Sustainability **2012**, *4*, 1580-1595; doi:10.3390/su4071580

OPEN ACCESS

sustainability

ISSN 2071-1050

www.mdpi.com/journal/sustainability

Article

Forest Stakeholder Participation in Improving Game Habitat in Swedish Forests

Eugene E. Ezebilo

Southern Swedish Forest Research Centre, Swedish University of Agricultural Sciences, Box 49, 230 53 Alnarp, Sweden; E-Mail: eugene.ezebilo@slu.se; Tel.: +46-40415197; Fax: +46-40462325

Received: 20 May 2012; in revised form: 6 July 2012 / Accepted: 6 July 2012 / Published: 11 July 2012

Abstract: Although in Sweden the simultaneous use of forests for timber production and game hunting are both of socioeconomic importance it often leads to conflicting interests. This study examines forest stakeholder participation in improving game habitat to increase hunting opportunities as well as redistribute game activities in forests to help reduce browsing damage in valuable forest stands. The data for the study were collected from a nationwide survey that involved randomly selected hunters and forest owners in Sweden. An ordered logit model was used to account for possible factors influencing the respondents' participation in improving game habitat. The results showed that on average, forest owning hunters were more involved in improving game habitat than non-hunting forest owners. The involvement of non-forest owning hunters was intermediate between the former two groups. The respondents' participation in improving game habitat were mainly influenced by factors such as the quantity of game meat obtained, stakeholder group, forests on hunting grounds, the extent of risk posed by game browsing damage to the economy of forest owners, importance of bagging game during hunting, and number of hunting days. The findings will help in designing a more sustainable forest management strategy that integrates timber production and game hunting in forests.

Keywords: forest management; game hunting; stakeholder participation; sustainability; timber production

1. Introduction

The increasing population of browsing ungulates such as moose (*Alces alces*) has consequences for forest ecosystems [1–4]. Browsing in forests threatens forest regeneration because it affects tree growth and survival as well as lowers timber quality [5–9]. Although attempts have been made to reduce browsing damage by reducing browsing ungulate population densities through culling [10] it has not been very successful [1]. Improvement of game habitats, *i.e.*, silvicultural practices in forests to increase food, water and vegetation cover available for game, is therefore becoming popular as a game management strategy [11,12]. It might contribute toward increasing body weight, survival rate and maintains high population densities as well as helps move ungulates activity away from young forest stands, traffic and habitat of high conservation value [11,13–16].

In Sweden the legislation regarding the use of forests stipulates that an increase in browsing by game in forests should be balanced with increased game hunting [17]. This implies that a forest owner who is affected by browsing damage by game in forests is not often compensated for loss in revenue in timber production. This often leads to a conflict of interests between hunters who are more interested in increase in game and forest owners who are more interested in timber production. Hunting for game in Swedish forests are mainly for recreation and meat [18]. Game are also essential for forest ecosystem processes but their feeding activities (e.g., browsing) lead to costs in timber production [19,20]. Although in Sweden timber production and hunting for game have economic values [21,22] and some hunters and forest owners engage in improvement of game habitat to redistribute game activities in forests [14] to help reduce browsing damage in valuable forest stands e.g., young Scots pine trees, conflict of interests between foresters and hunters persist. Some forest owners perceive ungulates such as moose and deer as a problem due to economic losses they often incur from browsing damage [23,24].

In a study regarding the use of supplementary feeding to redistribute moose in the Swedish forests [14] found that supplementary feeding affects moose movement, distribution and behaviour. [13,25] found that moose which use diversionary forage concentrated their space use around feeding stations with a decreasing probability of using areas away from feeding sites. [26] investigated the effects of fall cattle (*Bos taurus*) grazing on the availability of forages for elk (*Cervus elaphus*) and deer (*Odocoileus* spp.) in the following spring and summer in Montana, United States and found that fall cattle grazing can be used as a game habitat improvement strategy. In a study of landowner attitudes and preferences toward co-operative agreements in the United States [27] found that non-industrial private landowners are more likely to undertake collaborative management of forestlands when it focuses on improvement of game habitat. Thus, it is important to gain knowledge regarding the participation of hunters and forest owners in improving game habitat because the success of a sustainable game management strategy largely depends on the acceptance by the different forest stakeholders [28].

People tend to involve in activities that they expect to get benefits and decline activities that generate net losses [29,30]. This paper provides insight into participation of forest owners and hunters in improving game habitat. Their participation is expected to vary in accordance to the utility (benefits) they get from the forest environment. Non-forest owning hunter derives utility from meat and recreation associated with game and could be expected to participate in improving game habitat if the improvement increases hunting opportunities. Non-hunting forest owner derives more utility from timber production and could therefore be expected to participate in improving game habitat if the improvement helps to redistribute game activities in forests and reduce browsing damage on valuable forest stands (e.g., young trees). For the case of forest owning hunter she/he derives utility from meat, recreation, and timber production thus forest owning hunter could be expected to participate in improving game habitat if the improvement increases hunting opportunities and helps reduce browsing damage by game in forests. Developing a strategy to resolve the conflict between game hunting and timber production requires an understanding of how hunters and forest owners can be involved in activities that could help sustain game as well as timber production in the forest environment. The aim of this study is to explore the participation of forest owning hunters, non-forest owning hunters and non-hunting forest owners in improving game habitat in Swedish forests and possible factors influencing their participation. In this study, the term "forest owners" refers to non-industrial private forest owners. It is worth knowing that, more than 50% of the twenty three million hectares of the forestland in Sweden is owned by non-industrial private forest owners [31].

2. Materials and Methods

The data originated from a mail questionnaire [32] survey that involved people who were randomly selected from two national registers of hunters and forest owners, respectively. For the hunters, 2500 persons were selected from the Swedish national register of all the people paying the compulsory annual hunting fees (hunter sample). While for the forest owners, 400 persons were selected from a national register of people aged 18 to 75 years owning at least one hectare of forestland (forest owner sample). If the forest property had several owners, the questionnaire was sent to the contact person. The questionnaire included closed-ended and open-ended questions and was designed through focus group discussions, pre-test and previous surveys conducted on game hunting in Sweden [18]. The focus group consisted of scientists whose works were relevant to game management and forestry, officials of wildlife management organizations and the pre-test group also included six private persons with connections to hunting and forestry. After the initial focus group discussions a questionnaire was drafted and was sent to each member of the focus and pre-test groups. Issues raised prompted further discussions with members of the group before finalizing the questionnaire. The nationwide survey was conducted in June and July 2006, *i.e.*, at the end of the 2005/2006 hunting year. This paper is based on some parts of a larger survey. The main questionnaire that was used for the larger survey consists of 81 questions [33]. In this paper, only nine questions that are more relevant to improvement of game habitat were used.

2.1. The Game Habitat Improvement Question

The habitat improvement question asked the respondents about their involvement in forest management activities on their hunting grounds, forest estates or both to improve resources such as water, food, vegetation cover *etc*. available for game. The respondents were asked to mention the number of days in the last 12 months that they were involved in the forest management activities as:

0 day
1–2 days
3–4 days
5–10 days
11–20 days
>20 days

Among other questions in the main questionnaire (see, [33]) the respondents were asked about the quantity of meat from big game (e.g., roe deer, wild boar, red deer and fallow deer) except moose in the past 12 months and the quantity of moose meat they obtained. They were asked whether they hunt game, whether they owned forest estates or both. The respondents were asked whether their hunting grounds consists mainly forests and the number of days they hunted for game in the last 12 months. They were asked about how much importance they attach to bagging game during hunting. The respondents were asked about their gender and how they perceive the extent of risk posed by game browsing damage to the economy of forest owners.

2.2. The Ordered Logit Model

In this study the '0 day' was coded as 0. The '1–2 days' and '3–4 days' were classified as '1–4 days' and coded 1. The '5–10 days', '11–20 days' and '>20 days' were classified as '>4 days' and coded 2. The new classification should not have statistically significant effects on the results. Because for the forest owner sample only one per cent of the respondents used 11–20 days, and >20 days, and six per cent used 5–10 days, respectively in improving game habitat. For the hunter sample less than five per cent of the respondents used 11–20 days, and >20 days while it was 10% who used for 5–10 days, respectively. Because the number of days that the respondent used in improving game habitat is discrete and has more than two outcomes (dependent variables) the binary choice model is not suitable for analysis of the data. An extension of the binary model such as multinomial and ordered choice models, that allows for more than two dependent variables can be used for the analysis [34,35]. The multinomial model can be used for unordered dependent variables while the ordered model is more suitable for ordered dependent variables. In the present study it is assumed that the dependent variables are ordered thus the ordered choice model was used to explore the participation of the respondent in improving game habitat.

Let the number of days that the respondent participated in improving game habitat $IMPROVE$ be an ordered response taking on values {0,1,2}. The ordered model for $IMPROVE$ (conditional on explanatory variables c) can be derived from a latent variable model [36]. Assuming that a latent (unobservable) variable $IMPROVE^*$ is determined by:

$$IMPROVE^* = c\beta + \varepsilon \quad (1)$$

where ε is the error term which is assumed to be independently and identically distributed (IID) and distributed according to the logistic function [36]. Let $\mu_0 < \mu_1 < \mu_2$ be unknown cut-off points (threshold parameters) and the latent variable $IMPROVE^*$ can be censored as:

$$\begin{aligned} IMPROVE &= 0 \text{ if } IMPROVE^* \leq \mu_0, \\ &= 1 \text{ if } \mu_0 < IMPROVE^* \leq \mu_1, \\ &= 2 \text{ if } \mu_1 < IMPROVE^* \leq \mu_2 \end{aligned} \quad (2)$$

where $IMPROVE$ is the observed counterpart to $IMPROVE^*$, $\mu_0 ... \mu_2$ are estimated cut-off points. The probability that the respondent uses number of day j in improving game habitat is given as:

$$\Pr ob[IMPROVE = j|c] = F[\mu_j - \beta' c] - F[\mu_{j-1} - \beta' c], j = 0,1,2 \quad (3)$$

where F (.) is the cumulative distribution function of the logistic random variable.

Although probit model that assumes that errors are distributed normally can be applied in this study the calculated Lagrange multiplier [37] statistic for each of the included model were greater than the tabulated chi-squared statistic. Thus the hypotheses regarding the existence of normal distribution in the error term for each of the model were rejected at 0.1% statistically significant level, respectively. This implies that the assumption required to use the probit model could not be satisfied thus the ordered logit regression model was used in the analyses of the data.

The ordered logit regression model has a restrictive assumption called the Parallel Regression Assumption (PRA). This suggests that the relationship between each pair of the dependent variable is the same, *i.e.*, the coefficients of the explanatory variable that describe the relationship between the lowest and all higher classes of the dependent variable are the same as those that describe the relationship between the next lowest class and all higher classes [38]. The Brant test [36] can be used to evaluate whether the estimated model is in line with the PRA. The null hypothesis is that there is no difference in the coefficients between models. Thus a not statistically significant result implies that the PRA has not been violated (see Tables 3 and 4). The variance inflation factors of each explanatory variable included in this study did not exceed 1.84 and correlation between the variables did not exceed 0.23. This indicates that multi-collinearity and collinearity [39] are not serious problem in the estimated models. The ordered logit regression model was estimated using LIMDEP NLOGIT version 4.0.1 statistical package (Econometric Software Inc., New York, USA) and the effects of the respondents' attributes on the participation in the improvement of game habitat were analysed. The variables that were used in the analyses are presented in Tables 1 and 2. We expect the following effects (in parenthesis) of explanatory variables on participation in improving game habitat:

2.2.1. Stakeholder (+)

The improvement of game habitat can help increase hunting opportunities and redistribute game activities away from valuable forest stands such as young Scots pine trees. Forest owning hunter gets utility from game and timber production. All things being equal, the respondent who belongs to forest owning hunter should think that the more involved she/he is in improving game habitat the greater the benefit is.

2.2.2. Quantity of Meat Obtained from Game (+)

The greater the utility one derives from a resource the greater is the value she/he attaches to the resource [40]. The respondent who gets more game meat should think that it is important to improve game habitat. Thus she/he should be more involved in improving game habitat.

2.2.3. Importance of Bagging Game (+)

The improvement of hunting ground can help attract more game to the ground. Thus the respondent who attaches more importance to bagging game during hunting should think that the more the game habitat is improved the greater the opportunity of bagging game is.

2.2.4. Extent of Risk Posed by Game Browsing to Economy of Forest Owner (+)

Browsing damage by game leads to a reduction in timber quality and increases economic losses to forest owner [41]. The respondent who perceives that browsing damage by game poses great risk to her/his economy should be more involved in improving game habitat to divert game activities away from valuable forest stands.

Table 1. Definition of variables used in hunter sample.

Variable	Description	Mean
IMPROVE	Number of day (per year) used for improving game habitat	
	0 = 0	
	1–4 = 1	
	>4 =2	
ECO_RISK	Respondent perception regarding the extent of risk posed by game browsing to economy of forest owner.	
	big risk = 1	0.19
	small risk = 0	0.81
GAME MEAT	Quantity of meat obtained from big game (roe deer, wild boar, red deer and fallow deer) except moose (in kg)	14
HUNT_DAYS	Number of day (per year) used for hunting game	25
BAG GAME	Respondent attach importance to bagging game during hunting	
	yes = 1	0.28
	no = 0	0.72
MOOSE MEAT	Quantity of moose meat obtained (in kg)	43
	obtained at least 43kg of meat = 1	0.33
	obtained less than 43kg of meat = 0	0.67
FOREST	Hunting ground consists of mainly forest	
	yes = 1	0.88
	no = 0	0.12
STAKEHOLDER	Forest owning hunter	
	yes = 1	0.42
	no = 0	0.58

2.2.5. Hunting Area (−)

The more the forest type cherished by game the greater should be the game in forests and consequently more hunting opportunities. Thus the respondent who hunts for game on hunting ground dominated by forests should think that it is not important to improve game habitat and may be less involved in improving game habitat.

2.2.6. Hunting Days (+)

The more the number of days a respondent uses in hunting game the greater should be the value she/he have for hunting. Thus the respondent should think that it is important to improve game habitat in order to increase hunting opportunities and should be more involved in improving game habitat.

2.2.7. Gender (−)

In Sweden, female non-industrial private forest owners are often less likely to participate in silvicultural activities [42]. Thus, the female respondent may be less involved in improving game habitat.

Table 2. Definition of variables used in forest owner sample.

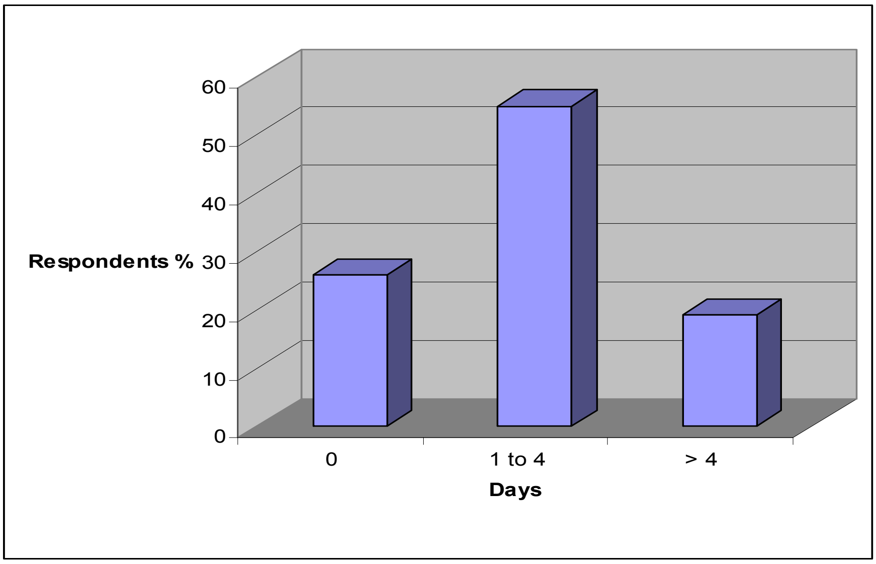
Variable	Description	Mean
IMPROVE	Number of day (per year) used for improving game habitat	
	0 = 0	
	1–4 = 1	
	>4 =2	
ECO_RISK	Respondent perception regarding the extent of risk posed by game browsing to economy of forest owner.	
	big risk = 1	0.35
	small risk = 0	0.65
GAME MEAT	Quantity of meat obtained from other big browsing ungulates (roe deer, wild boar, red deer and fallow deer) except moose (in kg)	4.0
GENDER	The gender of the respondent	
	female = 1	0.29
	male = 0	0.71
STAKEHOLDER	Forest owning hunter	
	yes = 1	0.44
	no = 0	0.56

3. Results

3.1. Improvement of Game Habitat by Forest Owning Hunter and Non-Forest Owning Hunter

Of the 2500 questionnaires sent to hunters, 1526 (66%) were returned. All the respondents answered the question regarding the stakeholder group they belonged. While only 573 "non-forest owning hunter" and 449 "forest owning hunter" who answered all the questions included in this study (see Table 3). Fifty-five per cent of all the respondents used one to four days in improving game habitat, about 20% used more than four days and it was approximately 26% who were not involved in improving game habitat (see Figure 1). Eighty per cent "forest owning hunter" was involved in the improvement of game habitat and it was 71% for the "non-forest owning hunter".

Figure 1. Distribution of respondents according to number of days used in improving game habitat.



To examine factors that might have influenced the respondents' participation in the improvement of game habitat, an ordered logit model was estimated (see Table 3). The results of the Brant test (Tables 3 and 4) were not statistically significant. This implies that the parallel regression assumption has not been violated, thus the application of the ordered logit model specification in this study was justified. The coefficients associated with game meat other than moose, number of days used for hunting game, forest on hunting ground and stakeholder had positive and statistically significant effects on participation in improving game habitat. The coefficients associated with the importance of bagging game during hunting and quantity of moose meat obtained had negative and statistically significant effects on the improvement of game habitat. The results imply that the respondents who have more game meat other than moose, use many days in hunting game, hunt on grounds dominated by forests and belonged to "forest owning hunter" were more likely to use many days in improving game habitat. The respondents who obtained at least 43 kg (*i.e.*, the average moose meat obtained by the respondents) of moose meat and attach importance to bagging game were less likely to use many days in improving game habitat.

The coefficients associated with stakeholder and forest on hunting ground had the highest odds ratios (1.1 and 2.3, respectively). In other words the respondents who were "forest owning hunter" and hunt on grounds which consists mainly forests were one to more than two times more likely to use many days in improving game habitat. However, for all hunters, an increase of one class in the "STAKEHOLDER" scale (e.g., being a "forest owning hunter"), has probability of 0.1 to spend many days for improving game habitat, compared to the "non-forest owning hunter". Although the coefficient associated with "STAKEHOLDER" is statistically significant its management importance is rather small. For the "non-forest owning hunter", an increase in one class of "FOREST" (e.g., the hunting ground is mainly forest), has 1.3 higher chance to spend many days for improving game habitat, compared to "hunting ground is not mainly forest". This implies that the effect of "FOREST" on improvement of game habitat is not only significant but also important from the management point of view.

Table 3. Ordered logit model result of forest owning and non-forest owning hunter participation**.**

Variable	Non forest owning hunter		Forest owning hunter		All hunters	
	Coefficient	Odds ratio	Coefficient	Odds ratio	Coefficient	Odds ratio
Constant	−0.29		0.59		−0.99 ***	
	(0.35)		(0.39)		(0.07)	
ECO_RISK	−0.16	0.85	0.07	1.07		
	(0.24)		(0.24)			
GAME MEAT	0.03****	1.03	0.02 ****	1.02		
	(0.01)		(0.004)			
BAG GAME	−0.24	0.79	−0.58 ***	0.56		
	(0.19)		(0.20)			
HUNT_DAYS	0.03****	1.03	0.04 ****	1.04		
	(0.01)		(0.01)			
MOOSE MEAT	−0.39**	0.68	−0.52 **	0.59		
	(0.18)		(0.20)			
FOREST	0.82 **	2.27	0.45	1.65		
	(0.34)		(0.38)			
STAKEHOLDER					1.72 *	1.12
					(0.09)	
Cut-point 1	1.94 ****		2.39 ****		1.61 ****	
LogL	−544.33		−411.51		−1653.09	
Restricted LogL	−613.75		−461.73		−1654.707	
Chi squared	138.84		100.46		3.22	
Prob [Chi squared > value]	0.0000 ****		0.0000 ****		0.07 **	
McFadden Pseudo R^2	0.11		0.11		0.001	
Brant specification test						
Chi squared statistic	6.46		6.88			
DF	6		6			
p value	0.37		0.33			
Number of observations	573		449		1526	

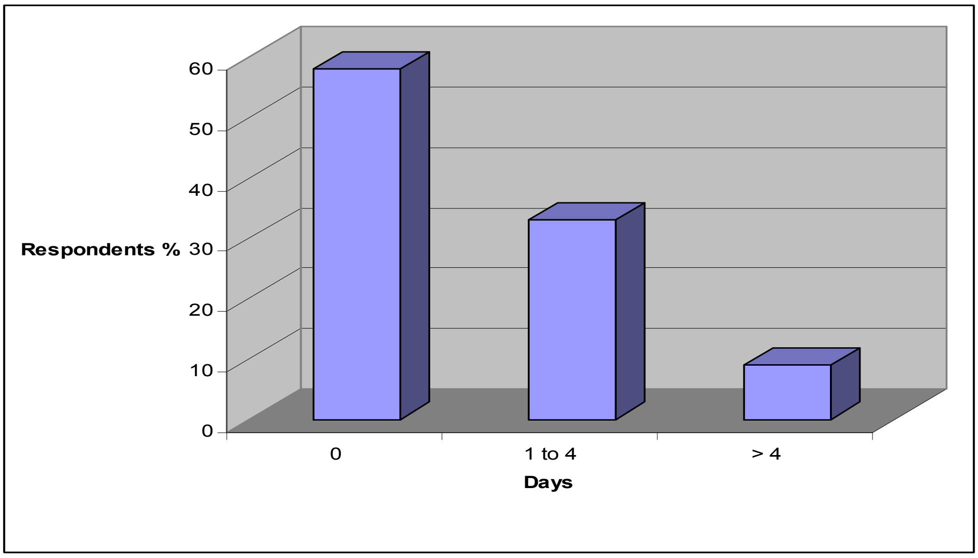
*, **, ***, **** represent 0.1, 0.05, 0.01 and 0.001 levels of statistical significance, respectively. Standard error is in parenthesis. Odds ratio is the chances of the improvement of game habitat occurring in a higher level to the chances of it occurring in a lower level of a given explanatory variable. An odds ratio of one indicates that the chances of the improvement occurring in the higher and lower levels are the same. An odds ratio of >1 indicates that higher level of a given explanatory variable increases the chances that the respondent uses many days in improving game habitat. An odds ratio of <1 implies that higher level of the explanatory variable reduces the chances that the respondent will use many days in improving game habitat [43].

For the "non-forest owning hunter" the coefficients associated with the extent of risk posed by game browsing to economy of forest owners and importance of bagging game was not statistically significant. The coefficients associated with the extent of risk posed by game browsing to economy of forest owners, and forest on hunting grounds was not statistically significant for the case of "forest owning hunter". The gender of respondent was not explored because there were only few female respondents in the hunter sample.

3.2. Improvement of Game Habitat by Non-Hunting Forest Owner

Of the 400 questionnaires sent to forest owners, 244 (61%) were returned. Of all the respondents, 226 answered the question regarding the stakeholder group (STAKEHOLDER) they belonged while 106 "non-hunting forest owner" answered questions associated with "ECO-RISK", "GAME MEAT" and "GENDER" (see Table 4). Thirty-three per cent of all the respondents used one to four days in improving game habitat, about 10% used more than four days and it was approximately 58% who were not involved in improving game habitat (see Figure 2). Twenty-five per cent "non-hunting forest owner" was involved in improving game habitat and it was 66% for the "forest owning hunter".

Figure 2. Distribution of respondents according to number of days used in improving game habitat.



Although some "forest owning hunters" were observed in the forest owner sample ordered logit model analysis based on only "forest owning hunter" category could not be performed because the observations were few. Rather the observations were included in the analysis of the influence of the stakeholder group on participation in improvement of game habitat that involves all the respondents (*i.e.*, "non-hunting forest owner" and "forest owning hunter") in the forest owner sample.

The coefficients associated with the perception of the extent of risk posed by game browsing to economy of forest owner (ECO-RISK), gender and stakeholder group had positive and statistically significant effects on the participation in improving game habitat (see Table 4). The results imply that the respondents who perceive browsing by game as a big risk to the economy of forest owners, belonged to "forest owning hunter" as well as female were more likely to use many days for improving game habitat. The respondents were more than two to five times more likely to use many days in improving game habitat. For the "non-hunting forest owner", an increase in one class in "ECO_RISK", e.g., "big risk", has 1.2 higher chances in spending many days for improving game habitat, compared to "small risk". This reveals that "ECO_RISK" is not only statistically significant but also important with regards to involvement in improvement of game habitat. An increase in one class in "GENDER", e.g., "female", has 1.3 higher chances in spending many days for improving game habitat, compared to "male". Thus "GENDER" is important in participation in improvement of game habitat. For all the forest owners, an increase in one class in the "STAKEHOLDER", scale e.g., "Forest owning hunter", has 4.4 chances in spend many days for improving game habitat compared to "non-hunting forest owner". This reveals that "STAKEHOLDER" is not only statistically significant but is also an important factor influencing participation in improvement of game habitat.

The coefficient associated with the meat from game other than moose was not statistically significant. The quantity of meat obtained from moose was not included in the analysis because there were only few observations.

Table 4. Ordered logit model result of non-hunting forest owner participation.

Variable	Non-hunting forest owner		All forest owner	
	Coefficient	**Odds ratio**	**Coefficient**	**Odds ratio**
Constant	−1.63 **** (0.40)		0.59 ** (0.20)	
ECO_RISK	0.78 * (0.43)	2.18		
GAME MEAT	0.05 (0.03)	1.05		
GENDER	0.83 ** (0.44)	2.29		
STAKEHOLDER			1.69 **** (0.28)	5.42
Cut-point 1	1.49 ****		1.57 ****	
LogL	−81.07		−196.87	
Restricted LogL	−84.79		−216.29	
Chi squared	7.44		38.83	
Prob [Chi squared > value]	0.006 ***		0.0000 ****	
McFadden Pseudo R^2	0.04		0.09	
Brant specification test				
Chi squared statistic	3.51			
DF	3			
p value	0.32			
Number of observations	106		226	

*, **, ***, **** represent 0.1, 0.05, 0.01 and 0.001 levels of statistical significance, respectively. Standard error is in parenthesis. Odds ratio is the chances of the improvement of game habitat occurring in a higher level to the chances of it occurring in a lower level of a given explanatory variable. An odds ratio of one indicates that the chances of the improvement occurring in the higher and lower levels are the same. An odds ratio of >1 indicates that higher level of a given explanatory variable increases the chances that the respondent uses many days in improving game habitat. An odds ratio of <1 implies that higher level of the explanatory variable reduces the chances that the respondent will use many days in improving game habitat [43].

4. Discussion and Conclusions

The findings of this study revealed that the number of day that the respondents were involved in improving game habitat vary widely. This implies that the value that the respondents have for the improvement differs. The hunter sample generally had more respondents who were involved in improving game habitat than the forest owner sample. This reflects the relative importance of hunting and timber production to the two groups. It is not surprising that more of the "forest owning hunters" were involved in improving game habitat. Because the improvement of game habitat can help increase hunting opportunities as well as has the potential to reduce browsing damage on valuable forest stands [11,14]. Thus the "forest owning hunters" have a greater incentive to participate in the improvement of game habitat compared to "non-forest owning hunters" and "non-hunting forest owners". More of the "non-forest owning hunters" were involved in the improvement than the "non-hunting forest owners". This suggests that the "non-forest owning hunters" may benefit more from the improvement. For example, trees especially young Scots pine in forest stands near areas where game habitat has been improved often suffers browsing damage from game [3,25] this has economic implications to forest owners. This calls for caution in designing strategies with regard to the improvement of game habitat. It may be a good idea to improve game habitat in areas greater than one kilometre away from valuable forest stands [9,13] to help divert game away from the stands in accordance with central-place foraging theory [44].

The "forest owning hunters" gain from hunting and the benefits can compensate for costs they incur from browsing damage thus helping them to internalize some of the costs. The findings are supported by the ordered logit model results (see Tables 3 and 4) which revealed that the "forest owning hunter" were more likely to use many days in improving game habitat. This shows that "forest owning hunters" have an important role to play in improving game habitat in a way that could integrate game hunting and timber production in forests. The results (Table 3) reveal that meat from game can serve as an incentive with regard to participation of "forest owning hunter" and "non-forest owning hunter" in improvement of game habitat. In other words the more the quantity of meat obtained from game the more would be the willingness of "forest owning hunter" and "non-forest owning hunter" to participate in the improvement is. However, the value of "moose meat" increases at a decreasing rate (*i.e.*, decreasing marginal value, see [29]). This implies that the more the "moose meat" the lesser is the per unit value compared to other goods and consequently the "non-forest owning hunter" or "forest owning hunter" who have at least 43kg "moose meat" (average moose meat obtained by hunters) will less likely use many days in improving game habitat.

The findings revealed that people (e.g., "non-hunting forest owners") who are affected by game browsing damage would be more involved in improving game habitat. This is in line with [45] who found that an individual's belief determines her/his attitudes and behaviour; and [27] who found that non-industrial landowners in North-eastern United States collaborate in improvement of game habitat. This suggests that the improvement of game habitat can help redistribute game activities in forests and reduce browsing damage in valuable forest stands, consequently helping to lower economic losses in timber production. The findings regarding influence of gender in improvement of game habitat is in contrast with the findings of e.g., [42]. In their study of forest management behaviour among non-industrial private forest owners they found that the female are less likely to participate in silvicultural practices. A reason may be that in Sweden the female are often more involved in forestry than game hunting this implies that the female get greater benefits in timber production. To sustain the benefits the female has an incentive to use many days in improving game habitat to redistribute game activities in forest and help reduce economic losses in valuable forest stands.

Some hunters often engage in activities such as fencing and habitat management thus improvement of game habitat should not be new to them. Moreover, game has preferences for different tree species. For example, moose is often attracted by young Scots pine trees [46]. This implies that the greater the young Scots pine trees on a hunting ground the more should moose be attracted to the ground. Thus to increase hunting opportunities hunters will need to provide the preferred game food on their hunting grounds. This suggests the importance of forest type with regard to abundance of game. The findings reveal that the improvement of game habitat can be used to manipulate the distribution and movement of game. If an individual uses many days for game hunting it suggests that the individual gets greater benefits from hunting and thus should be more willing to use many days in improving game habitat. Therefore the findings regarding the involvement of the respondents who use many days for game hunting is not surprising. This implies that if there would be an increase in "hunting season days" more "forest owning hunters" and "non-forest owning hunters" may be more involved in improving game habitat. For "forest owning hunters" to maximise benefits from timber production and hunting they need to harvest game in an attempt of internalizing browsing damage. Thus the respondents may have incentive to use fewer days in improving game habitat. This may be the reason that "forest owning hunters" who attach importance to bagging game during hunting were unlikely to use many days in improving game habitat.

The findings of the present study suggest that the success of a sustainable forest management strategy that integrates hunting and timber production will depend on its ability to promote hunting opportunities as well as divert game activities away from valuable forest stands. Thus collaboration of "non-forest owning hunters", "forest owning hunters" and "non-hunting forest owners" are required for the improvement of game habitat to be effective. The "forest owning hunters" have over time being getting benefits simultaneously from game hunting and timber production in forests thus their experiences in managing these conflicting interests is central to developing a strategy that integrates game hunting and timber production. For the game habitat improvement to be sustainable it should have the potential to meet the needs of the different stakeholders else some of them may have less incentive to participate in the improvement activity. To increase stakeholder participation in improvement of game habitat one could encourage forest owners whose timber production is threatened by game browsing to improve part of their forest estate (sacrifice area) in order to redistribute game activities. Hunters who hunt on grounds dominated by forest could be encouraged to engage in improvement of the grounds to divert game activities away from valuable forest stands such as young Scots pine trees. Hunting quota (*i.e.*, the number of game harvested each year) could be manipulated in a way that each hunter do not get access to too much quantity of moose meat in order to motivate them to engage in improvement of game habitat.

As improvement of game habitat continues over time, it might lead to browsing on adjacent forest stands. Manipulating the game distribution by improving game habitat may be more successful if the improvement is done on the migratory routes of game and at longer distances away from valuable forest stands as suggested by [9,13]. Although improvement of game habitat might have the potential to reduce browsing damage by game in forests it might be more effective if it is used in conjunction with culling [10] as a game management strategy. The findings should help in the design of a more sustainable game management strategy to help support conflict resolution between wildlife and forestry sectors.

Acknowledgments

This study was funded through *Future Forests*, a multi-disciplinary research programme supported by the Foundation for Strategic Environmental Research (MISTRA), the Swedish Forestry Industry and the Swedish University of Agricultural Sciences (SLU), as well as Umeå University and the Forestry Research Institute of Sweden. The author will like to thank Mattias Boman and Leif Mattsson, SLU, for their useful comments concerning improvement of game habitat in Sweden. My appreciation goes to Göran Ericsson, SLU, for his contributions in designing the questionnaire.

Conflict of Interest

The author declares no conflict of interest.

References

1. Coté, S.D.; Rooney, T.P.; Tremblay, J.P.; Dussault, C.; Waller, D.M. Ecological impacts of deer overabundance. *Annu. Rev. Ecol. Evol. Syst.* **2004**, *35*, 113–147.
2. Rooney, T.P. Deer impacts on forest ecosystems: A North American perspective. *Forestry* **2001**, *74*, 201–208.
3. Hornberg, S. The relationship between moose (*Alces alces*) browsing utilisation and the occurrence of different species in Sweden. *For. Ecol. Manag.* **2001**, *149*, 91–102.
4. McLaren, B.E.; Peterson, R.O. Wolves, moose, and tree rings on Isle Royale. *Science* **1994**, 1555–1558.
5. Bergqvist, G.; Bergstrom, R.; Edenius, L. Effects of moose (*Alces alces*) rebrowsing on damage development in young stands of Scots pine (*Pinus sylvestris*). *For. Ecol. Manag.* **2003**, *176*, 397–403.
6. Persson, I.L.; Danell, K.; Bergstrom, R. Different moose densities and accompanied changes in tree morphology and browse production. *Ecol. Appl.* **2005**, *15*, 1296–1305.
7. Bergqvist, G.; Bergstrom, R.; Edenius, L. Patterns of stem damage by moose (*Alces alces*) in young Pinus sylvestris stands in Sweden. *Scand. J. For. Res.* **2001**, *16*, 363–370.
8. Kalen, C.; Bergqvist, J. Forage availability for moose of young silver birch and Scots pine. *For. Ecol. Manag.* **2004**, *187*, 149–158.
9. Millington, J.D.A.; Walters, M.B.; Matonis, M.S.; Liu, J. Effects of local and regional landscape characteristics on wildlife distribution across managed forests. *For. Ecol. Manag.* **2010**, 1102–1110.
10. Lavsund, S.; Nygren, T.; Solberg, E.J. Status of moose populations and challenges to moose management in Fennoscandia. *Alces* **2003**, *39*, 109–130.
11. Putman, R.J.; Staines, B.W. Supplementary winter feeding of wild red deer *Cervus elaphus* in Europe and North America: Justifications, feeding practice and effectiveness. *Mamm. Rev.* **2004**, *34*, 285–306.
12. Smith, B.L. Winter feeding of elk in western North America. *J. Wildl. Manag.* **2001**, *65*, 173–190.

13. Van Beest, F.M.; Loe, L.E.; Mysterud, A.; Milner, J.M. Comparative space use and habitat selection of moose around feeding stations. *J. Wildl. Manag.* **2010**, *74*, 219–227.
14. Sahlsten, J.; Bunnefeld, N.; Månsson, J.; Ericsson, G.; Bergström, R.; Dettki, H. Can supplementary feeding be used to redistribute moose *Alces alces*? *Wildl. Biol.* **2010**, *16*, 85–92.
15. Kilpatrick, H.J.; Stober, W.A. Effects of temporary bait sites on movements of suburban white-tailed deer. *Wildl. Soc. Bull.* **2002**, *30*, 760–766.
16. Andreassen, H.P.; Gundersen, H.; Storaas, T. The effect of scent-marking, forest clearing, and supplementary feeding on moose-train collisions. *J. Wildl. Manag.* **2005**, *69*, 1125–1132.
17. SOU. *Uthållig Älgförvaltning i Samverkan: Betänkande* (Sustainable moose management in collaboration: Report) (in Swedish); Fritzes kundtjänst: Stockholm, Sweden, 2009. Available online: http://www.regeringen.se/content/1/c6/12/84/56/c7f15b49.pdf (accessed on 5 February 2012).
18. Mattsson, L. Hunting in Sweden: Extent, economic values and structural problems. *Scand. J. For. Res.* **1990**, *5*, 563–573.
19. Ingemarsson, F.; Claesson, S.; Thuresson, T. *Älg- och Rådjursstammarnas Kostnader och Värden* (*Costs and values of the moose and roe deer populations*) (in Swedish); Report No. 3; Skogsstyrelsens förlag: Jönköping, Sweden, 2007.
20. Bergström, R.; Helldin, J.O.; Boman, M.; Mattsson, L.; Karlsson, J.; Ericsson, G.; Hake, M.; Mörner, T.; Persson, I.L.; Risberg, P.; *et al*. Viltet i Samhället (Game and Society). In *Vilt, Människa, Samhälle* (*Game, People, Society*) (in Swedish); Danell, K., Bergström, R., Eds.; Liber: Stockholm, Sweden, 2010; pp. 135–167.
21. Sandström, C.; Lindkvist, A.; Öhman, K.; Nordström, E.-M. Governing competing demands for forest resources in Sweden. *Forests* **2011**, *2*, 218–242.
22. Boman, M.; Mattsson, L.; Ericsson, G.; Kriström, B. Moose hunting values in sweden now and two decades ago: The Swedish hunters revisited. *Environ. Resour. Econ.* **2011**, *50*, 515–530.
23. Blennow, K.; Sallnäs, O. Risk perception among non-industrial private forest owners. *Scand. J. For. Res.* **2002**, *17*, 472–479.
24. Wam, K.H.; Hofstad, O. Taking timber browsing damage into account: A density dependant matrix model for optimal harvest of moose in Scandinavia. *Ecol. Econ.* **2007**, *62*, 45–55.
25. Gundersen, H.; Andreassen, H.P.; Storaas, T. Supplemental feeding of migratory moose *Alces alces* forest damage at two spatial scales. *Wildl. Biol.* **2004**, *10*, 213–223.
26. Short, J.J.; Knight, J.E. Fall grazing affects big game forage on rough fescue grasslands. *J. Range Manag.* **2003**, *56*, 213–217.
27. Stevens, T.H.; Dennis, D.; Kittredge, D.; Rickenbach, M. Attitudes and prefences toward co-operative agreements for management of private forestlands in the North-eastern United States. *J. Environ. Manag.* **1999**, *55*, 81–90.
28. Boman, M.; Mattsson, L. A note on attitudes and knowledge concerning environmental issues in Sweden. *J. Environ. Manag.* **2008**, 575–579.
29. Garrod, G.; Willis, K.G. *Economic Valuation of the Environment*; Edward Elgar: Cheltenham, UK, 1999.
30. Boardman, A.E.; Greenberg, D.H.; Vining, A.R.; Weimer, D.L. *Cost-Benefit Analysis, Concepts and Practice*; Pearson Prentice Hall: Upper Saddle River, NJ, USA, 2006.

31. National Board of Forestry. *Skogsstatistisk Årsbok* (*Swedish Statistical Yearbook of Forestry*); National Board of Forestry: Jönköping, Sweden, 2009.
32. Dillman, D.A. *Mail and Internet Surveys*; Wiley: New York, NY, USA, 2000.
33. Mattsson, L.; Boman, M.; Ericsson, G. *Jakten i Sverige—Ekonomiska Värden och Attityder Jaktåret 2005/06* (*Hunting in Sweden—Economic Values and Attitudes in the Hunting Year 2005/06*) (in Swedish); Report No. 1; Adaptive Management of Fish and Wildlife: Umeå, Sweden, 2008.
34. McElvey, R.; Zavoina, W. A statistical model for the analysis of ordered level dependent variables. *J. Math. Sociol.* **1975**, *4*, 103–120.
35. McCullagh, P. Regression models for ordered data. *J. R. Stat. Soc. Ser. B (Methodological)* **1980**, *42*, 109–142.
36. Greene, W.H.; Hensher, D.A. *Modeling Ordered Choices*; Cambridge University Press: Cambridge, UK, 2009.
37. Greene, W.H. *Econometric Analysis*, 5th ed.; Prentice Hall: Upper Saddle River, NJ, USA, 2003.
38. Harrell, F.E., Jr. *Regression Modelling Strategies: With Applications to Linear Models, Logistic Regression and Survival Analysis*; Springer: New York, NY, USA, 2001.
39. Chatterjee, S.; Price, B. *Regression Analysis by Example*; Wiley: New York, NY, USA, 1991.
40. Varian, H.R. *Intermediate Microeconomics*: *A Modern Approach*; W. W. Norton & Company: London, UK, 2010.
41. Bergquist, J.; Kalén, C. Assessing Effects of Wildlife on Forestry. In *Developing Principles and Models for Sustainable Forestry in Sweden*; Sverdrup, H., Stjnernquist, I., Eds.; Kluwer Academic Publishers: London, UK, 2002.
42. Lidestav, G.; Ekström, M. Introducing gender in studies on management behaviour among non- industrial private forest owners. *Scand. J. For. Res.* **2000**, 378–386.
43. Arifin, B.; Swallow, B.M.; Suyanto, S.; Coe, R.D. A conjoint analysis of farmer preferences for community forestry contracts in the Sumber Jaya Watershed, Indonesia. *Ecol. Econ.* **2009**, 2040–2050.
44. Orians, G.H.; Pearson, N.E. On the Theory of Central Place Foraging. In *Analysis of Ecological Systems*; Horn, D., Ed.; Ohio State University Press: Columbus, OH, USA, 1979.
45. Fishbein, M.; Ajzen, I. *Belief, Attitude, Intention, and Behaviour: An Introduction to Theory and Research*; Addison-Wesley: Reading, MA, USA, 1975.
46. Angelstam, P.; Wikberg, P.-E.; Danilov, P.; Faber, W.E.; Nygren, K. Effects of moose density on timber quality and biodiversity in Sweden, Finland and Russian Karelia. *ALCES* **2000**, *36*, 133–145.