational	15	6	21
undergraduate or vocational education, e.g. BSc (without MA)	0	1	1
higher degree	8	4	12
Total	75	25	100

Income

Table 6.3: The monthly income of the household after taxes (incl. pension etc.)

	Frequency	Percent	Cumulative
1-1000 PLN	9	9.00	9.00
1001-2000 PLN	24	24.00	33.00
2001-3000 PLN	21	21.00	54.00
3001-4000 PLN	10	10.00	64.00
4001-5000 PLN	7	7.00	71.00
5001-6000 PLN	2	2.00	73.00
6001-7000 PLN	1	1.00	74.00
7001-8000 PLN	1	1.00	75.00
9001-10000 PLN	1	1.00	76.00
hard to say/ no answer	24	24.00	100.00

The nominal exchange rate in June 2011: 1 €= 3.9695 zł

Ways to become a forest owner

Table 6.4: Ways to become a forest owner

Answer	Frequency
Purchase	18
Inheritance	79
Total	100

Note: Multiple answers were possible.

Forests visits pattern

Table 6.5: Visits frequency in the last 12 months

Answer	Frequency
Never	3
1-9 days	7
10-24 days	29
25-49 days	30
More than 50 days	31
Total	100

Table 6.6: Purposes of forest visits in the last 12 months

Answer	Frequency
individual physical works (logging, clearing, commercial mushroom harvesting)	82
labour management	12
walking	55
picking berries and mushrooms	60
wildlife watching	58
hunting	5
other	5
Total	277

Note: Multiple answers were possible.

Table 6.7: Distance from the place of residence to the possessed forest (in km)

	mean	sd	25% quartile	50% quartile	75% quartile	minimum	maximum
Age	10.28	50.99497	1	2	3	0	500

6.1.3 Survey Results

6.1.3.1 *General information about the forest property*

Of the 100 interviewed forest owners, more than half own less than 10ha (31% between 5-7 ha and 25% between 7 and 10 ha). A minority own more than 20 ha. The average total area of forest in the respondents' possession was equal to 15.7 hectares. On average the respondents declared that they owned 3 forests properties. The stated size of the largest coherent forest area was 9.2 hectares. In two cases respondents live in a different province than their forests are located.

Table 6.8: Size of total forest area in hectares

	mean	**Sd**	**25% quartile**	**50% quartile**	**75% quartile**	**minimum**	**maximum**
Size	15.665	23.66522	6	9	15	5	180

Table 6.9: Number of separate forest plots

	mean	**Sd**	**25% quartile**	**50% quartile**	**75% quartile**	**minimum**	**maximum**
Number	3.16	3.529729	1	2	4	1	30

Table 6.10: Size of your largest coherent forest area

	mean	**Sd**	**25% quartile**	**50% quartile**	**75% quartile**	**minimum**	**maximum**
Size	9.246	9.105902	4	7.5	10	1.2	63

Table 6.11: Geographic location of the forest and residence of the owner

Province	**Frequency**
małopolskie	15
mazowieckie	5
podkarpackie	9
podlaskie	5
pomorskie	41
świętokrzyskie	10
warmińsko-mazurskie	10
zachodniopomorskie	5

6.1.3.2 *Forest characteristics*

61% of the respondents stated they owned a coniferous forest, 59% that in majority their forests consist of trees younger than 60 years, 64% that paved roads were going through their forests. The vast majority declared that there were no touristic facilities in their forests, and none of forests were certified according to FSC or PEFC. Only 10% of the respondents had forest areas which were affected by some kind of conservation measure.

Table 6.12: Type of forest

Answer	Frequency
coniferous forest	61
deciduous forest	4
mixed forest	35
Total	100

Table 6.13: Three major tree species in owned forests

Answer	Frequency
Pine	77
Birch	59
Spruce	39
Oak	17
Beech	14
Larch	11
Alder	10
Fir	10
Poplar	1
Maple	1
sycamore maple	1
Total	240

Note: Multiple answers were possible.

Table 6.14: "In majority your forest consists of: …"

Answer	Frequency
old trees (older than 60 years)	8
young trees (younger than 60 years)	59
middle age trees (about 60 years)	30
hard to say	3
Total	100

Table 6.15: "Are there any streams, lakes, wetlands, glacial erratics or hills in your forest?"

Answer	Frequency
Streams	32
Lakes	4
Wetlands	27
glacial erratics	2
Hills	29
none of them	40
Total	134

Note: Multiple answers were possible.

Table 6.16: Roads

Answer	Frequency
Paved	8
Unpaved	64
None	28
Total	100

Table 6.17: Touristic facilities

Answer	Frequency
educational path	1
table with maps	1
Benches	0
litter bins	0
Shed	0
camping site	2
car park	1
none of them	97
Total	102

Note: Multiple answers were possible.

Table 6.18: Conservation measures in the forest

Answer	Frequency
Natura 2000 area(s)	7
Part of landscape park	3
None	90
Total	100

Table 6.19: Is the forest certified according to FSC or PEFC?

Answer	Frequency
Yes	0
No	100
Total	100

6.1.3.3 *Economy of the forest*

19% of the respondents declared that they used their forests for commercial timber production and 79% that they used timber for their own purposes. 55% of the respondents stated they received income from their forests during the last 12 months. The mean timber production for commercial purposes were 4 times higher than timber production for own purposes (such as e.g. heating). Majority of the respondents stated they removed dead wood from their forests. 55% of the respondents answered that their forests were a part of hunting areas; however, they did not receive any income from this activity. Additionally, they did not receive any payments for allowing for recreation activities in their forests. In the majority works in the forests were conducted by their owners and their family members. All data analysed in this chapter are annual (regarding income and costs respondents were asked about the last 12 months period).

Harvest volume

Table 6.20: Commercial timber production (in m^3)

	mean	**Sd**	**25% quartile**	**50% quartile**	**75% quartile**	**minimum**	**maximum**
Volume	82.78947	228.3033	4	15	50	0	1000

Table 6.21: Timber production for own purposes (in m^3)

	mean	**Sd**	**25% quartile**	**50% quartile**	**75% quartile**	**minimum**	**maximum**
Volume	20.35135	18.14133	10	19	25	0	120

Costs

Table 6.22: Total cost per year (in zł)

	mean	Sd	25% quartile	50% quartile	75% quartile	minimum	maximum
Cost	2296.596	7077.964	100	300	1500	0	60000

Table 6.23: The cost associated with timber production (in zł/m^3)

	mean	Sd	25% quartile	50% quartile	75% quartile	minimum	maximum
Cost	172.303	463.9664	0	0	0	0	2000

Table 6.24: The cost associated with a forest protection (in zł/ha)

	mean	Sd	25% quartile	50% quartile	75% quartile	minimum	maximum
Cost	266.4949	1181.686	0	0	0	0	10000

Table 6.25: The cost associated with planting (in zł/ha)

	mean	Sd	25% quartile	50% quartile	75% quartile	minimum	maximum
Cost	755.5556	5046.973	0	0	200	0	50000

.

Table 6.26: Forest taxes (in zł/ha)

	mean	Sd	25% quartile	50% quartile	75% quartile	minimum	maximum
Taxes	228.81	246.1364	16.5	180	400	0	1249

Income

Table 6.27: Income from the forest (in zł)

	mean	Sd	25% quartile	50% quartile	75% quartile	minimum	maximum
Cost	4100.8	14043.99	0	0	2200	0	110000

Table 6.28: Income from timber production (in zł)

	mean	Sd	25% quartile	50% quartile	75% quartile	minimum	maximum
Taxes	1172.525	3382.162	0	0	0	0	20000

Table 6.29: Share of income from the forest in the household income

Answer	Frequency
Missing obs.	1
0%	44
5%	39
10%	8
20%	5
40%	2
80%	1
Total	100

Activities in the forest

Table 6.30: "Do you remove the dead wood from your forest?"

Answer	Frequency
Yes, accordingly to the level established in a simplified forest management plan and administrative decisions prepared by poviat apply.	66
I remove even more fallen and dead trees than it is ordered in simplified forest management plan and administrative decisions prepared by poviat apply.	22
I leave fallen trees in forest.	9
There's no need to do this – young forest, no fallen trees.	3
Total	100

Note: Poviat – a unite of administrative district.

Table 6.31: "Who works in your forest?"

Answer	Frequency
You and your family	98
Hired labour	14
Professional company	2
National Forest Holding workers	1
Total	115

Note: Multiple answers were possible.

6.1.3.4 *Valuation*

WTA for increasing the level of biodiversity (naturalness)

53% of the respondents stated that the programs focusing on maintaining the high level of biodiversity in some private forests in Poland were needed. 61 % of them declared they would like to take part in such a program. The average WTA to participate in this program for those who agreed was equal to **305 zł (76 Euro) per hectare.** However, more than half of the respondents noticed that such a program would increase the risk of tree disease and expansion of insects.

Table 6.32: "Do you think that protecting some of the private forests in Poland in order to maintain the high level of biodiversity is needed"?

Answer	**Frequency**
Yes	53
No	17
hard to say	30
Total	100

Table 6.33: "What are the advantages of managing private forests to increase biodiversity?"

Answer	**Frequency**
Increased level of biodiversity	41
Contact with untouched nature	35
Keeping nature for next generation	54
Improvement of forest aesthetics	20
Better conditions for tourism development	18
Possibility of money compensation	33
Total	201

Note: Multiple answers were possible.

Table 6.34: "What are the disadvantages of managing private forests to increase biodiversity?"

Answer	**Frequency**
Surplus population of some animals and plants species	23
Enlarged risk of tree disease and expansion of insects	62
Wood wasting	53
Deterioration of forest aesthetics	25
Worse conditions for tourism development	9
Decreased income from wood selling	37
Total	209

Note: Multiple answers were possible.

Table 6.35: WTA for increasing biodiversity.

Amount	**Definitely not**	**Rather not**	**Rather yes**	**Definitely yes**
A) 20 PLN/ha per year	91	6	3	0
B) 50 PLN/ha per year	88	9	3	0
C) 100 PLN/ha per year	83	14	2	1
D) 150 PLN/ha per year	75	21	3	1
E) 200 PLN/ha per year	65	24	10	1
F) 250 PLN/ha per year	55	23	16	6
G) 300 PLN/ha per year	35	26	25	14
H) 350 PLN/ha per year	32	16	27	25
I) 500 PLN/ha per year	27	5	20	48

Figure 6.1: WTA distribution for increasing biodiversity.

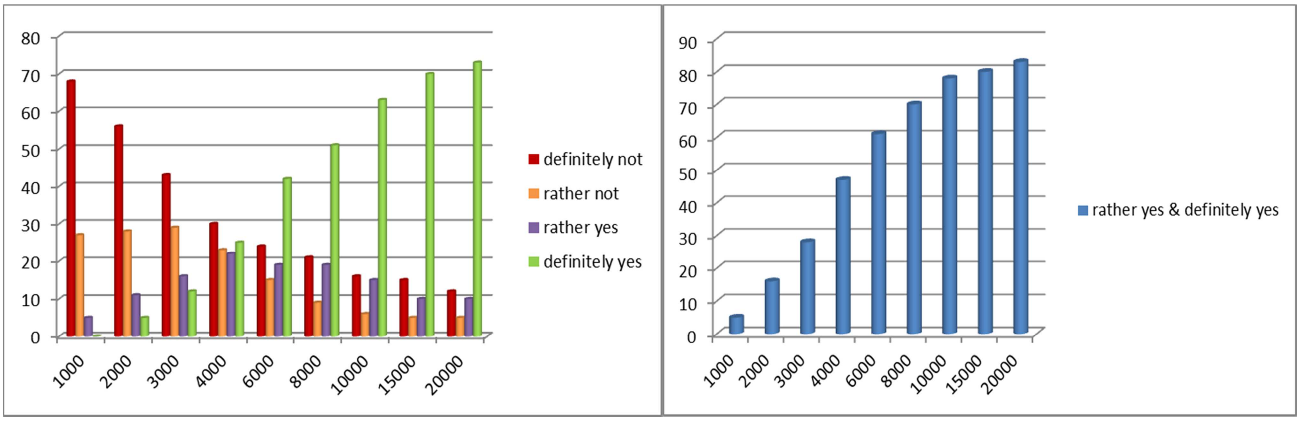


Table 6.36: "Why wouldn't you participate in this program"?

Answer	**Frequency**
because it's my property and no one has the right to restrict my activity there	21
because I think the program will cause degradation of my forest	17
because the amounts stated are too low	14
because I don't believe these compensations will be paid	3
because I don't run commercial wood logging and I don't plan to, regardless of compensation possibility	3
Total	58

Note: Multiple answers were possible.

Table 6.37: "Let's assume that the compensation could be calculated in different ways. What factors should be included in the calculation of the rate of compensation"?

Answer	**Frequency**
income lost due to limited trees cutting and wood selling which is calculated on the base of the previous yearly income	68
age of trees in the forest (i.e. the older the trees are, the higher the compensation ought to be)	67
current biodiversity level (the more valuable species of trees and plants are in the forest, the higher the compensation ought to be)	28
the distance to the forest from the village or town (the closer, the higher compensation)	21
other (what?)	8
Total	192

Note: Multiple answers were possible.

WTA for improving recreational (touristic) facilities

69% of respondents agreed with the statement that the public should be allowed to enter private forests in the recreational purposes. 79% of the respondents agreed to take part in the program improving the recreational facilities in their forest in return for the compensation. The average WTA to participate in this program for those who agreed was equal to **7013 zł (1753 Euro) per year.** More than the half of respondents agreed with the statement that the nature belongs to everyone so everyone has the right to benefit from it.

Table 6.38: "Do you think that people should be allowed to enter to private forests in recreational purposes"?

Answer	**Frequency**
Yes	69
No	31
Total	100

Table 6.39: "What are the advantages of public admittance in recreational purposes to your forest?"

Answer	**Frequency**
the nature belongs to everyone so everyone has the right to benefit from it	56
sharing the forest gives me pleasure	22
sharing the forest gives me the opportunity to communicate with others	14
sharing the forest gives me higher income (i.e. from selling forests products, running the bar, hunting fees etc.)	5
Other	3
Total	100

Note: Multiple answers were possible.

Table 6.40: "What are the disadvantages of public admittance in recreational purposes to your forest?"

Answer	**Frequency**
littering the forest	29
nature destruction (of trees, bushes, litterfall)	18
Poaching	11
wood stealing	14
increased fire risk	22
increased danger (robbery)	5
responsibility for tourists' accidents	5
Other	0
Total	104

Note: Multiple answers were possible.

Table 6.41: "What would lead you to share your forest with visitors? / (in case of current free admittance) What would lead you to improve recreation conditions in your forest?"

Answer	**Frequency**
money compensation from the government for maintaining the tourism infrastructure (benches, information boards, etc.) and for cleaning forest	67
the possibility of charging the visitors for accessing the forest	6
providing and maintaining tourism infrastructure (benches, tables) and purifying my forest by relevant departments	28
Other	4
I do not want to share my forest with others/ I do not want to improve recreational conditions of my forest in this way	23
Total	128

Note: Multiple answers were possible.

Table 6.42: WTA for improving recreational (touristic) facilities.

Amount	**Definitely not**	**Rather not**	**Rather yes**	**Definitely yes**
A) 1000 PLN per year	68	27	5	0
B) 2000 PLN per year	56	28	11	5
C) 3000 PLN per year	43	29	16	12
D) 4000 PLN per year	30	23	22	25
E) 6000 PLN per year	24	15	19	42
F) 8000 PLN per year	21	9	19	51
G) 10 000 PLN per year	16	6	15	63
H) 15 000 PLN per year	15	5	10	70
I) 20 000 PLN per year	12	5	10	73
J) 30 000 PLN per year	12	3	9	76
K) 50 000 PLN per year	11	3	6	80

Figure 6.2: WTA distribution for improving recreational (touristic) facilities.

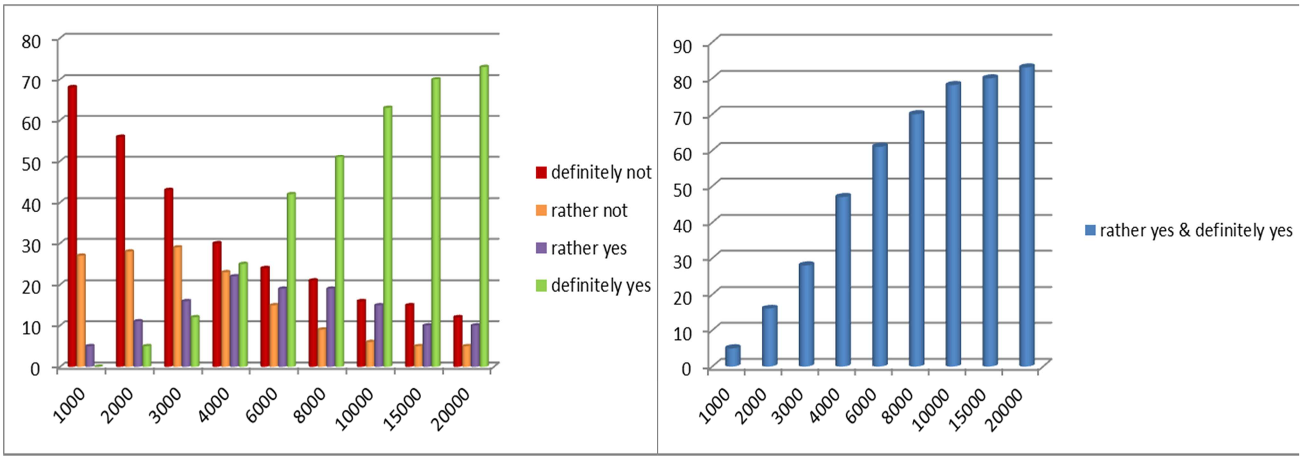


Table 6.43: "Why wouldn't you participate in this program?"

Answer	**Frequency**
because it's my property and no one has the right to restrict my activity there	10
because the more visitors, the more litter and as a result degradation of the forest	4
because the amounts stated are too low	0
because I don't believe these compensations will be paid	3
because I don't need compensation to share my forest with visitors	2
Total	19

Note: Multiple answers were possible.

Table 6.44: "Let's assume that the compensation could be calculated in different ways. What factors should be included in the calculation of the rate of compensation?"

Answer	Frequency
the type and amount of tourist infrastructure built in the forest	65
age of trees in the forest (i.e. the older the trees are, the higher the compensation ought to be)	65
current biodiversity level (the more valuable species of trees and plants are in the forest, the higher the compensation ought to be)	34
the distance to the forest from the village or town (the closer, the higher compensation)	27
other (what?)	8
Total	199

Note: Multiple answers were possible.

Interval regressions

Below we present the results from the interval regression models used to investigate willingness to accept the compensations for introducing two different management regimes. Unfortunately, both models explain rather poor the variation in the respondents WTA. Only in the model concerning the recreational scenario two coefficients were significant: for the age of the respondents and for the size of the forest. The younger respondents and those with the smaller forest sites were willing to accept the lower compensation for improving recreational conditions in their forests.

Table 6.45: Biodiversity

	Coef.	Std. Err.	z	P>z	[95% Conf. Interval]	
Sex	21.06861	50.62133	0.42	0.677	-78.14737	120.2846
Age	2.398499	1.786594	1.34	0.179	-1.103161	5.90016
edu_p	85.06924	57.96828	1.47	0.142	-28.54649	198.685
edu_h	117.2242	91.20341	1.29	0.199	-61.53115	295.9796
house_inc	-.0040163	.015454	-0.26	0.795	-.0343056	.0262729
Size	3.975561	3.312849	1.20	0.230	-2.517504	10.46863
Cost	-.0005326	.0076703	-0.07	0.945	-.015566	.0145009
_cons	153.9093	149.277	1.03	0.303	-138.6683	446.4869
/lnsigma	5.160947	.1124778	45.88	0.000	4.940494	5.381399
Sigma	174.3294	19.60819			139.8394	217.3261
Log likelihood = -110.81337						
LR chi2(7) = 6.39						
Prob > chi2 = 0.4956						
Number of obs = 76						

Table 6.46: Recreation

	Coef.	Std. Err.	z	P>z	[95% Conf. Interval]	
Sex	-7419.539	5328.417	-1.39	0.164	-17863.05	3023.966
Age	392.7964	186.5908	2.11	0.035	27.08514	758.5076
edu_p	-250.9971	6155.588	-0.04	0.967	-12315.73	11813.73
edu_h	7729.195	9627.614	0.80	0.422	-11140.58	26598.97
house_inc	-.4673239	1.624049	-0.29	0.774	-3.650402	2.715754
Size	794.3539	347.8604	2.28	0.022	112.5599	1476.148
Cost	-1.28712	.8260834	-1.56	0.119	-2.906214	.3319733
_cons	-4071.786	15811.88	-0.26	0.797	-35062.5	26918.93
/lnsigma	9.862505	.1001165	98.51	0.000	9.66628	10.05873
Sigma	19196.92	1921.929			15776.56	23358.82
Log likelihood = -210.06894						
LR chi2(7) = 13.09						
Prob > chi2 = 0.0700						
Number of obs = 76						

6.1.4 Discussion

Private forests in Poland are very small and often fragmented, owned by the largest number of forest owners in Europe (about 840 000 people). The ownership structure remained almost unchanged in the whole post-war history. Since the beginning of the political transformation in Poland (started in 1989), there has been a slight increase in the area of private forests (0.8%). A small number of the forest owners are members of the few local forest associations. There is no forest owner association at the national level.

The private forest owners' rights are constrained by the law. Forest management, either in state forests or in private ones is based on 10 year forest management plans prepared by the Forest Management and Geodesy Bureau. The aim of those plans is to keep "the sustainable forest management". Based on them the local forest management plans are developed by the administrative body (*poviat*). Private forest owners have a right to harvest trees according to those plans. They have the right to forbid access to a forest, what they do very rarely in practice. They do not charge the entrance fee for visitors.

Polish forest owners do not have an experience in participating in any payment for ecosystem services scheme, so proposed the survey scenarios could seemed for the respondent quite abstract. Rarely the income from the forest constitutes a significant share in household funds. Mostly, timber from private forests is used for owners own purposes.

The results of conducted survey indicate that the majority of the respondents would be interested in participation in voluntary schemes regarding enhanced biodiversity measures or recreational opportunities for the public. The average WTA to participate in the program concerning the enhancement of biodiversity for those who agreed was estimated at 305 zł (76 Euro) per hectare. The average WTA to participate in the program improving recreational (touristic) facilities in the forest for those who agreed was equal to 7013 zł (1753 Euro) per year.

The results from the interval regression models used to investigate willingness to accept the compensations for introducing two different management regimes show rather poor fit. That can be explained by a few factors. Firstly, as it was mentioned, Polish forest owners have no experience with voluntary schemes, secondly their economic activities in the forests is constrained by the law. Additionally, from the methodological point of view, the analysed sample was quite small. Only in the model concerning the recreational scenario two coefficients appeared to be significant: for the age of the respondents and for the size of the forest. The younger respondents and those with the smaller forest sites were willing to accept the lower compensation for improving recreational conditions in their forests. The first case can be explained by the fact that younger people in Poland are more familiar with the market mechanisms and they are more rational in their expectations concerning payments for ecosystem services. In the second case, since the compensation was defined in zł per year unit, a wish to receive higher compensation for the larger forest seems to be reasonable.

6.2 *Determinants of success of ecosystem services provision auctions: An experiment*

6.2.1 Introduction

We have run an experimental study focused on testing a mechanism of auctions for the provision of ecosystem services (APES) in the context of privately-owned forest areas and a publicly-owned national park (NP). A point in case is a national park surrounded by hitherto unprotected forest (a buffer zone). The willingness to accept of a forest owner if she was required to provide ecosystem services (ES) at a particular plot may well be her private knowledge. The external benefit, on the other hand, will typically depend on the location of the plot and location of other plots providing ES. In particular, it may be important to have ES plots clustered together, adjacent to the NP and providing wildlife "corridors".

First, we have investigated <u>two different auction formats</u>: **discriminatory vs. uniform**. Both of them have their merits in practical applications. In the discriminatory auctions, transaction prices are determined in a straightforward manner—they are identical to (accepted) offers—and this simplicity is a major virtue in these otherwise complicated markets. On the other hand, uniform auctions place less burden on the participants as far as the determination of their bidding strategy is concerned—bidding their own reservation prices is a reasonable option under uniform pricing only (although it is generally speaking NOT an equilibrium strategy as will be discussed later). For the same reason, their results are very likely to be more informative for the auctioneer, i.e. she learns more about the actual sellers' reservation prices. Finally, given that the resulting transaction prices are identical, the sellers may consider this auction format as more fair.

In familiar single-object auctions, where just one unit of good may change hands, the analogon of the discriminatory auction is the first-price sealed-bid auction, while second-price (Vickrey) auction is the relative of the uniform auction formats. The properties of these two variants are well understood. Assuming private values (each bidder knows his valuation and does not care how much others would be willing to pay), second-price auctions induce truth-telling (bidding identical to reservation price) and first-price involves just the right degree of bid shading to make the expected revenue identical for the seller. In either case the auction is efficient, i.e. the player with higher valuation will always win the auction. The case of multiple potential sellers and single bidder interested in one unit (procurement auctions) which is obviously the relevant one for APES is just the mirror image – they should request more than the reservation price under first-price rules only.

The reason why (single-object) second-price auctions induce truthful bidding is simple: each buyer only submits one bid, so if his bids affects the price – he is not the winner, because his bid is only second-highest. There is thus no reason to shade the bids. In this sense, *strategic uncertainty* that the bidders are facing is reduced which is believed to encourage entry (also of less experienced bidders) and reduce costs. It is tempting to extend this reasoning to multiple-object auctions (in which buyers submit a number of bids for the first, second, … n -th unit—a demand schedule).

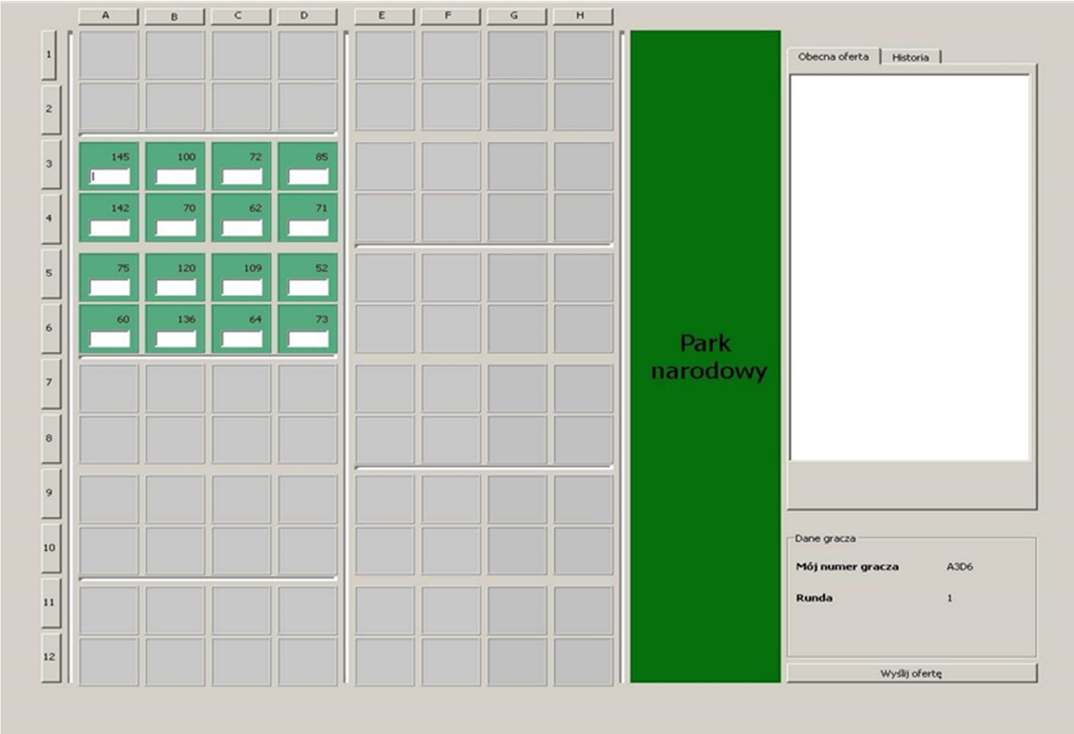
In the case of multiple bids, any buyer's lower bid can affect the price charged on a (succesful) higher bid so some shading pays off.

Secondly, we have investigated was **the possibility of communication between participants**. From practical viewpoint, this is an important consideration in APES because (1) the owners of specific lots will often know each other and might indeed want to coordinate their strategies and (2) complex, multi-round auctions will often give the participants enough time to communicate. From theoretical perspective, it is an interesting open question of how communication may affect auction results. This is not so in standard auctions—there we expect that it will facilitate collusion, thereby decreasing the auctioneer's revenue (or, in procurement auction as in our case, increasing the amount she will have to pay). In the case of APES, where efficiency may depend on participants' ability to coordinate strategies with their neighbours, such that larger contagious areas of wildlife protection are created, communication may turn out to support the auctioneer's effort to maximize environmental benefits.

6.2.2 Design and procedures

Participants of the experiment were divided into groups of 6 (typically, there were 18 subjects in one session). Each of them was assigned a property consisting of 16 *cells* (see Figure 6.3 showing the initial information displayed to subject owning cells A3-D6, the white lines delineating each player's property). Each property was a 4x4 square, except for the subject holding A1-D4 and A11-D12 squares, although this makes no strategic difference. Each cell had specific *production value* in experimental dollars (ED), drawn independently from a $U(50,150)$, that could be realized if that particular cell was retained by the owner at the end of the experiment. Each owner could also offer any of his cells at any ED price he wished at a multi-round auction run by an automated *government*.

Figure 6.3: Screenshot showing the initial information displayed to subject owning cells A3-D6.



There was no limit on the number of offers per round. In each round, the government would *provisionally* "purchase" such a combination of cells offered by some or all the sellers that would maximize *environmental value* per experimental dollar spent on purchases, subject to the constraint that an amount betweeen 4000 and 5000 ED is spent. Environemental value of any combination of cells that could be purchased would be calculated as follows (see the transcript of experimental instructions is section 6.2.4 for an example):

- one point per each cell purchased in columns A-F
- two points per each cell purchased in columns G-H
- additionally one point for each two purchased cells sharing a vertical border (i.e. constituting a horizontal corridor)

In setting these rules we were trying to mimic some characteristic features of usefulness of ecosystem services. First, the lots close to the existing wilderness (the National Park) were considered more valuable. Second, creation of corridors stretching out of the wilderness, facilitating migration of wild animals, was appreciated. At the same time, the rules were kept as simple as possible. Note also that by assigning one of the owners a discontinous A1-D4, A11-D12 property we have made sure that each participant had exactly two neighbours with whom to build horizontal corridors – the situation was strategically identical for each of the three A-D owners and similarly among the three E-H owners.

The experiment would end for the group if the environmental value per ED spent failed to improve by more than 5% in each of 5 consecutive rounds (and otherwise it would end after round 30). The provisional purchases would then become actual purchases and the subjects would earn the amount in ED resulting from adding up the production values of non-sold cells and transaction prices of sold cells. It would be exchanged into Polish Zloty at the rate of 1ED=.015 zloty (ca. 4 eurocent). If the round was not the final one, the offers made in it had no direct impact but would by default be proposed for the subsequent round (yet they could be altered, altogether removed or suplemented with offers for previously un-offered cells at subjects' discretion).

Subjects' information

As is clear from Figure 6.3, every participant knew all production values of own but not others' cells. After each round they were shown all bids and told which were provisionally successful at which price (see Figure 6.4). Subjects knew that the automated government aimed at possibly high environmental value and how it was calculated. They were not informed about the exact stopping rule – they were told that each round could prove to be the last one (and thus its results would matter for real). Forestry framing was used, chiefly to facilitate understanding of some features of the design.

Figure 6.4. Screeshot showing bids which were provisionally successful at which price (the discriminatory version with chat).

Experimental treatments

Each group would operate under one of two auction formats. Under Discriminatory conditions, each accepted cell would be purchased at the price offered. Under Uniform conditions, all purchases in columns A-F had to be at the same price. Similarly, all cells purchased in columns G-H would be bought at the same price.

This distinction would be crossed with the availability of chat: in ca. half the groups the subjects were allowed to send any chat message to any combination of other participants at any time. In the no-chat condition, no communication was allowed whatsoever. Table 1 shows the number of groups in each of four resulting treatments.

Table 6.47. Experimental treatments: number of groups

Treatment	**Discriminatory**	**Uniform**
Chat	6	6
No chat	7	7

The experiment was conducted in the spring of 2013 at the Laboratory of Experimental Economics at the University of Warsaw, using the local (student) subject pool. It was computerized using Python-based program developed by Jean-Marc Rousselle from the INRA in Montpellier. Printed instructions were used (section 6.2.4). Both software and instructions were perfected in pilot sessions to ensure that subjects had no problem understanding their decision environment. 11 sessions with 1 to 3 groups each were run. A short post-experiment questionnaire was deployed to collect demographic data. Table 6.48 shows the desriptive statistics of the sample.

Table 6.48. Descriptive statistics of the sample.

	Discriminatory Chat (DC)	**Discriminatory No chat (DNC)**	**Uniform Chat (UC)**	**Uniform No chat (UNC)**	**Total**
Mean age	23.79	23.79	24.00	22.38	**23.36**
Gender (1=woman, 0=man)	58%	72%	41%	49%	**52%**
Students (1=student, 0= not student)	74%	80%	78%	96%	**84%**
Experience in lab experiments (1=yes, 0=no)	74%	59%	79%	43%	**62%**
Mean net houshold income (in zł)	5422	4076	4998	6057	**5260**

6.2.3 Results

Because the decision making environment was relatively complex, it may be worthwile first to establish that subjects' behavior followed rules that we would find reasonable. First, we have argued that there were very limited incentives to bid below production value, especially in the discriminatory treatment. It is thus somewhat reassuring to see that such choices were rare. A typical bidder in the Discriminatory condition would make 13.86 offers above the relevant production value and just .21 and .41 offers at or below it, respectively (remaining 1.52 cells on average would not be offered at all). Corresponding figures for the uniform treatment were 10.69, 1.98, 1.03 and 2.30 (note that, in line with our expectations, offers at or below PV were much more common here). Figures 6.5, 6.6, 6.7 and 6.8 show prcie margines for accepted offers (the offer divided by the production value) per each round in respect to an applied treatment.

Another check of subjects' ability to respond to strategic incentives would be to compare the bids for "inner" and "outer" columns of each owner's property. Indeed, because of the horizontal connectivity bonus, it would on average be more important to have an offer in column B or C accepted than in column A or D because the former would increase attractiveness of two of the same owner's cells, while the latter would only help one offer. Similarly, we expect that offers in column F should be more competitive than in E and in G more than in H.[3] It turns out this is indeed the case: when we define a variable relative_offer equal to the offer divided by relevant production value, we find it is indeed modestly but significantly higher for "outer" than "inner" columns: 1.499 vs. 1.484 in Discriminatory and 1.303 vs. 1.280 in Uniform.

Finally, given that the cells in columns G and H had higher environmental value, we would expect our subjects to seize the opportunity and require higher profit margin. Indeed, when compared to cells in columns E and F (i.e. owned by the same subjects), the relative offers where much higher for them (1.728 vs. 1.390 in Discriminatory and 1.423 vs. 1.279 in Uniform, both differences are obviously highly significant).

We have not observed significant diffrences between offers in "chat" and "no chat versions. The uniform sessions lasted longer and were characterized by more rounds.

[3] Comparison for these columns is complicated by the fact that G and H provided higher environmental value but this is orthogonal to our definition of "inner" or "outer" columns.

Figure 6.5. Price margins - DNC

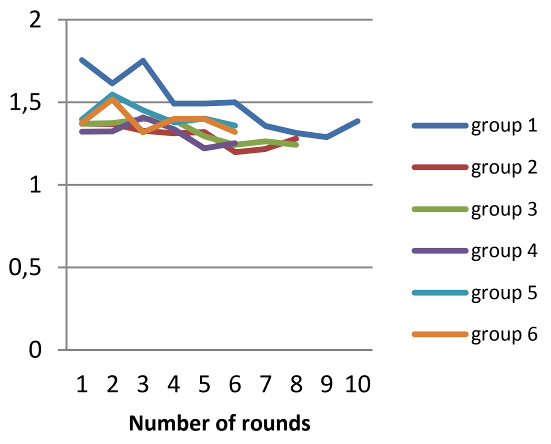


Figure 6.6. Price margins - DC

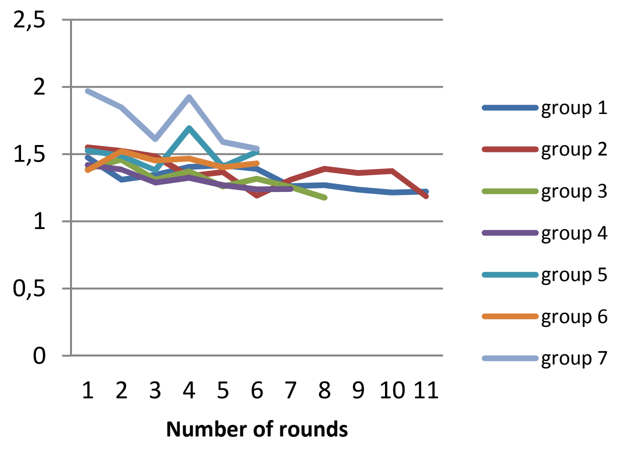


Figure 6.7. Price margins - UNC

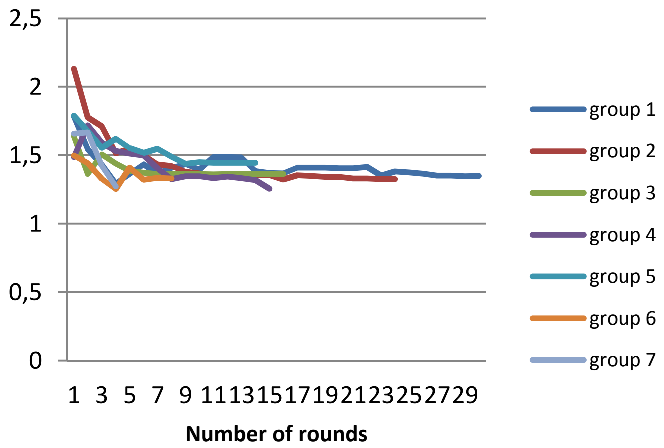


Figure 6.8. Price margins - UC

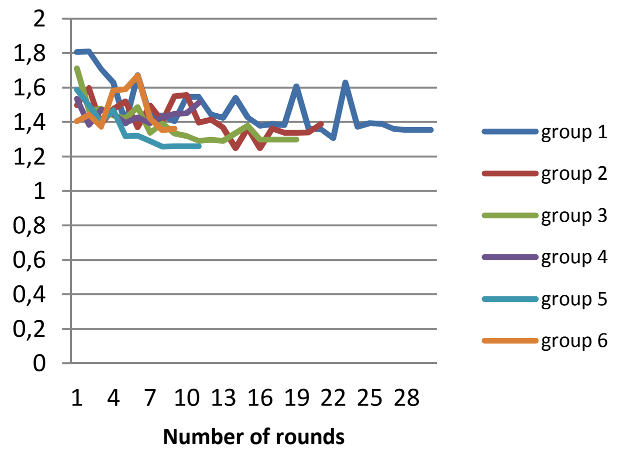


Table 6.49. The number of rounds and the mean earnings from the experiment.

	Mean	Min.	Max.
Number of rounds	**16.11**	**4**	**30**
DC	7.63	6	10
DNC	8.11	4	11
UC	20.05	9	30
UNC	20.11	4	30
Mean earnings (in zł)	**26.71**	**18.81**	**39.60**
DC	26.79	18.81	33.44
DNC	26.73	20.87	35.78
UC	26.75	20.64	33.36
UNC	26.65	19.44	39.60

6.2.4 Appendix: experimental instructions [Discriminatory, with Chat]

INSTRUCTIONS

Thank you for your interest in our experiment! During the experiment you will be able to earn Experimental Dollars. The amount of money you earn will depend on your choices and the choices of other participants. At the end of the experiment Experimental Dollars you earn will be exchanged to Polish zloty.

Please turn off your cell phones and refrain from talking or communicating with other participants in any other way, with the exception of the chat dialogue box, as described below. Participants disobeying this rule may be excluded from the experiment without receiving any payment. In case of any questions or doubts please alert the experimenter by raising your hand.

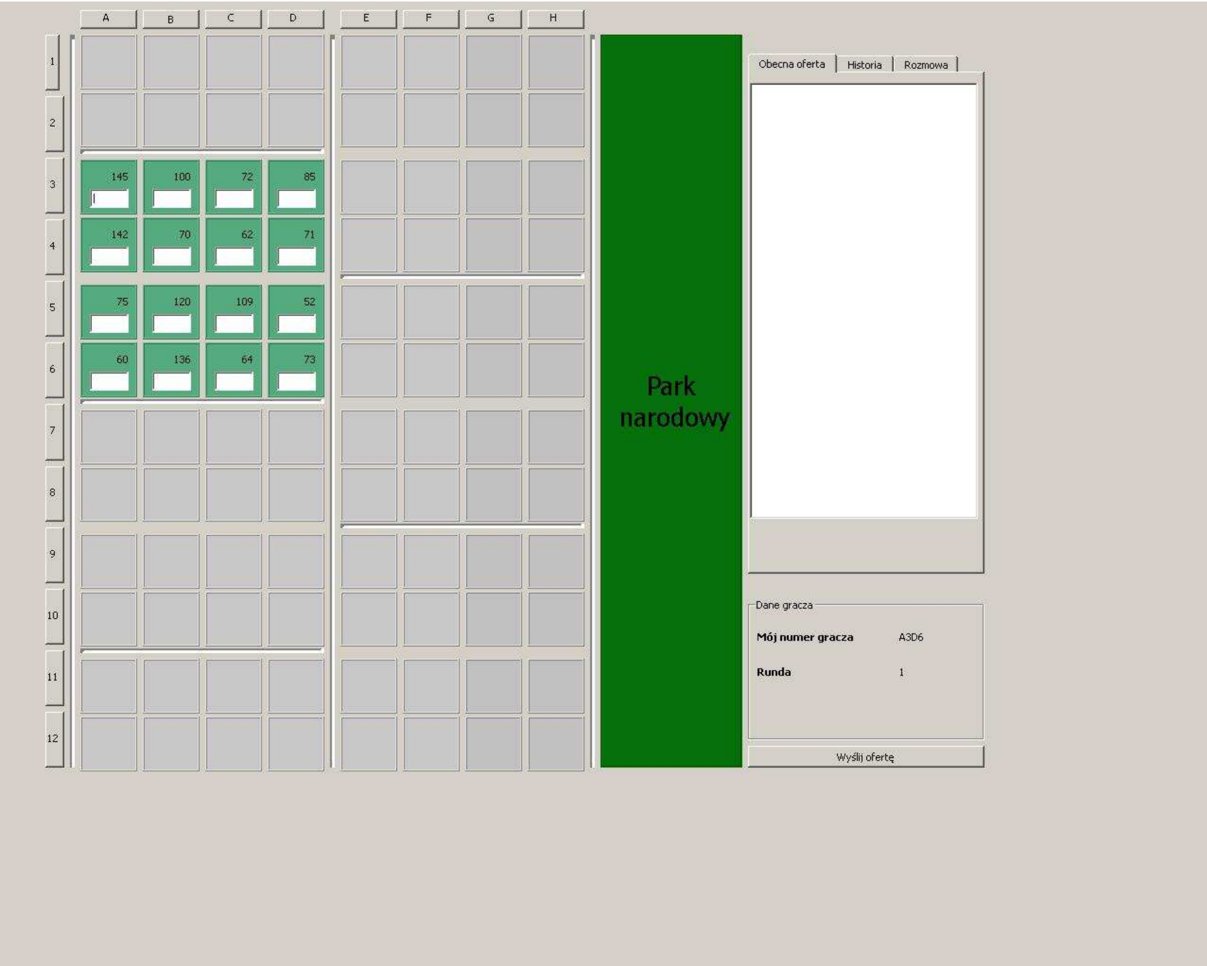
In this experiment you have been assigned to a **GROUP of six**.

Each member of the group is in possession of a forest **PROPERTY** consisting of **16 FIELDS**. The PROPERTIES of players may be closer to of further away from the **NATIONAL PARK.**

For example, the screen shot provided (Figure 0) shows the situation of a participant of the experiment, who possesses a PROPERTY not in immediate proximity to the PARK, consisting of fields: 3-A, 3-B, …, 6-C, 6-D, (the FIELDS marked with color green).

The narrow white lines separate the PROPERTIES of each of the six members of the group. Fields marked 1-A, …, 1-D, 2-A, …, 2-D, and fields 11-A, …, 11-D, 12-A, …, 12-D (upper and lower left hand corner) comprise a single property, that is, are in possession of a single participant.

Figure 1. *An exemplary screen shot at the beginning of the game.*



Each FIELD has its own **PRODUCTION VALUE**, for example, 4-B has the PRODUCTION VALUE of 70. It is the value of that field to the owner (for example profits from selling lumber). **If by the end of the experiment the FIELD is still in possession of the owner, he or she will be granted 70 Experimental Dollars.**

The PRODUCTION VALUES of different FIELDS comprising your PROPERTY will vary. The rationale behind that is the varying density of the forest on various FIELDS, or different ages or species of the trees. The value of each FIELD will be constant during the whole experiment. **Each participant knows the PRODUCTION VALUE of every FIELD in his or her possession, but does not know the values of FIELDS that belong to other participants.**

An AUCTION will take place during the experiment, during which you will have the possibility to sell some or all of your FIELDS to the GOVERNMENT. The GOVERNMENT buys the FIELDS in order to protect the buffer zone of the NATIONAL PARK and to create migration corridors for animals from different dwellings. The GOVERNMENT is NOT represented by any participant in the experiment, its behavior had been pre-programmed by the experimenters. Participants are not allowed to buy or sell FIELDS to other participants (owners of other properties).

- The AUCTION consists of MULTIPLE ROUNDS
- **Only the FINAL ROUND determines the earnings in Experimental Dollars, which in turn determine your earnings in zloty.**
- **The results of past ROUNDS inform you of the earnings you would have, if that round had been final.**
- However, it is not explicitly stated which ROUND will be FINAL. It depends on the behavior of all of the participants in subsequent rounds. By bidding in any given round you acknowledge that it might turn out to be the FINAL ROUND and the results will be binding (that means that the FIELDS you put up for sale will be bought by the GOVERNMENT for the price you list).

YOUR STEPS IN THE AUCTION:

- In each ROUND you can put up for sale any number of the 16 FIELDS in your possession (you can choose not to offer any)
- For each FIELD you put up for sale you must name a price (a BID). The BIDS may vary for different FIELDS.
- Enter the BID for each FIELD you want to put up for sale into the text box (or leave it blank if you do not wish to sell it in this round).
- Submit your BID.

At the end of a ROUND it might turn out that you have “sold” one, many, all or none of your FIELDS. The “sold” FIELDS will be marked RED. You will also find out what were the BIDS of other participants, and which of them were “accepted”. The “accepted” bids will be marked ORANGE.

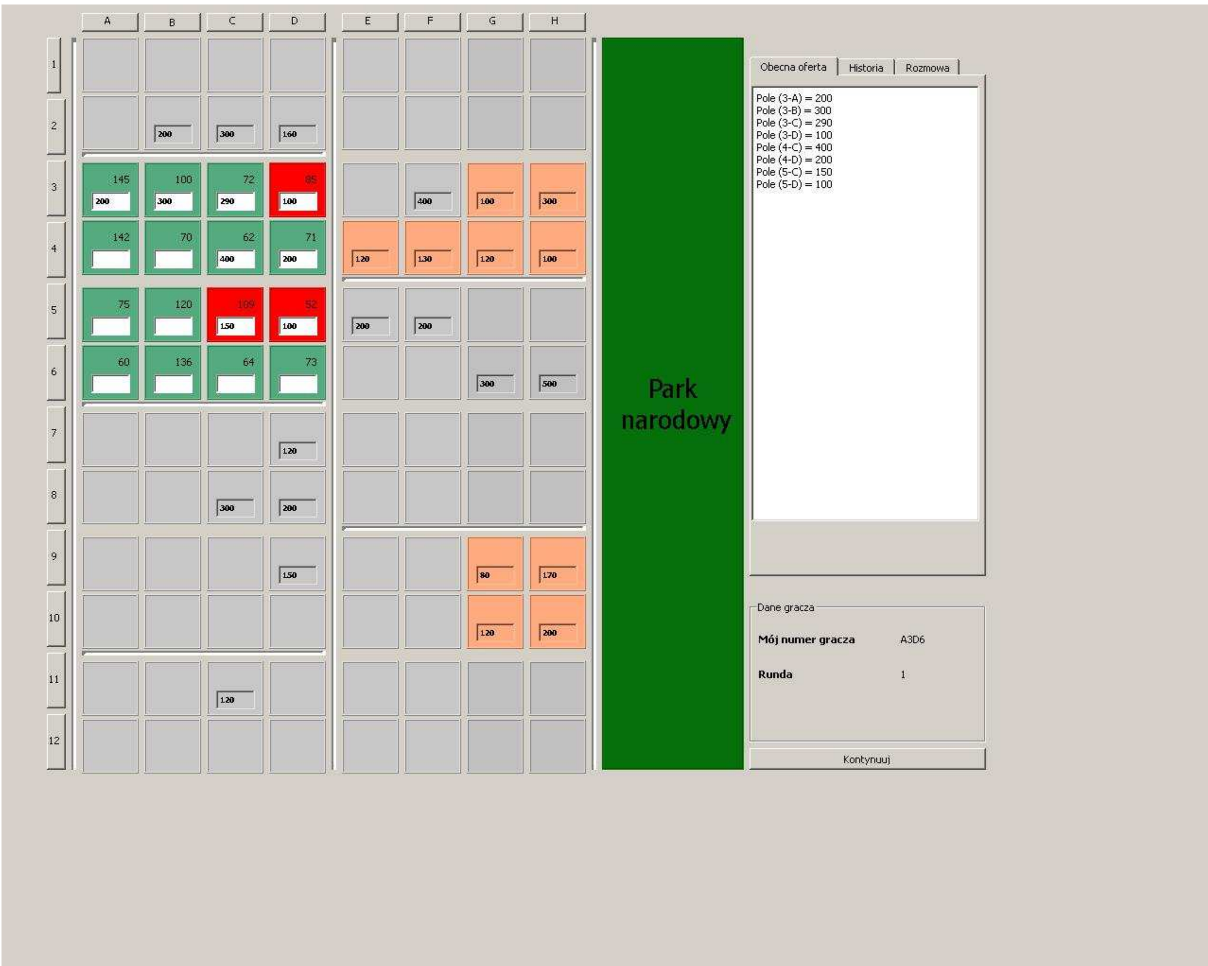
If the ROUND in question will not turn out to be the FINAL ROUND, the transactions are VOID. That means the results are not binding and do not have consequences either for you or for the other participants (that is why the terms “sold” and “accepted” in the previous paragraphs have been put in quotation marks).

If the current ROUND is followed by another you repeat the procedure with all the 16 FIELDS originally in your possession, with the PRODUCTION VALUE of each field remaining unchanged (that is, the fact that you provisionally "sold" any specific FIELD in the previous ROUND has no effect - you still own it).

You can however change the BIDS and/or the FIELDS you wish to put up for sale in each ROUND.

Figure 2 shows the situation after a certain ROUND, which did not turn out to be FINAL. Not all the BIDS of the selected participant have been "accepted", only those marked RED. For example, he or she succeeded in "selling" (BID of 100) FIELD 3-D, but he did not "sell" FIELD 3-C with the BID 290. The figure also shows the BIDS (but not the PRODUCTION VALUES) for FIELDS that belong to other participants. For example the owner of FIELDS from columns E-H and rows 1-4 "sold" 6 of his or her FIELDS, but failed to "sell" the FIELD 3-F for a price of 400. Naturally he or she also did not sell their remaining 9 FIELDS, none of which have been put up for sale. In the next ROUND each participant is allowed to raise or lower the BID for each FIELD, as well as change the combination of FIELDS he or she puts up for sale.

Figure 2: *An exemplary screen shot of the situation after a round that was not the final round.*



If a given ROUND turns out to be FINAL and a certain BID gets accepted, the GOVERNMENT has buys the FIELD at the price equal to the BID. Naturally you will not receive money for the PRODUCTION VALUE of the FIELDS you have sold.

Your earnings in the experiment will be calculated according to the formula:

Sum of BIDS for sold FIELDS + sum of PRODUCTION VALUES of FIELDS not sold = earnings in Experimental Dollars

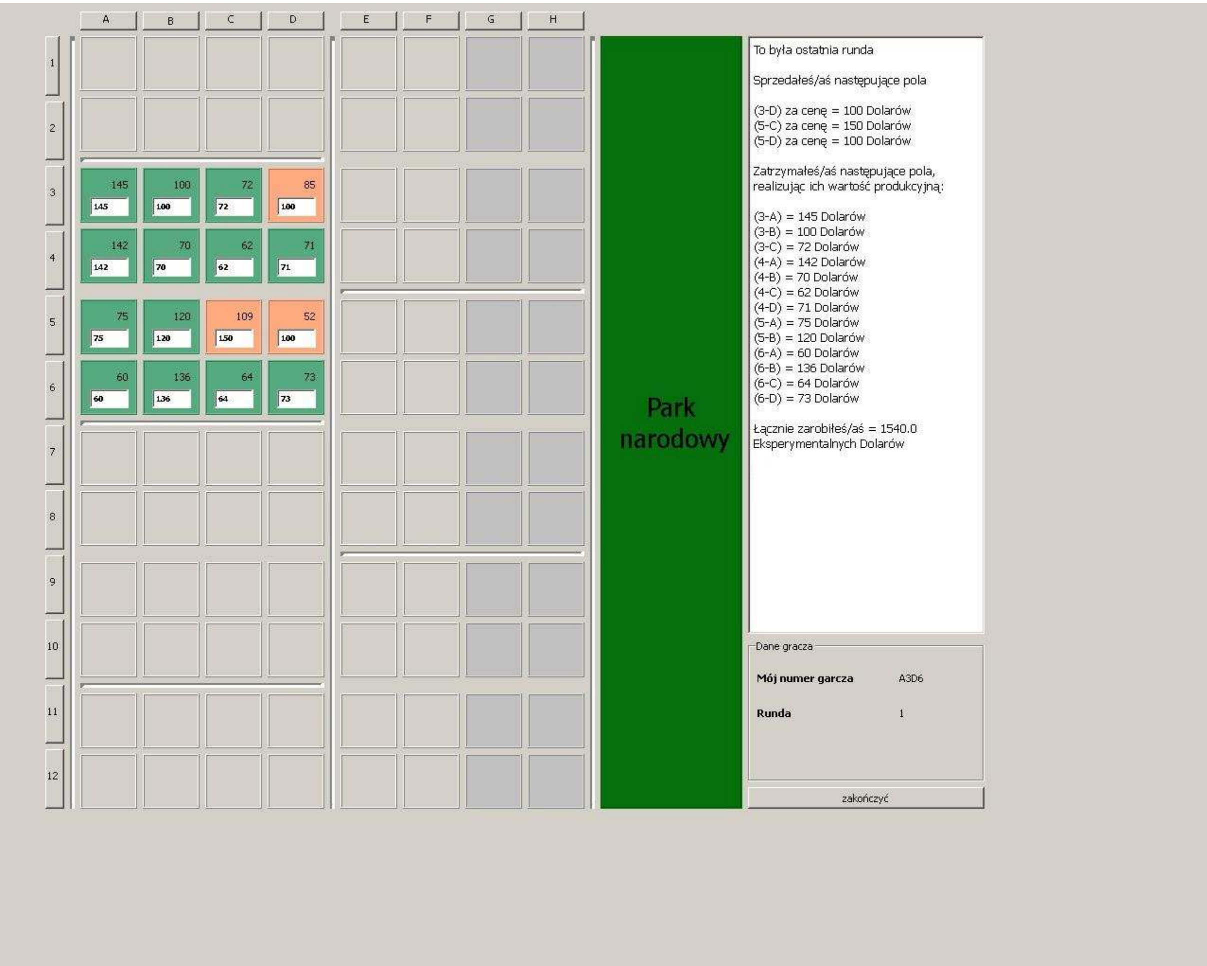
For every Experimental Dollar you earn you will be granted .015 zloty.

For example, should your earn **2000 Experimental Dollars**, you will receive **30 zloty.**

CAUTION: Each ROUND could be the FINAL ROUND!

Figure 3. shows the situation after a ROUND that turned out to be FINAL.

Figure 3: *An exemplary screen shot of the situation* after a *round that turned out to be final.*



The results are discussed for the selected participant only. Carefully read the text in the column to the right of the national park.

HOW DOES THE GOVERNMENT DECIDE WHICH FIELDS TO BUY?

The pre-programmed GOVERNMENT has the budget of **5000 Experimental Dollars** to buy the FIELDS from the participants. It will try to spend that amount (or slightly less) buying the FIELDS offered by the participants in a way that will maximize the joint ENVIRONMENTAL VALUE (the benefit for the environment). The optimal combination is found by a special algorithm. After buying the FIELDS the GOVERNMENT will not exploit the terrain—it will neither extract lumber nor disturb the ecological processes.

The ENVIRONMENTAL VALUES vary between FIELDS.

- FIELDS that lie in the buffer zone of the NATIONAL PARK (that is, in the columns adjacent to the PARK, marked with darker colors) are the most valuable.
- Buying FIELDS that form a horizontal line on the board offers a higher ENVIRONMENTAL VALUE. They are the corridors that will allow the animals to migrate between the NATIONAL PARK and other dwellings.

The exact formula that is used by the GOVERNMENT to calculate the aggregated value of the ENVIRONMENTAL VALUE of the FIELDS:

For each FIELD bought in columns A-F: 1 For each FIELD bought in columns G and H: 2

Additionally, in case of acquiring a pair of FIELDS form the same row adjacent to each other (that is FIELDS that share a vertical border, creating a horizontal connection), regardless of the columns they are in, the ENVIRONMENTAL VALUE bonus: 1.

For example, if the GOVERNMENT buys fields 6-D, 6-E, 7-E, 7-F and 7-G the total ENVIRONMENTAL VALUE equals:

1 [for 6-D] +1 [6-E] +1 [7-E] +1 [7-F] + 2 [7-G is in the buffer zone] + 1 [bonus for adjacent 6-D and 6-E] +1 [bonus for adjacent 7-E and 7-F] + 1 [bonus for adjacent 7-F and 7-G] = 9

Take note that:

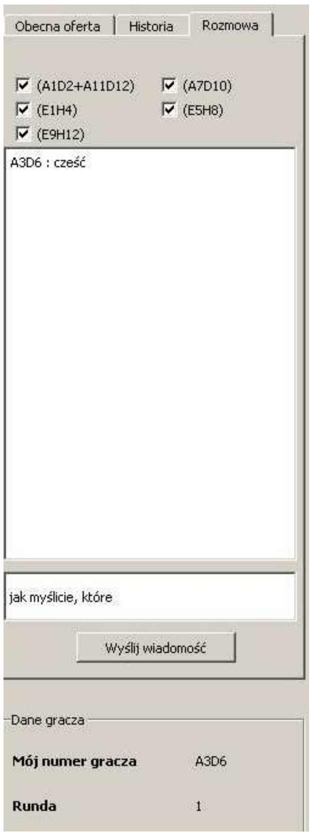
- No additional ENVIRONMENTAL VALUE is added for FIELDS that share a horizontal side thus creating a vertical connection (here: 6-E and 7-E)

- The ENVIRONMENTAL VALUE bonus connected with creating a horizontal connection does not take into account whether the FIELDS belonged to one or two participants.

What are the implications of such behavior of the government for you:

- If your BID is too high you will not sell said FIELD. You will be left only with its PRODUCTION VALUE.
- The question whether a certain BID is “too high” depends mostly on the behavior of other participants - in general you will not be able to sell FIELDS that are relatively more expensive than FIELDS offered by others.
- Additionally, the maximum BID for said FIELD that the GOVERNMENT will be willing to accept will be considerably higher for FIELDS more attractive to the GOVERNMENT - that is those located in columns G and H and those that together create a horizontal corridors with other FIELDS offered either by you or by other participant.

CONVERSATION BETWEEN PARTICIPANTS



Perhaps you have noticed the tab “Chat” [Polish: Rozmowa] on Figures 0 and 1. Participants belonging to the same GROUP of 6 have the possibility to communicate with each other via this tool. The figure on the right shows how to use it. The screen shot presents the point of view of a participant who has FIELDS in columns A-D and rows 3-6 (A3D6). In the upper part of the panel he or she can choose which of the other 5 participant he or she wishes to contact. Type each message into the text box immediately above the “Send message” button. In the captured moment the participant began to type a new message “What do you think, which ” to all of the other participants. All sent and received messages will appear in the bigger text panel above. As you can see, the chosen participant has previously sent a message “Hello” [Polish czesc]. You will be able to send and receive messages in every round of the auction. Naturally you do not have to use this tool.

You can use this tool to ask questions, make proposals or promises, reveal your plans, comment on the actions of others, coordinate strategies etc.

ATTENTION! You can send any message, as long as you abide by the following rules:

- You are not allowed to use words or expressions that are considered vulgar or aggressive or to offend other participants.
- You are not allowed to reveal your true identity (first or last name, etc.) or physical location in the lab, or to encourage anyone else to do so.
- You are not allowed to make promises or threats that would extend beyond the experiment (for example promise to share your winnings or threat to withhold social contact) or to encourage anyone else to do so.

The experimenter has the possibility to inspect the content of sent messages both during the duration of the experiment and after it is finished. Blatant disregard for the rules listed above will result in exclusion from the experiment without earnings. If you believe that another participant has broken the rules of chat please raise your hand and wait for the experimenter.

Raise your hand in case of any questions. If not, please press the button on the screen to begin.

7 THE FRENCH STUDY

This chapter is organized in two main sections. In the first section, the aim is to present the main results from the French pilot study survey. A proxy of the opportunity cost of amenities provision is derived by considering the reduction of the timber income per unit of forest area due to an increased importance of non-timber services in the management objectives.

In the second section, the purpose is to investigate the joint production of timber and non-timber, especially biodiversity and recreation, using a simulation approach. Through the derivation of a production possibility frontier for the modelled forest, it is then possible to compute opportunity costs for preserving biodiversity and forest recreation.

7.1 *French pilot study survey*

This section is organised as follow. After having briefly described the survey, the data representativeness as well as the methodology, the main results from the questionnaire are presented in a descriptive manner. Successively, a heuristic estimation of the expected income from the forest is computed for different degrees of importance of amenities provision in the forest owner's management objectives. Finally, a brief discussion of the results is presented.

Please note that in the survey analysis presented in this deliverable, it was not always possible to treat the different forest externalities separately. As a consequence, most of the times they were considered in one general category called amenities, in contrast with timber production. The terms amenities, non-timber services, environmental services, forest externalities are hereby used as synonyms.

7.1.1 **Introduction to the survey**

In France, the total forest area extends over 16 million ha (additional 9 million are located in overseas regions). It is mostly covered by deciduous species (67%). Private forest represents three quarters of the total forest area in France. The share or private forest is significantly higher than the national average in western France – Limousin, Brittan, Poitou-Charentes, Aquitaine, Pays de la Loire; whereas it is smaller in the North – Lorraine, Alsace and Franche-Comté (IGN, 2012). In general, the private forest property is highly fragmented. As a matter of fact, the average size of forest properties is 2.73 ha (Agreste, 2012)

Property fragmentation results to be the major economic limitation to wood mobilization (Elyakime & Cabanettes, 2009). Actually, only about one third of forest owners harvest timber. In light of the above, the French pilot study focussed mostly on investigating forest owner willingness to harvest timber and the factors affecting such decision. Secondarily, it explored forest owners' management objectives and the services provided by their forests (possibility of leisure activities, presence of protected areas, climate change mitigation, etc.).

The experiences derived from this pilot survey were used to develop case-study specific conceptual questionnaires.

7.1.2 Data and methods

7.1.2.1 *Summary of data collection*

Survey design

As already discussed in Deliverable 3.2, the pilot forest owner survey was mailed to forest owners from five different regions (Auvergne, Bourgogne, Lorraine; Provence-Alpes-Côte d'Azur, Pays de la Loire). Forest owners were selected by stratified random sampling from a cadastral list. Overall, 15000 questionnaires accompanied by a stamped return letter were mailed. Selected forest owners also had the possibility to complete the questionnaire on-line.

The questionnaire was divided in three sections. The first section addressed the description of the forest, the forest management, the owner's objectives and habits as well as the non-timber services provided by the forest. The second section concerned timber production and timber sale. The last part dealt with the owner involvement in forest development networks and the owner's socio-demographic characteristics.

It is important to notice that in the questionnaire, questions are referred to the forest owned by the respondent, which is within the limits of the municipality stated in the attach letter. This property is referred as "forest studied". However, some questions focussed on the overall forest property (in the case the respondent owned more than one forest property). In these cases, the changing of the object of the question was clearly stated.

Final sample, response rate and data quality

In total 590 questionnaires were returned. The response rate was only 3.9%. "No-response" was higher especially among owners with small forest properties. Many of the returned questionnaires were partially uncompleted, limiting thus the full statistical exploitation of the data.

Before the analysis, the data were controlled, cleaned and corrected. Some inconsistencies where detected in the data, for instance the size of the total property was smaller than the size of the forest studied or the size of the protected area was larger than the size of the property, and the like. When possible, such inconsistencies were corrected by using information contained in the data. In the other cases, the observation where excluded from the analysis, by changing the value of the inconsistent variable into a missing value. In this way, the other information about those specific respondents could still be used.

7.1.2.2 *Descriptive data of the sample of respondents*

The representativeness of the French pilot study sample is compared with data presented in the Enquiry on Private Forest Ownership in Europe (UNECE/FAO et al., 2006) and the data from the land registry (Ministère de l'Agriculture, de l'Agroalimentaire et de la Forêt, 2012).

Although the sample refers to only five different administrative regions, it is still reasonable to compare the sample characteristics with the ones of the population of French private forest owners, because of the scattered spatial distribution of the sampled regions across the France and their different levels of forest covering and different ratios of private and public forest area. As a matter of facts, these five regions were selected because they represent the different forest paradigms in France.

In general, the sample does not represent the forest owner population in terms of property size and gender. A higher degree of representativeness is found regarding the age structure and the professional situation.

Forest area

With regard of total forest area owned, the sample is not representative of the forest owner population. Individuals owning a forest property with size less than 1 ha are largely underrepresented. Whereas owners of forest with a size larger than 10 ha are overrepresented. The average size of the total forest owned by the respondents is approximately 99 ha. In contrast, the population average forest size is 2.73 ha.

Table 7.1: Size of total forest area owned in France (hectares)

Size category	**Number of owners**	**Percent (sample)**	**Percent (population)**
Less than 1 ha	50	8.47	65.56
1 ha to less than 4 ha	81	13.73	23.09
4 ha to less than 10 ha	78	13.22	7.01
10 ha to less than 25 ha	98	16.61	2.84
25 ha to less than 100 ha	156	26.44	1.23
100 ha and over	127	21.53	0.27
Total	590	100	100
Average size (sample)	98.99		
Std. Dev. (sample)	240.46		
Average size (population)	2.73		

The average size of the forest studied is approximately 71 ha. The smallest is 0.2 ha, whereas the largest is 1681 ha.

Table 7.2: Size of the forest area within the limits of the municipality whose name is printed in the attach letter (referred to as "forest studied")

	mean	**sd**	**25% quartile**	**50% quartile**	**75% quartile**	**minimum**	**maximum**
Hectares	70.64	167.53	4	19	62	0.2	1681

Age distribution and gender

The age distribution of respondents reflects quite well the age structure of French forest owners. Nevertheless, the difference between the two distributions is statistically significant (α=0.05), the age structure of the sample is characterised by a large majority of forest owner with an age over 60, which is also found in the population data. Similarly, the low percentage of young forest owner (aged less than 30) is in line with the population data, although slightly overrepresented.

As far as gender is concerned, female respondents are underrepresented for all age classes in the sample compared to the population values.

Table 7.3: Age structure and gender in the population and in the sample

Age class	**Number**	**Percent (total sample)**	**Percent (total population)**	**Share of female in the sample (%)**	**Share of female in the population (%)**
Less than 30 years	5	0.85	0.58	20	24
31-60 years	183	31.02	39.97	15	25
More than-60 years	372	63.05	59.45	19	32
No reply	30	5.08			
Total	590	100	100	18	30
Chi-test p-value		0.001			

Income

The most frequent gross income class (about 24%) ranged from 35000 to 50000 € on an annual basis (equivalent to 2917 € to 4167 € on a monthly basis). Around 22% of the respondents did not answer this question. Yearly

Table 7.4: The yearly income of the household before taxes (incl. pension etc.)

Income per year (euro)	**Total**	**Percent**
0 - 6000	17	2.88
6000 – 12000	47	7.97
12000 – 18000	40	6.78
18000 – 25000	45	7.63
25000 – 35000	64	10.85
35000 – 50000	108	18.31
50000 – 100000	100	16.95
More than 100000	36	6.1
No reply	133	22.54
Total	590	100.00

Table 7.5: Share of the forest income compared to the total income

	mean	sd	25% quartile	50% quartile	75% quartile	min	max	No reply
Percentage of forest income over total income	3.53	11.91	0	0	1	0	100	194

Education

Data on the educational level of the forest owner population are not available; therefore no conclusions can be made on the representativeness of the sample regarding this aspect. However, in the sample over 50% of the respondents have at least two years of higher education after the high school diploma suggesting for an overrepresentation of highly educated people in the sample. This is rather typical in survey studies.

Table 7.6: Latest completed education

	Total	Percent (sample)
No degree or diploma	56	9.49
First-cycle educational diploma (BEP-C), middle school diploma, occupational certification (CAP), certificate of professional proficiency (BEP)	121	20.51
High school diploma	59	10
2-year higher education (BTS, DEUG, etc.)	75	12.71
3-4-year higher education (licence, master degree, master 1, etc.)	60	10.17
5-year higher education (engineer, master2, etc.)	172	29.15
No reply	47	7.97
Total	590	100

Professional situation

The percentage of retirees in the sample reflects rather well the population values. According to the Enquiry on Private Forest Ownership in Europe (UNECE/FAO et al., 2006), 57% of the forest owners are retired which is close to the 58% found in this survey. In the sample, farmers and foresters are underrepresented. In contrast, the sum of the other professions presented in Table 7.8 is overall overrepresented in the sample (33%, against the 26% at the population level). No information about the percentage of each single profession (except for forester, farmer and retired) is available at the population level. The chi-square statistic indicates to reject the hypothesis that the sample and the population share the same job distribution (α=0.05).

.Table 7.7: Professional situation

Profession	*N* of respondents	Percent
Farmer	39	6.61
Executive, highly educated professional (e.g. doctor, engineer, university professor)	66	11.19
Tradesman, businessman, entrepreneur	36	6.1
Salaried employee	15	2.54
Labourer	15	2.54
Intermediate occupation (e.g. nurse, school teacher, senior technician)	19	3.22
Retired	343	58.14
Forester	12	2.03
Other	15	2.54
No reply		5.08
Total	560	100

Geographic location of the forest

The majority of the respondents live in Pays de la Loire followed by Bourgogne. The least represented region is Provence-Alpes-Côte d'Azur. The problem of underrepresentation of small ownerships is present in each region in the study, in particular in Lorraine and in Pays de la Loire.

Table 7.8: Geographic location of the forest and residence of the owner

Region	*N* of respondents	Percent	Perc of respondents with less than 1 ha (sample)	Perc of respondents with less than 1 ha (population)
Auvergne	98	16.61	9.18	56.25
Bourgogne	123	20.85	7.32	67.00
Lorraine	111	18.81	9.01	81.58
Provence-Alpes-Côte d'Azur	93	15.76	11.83	65.95
Pays de la Loire	164	27.80	6.71	72.99
No reply	1	0.17		
Total	590	100		

7.1.2.3 *Statistical analysis*

In the questionnaire, respondents were asked to specify the management priorities for their forests. A list of proposed management objectives were presented with the following options: wood production; leisure activities, hunting; participation in the climate change mitigation, preservation of biodiversity; preservation of water quality, risk prevention (erosion, landslides, avalanches), other. Respondents were asked to assign a value of 1 to their main management objectives (more than one objective could have been selected); a value equal to 2 to their secondary objectives and leave an empty box for all the objectives not considered. Some respondents misunderstood the question and ranked the eight options. In this case the observation was kept and management objectives considered as strictly ranked (no ties).

Information from this question were reorganised in a five level ordinal variable called "mobj". The variable assumed a value equal to one, labelled as "only production", when the respondents indicated wood production as their unique management objective (they assigned a value of 1 to the wood production option, leaving other options' boxes empty). On the other extreme of the scale; mobj assumed a value of five, labelled as "no production", when respondents did not assigned any value to wood production and a positive value to at least one of the other options. Intermediate levels of mobj expressed a respectively a further decrease of the relevance of timber production in the respondent management objective. A description of mobj is presented in Table 7.9. Given the low number of respondents in the only production category, only production and mostly production were grouped together in the analysis.

Table 7.9: Management objectives

Management objectives	Freq.	Percent	Value of mobj	Description
only production	34	5.76	1	Wood production=1 Other options left empty
mostly production	163	27.63	2	Wood production=1 Other options>1
production & amenities	93	15.76	3	Wood production=1 At least one of the other options=1
priority to amenities	92	15.59	4	At least one of the other options=1 Wood production>1
no production	49	8.31	5	At least one of the other options=1 Wood production left empty
no response	159	26.95	.	
Total	590	100		

Given that the main focus of the pilot questionnaire was the willingness to harvest timber, the quantification of the costs of provision of forest externalities could not be directly determined. To overcome this problem, a preliminary and rather heuristic derivation was implemented.

The main idea was to compare the expected forest income per hectare across individual with different management objective. The underlying theoretical background is related to the concept of opportunity costs. Let's consider two identical individuals with different management objectives (i.e. only timber production vs. only environmental services), owning identical forest properties (size, location, soil type; species composition, etc.). Assuming the existence of a trade-off between timber and non-timber services' productions, it is reasonable to think that the forest owner with a focus only on timber production would obtain a higher forest income per hectare. In other words, it can be assumed that the higher the importance of non-timber services in the management objectives of the forest owner, the lower the expected forest income per hectare. The difference between the forest income under only-timber-production objective and the forest income under only-services objective can be seen as the opportunity cost for producing such services.

Because of the structure of the data, it is not possible to compare the effects of different management objective in the same forest, making the estimation of the opportunity cost not possible. However, a proxy of this opportunity cost could still be obtained by comparing the average forest monetary outcome per unit of surface across different management objectives. In other words, it is expected that forest owners with a preference for timber production would obtain on average a higher monetary income per unit of forest surface compare to owners with a greater interest for amenities provision. The difference between these average values could be considered as proxies for opportunity costs of forest non-timber services. In order to do so, three different measures of forest monetary outcome were considered:

1. **Expected mean timber revenue per hectare of productive private forest (EMTRH)**: the first measure is defined as follow:

$$E(\bar{r}_i) = P(H|\varphi_i, X_i)\,\frac{\sum \pi_j}{\sum S_j},$$

where $P(H|\varphi_i, X_i)$ is the probability for each respondent i of harvesting timber which depends on his/her management objective φ_i and on a vector X_i of socio-demographic characteristics as well as the characteristics of the forest owned; $\sum \pi_j$ represents the total roadside wood value (π) produced in private forest owned by individuals in France (1280 million €, source: UNECE/FAO et al., 2006); $\sum S_j$ is the sum of the total area productive forest owned by private individual in France (9067 thousand ha, source: Ministère de l'Agriculture, de l'Agroalimentaire et de la Forêt, 2012). In practice, $\sum \pi_j / \sum S_j$ (141.17 €/ha) represents the average monetary revenue from timber for one hectare of productive private forest in France. By multiplying it by the individual probability of harvesting, the expected timber revenue per hectare $E(\bar{r}_i)$ is obtained for each individual included in the sample.

2. **Forest income per hectare of owned forest (FIH)**: the second measure is directly derived from the data in the questionnaire. It is constructed as follow:

$$y_i = \delta_i\,\frac{\bar{Y}_{c,i}}{S_i}, \qquad c = 1, \dots, 8;$$

where δ_i is the share of the respondent's total income deriving from his/her forest properties (Table 7.5), and $\bar{Y}_{c,i}$ is the midpoint of the income class c in which the total income of respondent i is included (Table 7.4). The midpoint of the lowest income class (0-6000 €) was set equal to 4800 €; whereas the midpoint of the highest income class (>100000 €) equal to 120000 €. The product of δ and $\bar{Y}_{c,i}$ gives a proxy of the yearly forest income for each respondent i, which is then scaled to a per hectare basis through the size of the total forest owned, S_i.

3. **Expected forest income per hectare of owned forest (EFIH)**: the third income measure is defined as:

$$E(y_i) = P(H|\varphi_i, X_i)\, y_i \;= P(H|\varphi_i, X_i)\, \delta_i\, \frac{\bar{Y}_{c,i}}{S_i}, \qquad c \;= 1, \dots, 8;$$

where $P(H|\varphi_i, X_i)$ is the probability for each respondent i of harvesting timber and y_i is the forest income per hectare of forest owned by each respondent i, as defined in the previous point.

The probability of timber harvesting $P(H|\varphi_i, X_i)$ was estimated through a logistic model. The dependent variable was binary, assuming a value of 1 in case the respondent did harvest timber in the previous five years (2005-2009), and zero elsewhere. The independent variables dealt with the characteristics of the forest studied, with the type of management carried out, the socio-demographic characteristics of the respondent and his/her management objectives (variable mobj).

After the three measures of forest income had been computed for each forest owner in the sample, they were averaged among respondents with similar management objectives. For each income measure, the difference in the average income per hectare between the group of respondents with "only production" objective and the groups with greatest interest for amenities provision served as proxies for the opportunity costs.

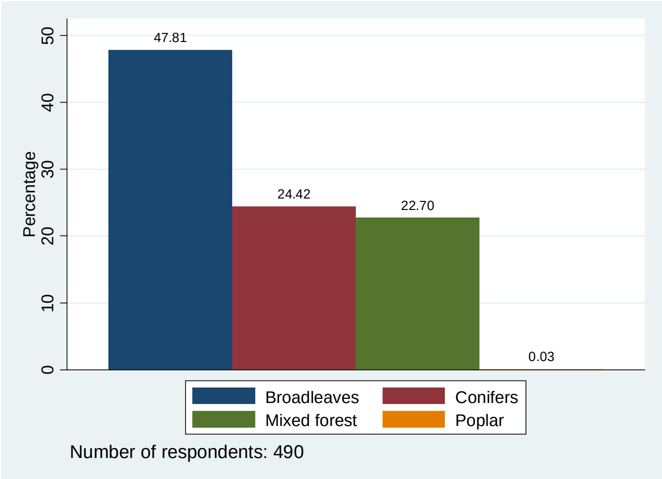
7.1.3 Survey Results

7.1.3.1 *Facts about the forest property*

Species composition

In general, in the sample the largest part of the forest area was covered by broadleaves (Figure 7.1). However, the share of broadleaves in the sample was lower than in the population.

Figure 7.1: Average forest type



Travel time to the forest and forest access

Two third of the studied forests were located less than one hour far from the main place of residence of the forest owner (Table 7.10). However, the majority of respondents (329 out of 580 who did answer this question) owned more than one forest property in the area. In these cases, the travel time was referred to the closest block of property. The largest majority of the forest properties (about 88%) were served by an access road (Table 7.11).

Table 7.10: Travel time between the main place of residence and the studied forest (n=590)

Travel time	Percent
Less than 1 hour	66.78
From 1 to 2 hours	13.39
More than 2 hours	18.31
No reply	1.53

Table 7.11: Access: Which access road serve the forest studied? (More than one option could be selected, n=590)

Type of road	Percent
Paved road	36.27
Forest road	20.85
Gravel road	33.56
Other forest road	41.02
No road	12.20
No reply	3.22

7.1.3.2 *Wood supply and economy of the forest*

Approximately 44% of the forest owners in the sample do not have a management plan, and only 28% obtained a forest certification for his property. The management of the forest is largely done directly by the forest owner (69%).

Overall, 56% of the respondents logged wood in the period 2005-2009. However, large differences in the percentage of harvesting were found depending on the type of management objectives respondents (Figure 7.2). In general, the majority of respondents made a profit from wood production, with exception of respondents with a priority for producing amenities (Figure 7.3). Only 19% of French forest owners interviewed actually were responsible of the logging operation directly (or through a member of his family). The largest part of the harvesting operations (approximately 58%) was carried out by the timber buyer. In the remaining 21%, contractors were employed. Overall, 327 forest owners provided information on the procedures of harvesting operations.

In most cases, respondents who did not put wood in the market (approximately 44%) affirmed that the reason was that the wood was not yet mature. About 9.4% of the forest owner affirmed instead that they had preferred to develop amenities (Table 7.15).

Only a small part of the respondents (163 out of 590) provided information about revenues and costs related to the management and the operations in their forest properties. An overview of the responses is presented in Tables 7.16 and 7.17.

Table 7.12: Do you have a management plan for the forest? (n=590)

	Percent
Yes	44.58
No	53.90
No reply	1.53

Table 7.13: Who manages your forest? (More than one answer possible, n=590)

	Percent
The respondent directly	69.49
A member of the family	5.76
An independent forestry expert	12.71
Another person qualified in forest management (a salaried expert, a technician of the French Forestry commission ONF, or from Regional Centres for Forest owner, etc.)	16.61
No reply	10.17

Table 7.14: Is the forest studied part of a forest certification scheme? (n=590)

	Percent
Yes	28.14
No	64.41
No reply	7.46

Table 7.15: Why did not you sell wood over the past five years? (Only for respondents who answer negatively to the timber harvested question. More than one options possible, n=255)

Reasons	**Percent**
The wood was not yet mature	33.73
The wood was for personal use	21.57
The wood price was too low	13.33
Preference for amenities production	9.41
Lack of time	12.94
Lack of know-how	7.45
Other reasons	13.33
No reply	18.43

Table 7.16: Approximate revenue, harvested area and harvested volume for the studied forest <u>during the last five years (five year totals, period 2005-2009)</u>

Revenue from sold timber from the forest studied (€)						
Number of non-zero responses	163					
Statistics	Mean (sd)	25%	50%	75%	Min	max
Overview	65184.5 (188426.9)	3400	13700	50000	52	1954000
Area harvested in the forest studied (ha)						
Number of non-zero responses	163					
Statistics	Mean (sd)	25%	50%	75%	Min	max
Overview	41.05 (107.82)	2	12.25	31	0.1	900
Timber volume put on the market (m^3)						
Number of non-zero responses	139					
Statistics	Mean (sd)	25%	50%	75%	Min	max
Overview	1349.96 (3351.92)	120	350	1300	4	32668

Table 7.17: Approximate costs for the studied forest

Current management expenses (€/year)						
Number of non-zero responses	83					
Statistics	Mean (sd)	25%	50%	75%	Min	Max
Overview	9322 (34128.02)	250	1200	50000	5	275000
Harvesting cost (€/m^3)						
Number of non-zero responses	51					
Statistics	Mean (sd)	25%	50%	75%	Min	Max
Overview	219.18 (34128.02)	7	16	23	1.47	2700
Regeneration cost (€/ha)						
Number of non-zero responses	27					
Statistics	Mean (sd)	25%	50%	75%	Min	Max
Overview	2073.11 (2398.59)	70	1500	2800	4	10000
Planting cost (€/ha)						
Number of non-zero responses	84					
Statistics	Mean (sd)	25%	50%	75%	min	Max
Overview	2575.8 (7254.91)	500	1725	2500	4.74	66500
Property tax on undeveloped land (€/ha)						
Number of non-zero responses	186					
Statistics	Mean (sd)	25%	50%	75%	min	Max
Overview	294.26 (933.69)	5.16	18.57	200	0.75	10000

Figure 7.2: Have you logged wood in the last five years? Reference period 2005-2009 (n = 584)

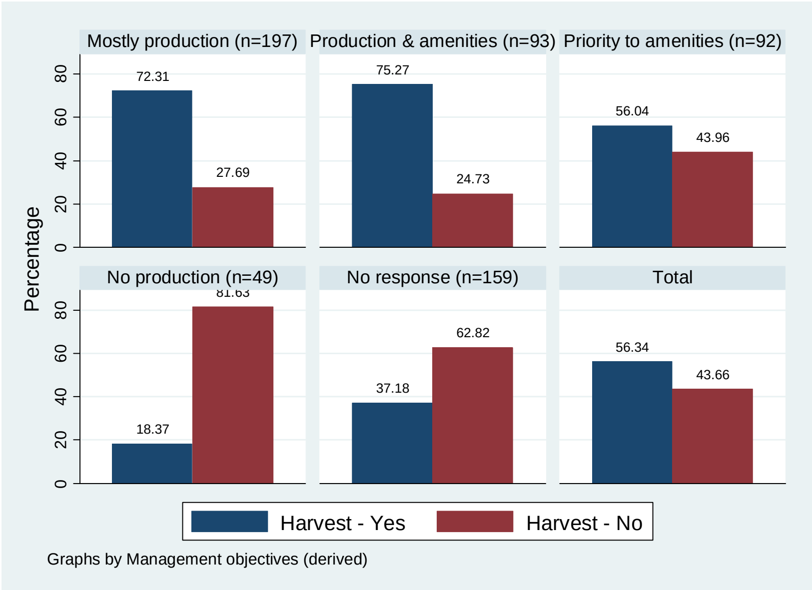
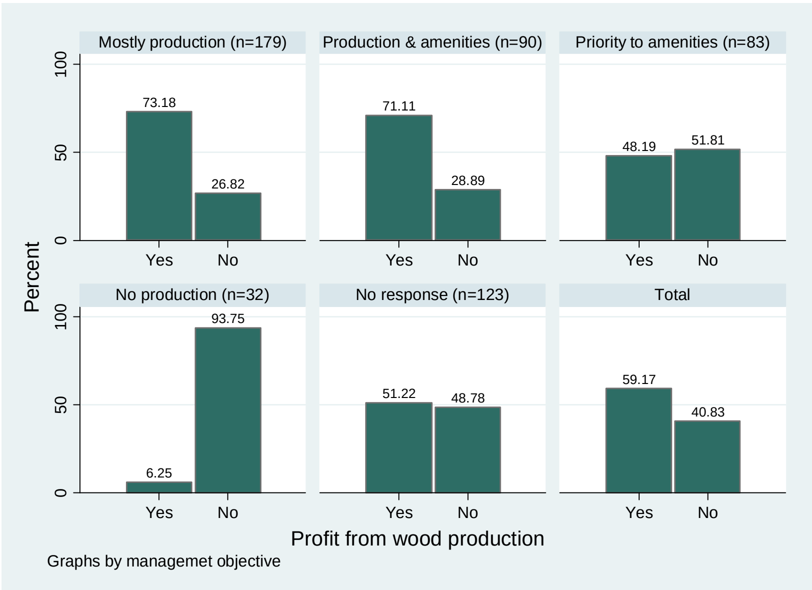


Figure 7.3: Do you derive a profit from wood production? (n = 507)



7.1.3.4 *Services provided by the forest*

The average respondent visits his/her forest both for recreational purposes and for work related purposes (Table 7.18). Circa one each three respondents used his/her forest for hunting. Nevertheless, hunting was practiced in 84% of the studied forest. (Table 7.21).

In contrast, the possibility of leisure activities is offered in less than half of the studied forests (Table 7.22). On average, the share of the protected areas within each property is about 20% (Table 7.20.1).

The largest part of respondents did not cooperate with other forest owners (Table 7.23). Among the respondents who cooperated, the main reason was for coordinating forestry operations. However, some cooperation was done to protect the environment (26%), to promote leisure activities (c.a. 10%).

Table 7.18: Number of days per year of presence in the studied forest (n=590)

	Percent
Absent	11.19
1-9 days/year	33.39
10-24 days/year	17.8
25-50 days/year	10
>50 days/year	24.92
No reply	2.71

Table 7.19: Reason for the presence in the forest (more than one option possible, n=590)

Reasons	**Percent**
Forest work (maintenance, cutting)	54.58
Management, overseeing operations	40.85
Leisure, hiking	48.14
Hunting	29.49
Other	7.98

Table 7.20.1: Percentage of protected area zoning in the forest studied (Natura 2000, natural national or regional park, natural reserve, perimeter of a water collection site)? (n=590)

	mean	**sd**	**25% quartile**	**50% quartile**	**75% quartile**	**min**	**Max**	**No reply**
Percentage of protected areas in the studied forest	20.59	39.19	0	0	0	0	100	0

Table 7.20.2: Conservation measures in the forest

	Percent
Natura 2000 area(s)	7.97
Part of national park	1.02
Part of a regional park	9.49
Part of a natural reserve	1.19
Other	11.02

Table 7.21: Use of forest for hunting purposes: Is hunting practiced in the studied forest? (n=590)

	Percent
Yes	84.07
No	13.56
No reply	2.37

Table 7.22: Are leisure activities (hiking, mountain biking, etc.) possible in the studied forest? (n=590)

	Percent
Yes	43.39
No	53.73
No reply	2.88

Table 7.23: Do you plan to take actions in conjunction with your neighbouring property owners (more than one reason possible, n=539)

	Percent
Yes	28.76 (155 respondents) of which:
to carry out forestry operations	52.26
to protect the environment	26.45
to preserve an area for leisure activities, hiking	9.68
to establish a hunting ground	23.87
other	21.93
No	71.24 (384 respondents)

The drivers for cooperation have been further investigated (Darses et al., 2012). It emerged that intention to harvest and market timber tended to reduce the willingness to cooperate for both amenities provision as well as for timber production. In other words the possible gains from cooperation did not overcome the production choice benefits. A hypothesis for this fact may be that when a private forest owner plan to sell his timber production, he does not have any interest to cooperate with other landowners (Darses et al., 2012).

7.1.3.5 *Probability of harvesting timber*

The probability of harvesting was estimated through a logit model. The significant independent variables are presented in Table 7.24. Coefficients, standard errors and significance values are presented in Table 7.25. The signs of all coefficients confirm the *a priori* expectation.

In particular, the variable describing the relevance of amenities in the management objective (mobj) has a negative coefficient. This indicates that, *ceteris paribus*, the higher the importance of amenities in the forest owner's management objective, the lower the probability that he/she harvest timber. It is important to notice, that according to the estimated model, the higher the (log) income of the respondents, the higher the probability of harvesting timber. Similarly, when the forest owner is highly dependent on his/her forest for living (i.e. the income from forest is a large share of his total income); it is more likely that he/she will harvest timber in his/her forest.

Due to the large number of incomplete questionnaires; the total number of observation used in the estimation of the model is 241.

Table 7.24: Dependent and significant independent variables

Attributes	Mean	Std. Err.	Type	Description
Dependent variable				
Coupe	0.63	0.485	dummy	Did you harvest timber in the last five years?
Independent variables				
Sup	70.29	133.487	continuous	Area of the studied forest in hectare
po_s2	0.02	0.156	dummy	Presence of poplar with small diameters
br_s1	0.15	0.353	dummy	Presence of broadleaves with large diameters
obj1	0.65	0.479	dummy	Reason of presence in the forest – forestry work
Mobj	2.84	1.101	ordinal	Management objective (from only timber production to no timber production, 5 levels)
man_exp	0.13	0.340	dummy	Management carried out by a forestry expert
Farmer	0.08	0.270	dummy	The forest owner is a farmer
ln_inc	10.51	0.818	continuous	Natural logarithm of the midpoint value of the income class
perc_fi	4.50	13.554	continuous	Percentage of forest income relatively to total income

Table 7.25: logit model estimation results

Attributes	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
Sup	0.014	0.005	2.99	0.003	0.005	0.023
po_s2	-3.502	1.209	-2.9	0.004	-5.870	-1.133
br_s1	-0.879	0.478	-1.84	0.066	-1.816	0.058
obj1	1.466	0.367	3.99	0	0.746	2.186
Mobj	-0.301	0.147	-2.04	0.041	-0.589	-0.012
man_exp	1.734	0.860	2.02	0.044	0.050	3.419
Farmer	1.062	0.621	1.71	0.088	-0.156	2.279
ln_inc	0.767	0.232	3.3	0.001	0.312	1.223
perc_fi	0.160	0.071	2.24	0.025	0.020	0.300
Number of observations			241			
LR chi2/ Prob > chi2			92.62/0.0000			
Log likelihood/ Pseudo R2			-112.93607/0.2908			

7.1.3.6 *Opportunity costs' proxies*

Results from the estimation of the expected monetary outcome per unit of private forest are presented in Figure 3.4. All three measures used had a similar pattern. An analogous average monetary outcome per hectare is observed for the only production group and the production & amenities group. In contrasts, respondents with priority to amenities or no production objectives had on average a lower monetary outcome per unit of forest.

Not surprisingly, the expected mean timber revenue per hectare (EMTRH) is larger than the other two income measures, which by definition are net of the production costs. It can be observed, that the reduction of the revenue per hectare for an increase of the importance of amenities is larger compared to the revenue measures.

The proxies for opportunity costs – computed with the only production level as a reference – ranged between 9.3 €/ha and 33.6 €/ha, for the priority to amenities group, and between 26.6 €/ha and 60.9 €/ha for the no production group (Table7.26).

Figure 7.4: Expected mean timber revenue per hectare of productive private forest (EMTRH), Forest income per hectare of owned forest (FIH), Expected forest income per hectare of owned forest (EFIH)

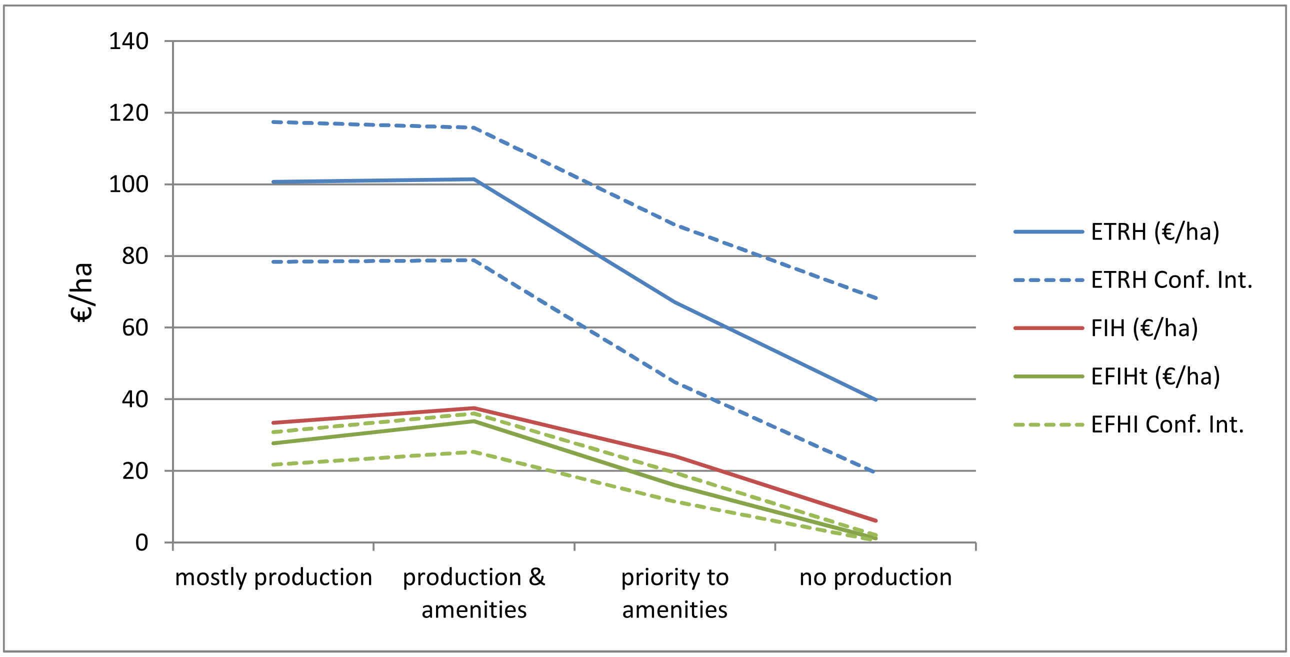


Table 7.26: Proxies of opportunity cost of amenities provision

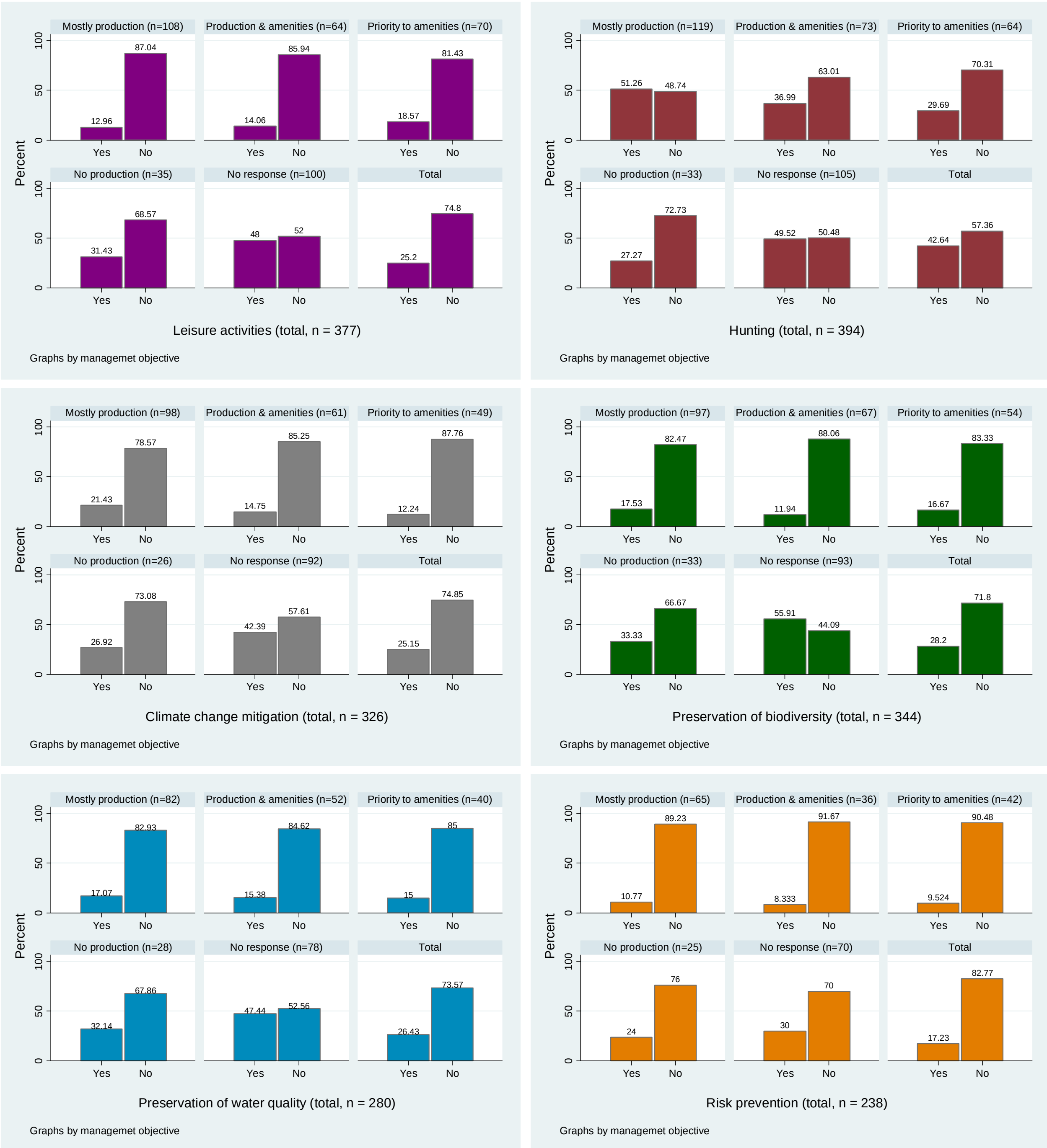
Management objective	**Number of observation**	**Opportunity cost proxy – ETRH (€/ha)**	**Opportunity cost (proxy) – FIH (€/ha)**	**Opportunity cost (proxy) – ETRH (€/ha)**
mostly production	118	0.0	0.0	0.0
production & amenities	52	-0.7	-4.1	-6.2
priority to amenities	53	33.6	9.3	11.7
no production	20	60.9	27.4	26.6

7.1.3.7 *Profits from amenities provision*

Overall, none of the non-timber services investigated in the questionnaire (leisure activities, hunting; climate change mitigation; preservation of biodiversity, preservation of water quality, risk prevention) generated a profit for the forest owner, with exception of a small minority of respondents (Figure 7.5).

The higher the importance of amenities provisions in the management objectives, the higher the likelihood that they generate a profit. However, the percentage of respondents making a profit from the provision of such services is always below 35%.

Figure 7.5: Do you derive a profit from….?



7.1.4 **Discussion**

The low response rate together and a high percentage of incomplete questionnaires constituted an essential limit for the development of the statistical analysis. The representativeness of the sample is rather poor, in particular for smaller forest owners. This aspect must be taken into account when interpreting the results from this study. As a matter of fact, given that timber logging seldom practiced in these properties, they are potentially a relevant source for amenities provision. Further research should then be address in particular towards this category of forest owners.

The first key element for understanding the results presented is the structure of the management objective variable. The way the management objective variable was constructed could be interpreted as an index measuring the relevance of amenities in the management objective with an ordinal scale. Results from the logit model and from the opportunity costs' proxies seemed to be consistent with this interpretation.

The management objective variable influenced the opportunity costs in two ways. Firstly, it affected the likelihood of harvesting. A higher importance of amenities provision in the management objective implied a lower likelihood of harvesting. In other words, forest owner willing to provide amenities would harvest less frequently than more production oriented owners. Secondly, the management objective variable affected the level of income. As a matter of fact, the forest income per hectare is higher for production oriented owner groups (mostly production and production & amenities) compared to amenities oriented owner groups (mostly amenities and no production). This can be explained by the fact that forest owners with a preference for amenities provision would harvest less intensively per unit of forest area and likely with higher costs. For instance, he/she would retain old tree, implement close to nature silviculture, follow a reduced impact logging, etc.

The second key element is related to the levels of the monetary income variable. It can be easily understood that they were crucial in the estimation of the opportunity cost of amenities provision. As far as the timber revenue is regarded, internal data from the sample were too few to be used in the estimation. Therefore, the use of an external source was required. The data from the sample were then compared with the external source. The levels were checked and the average timber revenue per hectare form the UNECE/FAO data (equal to 141 €/ha/year, 2004 data) was found in line with the value found in the sample (135 €/ha/year). Therefore, no distortion was introduced. It would have been important to compare the income data from the sample with external sources, but unfortunately the latter were not available.

In general, the average forest owner in the sample seemed to focus on timber production and only secondarily on amenities production. Most of the forest management was done directly by the owner. Among the provision of amenities, hunting was more diffuse in the forests, whereas hiking the most practiced by the respondents. The area under natural protection represented on average 20% of the property.

Results from this analysis confirmed the presence of opportunity costs in terms of reduced timber revenue (or income) related to the amenities provision. The three monetary outcome measures showed a rather similar pattern, but with different levels (the difference was about 25 €/ha/year for the mostly amenities group, and about 34 €/ha/year for the no production group). This is not surprising since, by definition, revenues are higher than incomes. The trade-off between timber production and amenities provision seemed to be confirmed. However, whether timber production plays a primary role (as for mostly production group) or a co-primary role (as for the production & amenities), there seemed to be no difference in the opportunity costs. This may be explained by the existence of a threshold level of services production below which the join production of timber and services is somehow complementary. Information on complementarity between timber production and amenities provision is an important issue in shaping payment schemes. This pattern should be further investigated.

Three proxies of the opportunities cost were computed; one for each monetary outcome variable. These are expected to be an underestimation. In fact, given the underrepresentation of small forest owners, timber harvesting is more frequent in the sub-sample used for the model estimation (percentage of harvest 63%, vs. 56% in the sample) than in the private owners' population.

However interesting indication can be derived from comparing forest revenues and income. Essentially, the difference between the ETRH line and the EFIH line could be interpreted as the expected total production costs of timber. From Figure 3.4 it can be noticed that the expected total cost of timber production is also decreasing (as the revenue does) for higher levels of importance of amenities provision. Indeed, by reducing the frequency and the intensity of logging, costs are expected to decrease. However, it is interesting to notice that they are not going to zero. That is, even if the forest owner did not have timber harvesting as an object and consecutively timber were seldom logged, he/she would face positive management and operational costs. The expected forest income therefore is close to zero for the no production group (some of these respondents had positive income from timber harvested; none of them indicated a negative forest income).

The first main limit of this approach is that it compares groups of different individual with similar management objectives, but different forest properties and characteristics. In other words, comparison of the business as usual with alternatives was not possible. As a result, the analysis was possible through an averaging of the monetary outcomes which inevitably implied a loss of information. Results, consequently, must be interpreted as a comparison between the outcome of the traditional and more diffuse management paradigm (mostly timber production) with alternative paradigms implemented in different forest properties. This comparison provides a proxy of opportunity costs for amenities provision as long as the forest properties are on average similar. If not; it could happen that amenities provision could be the main management objective because there were no profitable alternatives, i.e. when wood production is not feasible (steep terrain; low quality timber; inaccessible forests, etc.). Further investigations are needed about this aspect.

The second main limit concerns the fact that all non-timber services were treated as a single product. To overcome this problem, a simple interpretation is to consider the opportunity cost as the average cost for amenities production per hectare of privately owned forest. It is important to consider, however, that trade-offs and complementarities are present among amenities provisions.

The results presented in this deliverable are preliminary and further refinement will be needed, in particular in the opportunity costs estimation. The estimation of the marginal effect of the management objective on the probability of harvesting timber could shed more light on the net contribution of amenities provision in the determination of differences in forest monetary outcome. A weighting mechanism should also be implemented in order to take into account the underrepresentation of owners with smaller forest properties.

7.2 *Production possibility frontier approach*

7.2.1 Objectives

Our purpose in this section is to investigate the joint production of timber and non-timber, especially biodiversity and recreation, using a simulation approach. Focusing on the smallest unit of forest management, the stand level, we first identify a methodology based on growth and yield simulators to model the production set. Then we derive the production possibility set for the modelled forest. We apply this methodology to an example of forest management with three outputs: wood production, the protection of bird biodiversity and the attractiveness for recreation. Last, we analyse the envelope of the simulated production set in terms of possible progress in management at the stand level and opportunity costs of preserving biodiversity and recreation.

7.2.2 Methods

We focus on one approach to forest multi-functionality that is based on the analysis of production possibilities. The production possibility set is the set of all production vectors (vector of quantities of inputs and outputs) that constitute feasible plans for the forest manager on his land. The production possibility frontier (PPF) is the outer envelope of the set. Points on the frontier correspond to an efficient use of the inputs for producing multiple outputs. The knowledge of the frontier makes it possible to characterize the quantities of output that can be produced by forest owners on a definite area, and thus to determine the efficiency of a given production process. If the production level is efficient, then the influence of a variation in the production of one output on the other outputs can be estimated; for example, the impact of an increase in wood harvesting on the provision of individual and public services or the opportunity cost of additional carbon storage or biodiversity conservation (Boscolo and Vincent, 2003).

The PPF analysis was applied at the stand level by Boscolo and Vincent (2000) to determine the possibilities of providing at the same time wood income and biodiversity, or wood income and carbon storage in tropical forests. They showed that modifying harvesting intensity and techniques to limit the impact of management on biodiversity and carbon storage in forests induces a reduction in income. Calkin et al. (2002) and Lichtenstein and Montgomery (2003) considered management practices at the regional level. They highlighted that adaptations of forest management to preserve biodiversity or to increase the quantity of carbon stored in the forest generally imply a reduction in the maximum net present value from the wood harvest. Montgomery (2002) and Nalle et al. (2004) highlighted that the effect of management depends on the habitat of the species studied. Management to produce high wood values is compatible with the preservation of species that live in young forest stands, but not with species that typically live in mature forests. Similarly, Polasky et al. (2008) used a production possibility frontier approach to determine the trade-offs between the present value of economic activities and the preservation of biodiversity. Multi-functionality cannot be limited to combinations of two outputs; moreover, the joint output production creates complex situations. In this work, we extend the PPF approach to three outputs and highlight the interest of more-than-two-dimension analysis over analysis in pairs.

7.2.3 **Application to oak high forests in France**

Oak is the major tree species found in French forests. Pure oak forests account for 15% of the forest area (French National Forest Inventory, 2009). Recent political decisions aim at promoting the use of wood for both building and energy. In this context, our target is to estimate the PPF in oak high forests. In order to observe the manager's decision possibilities, we focus on the stand level. In our case study, we choose three different outputs: wood, biodiversity preservation and recreation. These functions can be described in various manners. We propose to use indicators corresponding to the profit made from wood harvesting, the diversity of bird species hosted by the forest and the attractiveness of the stand for recreational activities.

7.2.4 **Results**

Best management scenarios differ depending on the evaluation criterion

The quantity and the value of the services vary in a wide range depending on the scenarios. The net present value of wood products is comprised between −3034 euros and +4963 euros per hectare. The profit increases with the target diameter (*dgF*) until it reaches 72 cm, then it decreases because of the long time required to produce very large trees. The second determining factor is the stand density in the young ages (*rdiI*). Lower densities favour a rapid growth in diameter and consequently, a faster increase in value of the timber. However, when the density is too low, the productivity and the maximum profit are reduced due to a lower use of the soil and lights resources. The discounted bird diversity indicator (*BioPV)* takes values between 15.39 and 27.18. The discounted attractiveness for recreation (*APV)* ranges from 0.062 to 0.358. This indicator should be able to vary between 0 and 1, but since all simulated stands are even-aged starting from a natural regeneration on a cleared stand, the attractiveness of all scenarios stays low for a long time (the first 30 to 50 years).

Multiple production set and trade-offs analysis

We note that the management factors that influence the most the production of services are the target diameter and the initial density. The maximum supply of profit from harvesting wood, diversity of bird species or attractiveness for recreation are achieved with contrasted scenarios, for example the shortest scenarios produce the highest discounted level of biodiversity, but can produce neither a high income nor an attractive stand. Because it is impossible to find a scenario that maximizes the productions of the three modelled goods and services, we propose to analyse simultaneously these three outputs to characterize the range of compatibility and substitution.

The trade-offs between NPVIS and bird diversity on the one hand and between NPVIS and the attractiveness for recreation on the other hand are high. We note that the preservation of bird species is a stronger substitute to the profit than the attractiveness for recreation: the maximum profit is closer to the maximum attractiveness than to the maximum biodiversity. Starting from the Faustmann (1849) profit optimum, increasing the bird diversity by 10% (two more species) will cost 330 euros per hectare. An increase in the attractiveness by 10% will cost 140 euros per hectare. These two results however do not take into account that the increase in the service is done at a low cost because the level of provision of the second service is not constrained. Still starting from the Faustmann optimum, the opportunity cost of increasing the biodiversity by 10% subject to constant level of attractiveness for recreation would not be feasible (the corresponding point would be outside the production possibility frontier). An increase in the diversity indicator by 0.5 is possible at constant attractiveness and would cost 214 euros/ ha compared to 43 euros/ha for the same increase without constraints on the attractiveness. These results show the relevance of a multidimensional analysis over two-output estimations of the production possibility frontier.

7.2.5 **Discussion**

Based on our simulations, we find a clear trade-off between the biodiversity indicator representing the average possible number of bird species hosted by the forest during the rotation and the net present value in infinite sequence. Such results are also reported by Boscolo and Vincent (2003) and more generally, at the landscape scale by Arthaud and Rose (1996), Montgomery (2002) and Calkin et al. (2002). We show that NPVIS and the attractiveness for recreation are substitutes. Similar conclusions were presented by Bostedt and Mattsson (2006) or Eriksson and Lindhagen (2001). The financial effort to produce a more attractive oak high forest is less intensive than for preserving biodiversity, since the highest value of the indicator is obtained with an NPVIS of 3745 euros, compared to 173 euros for the maximum bird diversity. This conclusion is in line with the study of the cost of managing forests to meet the recreational demand in Sweden by Bostedt and Mattsson (2006).

This work highlights the interest and the possibility of establishing production possibility frontiers at the forest management scale using models. It confirms some established results, e.g., that NPVIS and bird species biodiversity on the one hand and NPVIS and recreation attractiveness on the other hand are substitutable goods and services. Consequently, the maximum quantity and value of wood that can be produced on a stand is reduced when biodiversity and recreation services are also expected. Results show and confirm that managing forests for multiple purposes creates real stakes and especially if payment are proposed to forest owners who change their management to provide more environmental services. Our modelling approach also allowed us to draw the envelope of a three dimensional production possibility set which give relevant information on the possible combinations of outputs and make it possible to evaluate the impact of a constraint on one of the outputs on the opportunity costs of increasing another output. It often reveals hidden costs of providing a service when it is combined with several others. All observations suggest that trade-offs between the three outputs – wood, biodiversity, recreation – exist, but not at the same time. The relative compatibility between the preservation of bird biodiversity and the attractiveness for recreation is such that the forest managers must first choose between amenities and wood production, and then select the amenity that they will prefer.

8 THE GERMAN CASE STUDY

8.1 *Introduction: survey description*

The German NEWFOREX forest owner survey was conducted nationwide. Since no NEWFOREX case study region is located there, the survey design was developed without a connection to a certain area and related research demands. To keep a clear structure in this open framework, it was decided to focus on one NEWFOREX research field. Work package 4 topics were selected, because UHAM shall provide most project input here. Due to the link between work package 3 and 4, the findings are interesting for work package 3 as well.

In Germany, like in Denmark[4] and in many other countries, doesn´t exist acknowledged information about the numbers of forest owners. Furthermore, the group of forest owners is very inhomogeneous – from forest estate sizes and management practices to socio-demographics. Another circumstance was crucial; more or less solely addresses from forest enterprises and larger forest owners are available on the internet and for purchase from address providers. This led to the conclusion to investigate forest owner management cooperatives[5] (FMCs) instead. This decision was enforced by a pre-test reply of a managing director of a forest union. He told us that the draft questionnaire would be too specific for most FMC-members (mainly forest owners with small forest estates).

In two postal mailing campaigns, 1479 questionnaires[6] were sent to forest owner management cooperatives. In the questionnaire was an internet link included (printed) that the forest owner management cooperatives should forward to their members by email. Thereby, it was possible to reach forest owners as well. Overall, 209 forest owners answered the online questionnaire.

8.2 *Content and Results*

The forest owner questionnaire contains 14 questions overall[7]. Results of 12 questions are presented here.[8] Requested subject areas are forest estate, forest management, subsidies and socio-demographics.

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[4] See Atlantic case chapter of D3.3

[5] FMCs are unions of forest owner that manage their forest together. In this way, they are able to lower emerging costs. FMCs have a big economic potential, because they manage large areas (hundreds to several thousand hectares) for their members. Some have a turnover of millions of euros, but lots of them are not very active. So the overall economic situation is inhomogeneous. Handling subsidy measures for their members belongs to their common tasks. FMCs support environmental and recreational subsidy measures as well.
It is assumed that around 1600 FMCs exist in Germany. The government supports FMCs mainly to mobilize timber in small forest estates.

[6] 282 questionnaires were sent back.

[7] The questionnaire was kept very short to increase the return.

[8] The two remaining questions (and further analysis) are included in D4.3.

1. How large is your forest estate?

***Table 8.1: Forest size in classes*[9]**

Class no.	Classes [ha]	Count of FOs	Percent
1	< 1	8	4,26%
2	1 - 5	67	35,64%
3	5 – 20	42	22,34%
4	20 – 50	20	10,64%
5	50 – 200	30	15,96%
6	200 – 500	9	4,79%
7	500 – 1000	8	4,26%
8	> 1000	4	2,13%

Most queried persons possess forest estates smaller than 20 ha (62,24 %). 27 % are between 20 ha and 200 ha. 11 % own 200 ha or more.

Table 8.2: Forest size basic statistics

	mean	sd	25% quartile	50% quartile	75% quartile	minimum	maximum
Size (ha)	148.3	838.67	2.65	10	56	0.3	11000

The mean is with 148.3 ha very large. It differs from the 50 % quartile by a factor of 14.83. This is explainable by the maximum values. The 6 largest estates are 11,000, 2,800, 1,045, 1,000, 800 and 730 ha. Altogether, these 6 estates make up 59.72 % of the area of all queried persons. So the mean has a strong bias. More attention should be paid to the 50 % quartile, especially for the characterization of the "average" FMC member etc. On basis of a previous study, the expected average forest size was 11 ha[10].

[9] Division adopted from the agriculture report of the German federal government.

[10] http://www.waldwissen.net/waldwirtschaft/fuehrung/unternehmen/fva_forstzusammenschluesse/index_DE (28-11-12). The results of this survey are not acknowledged.

2. Where is your forest estate located?

Table 8.3: Location of forests

Federal state	Total	Percent
Baden-Württemberg	11	5.56
Bavaria	77	38.89
Brandenburg	1	0.51
Hessen	27	13.64
Mecklenburg-Vorpommern	3	1.52
Niedersachsen	24	12.12
Nordrhein-Westfalen	24	12.12
Rheinland-Pfalz	5	2.53
Saarland	1	0.51
Sachsen	10	5.05
Sachsen-Anhalt	1	0.51
Schleswig-Holstein	11	5.56
Thüringen	3	1.52

The highest share of attendees states that their forest estate is located in Bavaria. FMCs in Bavaria are economically active and the model works well there in comparison to other federal states. There is also a quite high number of FMCs in Bavaria[11].

3. Who executes practical forest work?

Table 8.4: Logging

Logging	Total	Percent
FMC	51	23.61
On my own	129	59.72
Service provider	36	16.67

Mainly forest owners execute practical forest work by themselves.[12] Around 25 % of the work is executed by the FMCs.

4. Who executes work related to subsidies?

Table 8.5: Subsidies

Subsidies	Total	Percent
FMC	97	50.26
On my own	80	41.45
Service provider	16	8.29

[11] http://www.waldwissen.net/waldwirtschaft/fuehrung/unternehmen/fva_forstzusammenschluesse/index_DE (28-11-12)
[12] Further data on the way FMCs cooperate with their members regarding forest management can be found in D4.3.

The forest owners stated that the FMCs perform circa the half of work related to subsidies.[13] Around 40 % is done the forest owners themselves.

5. How important are the following forest values for you?

(0 = unimportant, + a bit important; ++ important, +++ very important)

Table 8.6: Forest values

Forest values	**0**	**+**	**++**	**+++**	**Sum**
	Total/ Percent	Total/ Percent	Total/ Percent	Total/ Percent	Total/ Percent
Covering own Requirements (Firewood, Hunting, Fishing, Mushrooms)	29 14.36	33 16.34	56 27.72	84 41.58	202 100
NATURE PROTECTION (Animal protection, Biodiversity preservation)	13 6.37	47 23.04	98 48.04	46 22.55	204 100
EXPERIENCE VALUE (Recreation, aesthetics, privacy)	34 17.00	69 34.50	68 34.00	29 14.50	200 100
ENTERPRENEURIAL USE (Timber sales, Hunting leases)	16 7.88	36 17.73	65 32.02	86 42.36	203 100
INVESTMENT (Savings for large purchases)	48 24.12	60 30.15	57 28.64	34 17.09	199 100
TRADITIONAL VALUE (Continuing family heritage)	15 7.50	19 9.50	72 36.00	94 47.00	200 100

The traditional value is of high relevance for the forest owners. 83 % considered this value as “important” or “very important”. Just taking into account the category “very important”, the traditional value is followed by “entrepreneurial use” and “covering own requirements”. All reached over 40 %. The categories “nature protection”, “experience value” and “investment” are between 14 % and 23 %. Nature protection reached the highest values in the category “important” (48.04 %).

8. How old are you?

Table 8.7: Age

Years	**Total**	**Percent**
Younger than 20	0	0.00
20 – 40	22	11.83
40 – 60	123	66.13
60 – 80	40	21.51
Elder than 80	1	0.54

The most attendees are between 40 and 60 years old (66.13 %), followed by 60 to 80 years 21.51 %.

[13] The contracts are around 20 pages long and difficult to understand. (Information received by phone calls and in the FMC survey.)

9. Your Gender:

Table 8.8: Gender

Gender	Total	Percent
Female	11	5.91
Male	175	94.09

94.09 % forest owners are male, 5.91 % are female. Like in the Atlantic case and in an UHAM investigation of German forest owner socio-demographics[14], the amount of men is much higher than in the average population.

10. How many people live in your household, yourself included?

Table 8.9: Size of household

	mean	sd	25% quartile	50% quartile	75% quartile	minimum	maximum
Persons	3.6	1.54	4	2	5	1	8

The average household size is with 3.6 persons in mean larger than the German average.[15]

11. How high is your monthly net-income?

Table 8.10: Net-income

Income per month (Euro)	Total	Percent
Less than 499 €	3	1.80
500 € - 999 €	4	2.40
1000 € - 1499 €	6	3.59
1500 € - 1999 €	24	14.37
2000 € - 2499 €	32	19.16
2500 € - 2999 €	33	19.76
3000 € - 3499 €	22	13.17
More than 3500 €	43	25.75

7.8 % of the persons have a monthly net-income less than 1500 €. The majority (38.92 %) earns between 2000 and 2999 € per month. 25.75 % have a monthly net-income above 3500 €.

[14] Results of this investigation will be published in a NEWFOREX article.

[15] https://www.destatis.de/DE/ZahlenFakten/GesellschaftStaat/Bevoelkerung/HaushalteFamilien/Tabellen/Haushaltsgroesse.html (28.11.12)

12. Do you work in one of the following fields?

Table 8.11: Fields of work

Work fields	Total	Percent
Forestal service provision	9	4.84
Forest administration/association/chamber	15	8.06
National parc maintenance, nature conservation	0	0.00
Eco tourism	0	0.00
Timber industry	12	6.45
In none of these fields active	150	80.65

The vast majority of forest owners (80.65 %) doesn´t work in listed fields that are closely linked to forestry and timber industry. Around 20 % of the queried persons work in the sectors “Forest service provision” (4.84 %), “Forest administration/association/chamber” (8.06 %) and “Timber industry” (6.45 %). None of them work in the “National park maintenance, nature conservation” or “Eco tourism” sectors.

13. What is your main occupation?

Table 8.12: Occupation

Main occupation	Total	Percent
Self-employed farmer	34	18.09
Self-employed	15	7.98
Free Occupations. self-employed academic	9	4.79
Employee	70	37.23
Official	27	14.36
Skilled worker (with apprenticeship)	11	5.85
Trained worker	1	0.53
Unemployed	6	3.19
Other	15	7.98

The very most persons are employees (37.23 %), followed by self-employed farmers (18.09 %) and officials (14.36 %). The rest is blow 9%.

14. How many inhabitants live in your town of residence?

Table 8.13: Inhabitants

Number of inhabitants	Total	Percent
until 2000	95	50.53
2000 - 20 000	74	39.36
20 000 – 100 000	12	6.38
100 000 – 500 000	3	1.60
More than 500 000	4	2.13

The very most queried persons live in villages (below 2,000 inhabitants) and in towns until 20,000 inhabitants. 10.11 % of the queried persons live in towns larger than 20,000 inhabitants.

8.2.1 Discussion

This forest owner survey was created to be able to understand the interactions between FMCs and their members regarding subsidy measures primarily. Since this study focusses only on members of FMCs, the survey differs from the other seven NEWFOREX forest owner surveys, which samples are not restricted in this respect. Focusing only on FMC members implies that mainly forest owners with less than 50 ha were queried. Moreover, the forest management of this group differs from other forest owners, because FMCs plan and carry out many forest management operations. The results have to be interpreted with this in mind.

Do FMCs add a further facet in the process of providing forest externalities and influence the costs of provision? When forest externalities are provided by forest owners, the costs are influenced by forest management, size of the forests, available technology for implementing measures and transaction costs. When FMCs support the forest management of the owners, all these costs change. Basically, FMCs have a similar impact on forest externality provision as in the case of traditional timber production. They facilitate the decision making process and rationalize forest management by handling several smaller estates at once. This lowers costs for nearly all kinds of management activities.

The stated values of the FMC members reflect that "nature protection/ecosystem services" are not "very important" preferences (22.55 %) compared to "Traditional values", "Covering own requirements" and "Entrepreneurial use" (all above 40 %). However, that 48.04 % FMC members valued them as "important" could be interpreted that "nature protection/ecosystem services" are an important side aspect, when forest owners follow their prior preferences.

Forest management in small forest estates changes, when forest owners become members in FMCs. More expertise, manpower and work equipment are available for forest management. Therefore the initial situation of externality provision changes as well and costs for providing forest externalities can be lowered (e.g. subsidy measures). In addition, it is easier for forest owners with small estates to participate in subsidy measures, because FMCs offer support for administration and execution.

This survey is described and discussed more deeply in D4.3.

9 THE MEDITERRANEAN CASE STUDY

9.1 *Introduction*

The present paper aims at investigating in the financing part of the improving the provision of certain externalities in Mediterranean forests. In the case study area of Catalonia the focus has been in the changes in biodiversity, wildfire risk, mushroom production and timber provision as a consequence of forest management actions. Recreation, CO_2 sequestration and water quantity are estimated.

Being 80% of Catalan forests owned by private agents, it is of crucial relevance their perception of costs incurred when modifying their status quo management and expectations towards a scenario where more forest goods and services are provided to society.

9.2 *Methodology*

Sixteen qualitative interviews conducted in the framework of WP3 and WP4 (see section 4.4 of Deliverable 3.2). The interviews had a brief section on the costs of participating in a program that enhances the provision of forest externalities. First, the externalities under study were presented by means of a card (see Annex 7.5 of Deliverable 3.2).

“In this project we are studying some forest externalities. Have you ever heard about the term “externalities”?”

Regardless his/her familiarity with the concept, the term was explained as:

“In this project we understand as externality those goods and services that forest produce as a consequence of certain management which benefit not so much the forest owner, but instead other people external to the property; that’s why is called externality”.

S/he was asked to point out the most important one:

“From these [card] services, which one do you think is the most important one that through your forest management is producing for externals, not for yourself?”

A hypothetical program was exposed (cards) referring to the selected forest externality. He was asked first about his willingness to participate. Secondly, forest owners were also asked to elicit the silvicultural measures that in their opinion could increase the provision of the studied forest goods and services. Third, he was asked about the amount s/he would request to enter into the program. It was followed with questions related to the instrument design (concerning WP4).

These opinions have been contrasted with objective scenario costs, trade-offs of produced externalities and opportunity costs of changing from one to another scenario. These scenarios have been built based on experts' opinion and bibliographic review on the available information on the relationship between *Pinus halepensis* silvicultural treatments and optimal timber production (Solano et al. 2007), wildfire risk (Beltrán Barba et al. 2011), biodiversity (Torras, Martin-Queller, and Saura 2009; Verkaik and Espelta 2006) and mushroom production (Palahí et al. 2009).

In order to compute the expenses and expected revenues, the following rates were used (see Conclusions

Forest owners have been found to have five different perspectives towards the provision of forest externalities, as follows: the synergic (self-interested), the indifferent, the annoyed, the business-seeker and the incompatible. Their economic expectations from the social benefit from their forest varies from: the self-financing of those actions in line with his forest use, the request of not incurring in any cost related to modifying their management, the request of modifying external (non-economic) behaviors among beneficiaries of the externalities and the request of a positive economic turnover from the externalities.

The numerical analysis of the Net Present Value of different realistic scenarios has provided proof to the often claims of forest owners of *Pinus halepensis* stands of not being financially interesting the management of these forest stands. However, managing their forest in one or other orientation may produce relevant increments of externalities' provision. On the other side, the present analysis sheds light about the role of the existing subsidies and their interest to be maintained in order to have the landowners in implementing the silviculture in a cost-sharing approach. However, landowners heavily rely on these subsidies.

Moving from a scenario to another is expected to be only interesting for the landowner when his NPV improves. We can see that the main externality that is likely to be improved by the own interest of the landowner related to the extractive use of a non-timber forest product (mushroom) combined with timber. Both, in the case that the landowner was not implementing any silvicultural treatment (status quo) or was timber-orienting his management, the owner has net gains.

Annex I – Rates used for the computation):

- market prices for timber were taken from two sources: on the one side, the official marketplace of Vic for autumn 2012 (Centre de la Propietat Forestal 2012) provides data about the trend in industrial timber prices (see Table 9.11). Given the stagnation of Aleppo pine, we assume this tendency in the future; this is, the actual timber price would be the same;
- prices for forest road repair and maintenance have been extracted from the bulleting of the Diputació de Barcelona (2011);
- official rates for forest activities were extracted from the public enterprise Forestal Catalana (Forestal Catalana 2007) and contrasted to the basic tariffs exposed in (Beltrán et al. 2011). Both were adjusted to inflation according to the Consumer Price Index (INE 2012) –see Table 9.13-. We assume the cost would be maintained.

The Net Present Value was calculated for each silvicultural itinerary corresponding to each scenario. It seeks the capitalized expected net cash flows (this is, the difference between expenses and revenues from forest products). The Net Present Value is computed for the period between forest stand age 10 (t=0) to 75 (t=66), which aims at simulating a single rotation period; rotation period for this species can be longer (100 years). The typical formula is applied:

$$NPV = \sum_{t=0}^{t=66} \frac{\text{Costs} - \text{Revenues}}{(1+i)^t}$$

Where i stands for the discount rate. The selected discount rate is 2%, given that this is the typical interest banks are offering in Spain for saving accounts in 2012.

Opportunity costs have been calculated from the comparatives among scenarios.

- From no management → Fire prevention management
- From no management → Timber-oriented management
- From no management → Subsidized timber-oriented management
- From no management → Close-to-nature (biodiversity provision) management
- From no management → Mushroom-oriented management
- From timber-oriented management → Timber + mushrooms management
- From timber-oriented management → Fire prevention + timber management
- From timber-oriented management → Close-to-nature (biodiversity provision) management
- From fire prevention management → Close-to-nature (biodiversity provision) management

9.3 *Perceptions of forest owners about the costs based on the qualitative study*

The qualitative approach (see section 4.4 of Deliverable 3.2) has revealed different perception of the externalities as well as economic expectations from their property, that later affects their stated level of willingness to accept amounts to enter in a program that enhances forest externalities. Forest owners were also asked to elicit the silvicultural measures that in their opinion could increase the provision of the studied forest goods and services.

The perceptions of forest externalities can be classified in five different categories:

Table 9. 14 – Categories of forest owners perceptions of forest externalities.

Symbol	Category	Statement	Why? (cause)
+	the synergic	"*it's* fine"	Because I also get benefited, because I go walking, or I like biodiversity, or I have a rural tourism business where clients appreciate that, or bec. It also positive a lower fire risk...
0	the indifferent	"it doesn't influence me"	Because I won't benefit in any case; I am used to see people here around; I have accepted this social use; they don't disturb me...
-	the annoyed	"behaviours associated to their benefit bother me"	Because they leave litter; because they pass through places where they shouldn't; they are unpolite/rude; they don't know that the forest is private; they break some infrastructure; they frighten away the animals...
--	the business-seeker	"I get upset because I cannot get profit from it"	Because I am used to extract some economic revenues from other forest products and if there is some people willing to pay for it, why shouldn't I get some proceeds? They are just another asset of my forest capital!
---	the incompatible	"its benefit interferes with my main forest objective"	Because I want to devote my forest to XX and people valuing that externality is against my objective

It should be noted that the same forest owner may be very negative towards certain externality (e.g. annoyed) but show great complicity (e.g. synergy) with another.

9.3.1 The synergic

The **synergic** forest owner is happy with the externality present in his forest and has self-motivation to maintain and perhaps even augment its provision. For example, some forest owners are themselves cyclists or quad riders, hence being aligned with those forest users. They do not usually expect an economic compensation for the externality provision, but instead either nothing, a recognition (increasing proudness of being provider of a good to the community) or an in-kind reward.

"… there is a mountain trail race passing through the middle of a property. There is a group of people who is organising and they clean the path (…) Yes, I find it very correct (...) they leave the paths in my forest in very clean conditions." (FO 12)

"... For us it [forest biodiversity] is more exactly so, a recreational use (...). We make [bird inventories and put bird-nests] ourselves (...). Many things should (...) be done to boost the species present there [in my property]" (FO 4)

9.3.2 The indifferent

The **indifferent** owner gives no symptoms of worry about the provision of an externality.

"[With mushroom pickers] fine, [the relationship is] good. Let them do, let them do..." (FO4)

"Mushrooms, yes, the forest produces. But there are not many mushroom pickers coming [to my property], and they don't damage". (FO 7)

His expectation is that the increase in externality provision does not entail a new expense; contrarily, they expect that all the related expenses are fully covered by the beneficiaries:

"I continue thinking that the owner (...) in the same way that he does not put money in the forest, he can not think about making money from the forest (...) In fact, if the owner wants to earn money with his forest, I would make him going to cut fuelwood or put beehives for honey extraction or selling the water of his springs..." (FO 8)

"What I want is that [the improvement activities] does not cost money for me" (FO 11)

Computing the opportunity costs incurred constitutes the first approach to negotaite with these category.

9.3.3 The annoyed

The **annoyed** forest owner has experienced bad behavior of those benefiting from the forest externalities their forest offer. They may be reluctant to promote any enhancement of the externality due to the fear of seeing these bad behaviors increased.

"Hikers… yes, I have. I have a summer camp house for children nearby; they bring here the children for hiking and they throw stones in the [fire extinction] water pool. An of course, later we have to clean it. And they leave the children alone with a sandwich and then they throw the aluminium foil everywhere" (FO 1).

"I don't like having to pay to go to the forest. But I don't want it to get promoted". (FO 1)

"There anyone goes to do canyoning (...) And they made fire and they will put fire again if they want six times more!" (FO 12)

9.3.4 The business-seeker

These forest owners see their forest as a capital from which they can expect profits, not only from the traditional but also extensible to new ones, such as the externalities. They are not satisfied only with covering the expenses incurred; they understand they should receive certain net gain due to their forest management. This may constitute the most typical discourse of forest owners.

"I think society must pay us for purifying [the air] with our forest, this is, because our forests are purifying everyboady's air that others pollute. (...) Why can we not exchange figures for depolluting? (...) It's obvious that we must get paid" (PF 8)

"(...) if we are really managing, we are working (...), we are doing whatever... biomass or whatever, we are doing a task. And hence we should have been rewarded for this task". (FO 6)

"The forest owner should gain money". (FO 9)

This collectivity would be most likely claiming an amount over the opportunity cost. Its calculation, however, sets the lower limit for a negotiation process.

9.3.5 The incompatible

Finally, there are certain owners whose forest objective does not fit with the externality provision. For that reason, even if there is an initiative rewarding the opportunity costs and also a bit more, they are not interested in taking part.

"It is fine that there is this program [compensating for not intervening in the forest during 30 years] but I think this is an error. Forests need to be worked. Otherwise they will end up burnt". (FO 7)

"I find it [the program] fine towards the owner [as he receives money]. But I don't believe in it. I think there are enough insects" (FO 9)

9.4 *Estimation of actual costs of scenarios*

9.4.1 Setting the reference stand

A standard forest stand of one hectare (1 ha) has been constructed with the average data of the National Forest Inventory for Catalonian Aleppo pine forests.

Pinus halepensis cover near 440.000ha, being 300.000ha pure formations and 140.000ha mixed forests. The most extended forest type within this species is the Coastal-influence Aleppo pine pure forests, covering approximately 273.000ha (Beltran et al, 2011). These authors understand pure forests as those where *Pinus halepensis* represents over 80% of the basal area and broadleaves with diameter class over 5 cm does not exceed 500 trees/ha.

There is a difference in site quality between coastal and continental Aleppo pine forests, meaning a variation in terms of annual growth and dominant height. In addition, different qualities can be found within each sub-region: Beltran et al (2011) propose three for the coastal and two for the continental, with certain equivalency. That comparability allows for generalizing the results for the medium and low quality stands in the coastal to the high and low quality in the continental area (see Table 9.2). The divergences in annual growth permit assigning the timber destination. Beltran et al (2011) differentiate between sawnwood and timber for chipping (*fusta de trituració*) and hence devote to particleboards, biomass (pellets or chips) or other fuel wood (*llenya*). This approach was considered by its authors as conservative, given that they do not include revenues from primary biomass production. Due to the lack of market data we have followed this approach.

Coastal pine forests	Average annual growth	Timber destination	Continental pine forest
High quality (A)	>5 m^3/ha·yr	>50% sawnwood	-
Medium quality (B)	2,5 - 5 m^3/ha·yr	A significant part for sawnwood; rest particleboard	High quality (B)
Low quality (C)	<2,5 m^3/ha·yr	No sawnwood; only particleboard	Low quality (C)

Table 9.2 - Quality classes defined for P.halepensis according to the volume and timber destination. Source: Beltran et al, 2011.

Recent expert consultation (CPF personal communication, 2012) reveals a simplification of destinations determined by the diameter 20cm: over such diameter is demanded by sawmills; smaller diameters are assigned to chipping. We have computed for the three different qualities.

Located in the coastal area, a zone with high human pressure, we assume an appropriate density of forest roads. No new roads are supposed to be opened, being the density of around 3 m road/ha. In the course of the studied period, however, at least one road maintenance work is foreseen. Given the natural location of Aleppo pine forests, they are relatively close to towns (we assume around 10-20km far from a town). This proximity means a relevant source of visitors and mushroom pickers, but also source of fire risk due to human negligence. 100% of Aleppo pine area is considered of high risk of wildfires (Beltran et al, 2011); therefore our reference stand would be facing this risk.

The assumed initial density is of 3.000 trees/ha, which is a relatively low density for a post-fire natural regeneration (that can range from 2.000 to 10.000 trees/ha). Natural regeneration provokes a roughly even-aged forest. Most landowners manage these forests as regular; however, irregular management can be applied if the objective is to maintain mixed stands or to enhance certain broadleaves. We assume for the stand an average slope corresponding to the typical for *P.halepensis* in the region, being lower than 30%.

We assume the first intervention occurs in the present year, which corresponds to the year 10 of the forest stand. The period studied ranges from year 10 to 75 of the forest stand. The calculations are made for the three site qualities.

There is a typical cost estimated at 100€/ha for forest management planning (personal communication, 2012); it corresponds to the forest engineer work in inventorying the forest holding, and discuss and formalize in a document the objectives of the forest and the foreseen silvicultural actions for the next 10 years. However, we will not include this amount as a cost, as we assume that forest management planning is fully subsidized to all forest owners, including the revisions after the 10-years period.

Beltran et al (2011) consider a fixed cost between 80 and 100€ applying to any silvicultural treatment implemented; it corresponds to the concept of taxes or tree marking i.a. We have not included this cost.

9.4.2 Status quo: only final cuttings

This is the most credible scenario in which a forest owner does not incur in silvicultural treatments that improve the mass; instead his focus is in just punctually extracting the best trees. The owner implements these harvests either when his family faces a punctual cash need or when he feels the market conditions are the most favorable for him. For this reason we assume that only final cuttings are held with a previous preparatory thinning. The aim of the preparatory thinning is to allow for accessibility, arranging forest roads and reducing 50% tree density. Around 10 years after it the final harvest is held, assuming an intensive extraction of 2/3 volume harvested. That intensity will created large forest openings which are foreseen to be quickly colonized by Aleppo pine seedling, because the stand will be mature enough to produce cones and because of the pioneer character of this species. It may create an irregular forest, this is, a stand where there will be trees belonging to more than two continuous age classes. The next harvest is difficult to be predicted, but we assume that it will take place after thirty years (year 40). We assume that the first two harvests are for chipping, given that diameters are not likely to reach the limit of 20cm. The third thinning would count with diameters valid for sawnwood.

This scenario constitutes a regressive selection of trees, given that the worst shaped individuals are left in the forest, hence the seedlings will be of a poorer genetic pool. In terms of timber destination, the later the owner cuts, the higher the tree diameter; hence the chance to be useful for more added value goals increases. However, the forest stand may be more sensitive to external disturbances (e.g. pests, drought periods, wind- and snowstorms), and therefore the mortality increases; we will assume a 4% spontaneous tree mortality in this case. In addition, resistance to fires is low due to the likely continuity of the canopy with lower fuel levels.

The main objective of this scenario is timber production with the least possible investment. Commitment from the forest owner is weak, and probably sees the forest as a “bank” (Domínguez and Shannon 2011). It may or not count with a management plan. In case he does not count with the corresponding planning instrument, he should ask to the Government for the timber harvest permits.

Legal restrictions applying in this scenario are the prohibition of clear-cutting and the limitation in steep slopes (which is not our case).

Results are shown in the following tables:

Table 9.3 – Summary of NPVs corresponding to the "no management" scenario.

Site quality	NPV
Quality A	-1946,19
Quality B	-2099,58
Quality C	-2080,54

9.4.3 **Intensive management (or Sustainable Timber production)**

This is the most typical approach of the CPF (public enterprise supporting private forest management in Catalonia). It is based in applying the traditional production tables and the traditionally recommended silvicultural treatments. The main objective is timber production, by means of implementing the forestry actions that production tables in view of maximizing timber. The stand is managed in a regular manner, maintaining the main species and the even-age characteristic. The same legal restrictions apply than in the previous scenario.

We assume the existence of a management plan for the stand where basic works for *P.halepensis* apply: an initial pre-commercial thinning (*aclarida de plançoneda*) when the stand has around 10 years in order to sensibly diminish tree density (one third of the volume); it includes intervening in the shrubs (*estassada*) and pruning the remaining trees in view of improving their later conformation. Around 15 years later a low thinning (*aclarida de millora*) intervention is performed, that aim at cutting the worst individuals (dominated or with health problems); it reduces another third the standing volume reaching 1200 trees/ha. For these two first interventions, we assume that the extracted timber will have a diameter under 20cm; since this point, diameters are larger and hence the better price rate applies. It is followed by mixed thinning (cutting not only bad exemplars, but also extracting good commercial trees) with periods of 15 years between each other (years 40 and 55 of our study). Tree density is reduced following indications of D.2.1. In year 65, a dissemination thinning is implemented, reducing the density until 250 trees/ha. For this last disseminatory thinning we assume that a better price can be negotiated, using the highest rate (18 €/tn).

This scenario corresponds to the “intensive management scenario” proposed in D.2.1. It is foreseen that biodiversity values are slightly improved due to the larger penetrability in the stand that allows sleeping plant species to develop and increases habitat for small mammals and birds. Fire resistance augments substantially, given the structure; however, no specific fire preventive measures are implemented. Due to the better health conditions, we assume an annual mortality of 3% (lower than in the “no management scenario”).

Results are presented in Annex Intensive management. It can be observed that even if this is the most productive-oriented scenario, NPV presents negative values, also for the best quality. For this reason, this management itinerary has been traditionally subsidized. The next scenario, then will present the same management itinerary but using current subsidy calls.

Table 9.4- Summary of NPV of the "intensive management" scenario for different site qualities.

Site quality	NPV
Quality A	-3463,66
Quality B	-3620,12
Quality C	-3661,91

9.4.4 Subsidized intensive management

This scenario includes the same management actions than in the "intensive management" scenario, but most of the activities can get a grant from the regional Government. Grant amounts are exposed in the Annex; they are assumed to be maintained along the period studied. Most of the active forest owners in Catalonia do apply for these grants and implement these works.

Annex

Subsidized intensive management shows the results, which are summarized in Table 5. It can be observed that for all qualities, the NPV is negative meaning that, even with subsidies, forest management has a negative balance.

Table 9.5 - Summary of NPV of the "intensive management" scenario for different site qualities.

Site quality	NPV
Quality A	-854,23
Quality B	-1184,12

Quality C	-1213,04

9.4.5 Fire prevention enhancement scenario

Fire preventive silviculture is based in the following premises (Beltrán et al. 2011):

a) To reduce forest cover and height (firebreaks) to reduce intensity of a potential surface fire;
b) To reduce ladder fuel (this is, biomass continuity from the ground to the first crown branches) in order to avoid the vertical development of fire; and
c) To separate vertical and horizontally the crowns in view of minimizing fire spread in the upper canopy.

In Catalonia, the ORGEST silvicultural guidelines have been developed to provide tools for managers to design their forest management plan including the objective of fire prevention. With high and medium quality stands, (Beltrán et al. 2011) contemplate the choice between timber and fire prevention whereas in low quality stands the management is purely addressed towards fire prevention. We have adapted their exercise by including our reference timber and cost prices, discount rate and other parameters.

The goal is the creation of forest structures less vulnerable to fire, while secondarily producing timber. In this line, the first intervention in Aleppo pine forests would have their first pre-commercial thinning later than in other management itineraries in view of creating an effective discontinuity. Early interventions will not have any effect in creating a more favorable structure against fire. In addition, canopy cover should be maintained over 70% due to the likely heliophilous shrub layer that can develop in the open areas. Interventions should be more frequent to maintain the low vulnerability structure. Silvicultural residues are ideally chipped in forest roads, no leaving them in the stand. In contrast to other scenarios, here we have included shrub cleaning.

We assume that the forest owner counts with a management plan and is willing to implement this type of management to the entire property area. In the real world, these interventions can in fact be implemented overall or restricted to priority areas determined by firemen and fire experts as crucial points for fire behavior (gullies, mountain ridges and passes, etc.).

Results are summarized in the following table:

Table 9.6 - Summary of NPV for fire preventive scenario.

site quality	NPV
Quality A (ORGEST Ph04)	-3743,42
Quality B (ORGEST Ph07)	-4088,28
Quality C (ORGEST Ph08)	-2581,46

Detailed explanation is available in Annex Fire prevention management. It looks contradictory that lower quality sites show less negative NPVs. This is consequence of the lower interventions required to maintain the low vulnerable forest structure. In sites with large tree growth rates, also shrubs develop largely.

9.4.6 Biodiversity improvement scenario

Biodiversity is foreseen to be improved by means of promoting an irregular stand; this means, converting the initial even stand (with a frequency of diameter distribution as shown in figure left of Image 1) to an uneven stand (see diameter distribution in the right graphic). Provoking such conversion requires the selection of individuals to be cut and the successive natural regeneration evolution during two or three periods; harvests would be incisive in the most populated diameter classes, diminishing them and allowing space for new seedlings to emerge. Once established the uneven stand, regular thinning would be applied reducing the equivalency of the grown volume during the period between interventions, distributed along the different diameter classes. In addition all interventions leave old trees (or those with a big diameter) and dead wood, in view of creating an adequate habitat for birds, fungi, bats or insects. This scenario corresponds to the “close-to-nature” management proposed in D.2.1. where interventions are less intense but held more often than in other scenarios.

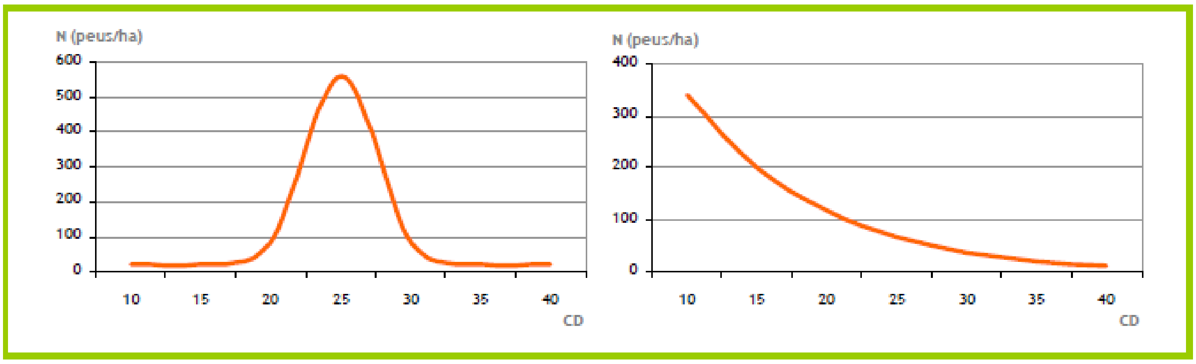


Image 1 - Prototypical distribution of trees along diameter classes, left graphic corresponding to an even-aged stand and right to an un-even-aged stand. Source: (Beltrán et al. 2011)

The objective of this scenario is the maximization number of different trees, assuming that they will host more varied fauna and flora. As a side goal, timber production is used to cover part of the incurred costs.

This conversion can be implemented in two main manners, as illustrated in Image 2: either selecting and harvesting individual trees (*por huroneo*) or selecting patches (*por bosquetes*). Due to the pioneer character of *Pinus halepensis*, it is foreseen that selecting individual trees may lead to the maintenance of the crown layer, given that seedling in the understorey may find problems to develop; however, opening patches provides a lighter space easier to be colonized by seedlings of Aleppo pine, creating the uneven, monospecific stand. However, if the aim is allowing other broadleaves that may be sleeping in the understorey seedbank, individual tree selection may be adequate if they are shadow-lovers. In this region, the main species that could take over the position of the Aleppo pine is the holm oak (*Quercus ilex)*. In some stands, holm oak appears spontaneously under the pine canopy, given that it needs shadow in its first stages. Then, when well established holm oak seedlings are found in the stand, the criteria would be selecting individually the pines that make competence to those seedlings, promoting a mixed, uneven forest. We have assumed the availability of such seedlings; otherwise, an under-canopy artificial plantation would enhance the establishment of new tree species.

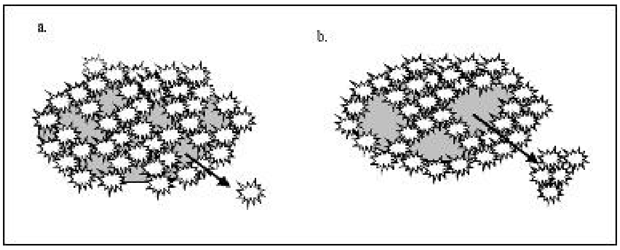


Image 2 - Two manners of selecting the trees to be harvested for forest conversion. Source: (Gagnon and Jokela 2010)

This scenario is foreseen to improve biodiversity in terms of trees species but also in fauna, given the creation of multiple habitats. However, its structure would show vertical and horizontal continuity, increasing wildfire vulnerability. On the other side, boosting the establishment of broadleaves has positive effects, especially if they are re-sprouting, as it is the case for holm oak.

Our assumption is that the stand vegetation cover proceeds from a wildfire occurred 25 years ago, then having a single diameter class. Because of the purposive left of old trees and the potential vulnerability of the stand to pests and diseases, we have considered a 4% mortality rate. We estimate that in three thinning the uneven structure is confirmed. Once reached the uneven structure we assume that 50% of the extracted timber corresponds to diameters under 20cm (applying the lower timber price of 3€ /t) and the rest over that diameter (applying the average price of 12 €/t). For high and medium quality we schedule the interventions every 10 years, whereas for the lowest quality they are scheduled every 15 years.

Results show the relevance of the intervention expenses, being the less negative NPV the corresponding to the lesser interventions. Further development can be found in Biodiversity improvement scenario

Table 9.7 - Summary of NOV for biodiversity improving scenarios

Site quality	NPV
Quality A	-3773,69
Quality B	-3998,23
Quality C	-3092,51

9.4.7 **Mushrooms' production improvement**

Mushrooms constitute a non-wood forest product highly appreciated in Catalonia, not only for their gastronomical value but also for the recreational experience of wild mushroom harvesting. Palahí et al. 2009 analysed the financial impacts of different silvicultural options for *Pinus sylvestris* and *Pinus nigra* that either optimize timber production (traditional), or timber and mushroom production, or only mushroom production (timber becoming a secondary product). They assumed the owner collects 50% of the production and commercializes them at an average market price.

This approach can shed light in the silvicultural treatment required for enhancing mushroom production (myco-silviculture).

According to the data from Martínez de Aragón et al. 2012, maximum mushroom production not only *for P.halepensis*, but also for other pine forests in Catalonia reaches its maximum when basal area is 15m²/ha (30 kg/ha.yr), being the between 10 and 25m²/ha when they produce an average of 20 kg/ha.yr. Hence, thinnings and cutting would be required to maintain forest structure in around that basal area.

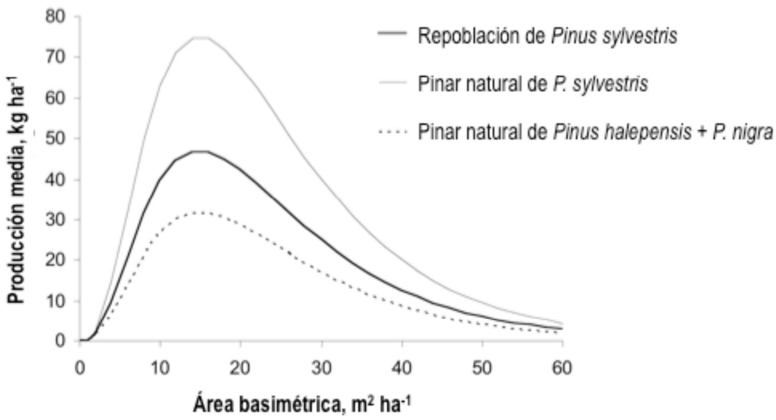


Image 3 - Average mushroom production according to the basal area for three natural pine forests in Catalonia. Source: Martínez de Aragón et al. 2012

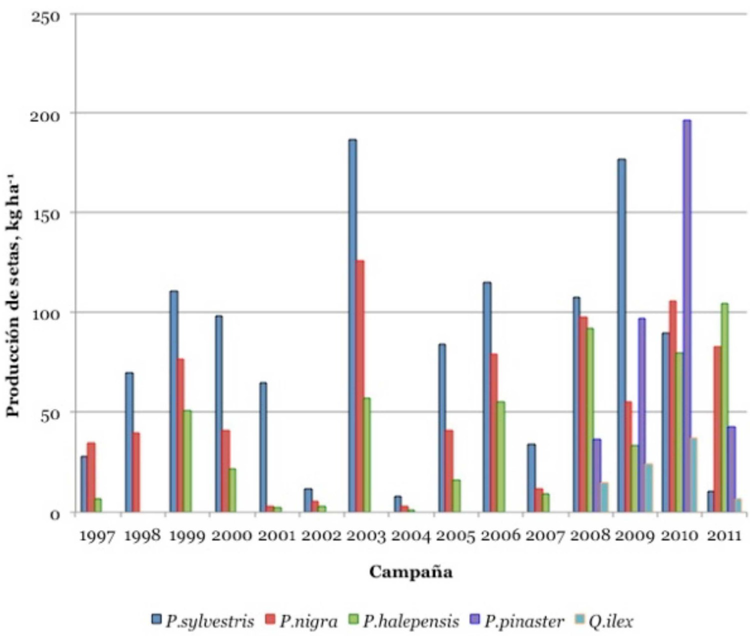


Image 4 - Mushroom production for different pine forests in Catalonia for the autumn season from 1997 to 2011. Source: (Martínez de Aragón et al. 2012)

Following (Palahí et al. 2009), we assumed that half of the mushroom production is yielded and marketed. We took the average price of 6,16 €/kg (taken from these authors, and updated it with the CPI). For the computations we have used two production levels:

- an average level of 17 kg/ha, valid for the thicket period of the forest (tree age of 10-25 years old), corresponding to basal area between 10 and 30;
- a maximum production of 20kg/ha, valid for the polewood forest (tree age of 26-40 years old), corresponding to basal area of 20.

Some forest owners have noticed the lack of mushroom production in the year of forest treatment and in the following; however, two or three years after the interventions the mushroom production increases considerably. It is attributed to the opening of certain spaces that benefit those fungi that need light for producing the carpophores. When logging residuals are left in the soil for decay, it lasts around 1-2 years to get rotten and hence increases organic matter in the ground, contributing to nutrient availability for mushrooms.

In addition, following the indications of moving forest structure to a basal area of 15 to 20, thinnings are scheduled in a way every 20 years at the beginning and 15 years towards the end of the studied period. Thinning intensity will be equivalent to the volume growth during the intermediate period. The last thinning is assumed to provide good quality timber, allowing for a better timber price.

Annex Mushroom production improvement shows the results for different forest qualities; they are summarized in the following table:

Table 9.8 - Summary of NPV for mushroom production in different quality sites.

Site quality	NPV (€)
Quality A	-197,52
Quality B	-342,08
Quality C	-438,18

Results show that even including mushroom production generates a less negative NPV for the forest owner. This contrasts with the findings for other pine forest typologies, where more mushrooms appear. Forest owners do not see the difference in productivity related to the species but instead to the climatic conditions, given that in rainy summer and autumn seasons, productivity in Aleppo pine forests can reach high figures (see Image 4).

9.4.8 Summary of scenarios results

Results are recapitulated in Table 9.9. Data show that every scenario generates negative figures. The most negative is the fire preventive management, especially for intermediate qualities, followed by the irregular treatments for biodiversity increase. The least negative outcomes are shown by the mushroom combined with timber production, assuming 50% of yield and from them a sale of 100%.

Table 9.9 - Summary of NPV of the different scenarios for each pine quality stand.

	VAN (€)		
	Quality A	Quality B	Quality C
Status quo	-1934,92	-2112,83	-2073,85
Timber-oriented	-3459,28	-3620,12	-3661,91
Timber + subsidies	-854,23	-1184,12	-1213,04
Fire prevention	-3743,42	-4088,28	-2581,46
Uneven (biodiversity)	-3773,69	-3998,23	-3092,51
Timber + mushrooms	-197,52	-342,08	-438,18

These results explain rather well the existing situation in the field, where all interviewed forest owners with *Pinus halepensis* justify their low investment in forest management by stating sentences similar than:

"The numbers don't add up […] the return is 0,0 " (FO 14)

"What happens is that with the current timber price we cannot [manage the forest]" (FO 12)

9.4.9 Differential costs among scenarios, synergies and incompatibilities

The following table compares the differences in NPV of the different scenarios for the different quality sites. Positive numbers remarks those changes that provide a net gain to the owner, and hence his own interest in moving from one to the other scenario could be feasible if other external conditions apply (e.g. knowledge on how to implement the new scenario). The negative figures give an idea of which management changes would be required to be incentivized with external financial aid equivalent to, at least, this difference.

Table 9.10 - Opportunity costs among different scenarios showing the cost of a change for the forest owner

OPPORTUNITY COSTS = difference between VAN	**Quality A**	**Quality B**	**Quality C**
• From no management → Fire prevention management (Dip. Bcn approach)	-1808,50	-1975,45	-507,61
• From no management → Timber-oriented management (traditional CPF approach)	-1524,35	-1507,29	-1588,06
• From no management → Subsidized timber-oriented management (traditional CPF approach)	1080,69	928,71	860,81
• From no management → Close-to-nature (biodiversity provision) management	-1838,77	-1885,39	-1018,66
• From no management → timber + Mushroom-oriented management	1737,40	1770,75	1635,66
• From timber-oriented management → Timber + mushrooms management	3261,75	3278,04	3223,73
• From timber-oriented management → Fire prevention	-284,15	-468,15	-507,61
• From timber-oriented management → Close-to-nature (biodiversity provision) management	-314,42	-378,10	569,40
• From fire prevention management → Close-to-nature (biodiversity provision) management	-30,27	90,05	-511,05

Moving from no management to subsidized timber-oriented management is the most usual change occurring in the area; subsidies cover part of the expenses and are directed mainly by the CPF.

Moving from no management to fire preventive management is being currently encouraged by the provincial government of Barcelona (*Diputació de Barcelona*) through a network of forest owner associations which plan and conduct silvicultural measures fully subsidized by the Diputació. Results show that due to the negative figures forest owners would not spontaneously perform this management change, unless they are not considerably financially supported. These figures, then, explain the success in participation of forest owners in the approach of *Diputació de Barcelona*.

In relative numbers, forest owners would be more economically motivated to change from a traditional timber-oriented management towards a myco-silviculture. This result is consistent with the findings of Palahí et al. 2009. Also moving from the status quo management to the mushroom production (with timber as a side product) would benefit the landowner regarding net financial flows.

In terms of costs, moving from fire prevention towards more biodiversity does not imply a relevant difference. Nevertheless, this change is largely dependent on the owner's preferences for forest stand objective, given that the outcomes are tentatively rather incompatible.

Finally, implementing fire preventive measures appears to provide a negative balance to the landowner. This may be caused by the increment of interventions, especially those related to the understorey and pruning. The impact of these extra activities is not reflected in increased volume growth, but it is likely that has certain synergies with timber production. For example, pruning can better shape trees and hence improve timber price due to a higher quality (this is especially relevant in this species given that it does not have self-pruning); or shrubs reduction may facilitate accessibility and hence reduce thinning costs.

9.5 *Conclusions*

Forest owners have been found to have five different perspectives towards the provision of forest externalities, as follows: the synergic (self-interested), the indifferent, the annoyed, the business-seeker and the incompatible. Their economic expectations from the social benefit from their forest varies from: the self-financing of those actions in line with his forest use, the request of not incurring in any cost related to modifying their management, the request of modifying external (non-economic) behaviors among beneficiaries of the externalities and the request of a positive economic turnover from the externalities.

The numerical analysis of the Net Present Value of different realistic scenarios has provided proof to the often claims of forest owners of *Pinus halepensis* stands of not being financially interesting the management of these forest stands. However, managing their forest in one or other orientation may produce relevant increments of externalities' provision. On the other side, the present analysis sheds light about the role of the existing subsidies and their interest to be maintained in order to have the landowners in implementing the silviculture in a cost-sharing approach. However, landowners heavily rely on these subsidies.

Moving from a scenario to another is expected to be only interesting for the landowner when his NPV improves. We can see that the main externality that is likely to be improved by the own interest of the landowner related to the extractive use of a non-timber forest product (mushroom) combined with timber. Both, in the case that the landowner was not implementing any silvicultural treatment (status quo) or was timber-orienting his management, the owner has net gains.

9.6 *Annex I – Rates used for the computation*

9.6.1 Timber prices

The marketplace of Vic constitutes the official platform where wholesalers and buyers of timber meet in Catalonia and decide on prices. Quotations are established twice a year. Even if they are prices calculated in the industry (not in the field), it is estimated to be not very different.

Table 9.11 - Prices of the marketplace of Vic. The first price corresponds to the overall price; the second to special prices obtained at the Vic or Girona marketplaces. Source: CPF (2012) and CFC (2008 & 2010).

Species	Characteristics	Quotation date	Price (€/t)	Variation since last quotation
Pinus halepensis	Diameter over 14cm	20/10/2012	38-39	=
	Diameter over 14cm	10/04/2010	36-39	=
	Diameter over 20cm		39-45	=
	Diameter over 14cm	04/10/2008	36-39	=
	Diameter over 20cm		39-45	+

Traditionally diameters smaller than 14cm are devoted for fuel wood, chips production, grinding or often left in the forest; diameters over 14cm are devoted for poles; and finally diameters over 20cm are devoted for sawnwood, mainly pallets. Given the slowdown of the construction industry in Spain, we see that for 2012 the demand for the sawnwood has decreased and the price is unified for any diameter over 14cm.

Experts' consultation has provided different prices regarding those directly paid to the owners (see Table 9.12).

Table 9.12 - Price paid directly paid to the forest owner. Source: Experts from CPF, 2012.

Species	Characteristics	Price (€/t)	Price (€/m^3)
Pinus halepensis	Diameter > 20cm	3	1,83
	Diameter < 20cm	8-18 (12 standard)	7,32

Price units have been converted from tones into cubic meters by applying the *Pinus halepensis* timber density of 0,61 kg/dm^3, following the indications for forest management planning of this species (CPF 2004).

9.6.2 Consumer Price Index variation for Catalonia

The national Statistics Institute (INE) elaborate computes the annual index, available until 2011. We have taken the index for the month of October as a rather accurate indicator after the different price augments in fuel and electricity prices. 2011 prices are established as the basis for calculation.

Table 9.13 - Consumer Price Index for Catalonia in the period 2007-2011 (annually) and October 2012 (as tentative forecast). Source: INE, 2012.

		Annual average				
Catalonia	oct-12	2011	2010	2009	2008	2007
General index	105	100	96,848	94,915	94,763	91,04
Increase since 2007	115,33	109,84	106,38	104,26	104,09	100

Turning the base year the one from which we have the silvicultural costs data, this is, 2007, we see that those prices should be increased in a 15,33%.

9.6.3 Silvicultural treatment unit prices

The table below shows the different rates updated for 2012. These prices correspond to expenses until the landing area, where an intermediary would transport them to the processor or factory.

Table 9.14: Silvicultural costs and prices

Amount	Units	Item	Source
500,00	€/ha	Non-commercial thinning, semi-systematic, up to 3m dominant height, low density	Beltran et al. (2011)
700,00	€/ha	Non-commercial thinning, semi-systematic, up to 3m dominant height, high density	Beltran et al. (2011)
800,00	€/ha	Non-commercial thinning, semi selective with 4.5m dominant height, high density	Beltran et al. (2011)
1595,34	€/ha	Non-commercial thinning and pruning in forests of low density. Cutting remaining trees and lower branches.	Forestal Catalana (2007)
2157,18	€/ha	Non-commercial thinning and pruning in forests of medium density. Cutting remaining trees and lower branches.	Forestal Catalana (2007)
2722,35	€/ha	Non-commercial thinning and pruning in forests of high density. Cutting remaining trees and lower branches.	Forestal Catalana (2007)
2157,18	€/ha	Shrubs cutting and non-commercial tree thinning with low density forest, including pruning of remaining trees.	Forestal Catalana (2007)
3235,77	€/ha	Shrubs cutting and non-commercial tree thinning with medium density forest, including pruning of remaining trees.	Forestal Catalana (2007)
4314,36	€/ha	Shrubs cutting and non-commercial tree thinning with high density forest, including pruning of remaining trees.	Forestal Catalana (2007)
1081,36	€/ha	Thinning with good forest road density and slope <30%	Forestal Catalana (2007)
650,00	€/ha	Low thinning, diameter class 10-15, density: 450 trees/ha	Beltran et al. (2011)
800,00	€/ha	Low thinning, diameter class 10-15, density: 1100 trees/ha	Beltran et al. (2011)
1000,00	€/ha	Low thinning, diameter class 20, density: 390 trees/ha	Beltran et al. (2011)
1200,00	€/ha	Low thinning, diameter class 20, density: 660 trees/ha	Beltran et al. (2011)
1200,00	€/ha	Low thinning, diameter class 25, density: 300 trees/ha	Beltran et al. (2011)
1600,00	€/ha	Low thinning, diameter class 25, density: 360 trees/ha	Beltran et al. (2011)
800,00	€/ha	Mixed thinning, diameter class 10-15, density: 700-800 trees/ha	Beltran et al. (2011)
900,00	€/ha	Mixed thinning, diameter class 10-15, density: 900-1000 trees/ha	Beltran et al. (2011)
1300,00	€/ha	Mixed thinning, diameter class 15, density: 1500 trees/ha	Beltran et al. (2011)
900,00	€/ha	Mixed thinning, diameter class 20, density: 600 trees/ha	Beltran et al. (2011)
1,00	€/ha	Forest road repair, 3 m road/ha, 1000 €/km in average terrain	DIBA (2011)

9.6.4 SFM subsidies

The Government of Catalonia launches annual calls offering subsidies for cost-sharing the activities that are considered as "not profitable", this is, those that with the revenues generated cannot cover their expenses.

Table 9.12 contains the rates for year 2011 (DOGC 2011), which are also those applying in 2012 (DOGC 2012).

Table 9.15 - Maximum subsidy amount in the 2012 call.

Item	MSA - Maximum Subsidy Amount	Units
Pre-commercial thinning		
forests presenting most trees of diameter class 5cm	1021	€/ha
forests presenting most trees of diameter class 10cm	1157,55	€/ha
Thinning		
forests presenting most trees of diameter class 15cm	1021,05	€/ha
forests presenting most trees of diameter class 20cm	736,8	€/ha
Selective cutting	1126,3	€/ha
Shrub cleaning Shrub species reduction where these significantly difficult regeneration and/or development of tree layer and accessibility	968,4	€/ha
Fire-preventive management		
Fuel reduction (intensive shrub cleaning, tree thinning and sprout selection of secondary trees)	2105,2	€/ha
Vegetation diversification: new species plantation	1999,95	€/ha
Chipping of logging residues along forest road edges	368,4	€/ha
Quality pruning		
Elimination of branches in the 2/3 bottom part of the trunk, leaving the top 1/3 with branches until the crown. For high quality species, Populus and coniferous only in plus trees within regular stands.	600	€/ha
Infrastructure improvement		
Construction of necessary roads for SFM	3.157,80-6.315,60	€/km
Substantial repair of necessary roads for SFM	900	€/km

9.7 *Annex II. Results*

9.7.1 Status Quo

Table 9.16 - NPV of "no management" scenario. Quality A.

QUALITY A									
Stand age	Year	**N** (trees/ha)	Annual growth (5 m³/ha.yr)	Harvesting (m³/ha.yr)	Stock after intervention (m³/ha)	intervention	cost of intervention (€/ha)	Actual value (€/ha)	Present value (€/ha)
35		3000	91,30	0,00	91,30				
36	0	1500	92,45	46,22	46,22	Road repair	3,00	-721,20	-721,20
						Pre-commercial thinning, up to 4m	800,00		
45	9	1500	33,43	0,00	33,43				
46	10	500	36,90	24,60	12,30	Mixed thinning, DC15, density: 1500	1300,00	-1125,88	-923,61
75	39	800	87,03	0	87,03				
76	40	500	88,35	33,13	55,22	Mixed thinning, DC 20, density: 600 trees/ha	900,00	-665,46	-301,38
								SUM	-1946,19

Table 9.17 - NPV for "no management" scenario. Quality B.

QUALITY B									
Stand age	Year	**N** (trees/ha)	Annual growth (3 m³/ha.yr)	Harvesting (m³/ha.yr)	Stock after intervention (m³/ha)	intervention	cost of intervention (€/ha)	Actual value (€/ha)	Present value (€/ha)
35		3000	54,78	0	54,78				
36	0	1500	57,39	28,69	28,69	Road repair	3,00	-752,22	-752,22
						Pre-commercial thinning, up to 4m	800,00		
45	9	1500	68,54	0,00	68,54				
46	10	500	70,60	26,47	44,12	Mixed thinning, DC15, density: 1500	1300,00	-1249,02	-1024,63
75	39	800	68,54	0	68,54				
76	40	500	70,60	26,47	44,12	Mixed thinning, DC 20, density: 600 trees/ha	900,00	-712,60	-322,73
								SUM	-2099,58

Table 9.18 - - NPV for "no management" scenario. Quality C.

QUALITY C									
Stand age	Year	**N** (trees/ha)	Annual growth (2 m³/ha.yr)	Harvesting (m³/ha.yr)	Stock after intervention (m³/ha)	intervention	cost of intervention (€/ha)	Actual value (€/ha)	Present value (€/ha)
35		3000	36,52	0	36,52				
36	0	1500	39,86	19,93	19,93	Road repair	3,00	-767,73	-767,73
						Pre-commercial thinning, up to 4m	800,00		
45	9	1500	28,56	0,00	28,56				
46	10	500	29,34	19,56	9,78	Mixed thinning, DC15, density: 1500	1300,00	-1161,55	-952,87
75	39	800	37,31	0	37,31				
76	40	500	39,65	14,87	24,78	Mixed thinning, DC 20, density: 600 trees/ha	900,00	-794,75	-359,93
								SUM	-2080,54

9.7.2 Intensive management

Table 9.19- NPV of "intensive management" scenario. Quality A.

QUALITY A										
Stand age	Year	**N** (trees/ha)	Intervention	Annual growth (m^3/ha.yr)	**Harvest** (m^3/ha.yr)	Stock after intervention (m^3/ha)	Actual income (€/ha.yr)	Cost of intervention (€/ha)	Actual value (€/ha)	Present value (€/ha)
9		3000		34,96		34,96				
10	0	2000	Road repair pre-commercial thinning	38,76	12,92	25,84	23,65	3 2157,178	-2136,53	-2136,53
24	14	2000		73,00		73,00				
25	15	1200	Low thinning	75,66	25,22	50,44	46,15	800	-753,85	-560,12
39	29	1200		89,05		89,05				
40	30	900	Mixed thinning	91,23	22,81	68,42	166,95	900	-733,05	-404,69
54	44	1000		100,79		100,79				
55	45	600	Mixed thinning	102,62	30,79	71,83	338,03	900	-561,97	-230,52
74	64	700		111,31		111,31				
75	65	250	Disseminatory harvest	112,82	65,81	47,01	722,59	1200	-477,41	-131,79
									SUM	-3463,66

Table 9.20 - NPV of "intensive management" scenario. Quality B.

QUALITY B										
Stand age	Year	**N** (trees/ha)	Intervention	Annual growth (m^3/ha.yr)	**Harvest** (m^3/ha.yr)	Stock after intervention (m^3/ha)	Actual income (€/ha.yr)	Cost of intervention (€/ha)	Actual value (€/ha)	Present value (€/ha)
9		3000		23,33		23,33				
10	0	2000	Road repair Pre-commercial thinning	25,54	8,51	17,03	15,58	3 2157,178	-2144,60	-2144,60
24	14	2000		44,79	0,00	44,79				
25	15	1200	Low thinning	46,36	15,45	30,90	28,28	800	-771,72	-573,40
39	29	1200		48,67		48,67				
40	30	900	Mixed thinning	52,06	13,01	39,04	95,27	900	-804,73	-444,27
54	44	1000		59,16		59,16				
55	45	600	Mixed thinning	62,24	24,90	37,34	273,36	900	-626,64	-257,05
74	64	700		63,56		63,56				
75	65	200	Disseminatory harvest	64,56	43,04	21,52	472,57	1200	-727,43	-200,81
									SUM	-3620,12

Table 9.21 - NPV of "intensive management" scenario. Quality C.

QUALITY C										
Stand age	Year	**N** (trees/ha)	Intervention	Annual growth (m^3/ha.yr)	**Harvest** (m^3/ha.yr)	Stock after intervention (m^3/ha)	Actual income (€/ha.yr)	cost of intervention (€/ha)	Actual value (€/ha)	Present value (€/ha)
9		3000		15,55		15,55				
10	0	2000	Road repair pre-commercial thinning	17,03	5,68	11,35	10,39	3 2157,178	-2149,79	-2149,79
24	14	2000		31,19		31,19				
25	15	1200	Low thinning	32,19	10,73	21,46	78,54	800	-721,46	-536,05
39	29	1200		39,37		39,37				
40	30	900	Mixed thinning	43,04	10,76	32,28	78,76	900	-821,24	-453,38
54	45	1000		44,49		44,49				
55	46	600	Mixed thinning	48,01	19,20	28,80	210,85	900,00	-689,15	-282,69
74	64	700		44,56		44,56				
75	65	250	Disseminatory harvest	45,17	30,11	15,06	330,61	1200	-869,39	-240,00
									SUM	-3661,91

9.7.3 Subsidized intensive management

Table 9.22 - NPV of subsidized "intensive management" scenario. Quality A.

QUALITY A											
Stand age	Year	**N** (trees/ha)	Intervention	Annual Growth (m^3/ha.yr)	**Harvest** (m^3/ha.yr)	Stock after harvest (m^3/ha)	Actual income (€/ha.yr)	Actual costs (€/ha.yr)	Subsidy (€/ha.yr)	Actual value (€/ha.yr)	Present value (€/ha.yr)
9		3000		38,88		38,88					
10	0	2000	Road repair Pre-commercial thinning	42,56	14,19	28,38	25,96	3 2157,18	2,7 1021	-1110,21	-1110,21
24	14	2000		71,96		71,96					
25	15	1200	Low thinning	74,65	29,86	44,79	218,57	800,00	1021,05	439,62	326,65
39	29	1200		85,37		85,37					
40	30	900	Mixed thinning	87,65	21,91	65,74	160,41	900,00	736,80	-2,79	-1,54
54	44	1000		99,04		99,04					
55	45	600	Mixed thinning	100,92	40,37	60,55	295,50	900	736,8	132,30	54,27
74	64	700		104,98		104,98					
75	65	250	Disseminatory harvest	106,68	68,58	38,10	753,02	1200	0	-446,98	-123,39
										SUM	-854,2

Table 9.23 - NPV of subsidized "intensive management" scenario. Quality B.

QUALITY B											
Stand age	Year	**N** (trees/ha)	intervention	Annual Growth (m^3/ha.yr)	**Harvest** (m^3/ha.yr)	Stock after harvest (m^3/ha)	Actual income (€/ha.yr)	Actual costs (€/ha.yr)	Subsidy (€/ha.yr)	Actual value (€/ha.yr)	Present value (€/ha.yr)
9		3000		23,33		23,33					
10	0	2000	Road repair	25,54	8,51	17,03	15,58	3	2,7	-1120,60	-1120,60
			Pre-commercial thinning					2157,18	1021		
24	14	2000		18,63		18,63					
25	15	1200	Low thinning	34,32	13,73	20,59	135,82	100,49	800,00	1021,05	321,54
39	29	1200		35,26		35,26					
40	30	900	Mixed thinning	35,57	8,89	26,68	65,10	900,00	736,80	-98,10	-54,16
54	44	1000		40,18		40,18					
55	45	600	Mixed thinning	48,61	19,45	29,17	142,34	900	736,8	-20,86	-8,56
74	64	700		55,10		55,10					
75	65	250	Disseminatory harvest	46,98	30,20	16,78	331,61	1200,00	0,00	-868,39	-239,72
										SUM	-1184,1

Table 9.24 - NPV of subsidized "intensive management" scenario. Quality C.

QUALITY C											
Stand age	Year	**N** (trees/ha)	Intervention	Annual Growth (m^3/ha.yr)	**Harvest** (m^3/ha.yr)	Stock after harvest (m^3/ha)	Actual income (€/ha.yr)	Actual costs (€/ha.yr)	Subsidy (€/ha.yr)	Actual value (€/ha.yr)	Present value (€/ha.yr)
9		3000		15,55		15,55					
10	0	2000	Road repair	18,00	6,00	12,00	10,98	3	2,7	-1125,20	-1125,20
			Pre-commercial thinning					2157,18	1021		
24	14	2000		30,28		30,28					
25	15	1200	Low thinning	31,31	12,53	18,79	91,69	800,00	1021,05	312,74	232,37
39	29	1200		34,72		34,72					
40	30	900	Mixed thinning	35,61	8,90	26,71	65,17	900,00	736,80	-98,03	-54,12
54	44	1000		39,89		39,89					
55	45	600	Mixed thinning	40,63	16,25	24,38	118,97	900	736,8	-44,23	-18,14
74	64	700		42,08		42,08					
75	65	250	Disseminatory harvest	42,76	27,49	15,27	301,81	1200,00	0,00	-898,19	-247,95
										SUM	-1213,04

9.7.4 Fire prevention management

Table 9.25 - NPV of improved fire prevention scenario. Quality A.

Quality A (ORGEST Ph04)										
Stand age	Year	**N** (trees/ha)	Intervention	Stock before harvest (m^3/ha.yr)	**Harvest** (m^3/ha.yr)	Stock (m^3/ha)	Actual income (€/ha.yr)	Actual costs (€/ha.yr)	Actual value (€/ha.yr)	Present value (€/ha.yr)
9		5000		38,88		38,88				
10	0	2800	road maintenace	42,56	18,73	23,84	34,27	3,00	-2125,91	-2125,91
			Pre-commercial thinning					2157,18		
19	9	2300		56,88		56,88				
20	10	1000	Low thinning, DC 10-15	60,03	33,93	26,10	62,09	800,00	-737,91	-605,34
33	23	1700		70,43		70,43				
34	24	1000	Low thinning, DC 10-15	73,16	30,13	43,04	220,52	1200,00	-979,48	-608,96
64	54	1000		114,10		114,10				
65	55	600	low thinning, DC 20	115,52	46,21	69,31	338,25	1200,00	-861,75	-289,98
85	75		Selective shrub cleaning	111,45		111,45		500	-500	-113,23
									SUM	-3743,43

Table 9.26- NPV of improved fire prevention scenario. Quality B.

Quality B (ORGEST Ph07)										
Stand age	Year	**N** (trees/ha)	Intervention	Stock before harvest (m^3/ha.yr)	**Harvest** (m^3/ha.yr)	Stock (m^3/ha)	Actual income (€/ha.yr)	Actual costs (€/ha.yr)	Actual value (€/ha.yr)	Present value (€/ha.yr)
14		3000		33,74		33,74				
15	0	1700	road maintenace	35,63	15,44	20,19	28,26	3	-2131,92	-2131,92
			Pre-commercial thinning					2157,18		
28	13	1700		45,31		45,31				
29	14	1000	Low thinning, DC 10-15	46,86	19,29	27,56	35,31	800	-764,69	-579,54
38	23		Selective shrub cleaning	44,21		44,21184	0	500	-500	-317,08
49	34	1000		59,24		59,24				
50	35	600	Low thinning, DC 20	60,37	24,15	36,22	176,77	1200	-1023,23	-511,64
65	50		Selective shrub cleaning	58,51		58,51353	0	500	-500	-185,76
74	59	600		78,47		78,47				
75	60	250	Dissemination thinning	79,03	46,10	32,93	506,17	1600	-1600	-362,33
									SUM	-4088,28

Table 9.27 - NPV of improved fire prevention scenario. Quality C.

Quality C (ORGEST Ph08)										
Stand age	Year	**N** (trees/ha)	Intervention	Stock before harvest (m^3/ha.yr)	**Harvest** (m^3/ha.yr)	Stock (m^3/ha)	Actual income (€/ha.yr)	Actual costs (€/ha.yr)	Actual value (€/ha.yr)	Present value (€/ha.yr)
25		3000		15,55		15,55				
26	0	1200	road maintenance pre-commercial thinning	17,03	10,22	6,81	18,69	3 1595,337	-1579,64	-1579,64
41	15		Selective shrub cleaning	28,03		28,03	0	500	-500	-371,51
64	38	1200		47,45		47,45			0	0
65	39	750	Low thinning, DC 20	48,94	18,35	30,59	134,34	1200	-1065,66	-492,28
91	65		Selective shrub cleaning	49,23		49,23	0	500	-500	-138,03
									SUM	-2581,46

9.7.5 Biodiversity improvement scenario

Table 9.28 - NPV for biodiversity improving scenario. Quality A.

Quality A										
Stand age	Year	**N** (trees/ha)	Intervention	Before harvest (m^3/ha.yr)	**Harvest** (m^3/ha.yr)	Stock (m^3/ha)	Actual income (€/ha.yr)	Actual costs (€/ha.yr)	Actual value (€/ha.yr)	Present value (€/ha.yr)
24		3000		75,029		75,03				
25	0	2000	Non-commercial thinning, semi selective, reducing main DC	76,827	25,61	51,22	46,86	800	-753,14	-753,14
34	9	2500		72,366		72,37				
35	10	1800	Mixed thinning, reducing main DC	74,272	20,80	53,48	38,06	1300	-1261,94	-1035,23
44	19	1800		73,930		73,93				
45	20	1000	Mixed thinning, final DC irregularisation	75,772	33,68	42,10	246,51	1300	-1053,49	-708,97
54	29	1200		66,049		66,05				
55	30	800	Mixed thinning, a % of all DC	68,207	23,95	44,25	175,34	900	-724,66	-400,07
64	39	1000		67,543		67,54				
65	40	800	Mixed thinning, a % of all DC	69,641	23,29	46,35	170,48	800	-629,52	-285,10
74	49	1000		68,996		69,00				
75	50	800	Mixed thinning, a % of all DC	71,036	22,64	48,39	165,76	800	-634,24	-235,64
84	59	1000		70,409		70,41				
85	60	800	Mixed thinning, a % of all DC	72,393	22,02	50,38	161,16	800	-638,84	-194,71
94	69	1000		71,783		71,78				
95	70	800	Mixed thinning, a % of all DC	73,712	21,41	52,30	156,70	800	-643,30	-160,84
									SUM	-3773,694

Table 9.29 - NPV for biodiversity improving scenario. Quality B.

Quality B										
Stand age	Year	**N** (trees/ha)	Intervention	Before harvest (m^3/ha.yr)	**Harvest** (m^3/ha.yr)	Stock (m^3/ha)	Actual income (€/ha.yr)	Actual costs (€/ha.yr)	Actual value (€/ha.yr)	Present value (€/ha.yr)
24		3000		45,02		45,02				
25	0	2000	Non-commercial thinning, semi selective, reducing main DC	46,10	15,37	30,73	28,12	800	-771,88	-771,88
34	9	2500		43,42		43,42				
35	10	1800	Mixed thinning, reducing main DC	44,56	12,48	32,09	22,83	1300	-1277,17	-1047,72
44	19	1800		44,36		44,36				
45	20	1000	Mixed thinning, final DC irregularisation	45,46	20,21	25,26	147,91	1300	-1152,09	-775,33
54	29	1200		39,63		39,63				
55	30	800	Mixed thinning, a % of all DC	40,92	14,37	26,55	105,20	900	-794,80	-438,79
64	39	1000		42,45		42,45				
65	40	800	Mixed thinning, a % of all DC	45,55	15,89	29,65	116,34	800	-683,66	-309,62
74	49	1000		42,67		42,67				
75	50	800	Mixed thinning, a % of all DC	43,85	13,02	30,83	95,31	800	-704,69	-261,81
84	59	1000		43,49		43,49				
85	60	800	Mixed thinning, a % of all DC	44,63	12,66	31,97	92,66	800	-707,34	-215,58
94	69	1000		44,28		44,28				
95	70	800	Mixed thinning, a % of all DC	45,39	12,31	33,08	90,10	800	-709,90	-177,50
									SUM	-3998,23

Table 9.30 NPV for biodiversity improving scenario. Quality C.

Quality C										
Stand age	Year	**N** (trees/ha)	Intervention	Before harvest (m^3/ha.yr)	**Harvest** (m^3/ha.yr)	Stock (m^3/ha)	Actual income (€/ha.yr)	Actual costs (€/ha.yr)	Actual value (€/ha.yr)	Present value (€/ha.yr)
24		3000		30,01		30,01				
25	0	2000	Non-commercial thinning, semi selective, reducing main DC	30,73	10,24	20,49	18,75	800	-781,25	-781,25
39	14	2500		32,46		32,46			0,00	0,00
40	15	1800	Mixed thinning, reducing main DC	33,09	9,26	23,82	16,95	1300	-1283,05	-953,32
54	29	1800		34,35		34,35			0,00	0,00
55	30	1000	Mixed thinning, final DC irregularisation	34,89	15,51	19,39	113,52	1300	-1186,48	-655,02
70	45	1200		32,49		32,49				
71	46	800	Mixed thinning, a % of all DC	33,11	13,10	20,01	95,91	900	-804,09	-323,37
84	59	1000		31,53		31,53				
85	60	800	Mixed thinning, a % of all DC	32,19	11,53	20,66	84,39	800	-715,61	-218,11
99	74	1000		32,56		32,56				
100	75	800	Mixed thinning, a % of all DC	33,18	11,90	21,28	87,11	800	-712,89	-161,44
									SUM	-3092,51

9.7.6 Mushroom production improvement

Table 9.31 - NPV of mushroom improvement management scenario. Quality A.

QUALITY A												
Stand age	Year	**N** (trees/ha)	Intervention	Stock before harvest (m^3/ha.yr)	**Harvest** (m^3/ha.yr)	Stock after harvest (m^3/ha)	Actual timber income (€/ha.yr)	mushroom production (kg/ha.yr)	Actual mushroom income (€/ha.yr)	Actual costs (€/ha.yr)	Actual value (€/ha.yr)	Present value (€/ha.yr)
9		3000		38,88		38,88						
10	0	2000	road repair pre-commercial thinning	42,56	14,19	28,38	25,96	0	0,00	3,00 700	-677,04	-677,04
12	2			36,25		36,25		17	52,32		52,32	50,29
...	...			...		...		...	...		...	...
20	10	2000	basal area of 20	63,37		63,37		17	52,32		52,32	42,92
21	11	1200	low thinning, reducing until BA 10	66,32	26,53	39,79	194,20	0	0	800	-605,80	-487,23
22	12			43,45		43,45		0	0		0,00	0,00
23	13			47,00		47,00		17	52,32		52,32	40,45
...	...			...		...		...	...		...	...
39	29	1200	basal area of 20	91,23		91,23		20	61,56		61,56	34,66
40	30	1000	low thinning, reducing until BA 15	93,34	15,56	77,79	113,88	0	0	800	-686,12	-378,79
42	32			82,74		82,74		17	52,32		52,32	27,76
...	...			...		...		...	...		...	...
54	44	1000	basal area of 25	106,91		106,91		20,00	61,56		61,56	25,75
55	45	600	mixed thinning, reducing until BA 20	108,55	29,12	79,43	213,16	0,00	0,00	900,00	-686,84	-281,74
69	59	700	basal area of 25	107,98		107,98		20,00	61,56		61,56	19,14
70	60	400	mixed thinning, reducing until BA 20	109,59	28,55	81,04	313,48	0,00	0,00	900	-586,52	-178,76
											SUM	-197,524

Table 9.32 - NPV of mushroom production improvement scenario. Quality B.

QUALITY B											
Stand age	Year	**N** (trees/ha)	Intervention	Stock before harvest (m^3/ha.yr)	**Harvest** (m^3/ha.yr)	Stock after harvest (m^3/ha)	Actual timber income (€/ha.yr)	mushroom production (kg/ha.yr)	Actual mushroom income (€/ha.yr)	Actual costs (€/ha.yr)	Actual value (€/ha.yr)	Present value (€/ha.yr)
9		3000		23,33		23,33						
10	0	2000	road repair pre-commercial thinning	25,54	8,51	17,03	15,58	0	0,00	3 700	- 687,42	- 687,42
11	1			19,42		19,42		0,00	0,00		0,00	0,00
12	2			21,75		21,75		17	52,32		52,32	50,29
...	...			...		...		...	...		...	...
20	10	2000	basal area of 20	39,96		39,96		17	52,32		52,32	42,92
21	11	1200	low thinning, reducing until BA 10	43,62	17,45	26,17	127,71	0	0,00	800	- 672,29	- 540,70
23	13			30,36		30,36		17	52,32		52,32	40,45
...	...			...		...		...	...		...	...
39	29	1200	basal area of 20	58,00		58,00		20	61,56		61,56	34,66
40	30	1000	low thinning, reducing until BA 15	61,11	10,186	50,93	74,56	0	0,00	800,00	-725,44	-400,50
42	32			53,65		53,65		17	52,32		52,32	27,76
...	...			...		...		...	...		...	...
54	44		basal area of 25	66,92		66,92		20	61,56		61,56	25,75
55	45	600	mixed thinning, reducing until BA 20	67,82	15,995	51,83	117,08	0	0,00	900,00	-782,92	-321,15
69	59	700	basal area of 25	69,45		69,45		20	61,56		61,56	19,14
70	60	400	mixed thinning, reducing until BA 20	72,22	17,621	54,60	193,48	0	0,00	900,00	-706,52	-215,33
											SUM	-342,08

Table 9.33 - NPV of mushroom production improvement scenario. Quality C.

QUALITY C												
Stand age	Year	**N** (trees/ha)	Intervention	Stock before harvest (m^3/ha.yr)	**Harvest** (m^3/ha.yr)	Stock after harvest (m^3/ha)	Actual timber income (€/ha.yr)	mushroom production (kg/ha.yr)	Actual mushroom income (€/ha.yr)	Actual costs (€/ha.yr)	Actual value (€/ha.yr)	Present value (€/ha.yr)
9		3000		13,98	0,00	13,98						
10	0	2000	road repair pre-commercial thinning	16,48	5,49	10,98	10,05	0	0	3 700	-692,95	-692,95
11	1			12,59	0	12,59	0,00	0	0,00		0,00	0,00
12	2			14,16	0	14,16	0,00	17	52,32		52,32	50,29
...	...			...		...		...	...		...	...
20	10	2000	basal area of 20	25,08		25,08		17	52,32		52,32	42,92
21	11	1200	low thinning, reducing until BA 10	26,27	10,51	15,76	76,91	0	0,00	800	-723,09	-581,55
23	13			18,65		18,65	0,00	17	52,32		52,32	40,45
...	...			...		...		...	...		...	...
39	29	1200	basal area of 20	36,40		36,40		20	61,56		61,56	34,66
40	30	1000	low thinning, reducing until BA 15	37,25	6,21	31,04	45,44	0	0,00	800	-754,56	-416,57
42	32			33,03		33,03		17	52,32		52,32	27,76
...	...			...		...		...	...		...	...
54	44		basal area of 25	42,71		42,71		20	61,56		61,56	25,75
55	45	600	mixed thinning, reducing until BA 20	43,37	11,67	31,70	85,45	0	0,00	900	-814,55	-334,13
69	59	700	basal area of 25	43,14		43,14		20	61,56		61,56	19,14
70	60	400	mixed thinning, reducing until BA 20	43,79	11,45	32,35	125,67	0,00	0,00	900,00	-774,33	-236,00
											SUM	-438,183

10 THE MONTAINOUS REGION CASE STUDY

10.1 *Introduction*

Forests have been targeted by few policies since the beginning of the last centuries in order to stimulate the provision of environmental services. The Royal Decree 3267/23 (national forest law) was an example of national policy designed to enhance the soil protection through the introduction of legal constraints on forest use. Intensive cutting activities, the high pressure of shepherds on forest and the physical fragility of the land were the main causes that push the policy maker to introduce the first forest law, thought to enhance the ability of the forest to protect the soil against erosion and instability processes. Nevertheless, from a socio-economical point of view, the main effect was the reduction of forest activities over time and a consequent increment of land abandon. The latter was further enhanced by the general welfare growth that pushed the rural dwellers to seek better job in urban areas, a social phenomenon still existing in certain remote area in Veneto Region as well in several parts of the alpine ridge. The national forest law introduced also the concept of forest sustainability addressed to two main typologies of forest owners: private and public. While the first were obliged to follow some general prescriptions[16], the second (public forest owners) were forced to draft a formal forest management plan verified by the regional forest authority. The distinction was adopted not only for the real rights hold by the forest owners, but also to the physical dimension that characterized the two forest owner typologies. Public land was characterized by large surface where several common rights such as grazing, firewood harvest and forest food picking were freely ensured to local dwellers by the local administration. On the contrary, private forest land average size was smaller than the public forest one and generally used by the household for its private needs and subjected to inheritance. This triggered the land fragmentation over time with the consequent increment of transaction cost to manage homogenously the land. In fact, according to the Royal Decree, private forest owners were not subjected to have any forest management plan due to the potential high costs that a household might have encountered. Since then, only small changes have been introduced in the national forest law, addressing general indications on the new demand of forest services (Legislative Decree 227/01) such as carbon storage, biodiversity conservation, recreation and landscape aesthetic view.

Another important aspect to understand the present structure of the forest ownership has to be sought in the way the land ownership passes from generation to generation. The introduction of the “minimal cultural unit[17]” in the civil code (art 846 of the Royal Decree 262/42) has been an effort to solve the process land fragmentation in order to set a limit

[16] For each forest type the law address the minimum rotation period, the cutting period, the maximum stock removal and the allowed forest silviculture practices.

[17] The article has never been enforced since a measure to define the “minimal cultural unit” has not been defined yet. The minimal land surface to allow a sufficient minimal income for a farm-base household.

below which the land could not be divided[18]. This political choice led to high fragmentation of the private forestland and the consequent increment of transaction costs to deal with a large number of owners or co-owners of the same forest land.

Between private and public land, "Regole" represent a mixture of the two main forms of ownership typologies enforced after the First World War. Regole history begins in the middle age and it continued till the national Italian unification when the Central government tried to pay off and remove all the customary rights in order to delete the huge number of right-right conflicts triggered during the transition period between the two wars (see law 1766/27). Nevertheless, the national policy makers have never minimized the right-holders diatribes, so the issue was transferred to the competence of regional authority, much closer to local problems (law 616/77). The regional government had the role to verify the proofs the local right holders claim according to the *qualitas soli* principle, or in other words the historical proof of land use. Since the law 616/77 has been implemented, 28 Regoles were re-established with a similar as extension to the public land. Regole was characterized by a formal private ownership status, in which the inheritance right could pass only to the original household descendants that remain to live next to the forest. Regole are today an important forest owner category that manage almost 300 Km^2 of alpine forests

Due to the complexity of the property right system and the lack of information especially on private forest owner, we tried to gather a large number of information among the different forest owner typologies, private, public and semi-private (regole), moving from the physical characteristics of the land (surface, forest types, position, etc.) and the economical aspect of the forest management, to the forest owners willingness to change the actual forest management practices to enhance the environmental service provision. In the following paragraphs we report the main findings of the survey addressed in Veneto region in 2012.

10.1.1 Objectives and context

This study was carried out in 4 mountainous provinces Belluno, Vincenza, Treviso, and Verona in the Veneto region (northern part of Italy). The first objective of the survey was to collect detailed information on the characteristics of the forest estates, the features of its owner/owners and the forest management practices in place. These are the basic pre-requisites to understand the potentialities of forest areas in the region to provide ecosystem services. The second objective was to collect information on revenues and costs of the forest management practices in place. The third objective of the survey was to explore more in detail the causal-effect relationships between the forest management practices in place and the provision of the four NEWFOREX externalities, namely Recreation, Biodiversity, Water (including also aspects linked to erosion control, very important in a mountainous context, where the slopes are steep) and Carbon sequestration. Finally, the survey wanted to collect information on forest owners' awareness (and knowledge) of the 'externality' concept,

[18] This was due to the potential contrast the article implementation could have triggered with regards the "inheritance rights"; moreover, another effect the article enforcement might have introduced was the potential incapability of the new land right holder to buy-out the other heirs, as required by the art 42 of the constitution.

attitudes and expectations towards possible changes on his/her forest management objectives in the view of shifting towards producing forest ecosystems. Note that a more detailed description of the questionnaire can be found in D3.2.

10.2 *Implementation*

The sampling of forest owners through face-to-face interviews took into account the distribution of forest area amongst the four mountainous provinces analysed and as well the ownership types (municipality, common property and private property). Based on the applied stratification, the Regional Administration identified the owners to be interviewed and sent them a letter introducing the purpose of the research and announcing the interview. Then, each selected forest owner was contacted by phone for an appointment. The interview took place at the forest owner's place of residence. Two interviewers were trained to carry out the interviews. The interviews have been completed November 2012. Overall, 197 forest owners were interviewed. At the time this report was written, data were preliminary analysed. More advanced data elaboration will be carried out in the future.

10.3 *Descriptive data of the forest owners samples*

Forest ownership has been introduced in the D2.1 – paragraph 6.3.1. pages 151-152 – showing the official data reported in the regional statistical yearbook (Regione-Veneto 2011). The most frequently studied land was the public forests, while private forests were rarely targeted in regional forest accounting (Preto 1984) as well on specific studies (Canton and Pettenella 2010). Moving from the qualitative to the quantitative data collection in agreement to WP3 coordinator, the survey was the largest non-institutional data collection on forest owner typologies run in the last decades, with a special focus on the ES provision. Traditionally, due to the physical structure of the private forest ownerships and the limited dimension of the real estates, there are no representative forest owner associations or lobbies, hence any information or data gathered have to be collect directly in the field since the privacy law allows limited access to the regional statistical forest database of active forest owners.

10.3.1 **Representativeness of the sample and sample size**

The representative data collection of regional forest owners in the Veneto's mountain areas was structured using a two stage nested sampling. In the first stage, we calculated the provincial forest surface through the regional forest maps (Regione-Veneto 2006), and then we assessed the dimension of forest surface per each forest owner typology. In the second stage, we selected the target municipalities in which the forest owners had been selected. The selection was based on the number of forest cut requests/declarations occurred in the last 10 years within each municipality, in other words the total number of active forest owners (private, public and regole) per municipality. However, due to the unknown total number of private forest owners (active and passive) we decide to sample each forest owner category by the forest surface they represent, independently to the reference population (see Table 10.1). Finally, we set up the total number of face-to-face interviews at 200 due to budget constraints.

Despite all the attentions we had on the theoretical sample design, the respondent number deviated from the design sample due to the high percentage of people who refuse or was not able to fit the interview date with the interviewer survey schedule. However, the final surface we sampled accounts for the 80% (f/d in Table 10.1) of the designed surface.

Private forest owners were the category mostly under sampled in terms of surface, although the number of the respondent accounted for the 70% of the sample.

Table 10.1: Sample design

		Veneto's forest		Mountain forest		Design sample			Respondents					Δ		
	Property Type	a) forest land [ha]	%	b) forest land [ha]	%	pop	c) sample	d)target land.surf. [ha]	e) n. resp.	f) land [ha]	g) grassland [ha]	h) forest [ha]	i) improductive [ha]	Δ1 [h/b]	Δ2 [(h+i)/b]	Δ3 [h/d]
Belluno	**Total**	**234298**	**0.53**	**234298**	**0.55**		**110**	**128760**	**122**	**101757**	**18977**	**54643**	**28137**	**0.233**	**0.353**	**0.424**
	Private	138817	0.59	138817	0.59	*20063*[a]	65	-	76	611	183	368	60	0.003	-	-
	Regole	27254	0.12	27254	0.12	28	13	14978	18	41874	5588	25665	10621	0.942	1.331	1.714
	Public	68227	0.29	68227	0.29	53*	32	37495	28	59271	13206	28610	17455	0.419	0.675	0.763
Vicenza	**Total**	**100943**	**0.23**	**100943**	**0.24**		**47**	**23900**	**48**	**27696**	**4650**	**21061**	**1985**	**0.209**	**0.964**	**0.881**
	Private	65840	0.65	65840	0.65	*38171*[a]	31	-	36	223	61	162	0	0.002	-	-
	Regole	284	0.00	284	0.00	1	0	-	-	-	-	-	-	-	-	-
	Public	34819	0.34	34819	0.34	26**	16	8244	12	27473	4589	20899	1985	0.600	0.657	2.535
Verona	**Total**	**51543**	**0.12**	**51543**	**0.12**		**24**	**6231**	**17**	**1199**	**815**	**381**	**3**	**0.007**	**0.007**	**0.061**
	Private	44813	0.87	44813	0.87	*12959*[a]	21	-	16	710	473	234	3	0.005	-	-
	Public	6730	0.13	6730	0.13	13***	3	814	1	489	342	147	0	0.022	0.022	0.181
Treviso	**Total**	**39557**	**0.09**	**39557**	**0.09**		**19**	**3670**	**10**	**714**	**93**	**619**	**1**	**0.016**	**0.016**	**0.169**
	Private	33343	0.84	33343	0.84	*4371*[a]	16	-	7	19	6	11	1	0.000	0.000	-
	Public	6214	0.16	6214	0.16	8****	3	577	3	695	87	608	0	0.098	0.098	1.055
other	**Plain for.**	**13062**	**0.03**	-	-		-	-	-	-	-	-	-	-	-	-
	Total	**439403**	**1.00**	**426341**	**1.00**		**200**	**162561**	**197**	**131366**	**24535**	**76704**	**30126**	**0.058**	**0.151**	**0.472**

Notes:

[a] Number of active private forest owner in the Mountain area of Veneto region

* 47 Municipalities, 5 villages, 1 Regional

** 25 Municipalities, 1 Regional

*** 12 Municipalities, 1 Regional

**** 7 Municipalities, 1 Regional

10.3.2 The forest property

The effect of the inheritance rules[19] had a clear effect on the forest ownership structure. In the sample, private forest owners had a limited forest surface, while Regole and public forest owners have definitely larger forest surface (see Table 10.2).

Table 10.2: Sampled forest types

	Forest types						
	n	%	Forest [ha]	Conifer [ha]	% of forest	Broadleaf [ha]	% of forest
Private	135	69	776	335	43.16	441.0	56.84
Regole	18	9	25665	23947	93.31	1718.1	6.69
Public	44	22	50264	37634	74.87	12629.7	25.13
	197	100	76704	61916	80.72	14789	19.28

Private lands were frequently covered by broadleaf forests, more dynamic and with higher annual wood increment. On the contrary, conifer forest, generally spruce and fir, had a longer rotation period, hence historically hold as common goods due to the risk of forest depletion, especially along the mountain slopes as for Belluno province.

The average land extension was very different. In fact, there were two orders of magnitude between private and public. Regole and public land had similar forest size, but definitely larger size compared to private owners (see Table 10.3, 10.4, 10.5). As already mention before, this was the result of policies looking more on the equality principle of the inheritance, than to keep higher competitiveness through large private land surfaces.

Table 10.3: Sampled land

	Sampled forest ownership types						
	n	%	Land sampled [ha]	Av.	St. Dev.	Min Ha	Max Ha
Private	135	68.53	1563.48	11.84	23.98	0.5	140
Regole	18	9.14	41874.00	2326.33	3808.35	313.0	16500
Public	44	22.34	87928.00	2093.52	2220.19	13.0	11000
	197	100	131365.48				

Table 10.4: Differences between the land surface distribution of the three forest owner categories

Anova - FO land surface differences				
Cases	diff	lwr	upr	p adj
Regole-Private	1419.94	826.95	2012.94	0.000
Public-Private	1190.89	772.78	1608.99	0.000
Public-Regole	-229.06	-893.94	435.82	0.695

[19] The equity principle implemented in the succession law allows the any land division in order to accomplish the statements of the art 42 of the Constitution.

Table 10.5: Analysis of variance of the forest surface by forest owner type

Anova - FO land surface differences					
Parameters	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Land ownerships	2	66108259	33054130	33.12	0.000***
Residuals	189	188641317	998102		

10.3.3 The forest management

Forest management is a tool the forest owners have to achieve their needs in a sustainable way. However, only large land surface are managed according to formal forest plan, while small estates and private forest owners prefer to cut their own forest filling up the cut delectation form provide by the forest administration (a compulsory protocol to be followed by any forest owner willing to cut the forest). The forest declaration form allows forest administration to record all the forest removal, even though several forest owners do not follow the procedure. In fact, 20 respondents declared to implement self-management without declaring the wood volume or the forest surface subjected to the cut (see Table 10.6Table 10.). From the qualitative part of the questionnaires emerged that two municipality administrations in the sample tried to promote the forest planning in private forests by covering the expenses of management plans for forest owners (Table 10.6, see the entry FMP for private land). These plans offered to private owners were not binding and offered general indications about silvicultural practices and rotation period for a 30 year period. Unfortunately, as the municipality administrations reported, these plans were seldom followed by the privates suggesting that the lack of a management plan is not the only factor limiting active forest management, and that other types of tools have to be researched and implemented.

Table 10.6: Actual forest management practices

	Forest management					
	Private		Regole		Public	
	n	[ha]	n	[ha]	n	[ha]
Cut declaration	101	599.17			3	1414
FMP			18	25664.75	39	48432
FMP for private land					**2**	**418**
Self-management	20	82.85				
No management	14	93.72				
	135	775.74	18	25664.75	44	50264

10.3.4 Wood supply and economy of the forest

As far as forest product and services are concerned, wood production is the most frequent activity in the forest either for self-consumption or for selling (see Table 10.7). This is a kind of paradox if we think that Regole and public owners are more business oriented than privates.

Table 10.7: Forest activities in forest

Activity	Wood for self-cons.	Wood to be sold	Ski	Game	Recreation	Agri-tourism	Cheese prod.	Water extraction	Mining	Other
	Activities in the forest									
Private										
Forest owner	119	25	0	0	0	0	19	0	0	4
Forest manager	3	0	0	0	1	0	7	0	0	0
Other	0	0	2	0	0	0	1	0	0	0
Regole										
Forest owner	18	18	1	1	5	1	2	0	2	0
Forest manager	0	0	2	0	2	2	4	0	0	1
Other	0	0	1	1	0	0	3	0	0	0
Public										
Forest owner	25	39	0	0	9	0	1	0	0	2
Forest manager	2	1	6	3	0	8	15	1	4	0
Other	6	1	4	8	5	9	19	0	7	1

Questions regarding wood production and price were addressed to forest owners. However, the response rate on these question was low (13%) and the quality of the responses was limited due to different the selling approach was very different waving from 8.9€/ton to 200€/ton for fuelwood and from 5.9€/m^3 to 170€/m^3 for timber. We prefer to report the overall cost of forest management since the cost of provision has been promoted by WP3. Table 10.8 highlights the cost per hectare declared by each forest owner summarized by category and province. Private has general higher cost of production compared to public owners. The price are similar to the ones reported by ISTAT, equal to 50€/m^3 on average for timber or wood extracted from the forest. The higher cost for private forest owners might be referred to the affective value, however the high cost heterogeneity does not allow to provide useful models (see Figure 10.1).

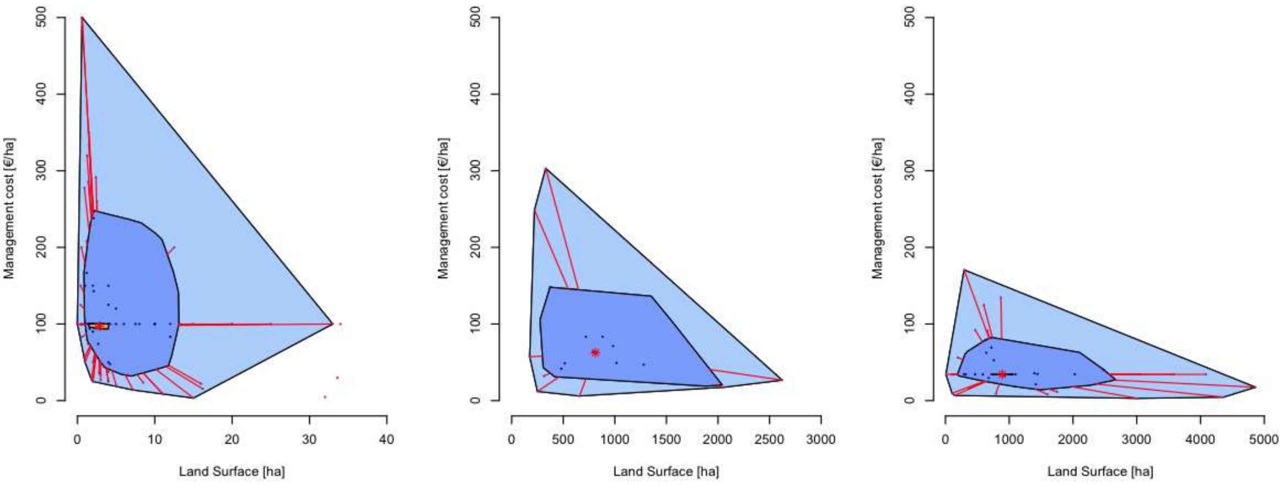
Once we look at the management cost per hectare we may understand the actual situation that characterized the different forest typology of forest owners. Small forests held by private forest owner have high management cost, while larger public or regole's forests may achieve better performance in terms of cost per hectares, according to the principle of the economy of scale.

Table 10.8: Forest total cost (all the costs are included)

+		Forest costs		
		n	Forest [ha]	Av. Cost [€/ha]
Belluno	**Total**	**122**	**54643**	**166.7**
	Private	76	368	237.6
	Regole	18	25665	74.8
	Public	28	28610	48.3
Vicenza	**Total**	**48**	**21061**	**122.5**
	Private	36	162	164.8
	Regole	-	-	-
	Public	12	20899	52.1
Verona	**Total**	**17**	**381**	**202.3**
	Private	16	234	300.0
	Public	1	147	6.8
Treviso	**Total**	**10**	**619**	**326.7**
	Private	7	11	326.7
	Public	3	608	-
		197	76704	164.4

Note: the cost per hectares is calculated dividing the total cost by the forest surface of the given respondent.

Figure 10.1: Land surface and management costs



Notes: light blue bag divide the good observation from the outliers, dark blue bag gathers the from 50% of the observations and the orange one it show the observations within the 95% interval from the mean.

10.3.5 Services provided by the forest and willingness to change

Forest management may affect the "presence of absence" of the environmental services, and the respondents were rather positive of stating their role toward the ES provision except for recreation and carbon. Probably these last two topics were seen as a sort of further forest constrains that has no additive income but rather a source costs.

Table 10.9: What FO think about their forest management related to ES provision

	Actual FM to ES provision seen by FO						
	Null		Positive		Unknown		total
	Forest management and **recreation** effect						
Private	90	0.67	39	0.29	6	0.04	135
Regole	0	0.00	17	0.94	1	0.06	18
Public	5	0.11	36	0.82	3	0.07	44
	Forest manag. and **biodiversity** enhancement						
Private	9	0.07	96	0.74	25	0.19	130
Regole	0	0.00	18	1.00	0	0.00	18
Public		0.00	42	1.00		0.00	42
	Forest manag. and **water** enhancement						
Private	13	0.10	94	0.74	20	0.16	127
Regole	0	0.00	18	1.00	0	0.00	18
Public	3	0.07	37	0.86	3	0.07	43
	Forest manag. and **carbon** enhancement						
Private	35	0.29	81	0.67	5	0.04	121
Regole	2	0.11	16	0.89	0	0.00	18
Public	13	0.30	27	0.63	3	0.07	43

The willingness to change forest management practices has been addressed in the last part of the questionnaire. The results are interesting for forest policy perspective, where the majority of the respondent stated their availability to change forest management also for free. However the answers have to be seen as the express declaration they want to change something without a formal bind with regards the performances obtained. Carbon sequestration showed the most different behaviour; in fact the effect of media and information platforms had an important role on communication, especially on the possibility to trade the ES.

Table 10.10: Willingness to change FMP

	Willingness to change forest management practice in relation to…												
	Only if Compensated		Also for free		With some benefits		Not applicable		No		I don't know		total
	…RECREATION												
Private	11	0.16	21	0.30	7	0.10	14	0.20	8	0.11	9	0.13	70
Regole	1	0.13	0	0.00	3	0.38	0	0.00	0	0.00	4	0.50	8
Public	1	0.09	6	0.55	2	0.18	0	0.00	0	0.00	2	0.18	11
	…BIODIVERSITY												
Private	28	0.21	66	0.50	5	0.04	14	0.11	9	0.07	10	0.08	132
Regole	3	0.17	6	0.33	2	0.11	4	0.22	2	0.11	1	0.06	18
Public	6	0.14	21	0.50	2	0.05	8	0.19	1	0.02	4	0.10	42
	…WATER QUALITY												
Private	40	0.31	43	0.34	6	0.05	29	0.23	4	0.03	6	0.05	128
Regole	6	0.33	3	0.17	2	0.11	7	0.39	0	0.00	0	0.00	18
Public	13	0.33	17	0.44	0	0.00	7	0.18	0	0.00	2	0.05	39
	…CARBON												
Private	36	0.28	9	0.07	4	0.03	27	0.21	20	0.15	34	0.26	130
Regole	8	0.44	0	0.00	0	0.00	6	0.33	0	0.00	4	0.22	18
Public	21	0.50	1	0.02	2	0.05	7	0.17	2	0.05	9	0.21	42

10.4 *Lessons learnt*

From the survey it emerged that the extreme fragmentation of the forest property in the Mountainous region is the main limiting factor for active forest management and hence for the forest sector. The private forest is rarely a source of income but rather a cost for the households. On the contrary, public forest owners should be considered as active economic players, achieving several targets, among which, the provision of environmental services. However, private forest owners are crucial for the provision of forest environmental services because they hold more than 60% of the total forest surface. Due to the small size of the property and the difficulties in the decision process generated by multiple ownerships, private forest owners are unable to achieve both better environmental services provision and active forest management for traditional market goods. The first important message for the policy makers that emerged from this survey is the need to cluster up private forest in order to facilitate a homogenous management. By doing so, costs reduction may be achieved as well as more constant output supply. Another important aspect to be underlined is the role of knowledge transferability among the local public administration. A more intense networking can contribute to the implementation of better policies through sharing both positive and negative experiences.

11 AMAZON CASE STUDY

In the Amazon case study, the main objectives are to investigate the causes of deforestation and forest degradation and to estimate the opportunity costs of protection the forest. A survey was carried out in February – April 2011. The results have been analysed and a paper is currently submitted and is under revision in an economic journal. It is expected than in the second half of 2013, when the journal review has been completed, this present report will be supplemented with the main results. Note that a more detailed description of the survey approach and hypotheses can be found in D3.2

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