Funding Biodiversity Conservation
- An assessment of local opportunity costs and instruments to compensate for them

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Abstract

Conservation of coniferous forests is a significant contribution to preserving biodiversity in Norway. At present about 2.7 percent of the productive forest area in Norway is conserved, while ecologists recommend at least 4.6 percent to have sufficient protection of biodiversity in Norwegian forests. Thus, from an ecological point of view, an increase in the conserved forest area is necessary. However, it comes at a cost to both local communities and the population as a whole. While the social benefits of conserving forest areas accrue to all households in Norway, the immediate costs in terms of foregone earnings will be borne by the local communities if they are not compensated for their economic losses by national authorities. The conservation process is often dominated by conflicts between pro-conservation interests at the national level and anti-preservation interests at the local level. The costs at the local level are not always taken into account at the national level as some of these costs are not considered to be social costs, but rather a distributive effect. This makes an extension of the conserved forest area harder to obtain in practice.

This thesis considers the costs, incurred by municipalities, due to establishing Norway's largest forest reserve, Trillemarka-Rollagsfjell Nature Reserve, and discusses to what degree they were compensated for these costs through a Development Trust Fund (DTF) from the government. Cost-benefit analyses (CBA) at both the local and the national level are performed for different scenarios of losses and gains. The results show that a DTF almost fully compensates the municipalities for their costs as a result of the conservation. Seen in the light of other instruments, a DTF is found to be most appropriate in high conflict areas, where conservation otherwise would be difficult to implement.

Sammendrag

Vern av skog er en viktig del av bevaringen av biologisk mangfold i Norge. Per i dag er 2,7 prosent av produktiv skog vernet, men for å oppnå tilstrekkelig beskyttelse av arter anbefales det å øke vernet til 4,6 prosent (Framstad et al., 2002). Denne økningen har effekter både på nasjonalt og lokalt plan. Mens nytten av skogvern tilkommer alle husholdninger i Norge, vil en stor del av kostnadene falle på lokalsamfunn i form av tapte muligheter for skogdrift og næring. Skogvernprosesser er ofte svært konfliktfylte, der naturverninteresser på nasjonalt nivå møter vernemotstand på lokalt nivå. Fra et nasjonalt ståsted blir mange av de lokale kostnadene ikke sett på som kostnader for samfunnet, men heller som fordelingseffekter som jevnes ut. Dette bidrar til at økningen i andel vernede skogområder blir vanskelig å oppnå.

I denne masteroppgaven vil jeg evaluere lokale kostnader for tre kommuner som fikk deler av sine arealer vernet gjennom opprettelsen av Trillemarka-Rollagsfjell naturreservat, og om kommunene ble kompensert for disse kostnadene ved å motta et næringsfond. Dette vil analyseres gjennom nytte-kostnadsanalyser på både lokalt og nasjonalt nivå. Gjennom den lokale nytte-kostnadsanalysen testes hypotesen om næringsfondet dekker kostnadene kommunene har ved vernet. Deretter undersøker den nasjonale nytte-kostnadsanalysen om nytten ved vernet er høy nok til å forsvare en kompensasjon av kommunenes kostnader. Under forutsetningen om at kommunene har kostnader som myndighetene har mulighet til å kompensere for, vurderes så ulike politiske/økonomiske virkemidler som brukes eller kunne blitt brukt for å øke vernet areal.

I analysen konluderes det med at næringsfondet dekker det meste av kommunenes tap ved vernet og at nytten ved vernet er så stor at kompensasjon kan forsvares. Sett i lys av andre virkemidler vurderes næringsfondet som mest egnet i situasjoner der frivillig vern er vanskelig å gjennomføre.

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Abbreviations

CAPM – Capital Asset Pricing Model

CBA – Cost-Benefit Analysis

CV – Contingent Valuation

CV' – Compensating Variation

DAA – Decare (1000 m^2)

DTF – Development Trust Fund

EV – Equivalent Variation

MB – Marginal Benefit

MC – Marginal Cost

MNOK – One Million NOK

NOK – Norwegian Currency (Krone)

NOU – Norwegian Official Report[1]

NPV – Net Present Value

SSB – Statistics Norway

TRNR – Trillemarka-Rollagsfjell Nature Reserve

WTA – Willingness to Accept

WTP – Willingness to Pay

[1] In Norwegian: Norges offentlige utredninger

1 Introduction

Norway is obliged through the Convention on Biological Diversity to protect endangered species, fight foreign species, establish conserved areas and promote international cooperation in order to protect biodiversity (Norwegian Directorate for Nature Management, 2012). A significant part of this work is preserving species living in forests.

About 60 percent of all known mainland species[2] in Norway have connection to forests (Gjerde, Brandrud, Ohlson, & Ødegaard, 2010). At present 2.7 percent of productive forest is conserved, while a recommended goal to achieve sufficient protection to avoid further loss of species is 4.6 percent of productive forest (Framstad et al., 2002). Reaching this goal and following up on international commitments requires action on both governmental and local level.

Conservation of an area often leads to conflict as the local actors lose the opportunity to use the area the way they have done previously. In forest conservation cases the conflict level is often high despite the fact that the forest owners get compensated for lost income from forestry. Previous research in the field has had a predominant focus on forest owners and how they can be compensated in conservation cases. Although this is important, there are also other actors that are affected by the conservation of an area.

An official government report on global environmental challenges (NOU 2009:16, p. 120) recommends an assessment of instruments that encourage municipalities to take biodiversity into account in decision making. Understanding the cost of conservation on the local level is crucial for understanding which instruments to use to promote conservation locally. Many municipalities are reluctant to have conservation within their borders, even if they are compensated for costs of administrating the area. Why are they not taking initiative to conserve? Are there any overlooked costs that could create this reluctance?

The conservation of an area within a municipality leads to positive externalities for surrounding areas, and potentially the rest of the country, that the municipality may not be compensated for. This market failure causes the provision of biodiversity protection to be lower than the socially optimal level. In addition to this, encouraging conservation amongst the municipalities is made

[2] All known species except microorganisms.

even more difficult when they potentially are forgoing tax revenues and job opportunities that contribute to their economic growth. Furthermore, the Nature Diversity Act and Forestry Act mandate municipalities with a number of forest conservation tasks whose management costs may currently not be fully compensated, and/or are not being carried out to the minimum intended by the law (Riksrevisjonen, 2012).

The EU-project POLICYMIX (Norwegian Institute for Nature Research, 2013) is evaluating the cost-effectiveness and incentive effects of economic instruments for increasing protection of biodiversity and ecosystem services. One of the proposed instruments in the POLICYMIX project is a state-to-municipality transfer of funds, which could give incentives for municipalities to conserve more. In the context of this project, this thesis will evaluate compensations in a case study of the Trillemarka-Rollagsfjell Nature Reserve in southeastern Norway. Here a state-to-municipality "local development trust fund"[3] was used. The trust fund will be compared to other alternative approaches to compensation of municipal costs of conservation currently in use in Norway and other countries participating in POLICYMIX (Barton et al., 2012).

The emphasis on municipalities does not exclude nor diminish the significance of a well-functioning compensation scheme for forest owners, but rather seeks to incorporate some of the concerns among both forest owners and other locals in the process of conservation. The municipality as a tax collecting entity has interest in keeping jobs and business opportunities to be able to provide good services and prevent a decrease in inhabitants. If inhabitants and municipalities alike have the prospect of getting new opportunities when an area is conserved it is more likely that conservation will be more welcome and maybe even encouraged by the local community.

The **main aim** of this Master's thesis is to evaluate whether a local development trust fund (DTF) has fully compensated the affected municipalities for their net costs of the establishment of the Trillemarka-Rollagsfjell Nature Reserve (TRNR), and whether this in turn is a preferred instrument to use from both the municipal and national perspective. My main hypothesis is that a development trust fund fully compensates the affected municipalities for their net costs of

[3] In Norwegian: "Næringsfond" or "Lokalt utviklingsfond" . In English: a "trust fund" where only returns are spent on local development.

establishing the TRNR. The hypothesis will be tested through an *in medias res* cost-benefit analysis (CBA); performed both at the local/municipality level and at the national level.

The local CBA will explore the lost opportunities to the municipalities as a result of the conservation, and test if the DTF was large enough to compensate the municipalities for their loss. The national CBA will then investigate the benefits and costs at the national/social level and test if the benefits from the conservation are large enough to justify compensating the municipalities. Next the DTF will be evaluated and compared to alternative instruments. Finally, a policy recommendation based on the results of the analysis will be made.

2 Trillemarka-Rollagsfjell Nature Reserve (TRNR)[4]

Trillemarka-Rollagsfjell Nature Reserve (TRNR) was established in 2008 and is the largest forest reserve in Norway. It is located in Buskerud County, shared between the three municipalities Sigdal, Rollag and Nore og Uvdal. The process started in 1988-1990 when the first registrations of potential areas for conservation in a smaller part of the reserve were made. Over the years natural areas of high importance were discovered and documented within the TRNR, and in 2002 an area of 43 km^2 was conserved as what was called Trillemarka Nature Reserve (Friends of the Earth Norway, 2007). Close to this reserve an additional area of 2.5 km^2 called Heimseteråsen was also conserved at the same time. The same year Friends of the Earth Norway[5] proposed to the Ministry of the Environment that an even larger area of a total 205 km^2 should be conserved in order to preserve the values in the forest in and around the existing reserve. This was the beginning of a long lasting conflict between environmental activists, the government, municipalities and forest owners.

Several different suggestions for the size of the extended nature reserve were put forward by the different groups. The forest owners and municipalities promoted an area of 99 km^2, the Ministry of the Environment asked for an evaluation of an area of 160 km^2, while the environmental activists stuck to their opinion that 205 km^2 had to be conserved to maintain the biodiversity

[4] Throughout the analysis Trillemarka-Rollagsfjell Nature Reserve will be abbreviated to TRNR.
[5] In Norwegian: Naturvernforbundet

values. After years of pulling back and forth the conservation was enacted, resulting in Trillemarka-Rollagsfjell nature reserve with a total size of 148 km^2.

The most important restrictions for local actors in this case were that they were no longer allowed to top cut the forest nor build cabins. These aspects will be the main focus in calculating the local opportunity costs.

3 Theory

In the grand scheme of it all the purpose of investigating the municipal costs of conservation and economic instruments for compensating the municipalities is to find out how biodiversity protection can be increased. It will be assumed that the local costs to conservation are larger than the social costs, and that this will lead to a market failure in the provision of biodiversity as a public good with positive externalities. Given that this is the case, the local costs needs to be recognized and compensated for in order to get an increase in biodiversity conservation, as shown in Figure 3.1.

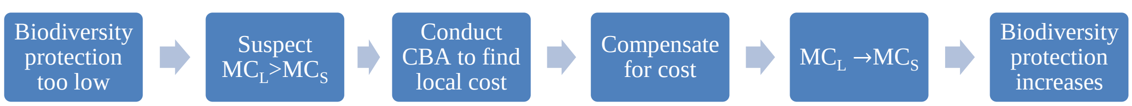

Figure 3.1. Stylized representation of how to increase biodiversity protection. MC_L is local marginal cost of conservation; MC_S represents social marginal cost of conservation.

It is not assumed that compensating municipalities and forest owners is the only way to conserve biodiversity, but that it will work alongside other measures. The effect of local costs on biodiversity conservation will be isolated from the other measures, so that they can be analyzed as a part of the issue.

This theory section will first go through the market failure caused by $MC_L > MC_S$; then move on to the development trust fund as fiscal transfer; and then go on to assumptions behind the cost-benefit analysis.

3.1 Market Failure

When the local and national costs of conservation are different, the level of conservation will deviate from the socially optimal level, as illustrated in Figure 3.2.

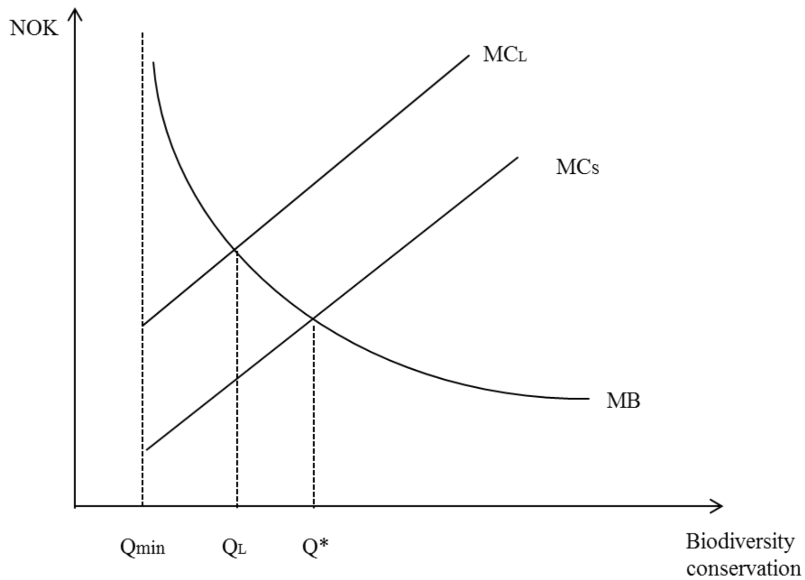

Figure 3.2. Market failure when the local marginal cost of conserving biodiversity is higher than the social marginal cost; i.e. when $MC_L > MC_S$, an area Q_L will be conserved instead of the higher social optimal level of Q.*

In Figure 3.2, Q* illustrates the optimal level of biodiversity conservation, which is where marginal social cost (MC_s) is equal to marginal benefit (MB). Q_{min} represents the minimum of biodiversity necessary for human life. When approaching this limit marginal benefit is approaching infinity, as it is crucial for the existence of life. When local cost is higher than social cost the preservation of biodiversity will be lower than optimal, resulting in conservation at the point $Q_L < Q^*$. To be able to reach the optimal level of conservation, the local actors can be compensated such that the level of conservation increases to Q*. This is of course a very simplified representation of the issue, but it serves to illustrate the point.

The decision to conserve an area is often taken by the high level of government, while the costs of the decision are borne locally. In these cases land use has a different value locally than nationally. The local inhabitants do gain benefit from the conservation, but the benefit may not be large enough to compensate for the loss of the alternative use of the land.

It should be noted that the (static) optimal level of biodiversity conservation is here defined as marginal benefit being equal to marginal cost. This does not necessarily represent the level of biodiversity protection that is considered optimal from a ecological perspective (as pointed out in e.g. Pearce (2007)). One may or may not agree with this definition, but this is the premise behind the optimal provision of a public good in economics.

According to Pearce and Moran (1994) market failures in biodiversity conservation occurs either at the global or at the local level. At the global level external benefits cross over national borders, where biodiversity loss in one country leads to a negative externality for other countries. At the local level the market failure manifests itself as a failure to account for the external cost of biodiversity loss, and an inability of the market to capture local and national benefits and costs of conservation. The latter is most relevant for the conservation in TRNR, so the local market failure will be the focus in this paper. In TRNR national goods are being preserved, but it seems unlikely that there are any global effects from this conservation (as we assume that most species in Norway can also be found in other northern boreal forests). Therefore, effects at the global level will not be considered here.

3.2 Fiscal transfers

Fiscal transfers in Norway are transfers between the central government, counties and municipalities. A development trust fund (DTF) is considered to be a fiscal transfer, and it will be compared to other instruments in terms of how well it is suited to compensate municipalities in conservation cases. To do this I will look to the guidelines presented by Boadway and Shah (2009) p. 352-353, which introduce a list of fifteen considerations for designing and analyzing fiscal transfers. I will not consider them all; only those who apply to the instruments and cause in this analysis.

A grant should seek to preserve autonomy in the subnational government, leaving as much room for local decision making as possible. It should vary with fiscal needs to cause a fair distribution of the contribution from the citizens. The objectives of the grant should be simple and clearly specified to effectively reach targets. Predictability is also key; allowing lower levels of government to plan around the transfer for longer periods of time. A grant program has to consider the budget constraint, to set up for sustainable future use. Finally, there should be accountability for results, so the recipient of the grant should be able to show results from receiving it. These considerations will be used in the discussion of alternative instruments.

The purpose of the development trust fund in the TRNR case was to compensate the municipalities and local community for their loss of business opportunities as a result of the conservation. In the guidelines for the fund it is stated that the funds shall be used to promote business development for the good of the inhabitants of the region (Sigdal Kommune, 2008). It can only give support to businesses that aim to generate profits and long term employment. Another condition is that it cannot be used for projects that a negative impact on endangered species or nature types in the area. Only the returns of the DTF are to be used, so that it benefits the local community on the long term.

In terms of fiscal transfers the DTF can be seen as a conditional non-matching transfer from the government. According to Boadway and Shah (2009) this particular type of grant is well suited for the provision of goods that are of high priority to the higher level of government, but at a low level of priority to the lower level of government, just as is the case with biodiversity provisioning. Figure 3.3 shows the effects of a conditional non-matching grant on the municipalities' budget line.

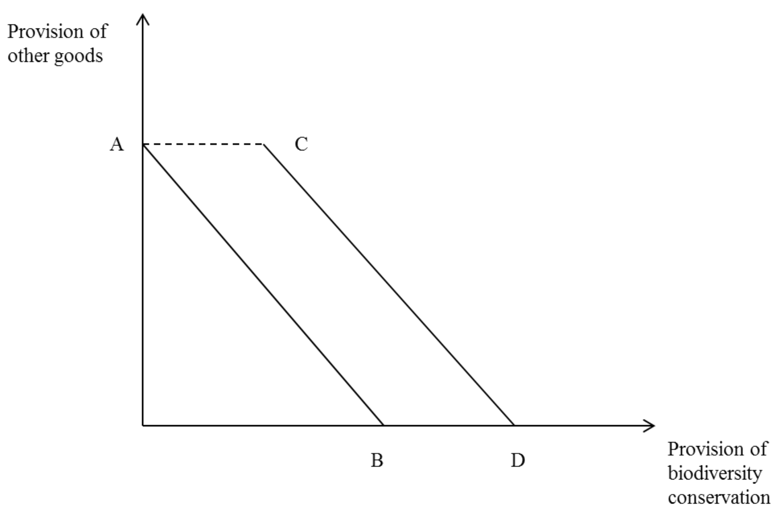

Figure 3.3. The effect of a conditional non-matching transfer on the provisioning of a public good, shifting allocation from AB to CD. Graph adapted from Boadway and Shah (2009).

In receiving a DTF to compensate for their loss as a result of conservation, the municipalities can keep up their spending in other areas at the same time as providing more biodiversity protection. The welfare of the municipalities will be maximized, as their spending pattern can stay the same as before receiving the grant.

3.3 Assumptions behind Cost-Benefit Analysis

To examine the local costs of conservation, an *in medias res* cost-benefit analysis of the conservation of Trillemarka-Rollagsfjell Nature Reserve on the local and national level will be conducted. *In medias res* means *into the middle of things*, and is a type of CBA that is used to analyze a project or policy while it is in effect. Since the conservation process is not yet finished and there are still losses and gains that are expected to accrue in the future this method is chosen. Before diving into the analysis, some assumptions about utility, discounting and time horizons will be made.

3.3.1 Utility and Compensating Variation

In a cost-benefit analysis one will conclude that if a project has a positive net present value (NPV) one should go through with it (Boardman, Greenberg, & Vining, 2011). To achieve this, the Kaldor-Hicks criterion must be met, which means that the beneficiaries of the project must be able to compensate the cost inflicted parties and still be better off (i.e. total benefits must exceed total costs to achieve this potential Pareto improvement). Behind the Kaldor-Hicks criterion lays the concept of compensating variation, which is a measure that reflects utility change in monetary terms. Before looking closer into this, it is appropriate to state a few assumptions about the utility functions used in the CBA at both the local and national (social) level.

At the local level the municipalities are assumed to be utility maximizing actors with a utility function depending on their income and expenditure. The municipal income, Y, consists of labor tax, real estate tax, municipal fees and transfers from the government. Expenditure, E, represents the costs of providing services to the inhabitants.

$U = U(\,Y(taxes, transfers, fees), E)$, where $\frac{\partial U}{\partial Y} > 0$, $\frac{\partial U}{\partial E} < 0$

It is assumed that the municipalities' utility functions display homothetic preferences, which implies that their income elasticity is equal to one. Realistically this assumption is questionable, but according to theory it is a necessary property for the correct use of compensating variation (Boardman et al., 2011 p. 77).

It is assumed that forest conservation leads to a decrease in income tax, real estate tax and municipal fees. This means that the municipality will have a decreased utility, as their income is decreasing while expenditure remains unchanged. This is analogue to the forest owners having their utility reduced when they cannot use their forests as before. For the municipality to have the same utility as before the change, they will have to be compensated for their loss. Assuming that the municipalities had an initial utility of U_0, the following condition would have to be fulfilled:

$$U_0(Y_0 + WTA, F_1, E_0) = U_0(Y_0, F_0, E_0)$$

Where U_0 is the initial utility level, Y_0 is the initial income, F_0 and $F_1$is the possible forest use before and after conservation respectively and WTA is the willingness to accept. Going from F_0 to F_1 implies a reduction in possibilities for the municipalities. The payment that the municipalities are willing to accept has to be such that the utility level stays the same as before the conservation of the forest. The equivalent variation counterpart to this would be if the municipalities were asked how much they would be willing to pay to *not* have the forest conserved; knowing that if they did not pay the conservation would take place. Assuming that the municipalities have a utility of U_1 post potential conservation the following condition must then be fulfilled:

$$U_1(Y_0 - WTP, F_0, E_0) = U_1(Y_0, F_1, E_0)$$

The municipalities are here paying to avoid the disutility of having the forest conserved. They would here be indifferent between giving up a sum corresponding to the willingness to pay from their income and having the forest conserved. If they have disutility from forest conservation their WTP must be positive in order to fulfill the condition.

Compensating and equivalent variation can also be used when looking at the change in the utility of the national population from increased protection of biodiversity. In the CBA at the national level, results from a Contingent Valuation survey will be used to illustrate the benefit of increased biodiversity conservation. The survey investigated the use and conservation of forests, in which a representative sample of Norwegian households were asked how much they would be willing to pay to have a certain part of the productive forest in Norway conserved. The compensating variation for this will be shown by the WTP when the following equation holds:

$$U_0(Y_0 - WTP, F_1, E_0) = U_0\,(Y_0, F_0, E_0)$$

If the increase in conservation leads to a higher utility for the respondent she/he would have to give up a part of her/his income to be at the same utility as before the change. Assuming that the stated willingness to pay is the true willingness to pay[6], the social welfare increase from the conservation can be monetized through the willingness to pay. Corresponding to the municipality example, this case also has an equivalent variation counterpart where the following condition must be fulfilled:

$$U_1(Y_0 + WTA, F_0, E_0) = U_1\,(Y_0, F_1, E_0)$$

Here the question would be: Given that we are not going to conserve the forest, how much would you accept in compensation to have the same utility after *not* making the change. The respondents would then have to state their willingness to accept, knowing that the forest will not be protected and they will have to forego the corresponding potential utility increase. To have as high a utility as they could have had with the conservation they would need to receive a sum corresponding to their WTA.

Assuming homothetic preferences are even more problematic for households in the CV survey than for the municipalities, as their preferences for different goods are quite unlikely to have an income elasticity of one. An environmental good like biodiversity can be regarded as a luxury good and hence have an income elasticity of demand larger than one, since being willing to pay for it takes priority after necessary goods such as food and housing. But as Mäler and Vinent (2005 p. 909) points out this is defined through the income elasticity of *demand* and not through the income elasticity of *WTP*. Empirical estimates of the link between the elasticity of demand and WTP shows that the elasticity of WTP varies in size and even sign when compared to the

[6] As will be shown when calculating the benefits in the CBAs, this is not necessarily the case; protest bids, biases.

elasticity of demand (Flores & Carson, 1997). The assumption of homothetic preferences still needs to be upheld for the validity of compensating variation.

Compensating variation can be seen as a necessary proxy to be able to capture the unobservable utility changes in monetary terms to be used in a CBA. As with any proxy it cannot be expected to correctly represent every aspect of the variable it is supposed to replace. In some cases the uncertainty of the proxy makes it better to omit the utility change from the calculation and rather describe the change qualitatively.

3.3.2 Use and Non-use Values

The total economic value (TEV) of a marginal change in quality or quantity of environmental goods such as biodiversity can be divided into two main categories; *use* and *non-use* values (Pearce, Atkinson, & Mourato, 2006). The use value reflects the actual, planned or potential use of the good in question, such as visiting the forest, berry picking or hunting. The potential use is the *option value* of a good, meaning that there is a value in having the option to use the good sometime in the future. The non-use value is based on a utility from simply knowing that the good exists or is being provided without having any plans of using the good itself. The non-use value can be divided into *bequest values*, *altruistic values* and *existence values* (Pearce et al., 2006). A bequest value is a willingness to pay for a good to be available to future generations, while altruistic value reflects a utility from knowing that other people in the same generation can enjoy the good. The existence value is the WTP to keep a good even if it is not used by anyone, reflecting that the good has an intrinsic value.

The public right of access[7] makes it possible to enjoy the use value of nature in Norway even when the forest is owned privately. This means that the use values of a forest are not necessarily increasing when an area is conserved. Only if the establishment of the nature reserve resulted in an increase in planned or actual visits, that was not the result of a decrease in visits somewhere else, we could say that we have an increase in use value.

[7] In Norwegian: Allemannsretten.

In practice these use and non-use values can be difficult to monetize. Different valuation methods have been designed to capture these values, both through revealed and stated preference techniques. However, only stated preference methods are able to capture non-use values. There are disagreements among economists about the validity of these methods, especially regarding stated preference techniques used to capture non-use values. For a discussion on this see e.g. Kling, Phaneuf, and Zhao (2012); Hausman (2012) and Carson (2012). In this analysis results based on the stated preference technique contingent valuation is used to estimate the benefit of the establishment of TRNR. This is described more closely in the section “Willingness to Pay for Conserving Forest Biodiversity”.

In this thesis the main focus is on biodiversity, but there are also other ecosystem services the forest provides that are not included in this analysis, for instance carbon sequestration. Conservation of forests preserves carbon stocks, which would have a positive effect in the short term, but in the long term the effect is uncertain (Framstad et al., 2013 p. 77). The uncertainties about the effects of many ecosystem services make them difficult to include in a CBA. There could also be an issue with double counting when including both biodiversity and other ecosystem services, as biodiversity is a regulator for ecosystem processes that support other ecosystem services (Mace, Norris, & Fitter, 2012).

3.3.3 Net Present Value (NPV)

Benefits and costs often occur at different times during a project/policy. To be able to compare these costs and benefits across time they are discounted to the present value of the set reference year using a discount rate. When all costs and benefits across time are taken into account we can calculate the net present value (NPV) of a project.

$$NPV = -I + \sum_{t=0}^{N} \frac{B_t - C_t}{(1+r)^t}$$

Where I is investment, t is time, B_t is benefit at time t, C_t is cost at time t and r is the discount rate. Instead of being constant, the discount rate r will be declining over time; based on the reasoning in the next section.

3.3.4 Discounting

The discount rate has a large impact on the result of a cost-benefit analysis through its effect on the net present value (NPV). A high positive discount rate puts more weight on the costs and benefits occurring in the near future, as costs and benefits in the far future get discounted to a low present value. Assume that a person living in the future, say 100 years from now, has a WTP of 1000 NOK to preserve a set area for biodiversity conservation. With a discount rate of five percent that WTP would be reduced to only 7.6 NOK in present value. In comparison the same WTP would be worth 138 NOK today with a discount rate of two percent. In both cases there is a sharp decrease in present value, but there is a large difference between the effects of the two discount rates when evaluating the outcome of the conservation project. This underlines the importance of the choice of discount rate. The following will briefly go through the interpretations of discount rates and argue that a declining discount rate is appropriate for projects with a long time horizon.

There are two main interpretations of the discount rate, one is based on consumption and the other is market based.

In the consumption based interpretation a consumer will make an investment if the future return is larger than the loss in benefit from forgoing consumption today. Following common assumptions about the consumer[8], this will be satisfied through the Ramsey rule (Harrison, 2010):

$$r = \rho + \mu g$$

Where r is the discount rate, ρ is the pure rate of social time preference, μ is the elasticity of marginal utility of consumption and g is the growth rate in consumption. Future utility is discounted through ρ, which reflects impatience. A high ρ represents a high degree of preference towards spending today rather than later. The elasticity of marginal utility of consumption, μ, is the percentage decrease in marginal utility when consumption is increased by one percent. The principles of the Ramsey rule are commonly agreed upon, but there are large differences in what is perceived as the “right” magnitude of the parameters. Harrison (2010) provides an overview where estimates of the discount rate range from 1.4 percent up to 8 percent using the Ramsey rule.

[8] Assuming a consumer with a constant relative risk averse utility function.

In the market based interpretation of the discount rate the expected rate of return on an asset consists of a risk free rate of return in the capital market and an additional risk premium that is specific to the investment (NOU 2012:16). This is described through the capital asset pricing model (CAPM) and is given by the following condition:

$$r_t = r_f + \beta(R - r_f)$$

Where r_t is the optimal rate of return, r_f is the risk free return, R is the expected return of the portfolio as a whole and β is the covariation between the return of the asset and the return of the total portfolio. The CAPM model was previously used to calculate the discount rate for CBAs in Norway, but has been critiqued for lacking relevance to public investments.

There are large uncertainties about future macroeconomic development and the size of yields from investments made today. The Norwegian guidelines for CBAs, NOU 2012:16, takes this into account by referring to a contribution by Weitzman (2012), which suggests that whenever there are projects where the systematic risk is smaller than the average market risk, the risk adjusted interest rate will decline over time. Weitzman (2012) bases his analysis around the CAPM, but changes the underlying assumptions. The static CAPM is built upon preferences that are defined by expected variance, while the Weitzman model is built upon assumptions of a constant relative risk averse utility function (NOU 2012:16). In the context of biodiversity, a constant relative risk averse utility function is consistent with the precautionary principle. There are large uncertainties about what effects biodiversity loss can have in the future, but we know there are possibilities of large economic and ecological losses. The underlying utility function makes it possible to interpret the result of the model as a dynamic generalization of the CAPM. In the model the optimal rate of return is defined by the beta weighted average of the return of a safe investment and the mean return of a representative risky investment. The optimal risk adjusted interest rate is given by:

$$r_t = -\frac{1}{t}\ln((1-\beta)e^{-r_f t} + \beta e^{-r_e t})$$

Where r_t is the optimal discount rate, t represents time, β is the correlation between the projects' contribution to net benefit and total consumption, r_f is the rate of return on a safe investment and r_e is the rate of return on a risky investment. By inserting values for the parameters r_f, r_e and β

the interest rate over time can be plotted, and we can see that it is declining over time. As displayed in Figure 3.4 the risk adjusted discount rate approaches the risk free discount rate over time. The parameter values are the same as the example used in Bye and Hagen (2013).

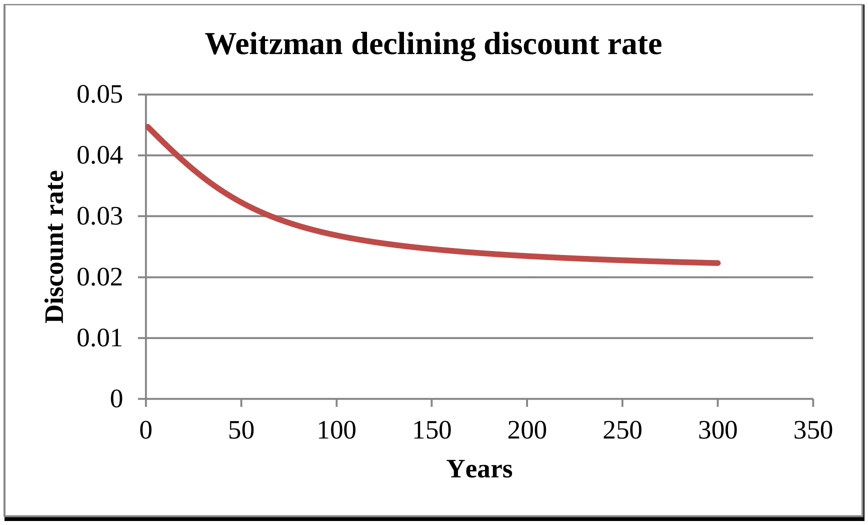

Figure 3.4. Declining discount rate over time using Weitzman's model. r_f = 2%, r_e= 7% and β= 0.5.

There are many uncertainties regarding the size of the parameters going into the Weitzman declining discount rate. I therefore chose to use the recommended stepwise declining discount rate from the Norwegian guidelines on CBAs for the calculations instead, using the assumptions in the Weitzman model as the reasoning for using a declining discount rate. For the first 40 years the discount rate is 4 %, from years 40-75 it declines to 3 % and from years 75-100 it declines to the assumed risk free rate of 2 %, which are corresponding to the guidelines (NOU 2012:16).

3.3.5 Time Horizon

When an area is conserved and stays conserved throughout time the benefits of biodiversity is reaped by several generations. The time horizon is set in order to reflect this aspect. In view of taking biodiversity conservation into account one should ideally have set the time horizon such that the costs and benefits go to infinity. At the same time the development in the economy becomes decreasingly predictable the further into the future we look. As a compromise between these two conditions a time horizon of 100 years was chosen for the main analysis. Sensitivity analysis on the time horizon will be performed, to see if it can have an altering effect on the results.

3.4 A Note on Estimations

The cost and benefit estimates are based on references and datasets from different years. All costs and benefits are therefore transformed to 2008 price level using the consumer price index, as 2008 is used as the base year of the analysis. It should be noted that using the consumer price index to transform prices across years could lead to some errors, as the price development of the different goods valued does not necessarily follow the CPI. On the other hand using the CPI to index all prices provides a consistency in the price transformation, which here is considered to be better than dealing with the uncertainties of forecasting price developments.

4 Local Cost-Benefit Analysis

The main cost-benefit analysis in this thesis is from the local perspective, as opposed to being at the national level. The local level analysis will take into account local costs that are incurred by the municipalities, mainly lost tax revenue and lost business opportunities in logging and cabin building. In the national CBA these costs is not taken into account, as it is assumed that actors in other municipalities will replace the reduced supply from the TRNR municipalities, and it will not be considered a loss.

The main purpose of the local CBA will be to test if the development trust fund compensates the municipalities for their costs. The fund had a total size of 30 million NOK, which was meant to compensate all three municipalities for their lost opportunities. Prior to the decision about the size of the fund, the municipalities had suggested that 100 million NOK was an appropriate sum, which was also supported by the opposition parties. The analysis will investigate which sum is closer to the estimated costs.

The municipal costs that are valued in the analysis are tax loss from foregone forestry, loss related to reduced cabin building activity and administration costs. The benefits are based on willingness to pay for conservation, where the benefits to the inhabitants of the municipality will be counted.

There are mainly four groups that have been affected by, and involved in, the conservation; forest owners, municipalities, environmental activists and the government. Even if a CBA seems to follow objective criteria there are many choices that can affect the results. In order for the reader to make up her/his mind on how to interpret the outcomes, the results will be divided into scenarios that are beneficial for different actors. In Table 4.1 below, the four groups are sorted after their preference for different outcomes of the scenario.

Table 4.1. Interests of different groups sorted after high and low scenarios for each part of the CBA, given that compensation of costs will be made.

	Low	**High**	**Indifferent**
Timber tax loss	Government, activists	Municipalities, forest owners	
Potential cabin building	Government	Municipalities, forest owners, activists	
WTP for conservation	Municipalities, forest owners	Government, activists	
Development trust fund	Government	Municipalities, forest owners	Activists
Administration cost	Government, municipalities		Activists, forest owners

The activists are assumed to value nature higher than the rest of the population, and will in every case prefer the alternative that gives the highest probability of conservation. The government is also assumed to be pro conservation, but unlike the activists they have to consider their budget constraint and will try to minimize their costs. The municipalities are assumed to be reluctant to conserve, as business opportunities and tax income will disappear. Forest owners are assumed to be even more reluctant than the municipalities, since they will have to give up their land with all its opportunities and the aspirations they had for its future use.

In Table 4.1 there are some surprising combinations, such as the cabin building scenario where proponents and opponents of conservation are on the same side. The municipalities and forest owners will try to get compensated for their loss and will hence claim that a high number of potential cabins could have been built, while the activists will agree to this with the reasoning that conservation is necessary to avoid damage to nature from the building. The government will agree with the activists on the potential damage, but since they will have to compensate for the loss they want to portray a low number of cabins.

It should be noted that the different actors have not acted according to how it is assumed in Table 4.1 throughout the whole conservation process. Some of them changed their strategies as the process progressed, when some options fell through and others came up. In cabin building for instance, the forest owners and municipalities first had an interest in saying that the number of potential new cabins were low, to project that they were capable of taking care of the nature values in the area in hope of avoiding conservation. Later, when the conservation was likely to happen, their incentives changed, as the number of cabins could indicate their loss in revenue and business opportunity.

4.1 The Municipal Tax Effect of Reduced Forestry

The establishment of Trillemarka-Rollagsfjell Nature Reserve made all forestry in the area prohibited. The forest owners received compensation for not being allowed to use the forest for logging, but the municipalities also have a loss in income from this through not being able to collect any tax revenue from forestry in the area. This section will explain how this loss was calculated and present estimates for the magnitude of the loss.

In Norway most forest owners are managing their forest as a sole proprietorship (Statistics Norway, 2013a), and according to Kjell Ove Hovde, the forest manager in Sigdal municipality (Hovde, 2013) most forest owners in the area ran their business in this way before the conservation process started. When an individual is running a sole proprietorship the taxable proportion of the income from the business is counted as a part of the individual's personal income. The municipalities' tax loss will therefore be based on the estimated income from forestry for the TRNR area. Three scenarios will be presented, where the main alternative is between a low and a high estimate to be able to capture the range in which the results could lie.

Obtaining the tax payment from forestry for each forest owner in the TRNR case has some difficulty attached to it. There are many individual effects on each person's tax payments, such as debt, number of children, primary income etc., making it difficult to estimate the true tax payments for them as a group. Another issue is that income from forestry for each individual owner comes in cycles, since parts of the forest that are planted at the same time also get cut at the same time in the future. Forest owners can smooth out their income from one year over five years to avoid disproportionally high taxation in high income years. To take these issues into account using statistics seems most accurate to capture the expected future tax loss for the municipalities. After consulting with representatives from local and national tax authorities, forest owners and Statistics Norway (SSB), the following two methods seems to be the estimation that is most accurate.

In the first method, which is the basis for the main scenario, statistics covering Norwegian forest owners' income from forestry sorted by property size (Statistics Norway, 2013c) has been used in combination with information on the property size of each forest owner to estimate the tax loss of the municipalities.[9] First the income data was transformed into the price level of one set base year using the consumer price index, and then the average income for the different intervals of areas was calculated. This number was then matched with data on forest owner compensation to find the average annual income for each property size. Finally the average municipal tax was calculated for each forest owner using an assumed tax percentage of 12 percent, which is based on the municipal tax percentage over the past five years[10].

The data on compensation of forest owners was obtained through Svein Ekanger, who is the forest expert representing the forest owners in TRNR. This data is not yet available to the public since the case is still open, and it is possible to recognize the forest owners based on the size and characteristics of the property. Due to the confidentiality of the data material I cannot list the size, compensations and estimated tax loss for all forest owners, but I will provide an example on how the tax estimation was made in Table 4.2 and Table 4.3.

[9] See Table 11.1 in Appendix C for details.

[10] The part of the tax percentage from income that go to the municipalities changes every year with the government budget, during the past five years from 2007-2012 it has been varying between 11.3 percent and 12.8 percent (Norwegian Government, 2007-2012).

Table 4.2. Calculation of tax loss for forest owner R-63, taking area of property into account.

Forest owner code	Productive forest area (in daa)	Estimated average income per year for this area size	Municipal tax rate	Estimated tax
R-63	574	32,982	0.12	3,958

To test the validity of this estimate, a tax estimation based on the actual compensation payments to the forest owners was conducted (with the same tax rate)[11]. The compensation payments are reflecting the value of the forest, which should be quite similar to the expected income found in the statistics for the estimate to be close to its true value. The net present value of the estimations turned out to be quite similar; the estimation based on statistics generated a tax loss of 9.2 million NOK, while the estimation based on compensation payments generated a tax loss of 9.6 million NOK.

It should be noted that the compensation payments from the forest expert were calculated with an infinite time horizon and a five percent discount rate, so the two numbers are not directly comparable (considering that the estimation based on statistics has a declining discount rate and a time horizon of 100 years). Since the time horizon is longer in the calculation based on the compensation payments, this would reflect a loss over a longer period of time, which naturally would be larger than a loss over a shorter period of time. However, since there is a relatively high discount rate on the calculations of compensation payments, payments made more than 100 years from now has a relatively small present value compared to the estimations with a declining discount rate. This makes the effect of the difference in time horizon smaller.

In the second method, which is used for the high scenario, statistics on forest owners' average income from forestry in Buskerud County (Statistics Norway, 2013b) is multiplied with the number of forest owners affected. The main difference from the first method is that the size of the property is not taken into account and that this data represents the county of Buskerud, and

[11] I also tried to compare the estimates to information on the annual tax income from forestry to municipalities, but this information was not possible to obtain during the time the thesis was written, see Appendix C for details.

not the whole country[12]. For the same forest owner used in the previous example the estimated tax loss with this method is higher, which is a trend for most of the other forest owners as well.

Table 4.3. Calculation of tax loss for forest owner R-63,not taking area of property into account.

Forest owner code	Estimated average income for forest owners in Buskerud owning areas larger than 25 daa	Municipal tax rate	Estimated tax
R-63	44545	0.12	5,345

This alternative seems to predict quite high estimates for potential loss when comparing them to the compensation payments to the forest owners.

4.1.1 Effect of Falling Timber Price

The price of timber is very volatile, fluctuating a lot from one year to the next. There has been a trend of decreasing real timber prices over a long period of time. To capture this trend the compound annual growth rate has been calculated based on available statistics on the average timber price. Using this method it was found that during the years from 1965-2011[13] the timber price (P) has had a negative growth rate of about two percent per year:

$$\left(\frac{P_{2011}}{P_{1965}}\right)^{\frac{1}{t}} - 1 = \left(\frac{364}{921}\right)^{\frac{1}{46}} - 1 = 0.02173$$

For the lowest estimate of the timber tax loss, the foregone tax income to the municipalities has a negative growth of two percent to reflect the forecast about timber prices. If this trend continues over the years this affects the forest owner’s forgone income and hence also the tax income of the municipalities from forestry. Assuming that one can use this previous trend to forecast the future timber price, the net present value of the forgone tax revenue of the municipalities will be reduced. This will be the assumption behind the lowest estimate of lost tax revenue.

[12] See Table 11.2 in Appendix C for the distribution in size of forest properties for TRNR, Buskerud County and Norway as a whole.
[13] See Table 11.3 in Appendix C for the data set this is based on.

One should be careful about forecasting into the future using the real growth rate from previous years, as there are other factors that could affect the timber price in the future. In the far future we could for instance see an increase in the timber price as a result of scarcity. The value of timber could also increase as a result of the value of carbon storage.

The foregone tax revenue for all the municipalities together in the main scenario is estimated to be 289,430 NOK per year. Over the course of 100 years this results in a net present value of 9.2 million NOK. In the lowest estimate, where the decline in timber price has been included, the NPV is 5.4 million NOK, while the highest estimate yields a NPV of 15.5 million NOK. The result is displayed in Figure 4.1 below.

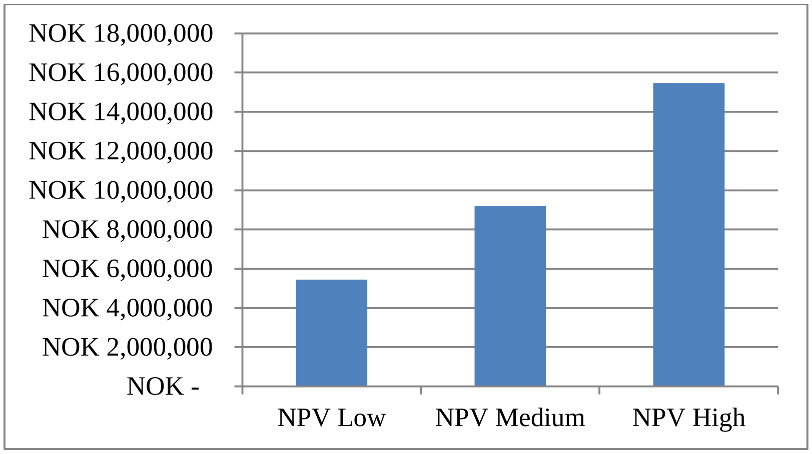

Figure 4.1. The net present value of low, medium and high scenarios for tax loss in forestry over a time horizon of 100 years.

The low scenario would be supported by the government since they are trying to minimize their costs. The environmental activists would also go for this scenario, as it is in their interest to claim that the market value of timber in the area is low. The municipalities and the forest owners on the other hand would support the high scenario, as this would maximize their compensation.

4.2 Loss from Foregone Cabin Building

Both forest owners and municipalities have pointed towards the opportunity of building cabins as an important use of land. The conservation prevents any further building activities in and in the peripheral zone around the reserve. All the municipalities have a high concentration of cabins; there are more than twice as many cabins as households in all three municipalities (Institute of Transport Economics, 2013 ,section "hyttetetthet og betydning"). This is a very important source of income and economic growth for the municipalities. The varied nature in and around TRNR makes it well suited for cabin sites. The closeness to larger cities and towns in the adjacent counties also makes it an attractive location (County Governor of Buskerud, 2005).

To find the effect of foregone cabin opportunities data from the Institute of Transport Economics[14] has been used. In a rapport on the impacts of tourism in Buskerud County Farstad and Dybedal (2011) presents findings that include the effects of private cabins on the local economy. These findings will be used in combination with estimates on the magnitude of cabin building. It is assumed that these cabins would have been built in addition to other cabins outside the reserve. For the municipalities Sigdal and Rollag this is a realistic assumption, since the reserve is taking up large areas within the municipal borders. For Nore og Uvdal on the other hand, it is more likely that other alternative locations for cabin building would be more important, as the part of the reserve that lies within Nore og Uvdal is quite small and the size of the rest of the municipality is relatively large.

4.2.1 Land Use Regulation

Before getting into the scenarios in potential cabin building a note on land use regulations is in order. Every municipality must have a municipal master plan[15], which consists of a community element and a land-use element (NOU 2009:16, p.24). This plan will, inter alia, give an overview of areas set off for building and future development. Based on the municipal master plan a zoning plan[16] is made, which in detail will describe land use in the area. When the area is approved for building in the zoning plan, a building permit must be obtained before any building

[14] In Norwegian: Transportøkonomisk Institutt
[15] In Norwegian: Kommuneplan
[16] In Norwegian: Reguleringsplan

can commence. This is relevant for the prediction on how many cabins potentially could have been built in the area that is now conserved. Appendix A provides a map displaying the zoning plans in the TRNR area before conservation.

4.2.2 Magnitude

An estimate of number of cabins that potentially could have been built in the area is necessary to find the effects of forgone income for the local community. Before the conservation was a fact a local newspaper reported that one of the municipalities were planning on building 1100 new cabins in and around the area that was considered for conservation (Moen, 2003). The numbers were taken from suggestions made in a municipal master plan. The newspaper article argued that one could not trust the forest owners and municipalities to protect the biodiversity in the area when there were extensive plans for cabin building.

Friends of the Earth Norway used the newspaper article to argue that conservation was a necessary step to take. They also made calculations suggesting that up to 2000 cabins were planned, when taking into account suggestions in municipal master plans from all three municipalities (Friends of the Earth Norway, 2003, 2006)[17]. Politicians in the municipalities contended that these plans were from before the conservation process started, and that they had discarded them at the time when the article was published, claiming that Friends of the Earth Norway were presenting false information (Ekholdt, 2006). This was refuted by the conservation proponents, saying that the plans were only temporarily put on hold while conservation was considered (Friends of the Earth Norway, 2006).

It should be noted that the numbers quoted above are referring to the environmental activists' proposal of an area of 200 km^2, which was larger than the one that ended up being conserved (148 km^2). The whole area of TRNR is now 148 km^2, but the conservation that took place in 2008 was as mentioned above an expansion of an already existing area of 43 km^2, making the addition to the conservation 105 km^2.

[17] Articles and email correspondence with Harald Baardset, the leader of Friends of the Earth Sigdal and Modum.

Even if the numbers from the newspaper were suggested in municipality master plans and they were referring to a larger area than what ended up being conserved, it is unlikely that such a large number of cabins would pass zoning plans and be allowed to be built in an area considered for conservation. A more conservative estimate can be provided by statistics on the average number of cabins per km^2 in each municipality, as displayed in Table 4.4 below.

Table 4.4.Average number of cabins per km2 in Buskerud County and the municipalities of Sigdal, Rollag and Nore og Uvdal(in 2008), and the projected total number of cabins in the area covered by TRNR (Institute of Transport Economics, 2013).

	Buskerud	**Sigdal**	**Rollag**	**Nore og Uvdal**
Cabins per km^2	3.05	4.93	3.99	1.63
Multiplied with area of TRNR (105 km^2)	320	518	419	171

The main alternative is based on the data above, and is assumed to be an average number of cabins per km^2 of all three municipalities combined, which corresponds to 369 cabins for the area under investigation. This assumes that the conserved area is as appropriate for cabin building as the average area in each of the municipalities. Similar to the calculation of forestry tax loss, two alternatives (low and high estimate of the main alternative) will also be presented to allow for different views.

At the time when the conservation plan process first started there were zoning plans for the building of 108 cabins within the area considered for conservation. But the regulation had not been fully approved at the time when the conservation process started, so these plans were halted (County Governor of Buskerud, 2005). It will be assumed that these plans would have been implemented if the area had not been conserved, as the planning process had already started and had been implemented in the zoning plan. This will be set as the smallest alternative within the estimation of lost revenue from cabin building. The largest alternative is set to be 500 cabins, representing the earlier mentioned number from the newspaper article, taking into account the size of the area that was actually conserved.

It is assumed that the municipalities will have an income loss as a result of reduced property tax, municipal fees and tax on local labor being used for cabin building. Farstad and Dybedal (2011) reports that, on average, there is a local labor cost of 306,629 NOK per cabin being built in Buskerud County. For the municipal fees and property tax the numbers are taken from Rollag municipality, which has a property tax of 0.25 percent of the value of the property and municipal fees of 875 per year (correspondence with Olaug Tveiten from Rollag municipality). The estimated loss from this is calculated and displayed in Table 4.5.

In the calculation of foregone revenue from property tax and municipal fees the hypothetical building of new cabins is spread out over time to reflect that not all cabins are likely to be built at the same time. It is assumed that the first 108 cabins would have been built quickly, as they were already approved in the zoning plan. To avoid overestimating the gains from cabin building and to simulate a real life building situation, it is assumed that the amount of cabins in the medium and high scenario is increasing over time. This adjustment is also made to take into account that Sigdal municipality does not have a property tax, trying not to overvalue the effect of cabin building. In the medium alternative it is assumed that about 50 extra cabins are built every 10 years until year 50 where 261 additional cabins have been built. In the high alternative the same procedure is used, but here the building stops in year 80, when 392 additional cabins have been built compared to the initial level.

Table 4.5. Estimated income loss to municipalities for different scenarios of potential cabin building in TRNR.

	Low	**Medium**	**High**
Assumed amount of cabins	108	369	500
NPV of tax loss from local labor (one-time loss)	3,973,912	13,577,532	18,397,749
NPV of tax loss from property tax and municipal fees	13,036,037	27,570,311	30,064,874

4.2.3 Increased Value from Conservation?

If locating a cabin in the vicinity of a nature reserve is significantly increasing the price of the cabin, there could be a potential for both the land owners and the municipalities to earn their lost revenue as a result of the conservation. This economic value could have been estimated using the

Hedonic Price method or expert assessments by real estate brokers. There has been a political focus on using preserved areas in order to promote tourism in rural areas (Heiberg, Christensen, Haaland, & Aas, 2006). This is an argument that has been used in favor of conservation.

Heiberg et al. (2006) has examined the price effect on cabin prices from being close to areas with nature conservation, and found that it was difficult to prove a significant effect on the price. A sample of real estate brokers were asked to consider several factors determining the price of cabins. Some believed that advertising closeness to a conserved area would make a cabin's location more attractive, but that it is difficult to distinguish this effect from the other characteristics of the location of the cabin.

The main result from Heiberg et al. (2006) was that one could not see any effect on cabin prices from being in the vicinity of a conservation area. Despite these results the report points out that the demand for a more quiet and secluded cabin experience might get increasingly more attractive in the future. At present most new cabins are built in large cabin sites rather than in more private locations. The potential scarcity of more secluded cabins might lead to a significant positive price effect of the large untouched areas that a nature reserve or a nature park can provide.

An article in the newspaper Laagendalsposten (Nordahl, 2010) reports that forest owners that previously were opposed to the conservation are now using Trillemarka-Rollagsfjell Nature Reserve as an attraction in promoting cabins in a secluded environment. They believe that the existence of the nature reserve has a positive effect on sales. This could be a sign of the predictions from Heiberg et al. (2006) coming true, but there is not enough evidence to claim this.

4.2.4 A Note on Law

Even if the forest owners and municipalities could forecast their loss of not being able to build cabins in the conserved area, like this analysis has done, they would not be entitled to any compensation according to The Law of Nature Conservation and The Nature Diversity Act[18]. In § 50 of the Nature Diversity Act (Naturmangfoldloven, 2009) it is stated that in cases where

[18] The Law of Nature Conservation was the current jurisdiction at the time of the conservation of TRNR. It was replaced by the Nature Diversity Act as of June 19th 2009.

permission from an authority is required for land use, the right to receive compensation only apply when the permit is given before the announcement of the conservation. This means that one cannot claim compensation based on the possibility of building something in the future. In The Law of Nature Conservation, which was the current law during the conservation of TRNR, this was less strictly formulated, but any compensation for this was rare.

4.3 Administrative Costs

The administration of the nature reserve is delegated to the municipalities, which have established a post within Nore og Uvdal municipality for management of the reserve. During the past years they have incurred the following costs:

Table 4.6. Administrative costs from management of the TRNR from the year of establishment until the present (Jaren, 2013).

	Administrator position	**Environmental Measures**	**Management plan**
2009	657,084	43,937	30,862
2010	1,279,799	248,852	561,648
2011	858,874	220,022	317,633
2012	891,036	6,428	138,860
Sum	3,686,793	519,239	1,049,003

The administration costs so far have been covered by grants from the government and there has been no extra cost to the municipalities for this. The grants have been 2,000,000 for management planning (one-time grant), 1,000,000 (5 year grant) to cover environmental measures and 1,000,000 per year for administrative positions. The left over grants are put into a fund for later use (Jaren, 2013). The future funding for administration is yet to be determined; the municipalities are in dialogue with the Ministry of the Environment to get a long term contract. According to the reserve administrator, Hege Jaren, the municipalities are expecting the annual funding to continue as it has up until now. In the analysis, the assumed administration costs are therefore estimated to be 1,000,000 NOK (in 2008 NOK) per year as of 2013.

4.4 Recreation

Recreational activities such as fishing, hunting and picking of berry/mushroom picking is still allowed within the nature reserve, so there is no loss in this respect. But restrictions in transportation and accommodation might lead to a reduction in these activities. Another effect that may contribute to less recreation is the fact that old growth forests with dead wood are hard to maneuver around, making it less attractive recreationally. At the same time the feeling of wilderness and knowing that nature is well taken care of has the opposite effect. This is supported by Gundersen and Aasetre (2008 p. 22), which found that people prefer forests with high trees and varied vegetation. A positive effect may come from the reserve's relative closeness to the capital of Oslo and the surrounding areas, which are densely populated by Norwegian standards.

4.5 Willingness to Pay for Conserving Forest Biodiversity

Many of the benefits from nature conservation are yet to be measured in monetary terms. An ongoing project is evaluating valuation of ecosystem services in Norway (Ministry of the Environment, 2013), but so far there are no results available to be used in CBAs. Since there is no market for biodiversity we cannot observe the prices. An environmental valuation study is in this respect useful in trying to capture the willingness to pay for biodiversity conservation; see Stenger, Navrud, and Harou (2009) for a review of non-timber benefits from forests and valuation methods to assess their economic value.

The optimal solution would be to make a survey to ask respondents their willingness to pay (WTP) for conserving the area Trillemarka-Rollagsfjell, but the timeframe of this thesis did not allow for this. It is therefore necessary to perform *benefit transfer* of values from an existing survey.

There are two ways of performing a benefit transfer, one can either do a *unit transfer* or a *function transfer* (Navrud, 2010; Riera et al., 2012). Unit transfers are split into *simple unit transfers* and *unit transfer with income adjustments*. A simple unit transfer is simply transferring the mean value of estimated benefit from one study to another, without making any alterations to the value. This is appropriate when the standards of living and income levels are similar in the study site and the policy site. One will here assume that the wellbeing of the average person being surveyed is representative of the wellbeing of those in the policy site.

If there are large differences between the study site and the policy site one can use a unit transfer with income adjustments, by adjusting the value with Purchasing Power Parities (PPP). When doing this one should be aware that PPP adjustment does not account for all differences that may affect the estimates, there might for instance be cultural and institutional differences that is not captured by the transformation (Navrud, 2010).

In a *function transfer* the value function from a study site is transferred to the policy site, keeping the dependent variable (in this case WTP for the good in question) the same as in the study site while the explanatory variables are replaced by those on the policy site. This requires data on the explanatory variables on the policy site, combined with a value function that has a sufficient degree of explanatory power. One could also use a meta-analysis for this purpose, where results from several surveys are combined into one function.

A function transfer takes more information into account in the transfer, and could in this way be preferred over a unit transfer. However, it is not yet established that a function transfer significantly reduces the errors appearing in unit transfers (Navrud, 2010).

Navrud (2010) proposes an eight step guideline when using a benefit transfer; this will be followed in the proceeding.

1. Identify the change in the environmental good to be valued at policy site.

The main change in environmental goods is that the biodiversity in the forest area of TRNR is preserved. The direct use value of recreation is assumed to remain the same, while logging and cabin building is prohibited. The indirect values and non-use values of biodiversity protection is assumed to increase. Other ecosystem services such as carbon sequestration and soil stabilization will also be preserved through the conservation, but these effects will not be valued monetarily in this analysis as biodiversity is the main focus.

2. Identify the affected population at the policy site.

The affected population can be split into two groups. The directly affected are forest owners and municipalities, as they face restrictions on their land areas and income. Since values of national importance are conserved, the whole population of Norway is indirectly affected. One might argue that inhabitants in and around the county of Buskerud could have a larger utility increase from the conservation than the rest of the population, but since the recreational values are assumed to be constant this will not be taken into account.

3. Conduct a literature review to identify relevant primary studies (preferably based on a database; but supplemented by journal and general web search) and *4. Assess the relevance/similarity and quality of study site values for transfer.*

After searching for relevant primary studies, one previous study clearly stood out among others as the most fitting. The chosen study was a survey on use and conservation of forests in Norway, conducted by Ståle Navrud and Henrik Lindhjem in 2007 (The data has previously been analyzed in Lindhjem and Navrud (2011) and Lindhjem and Navrud (2009)). Other possible options for benefit includes values in a meta-analysis by Lindhjem (2007), which reviews and analyses variation in WTP from valuation studies in Norway, Sweden and Finland from 1987-2002, and taking values from individual surveys included in the meta-analysis.

The chosen study site was preferred for its many similarities to the policy site; it was conducted just one year previous to the conservation of TRNR; it focuses on forests in southeastern Norway; it surveys a representative part of the Norwegian population and it asks the WTP for conserving forests in Norway. The subsamples used in the survey had a response rate of 69 % and 72 % (Lindhjem & Navrud, 2009), which is well beyond the guidelines' minimum response rate of 50 %. Contingent valuation (CV) was used to elicit the WTP for biodiversity protection, with reference to the best practice guidelines in the field. On the background of these characteristics I choose to do a simple unit transfer of the values from the survey to my case.

The largest drawback when it comes to using this survey for benefit transfer is the difference in scale of the area that is considered. The survey considers areas that are substantially larger than TRNR, which means that a constant value per daa has to be assumed when scaling down the WTP. This is commented under part six, when the values are transferred.

5. Select and summarize the data available from the study site(s).

The survey originally had ten subsamples, where alterations to certain questions were made. I removed two of the subsamples which only had respondents from Oslo in order to only have samples from one population.

A payment card was used to elicit the respondents' willingness to pay for an increase in conservation of productive forest. In all samples the respondents considered the possibility of an increase in protected areas from 1.4 percent to 2.8 percent. The respondents were informed that this increase was equivalent to an additional 1.05 million daa of protected forest. The payment card contained 24 alternative payments ranged in intervals that were relatively close together. The respondents' willingness to pay would lie within these intervals, but one cannot say exactly where the data point lies. This means that there is interval censoring in the sample. I recoded the responds using the midpoint between each interval to capture the willingness to pay. Due to the closeness of the intervals and the large size of the sample I assume that the potential error in this method is quite small.

In contingent valuation studies there is always a risk of getting protest answers from respondents. This is displayed through the respondents not being willing to state their real willingness to pay for the good. Some people might believe that putting a monetary value on nature is inherently wrong; others might have a dislike towards paying taxes. They will show this protest by ticking off the zero willingness to pay box or stating that they do not know their willingness to pay. This will not reveal their true preferences and will create a bias in the result of the analysis. It is therefore important to distinguish the protest answerers from the respondents that actually have a zero willingness to pay.

A question following the payment card in the survey was designed to pick up on these protests, where the respondents that gave a "zero" or "do not know" response was asked to tick the most important reason for their answer. I sorted out the respondents that were characterized as protesters and removed them from the sample. After doing this the average willingness to pay increased significantly. The reason for this is that the protest zeros that are removed are then assumed to have the same WTP as the average respondent of the remaining sample; as opposed to counting them as zeros. There is some controversy surrounding the removal of protest responders, as it is not given that an answer is a protest even if it is characterized as one. For this reason I will test if censoring the protest answers will have an altering effect on the result of the CBA in the sensitivity analysis.

Skewness and kurtosis tests for normality showed that the data for willingness to pay was significantly non-normal in both skewness (p-value: 0.00) and kurtosis (p-value: 0.00). This manifests itself in a large difference between the mean and the median willingness to pay. After the protest answers are removed the mean WTP is 1176 NOK while the median WTP is only 600 NOK. The median might here better represent WTP in a democratic view, as this is what the majority is willing to pay. Regardless of this, the mean value is the theoretically correct measure to use in a CBA.

6) Transfer value estimate from study site(s) to policy site.

After the alterations I found the mean annual willingness to pay for Norwegians to increase the level of conservation of forests from 1.4 percent to 2.8 percent, which as mentioned above corresponds to an increase of 1.05 million daa. To be able to apply these numbers in my analysis I calculated the average annual WTP per household per daa and then multiplied this with the area of the expanded TRNR (105 km^2). This simplification could lead to some bias in the willingness to pay. In stated preference surveys on use and non-use values of ecosystems there is no evidence supporting that WTP increases proportionally with the size of the area (Riera et al., 2012) and (Lindhjem, 2007). One should therefore be cautious when transferring WTP between areas of different sizes. The average estimated WTP per household per year for the conservation of TRNR is 118 NOK in the medium alternative, which does not seem like a gross overestimation. I choose therefore to go through with these numbers in the analysis.

7) Calculate total benefits or costs.

Using the mean willingness to pay of 118 NOK per household per year yields the net present values in Table 4.7.

Table 4.7. Net present value of households' willingness to pay for conservation of Trillemarka-Rollagsfjell Nature Reserve (time horizon 100 years, declining discount rate).

	Nation	**Municipalities**	**Forest owners**
NPV of WTP for TRNR	7,870,536,193	11,933,719	430,078

For all households in the nation this estimates a WTP of 7.8 billion NOK for the conservation of TRNR, this will be used as the benefit in the national CBA. In the local CBA the WTP based on the number of households in the three municipalities will be used, resulting in a benefit of 11.9 million NOK. It is assumed that the WTP of the inhabitants of the municipalities does not deviate significantly from the national average.

Increased relative income and increased scarcity of environmental goods such as biodiversity might lead to an increased valuation of these goods in the future. This could have been incorporated in the analysis by increasing the WTP with income growth. However, the guidelines for Norwegian CBAs, NOU (2012:16), recommends not doing this adjustment since the empirical background is not strong enough.

8) Assess uncertainty and transfer error.

When transferring values from a study site to a policy site there is as mentioned likely that some transfer error will occur. It is uncertain whether or not the benefit transfer yields valid estimations of the benefit of the project. To take this into account it is here assumed that the value would lie within $\pm$ 20 percent of the estimate of average WTP per household per year of the original WTP in the survey. The average WTP in the survey was found to be 1176 NOK, yielding a range between 941 NOK (- 20%) and 1411 NOK (+ 20%). These numbers are transferred to fit the size of TRNR and represent the foundation for the high and low estimates referred to in the results.

5 Results of Local Cost-Benefit Analysis

Based on the benefits and costs evaluated in the last section the result of the local CBA is presented in Table 5.1 below.[19]

Table 5.1. NPV of costs and benefits in the low, medium and high scenario at the municipal level. In 2008 prices, with time horizon of 100 years and declining interest rate over time.

	Low	**Medium**	High
Costs			
Forestry tax loss	5,440,291	**9,204,182**	15,469,056
Tax loss from labor	3,973,912	**13,577,532**	18,397,740
Loss in real estate tax and municipal fees	13,036,037	**27,570,311**	30,064,874
Administration costs	31,934,866	**31,934,866**	31,934,866
Sum costs	54,385,106	**82,286,891**	95,866,536
Benefits			
Administration grants	37,175,965	**37,175,965**	37,175,965
WTP inhabitants	9,549,005	**11,933,719**	14,318,433
Sum benefits	46,724,970	**49,109,684**	51,494,398
Net Cost (NPV)	7,660,136	**33,177,207**	44,372,138

For the medium scenario, which is considered the most likely, the municipal cost to conservation is estimated to be 33 million NOK when benefits are subtracted from costs. The development trust fund of 30 million NOK is here covering most of the costs to the municipalities.

Going back to the utility function of the municipalities, the willingness to accept (WTA) conservation in the medium scenario would be equal to 33 million for the municipalities to be at the same utility level as before.

$$U_0(Y_0 + 33{,}000{,}000, F_1, E_0) = U_0\ (Y_0, F_0, E_0)$$

The costs at the municipal level are not fully covered by the development trust fund, as 3 million of the costs are not compensated for. This result changes when sensitivity analysis is performed, by changing the interest rate and time horizon. Taking the medium scenario as a basis, a decrease in the time horizon from 100 years to 50 years decreases the net costs of the municipality to 22 million NOK (see Table 11.5 in Appendix E for the complete result of sensitivity analysis with respect to time). An increase in the discount rate from the declining discount rate (4% to 2% over

[19] For detailed NPV calculations and sensitivity analysis, se Appendix E.

time) to a 4 % discount rate over the whole time period leads to a net cost of 24 million NOK (see Table 11.4 in Appendix E for the complete result of sensitivity analysis with respect to interest rate). Since the result is not robust against these alterations in assumptions, the hypothesis of the development fund covering the municipal costs cannot be rejected.

In the calculation of WTP for conservation protest answers were taken out of the sample, which as mentioned led to an increase in WTP. Replacing the corrected WTP with the uncorrected WTP in the medium scenario leads the net costs to the municipalities to increase from 33 million NOK to 37 million NOK. This could point towards a rejection of the main hypothesis. However, this is refuted when performing a sensitivity analysis equivalent to the one above. An increase in interest rate to 4 percent yields a net cost of 27 million NOK, while a decrease in time horizon to 50 years yields a net cost of 25 million NOK. Based on this, the conclusion that the hypothesis cannot be rejected remains.

The DTF compensates the municipalities on the aggregate level in a long term perspective, but it delays the municipalities' income. Only the returns of the fund can be used, so this creates a period of time in which income is reduced. This is to the disutility of the municipality now, but will be made up for by increased income in the future. Another issue is that the funds in the DTF are restricted to use within local business development, as opposed to tax income that has no strings attached. In the long term, however, this business development is assumed to lead to tax income which the municipality can freely decide how to spend.

Looking at the high and low scenarios from estimations (e.g. not the sensitivity analysis) yields different results. Combining the *lowest* costs and the *highest* benefits yields a net cost of only 3 million NOK to the municipalities. In this scenario the development trust fund would more than compensate the municipalities and they would profit well on the fund. This is the scenario that is most favorable to the government, with low costs on their part given that they only have to compensate with 3 million NOK. This also represents the scenario that environmental activists would stand behind, since the benefits from conservation are very high.

The *highest* costs and the *lowest* benefits yields a municipal cost of 53 million NOK from the conservation. In this case the development fund should have been substantially higher in order to cover the costs. This scenario would be preferred by municipalities and forest owners, given that the forest owners live in the municipalities that receive the fund. Even if this is the highest estimate in this analysis it does not come close to the proposed fund size of 100 million, which was suggested by local politicians and members of the opposition parties before the conservation.

6 National Cost-Benefit Analysis

In the main scenario of the local CBA it was established that a development trust fund would compensate the municipalities for most of their costs. Using this compensation is a part of achieving a Pareto improvement, as the lost utility of the cost inflicted is regained. The national CBA will explore if the benefits are large enough to justify this Pareto improvement. Even if the benefits of the policy are high enough to be able to compensate through the fund, the transfer does not necessarily have to be completed, as only the ability to pay is enough to conclude that the policy is beneficial.

The national CBA takes into account different aspects than the local CBA. In the national CBA it will be assumed that other municipalities would take over the reduced supply of timber and cabins from the affected municipalities, so that the aggregated effect of the conservation with respect to this would be negligible.

This analysis will assume that the nature values in TRNR are unique and that the conservation of this particular area was necessary. This assumption could be disputed by arguing that other areas in Norway could preserve most of the values in TRNR, and that for instance the size could have been reduced without loss in nature value. Although this is a relevant consideration, it is beyond the scope of this thesis to get into these issues.

6.1 Benefits

The benefits of establishing TRNR are based on the same calculations as in the local analysis. It is assumed that since the reserve contains nature values of national importance, the protection of these values are affecting the whole population of Norway. As in the local analysis the use values, such as fishing, hunting and berry picking, are not assumed to change significantly as a result of the conservation. This leaves non-use values and indirect values, which are valued in the contingent valuation study that is used for benefit transfer. For the nation as a whole the estimated benefit of TRNR, over 100 years with a declining discount rate, is 7.8 billion NOK as shown in Table 4.7.

6.2 Compensation for Reduced Income from Forestry

The forest owners in the area were compensated by the government for their loss of economic value as a result of the conservation on their properties. The value of timber was the most substantial part of the compensation, where site quality and tree species were taken into account. Forest owners were also compensated to some degree for increased difficulties regarding transportation, access to property and operating costs (Ekanger, 2013). The municipalities also owned some forest areas, which were compensated for in the same way as the forest owners. All the compensations were based upon direct economic loss; areas that did not have a market value were not compensated for.

Many of the forest owners were frustrated with the process, feeling that they did not have any say in what was happening on their property. Some felt that they were being “punished” for taking care of the forest so well that many of the nature values were still intact. These feelings were also a loss related to the conservation, but they were not been compensated for in any way (Ekanger, 2013).

The process of agreeing upon compensation for the forest owners has been long and dreary; the conservation was a fact in 2008, while most compensation agreements were in place as late as at the end of 2012. In addition to a high conflict level, the large costs involved in the conservation delayed payments as a result of insufficient funding through the government budget. There are still a few forest owners that have not agreed to the compensations they were offered, and it is uncertain when they will reach an agreement. By the time this thesis was written the total compensation paid to the 101 forest owners that have accepted the agreement were approximately 82 million NOK. In addition to this compensation was also paid for forest areas owned by Rollag and Sigdal municipality, which amounted to approximately 20 million NOK.

This leads to a combined compensation cost of 93 million NOK. It will be assumed that the valuation and compensation is correct according to the actual timber values.

6.3 Processing cost

In addition to compensation costs the government also incurs processing costs when an area is conserved. This includes costs related to recording of species and nature values, forest experts, lawyers and administrative procedures in environmental management (Skjeggedal, Gundersen, Harvold, & Vistad, 2010 p. 120). TRNR was conserved through a command and control approach, where there was not a voluntary agreement with the local community on the regulation. In this type of conservation the processing costs are usually larger than when an area is conserved through voluntary agreements. Skjeggedal et. al (2010) found the processing cost averaging at 35 percent for command and control regulation, as opposed to 20 percent through voluntary conservation. For simplicity the average 35 percent processing cost will be used in the analysis. In addition to the compensation and processing cost there are also administrative cost; see the local CBA for a description of these costs.

6.4 Marginal Cost of Public Funds

When the government is compensating forest owners and municipalities for their loss as a result of their provision of a public good this is assumed to be financed through taxes. Hence, it is assumed that additional tax revenues would have to be raised to achieve this financing. There are transaction costs associated with this tax collection, both through loss of efficiency and through administrative costs. The marginal cost of 1 NOK of public spending is calculated to be 20 percent at average (NOU 2012:16, p. 20).

7 Results of National Cost-Benefit Analysis

Based on the benefits and costs evaluated in the last section the result of the national CBA is presented in Table 7.1 below:

Table 7.1. Net present values of benefits and costs in national CBA. In 2008 prices, with time horizon of 100 years and declining interest rate over time.

Benefits	
Willingness to pay	**7,870,536,193**
Costs	
Compensation to forest owners	94,920,761
Development trust fund	30,000,000
Processing costs	43,722,266
Administration of reserve	37,175,965
Marginal cost of tax collection	41,163,798
Sum costs	**246,982,791**
Net benefit (in NPV)	**7,623,553,402**

The benefits from establishing TRNR at the national level clearly outweighs the costs, with a net present benefit of 7,6 billion NOK. Some might argue that the WTP derived from the survey is larger than the actual WTP among the population. This is a common critique of results from contingent valuation studies. The WTP can in this case be lowered drastically and still cover the costs of establishing the reserve. The costs are covered even when the willingness to pay is only 4 NOK per household per year, which yields a benefit of 267,705,313 NOK. As mentioned above TRNR contains natural areas of national importance, which is the reason why the whole population is counted in the analysis. This could be questioned by reasoning that the benefits occurring do not reach beyond the local level. In response to this, I find that even by only considering the benefit from WTP for conservation in the county of Buskerud, the benefits will still outweigh the costs, yielding a net benefit of 416,610,571 NOK.

Sensitivity analysis with respect to interest rate and time horizon did not change the sign of the NPV in the national CBA. Since most of the costs have already incurred changing the time horizon or interest rate on them has no effect on the result. Changing the time horizon to 50 and then to 25 years reduced the NPV of the benefits to 5.8 billion NOK and 4.1 billion NOK respectively, while increasing the interest rate to 4 percent reduced the NPV of the benefits to 6 billion. None of these changes resulted in a change in the result of the national CBA. This is as expected considering the magnitude of the NPV of the benefits compared to the costs.

8 Instruments

Through the local CBA it has been established that municipalities are incurring some costs as a result of conservation in forests, and the national CBA has shown that the benefits from conservation are large enough to cover compensation of these costs. On the premise of this the following section will go through alternative instruments that are used in conservation, keeping in mind the guidelines from the theory section (Boadway & Shah, 2009). The development trust fund will be compared to changing the municipal distribution key and using Ecological Fiscal Transfers (EFT). Voluntary conservation for forest owners and regulation will also be evaluated, to take into account that compensation of municipalities does not necessarily have to take place.

Benefits and costs in the CBAs should be seen in light of the budget for forest conservation in Norway. In 2013 the government budget for forest conservation was 231 million NOK, which was the largest appropriation to this budget entry of all time. In comparison the annual benefit from the conservation of TRNR is estimated to be 266 million in 2013 NOK[20] in the national CBA. This exceeds the entire budget for the total funds for all forest conservation projects in the country for one whole year. Hence, the estimated benefits are not even close to being consistent with the amount of funds set off to this purpose by the government. Using the net benefit from conservation based on WTP-data would justify instruments that are unlikely to receive sufficient funding in real life. If the politicians were basing their budget on the result of this type of data, the spending on biodiversity protection should have been substantially higher than it currently is. The government has recently signaled that forest conservation is a priority both in terms of biodiversity protection and carbon sequestration, which may lead to increased future funding (Ministry of the Environment, 2012). It remains to be seen if results from valuation studies will contribute to increase future budgets. But for now, keeping the current budget in mind will ensure that the discussion stays within reasonable limits.

[20] This is the annual benefit from WTP in 2008 NOK adjusted to January 2013 prices with the consumer price index.

8.1 Development Trust Fund

The purpose of the development fund in TRNR was, as previously stated, to compensate the municipalities for their lost business opportunities as a result of the conservation. A total of 30 million NOK were given to the municipalities over a period of five years. According to the Ministry of the Environment there was no official record of the reasoning behind the size of the development trust fund (conversation with senior advisor Asbjørn Solås, 22 February 2013). It was decided through a political process that is not open to the public.

The development trust fund is set up to benefit the local community for many generations ahead, as only the returns of the investments made with the fund is used. A fund size of 30 million NOK does not yield much to spend during the first years, which has led to some impatience in the local community. It also requires the municipalities to administer the fund in a profitable way, making investments that give reasonably good returns.

As the use of the development trust fund has a long term perspective, there are few projects that have been supported by it to date. The project VER-DI is partly funded by the development fund, and has made some contributions to tourism in the area. The project has made a smartphone application for the Trillemarka area to make visits easier and more interesting; and has also developed a bicycle route around the reserve. This type of work could help increase nature based tourism around nature reserves, which would yield growth for private business within the municipalities.

For future use there are several conditions that should be fulfilled in order for a development trust fund to work as an incentive for municipalities to welcome conservation within their borders. In line with the guidelines for good policy instruments, there must be a prospect of receiving compensation from the beginning of the conservation process for it to give any incentives for conservation. Some have argued that in the TRNR case the DTF was given at the end of the conservation process as a consolation for not choosing the alternative that the local community wanted. The size of the fund should be grounded in an expectation of future loss from conservation in order to justify the spending, as opposed to a closed political decision. The municipalities should also be able to show results from the outgoing funds, to ensure efficiency of spending.

As mentioned in the discussion on results of the local CBA, there are some issues regarding the DTF's restrictions on spending. For the DTF to be a full compensation for the fiscal loss of tax income, the funds should have been without restrictions. The purpose of the fund takes the municipalities' wish for business development into account, but for the municipalities' autonomy to be fully preserved they should be able to decide whether or not they wanted to spend the funds on business development.

Taking the government budget for forest conservation into account, the size of the development fund in the TRNR case is of a realistic magnitude. This speaks in favor of using a development fund in the future, as it is something that is likely to fit in the budget.

8.2 Municipal Distribution Key[21]

One of the alternative proposed instruments to deal with environmental costs for municipalities is to include it in the cost equalizing transfer[22] from the government to the municipalities (Barton et al., 2012). The cost equalizing part of a governmental transfer in Norway is supposed to compensate municipalities for having to provide services with costs they do not have the power to influence. For example, a municipality whose population has a large proportion of people over the age of 70 would get extra funds to be able to provide the services that these citizens are entitled to. In this way the extra costs of having many elderly is equalized by the cost equalizing transfer.

This transfer has to be based on objective criteria, which means that it is only supposed to compensate for costs that the municipality cannot change. In the context of biodiversity protection, this instrument could hence not be used to give incentives to conserve more on its own initiative. In the specific case of TRNR the conservation was imposed by the State, so that the municipalities did not have the power to change the costs, and in this way the cost equalizer could have been used to compensate them.

In an effort to include environmental costs in the municipal distribution key Håkonsen and Lunder (2009) made some tentative calculations of a new distribution within cost equalizing. The

[21] In Norwegian: Kommunenøkkel
[22] In Norwegian: Utgiftsutjevningen

criteria that proved to significantly explain the variation in environmental costs in their analysis was a base criteria, conserved area per capita, total area per capita, population size and sparsely populated areas. They calculated the effect of using this new cost equalizer and found what changes it would yield between the municipalities. Table 8.1[23] below shows the potential annual change in transfers to the municipalities Sigdal, Rollag and Nore og Uvdal.

Table 8.1. Grants to municipalities Sigdal, Rollag and Nore og Uvdal if the costs equalization distribution was changed with respect to environmental costs, according to estimations in Håkonsen and Lunder (2009).

	Sigdal	**Rollag**	**Nore og Uvdal**
In total	287,671 NOK	3,701 NOK	711,160 NOK
Per capita	82 NOK	3 NOK	274 NOK

For all three municipalities combined the annual increase in transfers sum up to 1,002,532 NOK, which with a declining discount rate and a time horizon of 100 years, leads to a net present value of 31.8 million NOK. This would almost cover the previously calculated net costs of conservation to the municipalities in the TRNR case (33 million NOK). However, this sum is also supposed to equalize the costs of all other environmental obligations the municipalities may have. As the nature reserve is not the only environmental cost for these municipalities, this is not likely to give as adequate compensation as the DTF.

Also, it should be noted that Nore og Uvdal benefits substantially more than the two other municipalities from the change in the cost equalizer, while only a small part of TRNR, and hence also the cost, lies within Nore og Uvdal.

The change in cost equalizing transfers is supposed to be self-financing, so the municipalities that do not fill the criteria to receive extra grants for environmental tasks are paying for the municipalities that do. This means that there is a shift in distribution from one set of municipalities to the other. With the proposed distribution the municipalities that are entitled to the highest grants to cover their environmental cost happen to coincide with the municipalities that already have a relatively high income per capita (Håkonsen & Lunder, 2009). This should be

[23] The data in this table was obtained through one of the authors of the report, Trond Erik Lunder, as these particular municipalities were not discussed in the report.

dealt with through the income equalization transfers between the municipalities, so this “unfair” distribution outcome should not have an effect on policy making. However, as the authors note, it can be less politically viable to propose a change in transfers that for the most supports the most affluent municipalities.

8.3 Ecological Fiscal Transfers (EFT)

Internationally, covering environmental costs through an instrument such as cost equalizing comes under the term Ecological Fiscal Transfers (EFT). EFT’s have been in use in Brazil and Portugal for several years. In addition to environmental cost equalization, the term EFT also includes fiscal transfers that are based on the environmental accomplishments of each municipality.

In Brazil a part of the value added tax (VAT) is earmarked transfers for both cost equalization and also as explicit incentives for improving the quality of conservation; stricter protected area categories are for example weighted more heavily in the calculation of transferred funds (Ring, 2008). If this were to be used in the TRNR case the municipalities could have received funds based on their additional contribution to conservation, beyond non-voluntary state-imposed conservation of TRNR. The funds are distributed after an Ecological Index ranging from 0 to 1, in which the municipality with the highest index number represents the municipality that has the best quality conservation within its borders (see Appendix B for a more detailed description of how the funds are distributed). The municipality that conserves the largest areas with the highest conservation quality will get the largest share of the available funds.

There are several issues with using this type of transfer in Norway. An Ecological Index would first of all have to be established; using the Nature Index[24] could be a possibility here, but it needs to be further developed on the local level first. Statistics Norway has been working on this the past year, but it has proven more difficult than expected.

The transfer system as it has been introduced in other countries would also require earmarking of public funds, which is generally opposed by the Ministry of Finance (Barton et al., 2012;

[24] In Norwegian: Naturindeksen

Håkonsen & Lunder, 2009). To justify earmarking externalities across municipal borders would have to be established. Until this is thoroughly proven it will be difficult to get such an instrument approved politically. Considering the opposition against earmarking, it is somewhat a paradox that the government allows for specific restrictions within the DTF, but is skeptical to earmarking funds through the transfer system described here.

There could potentially be high costs involved in sustaining a new system like this, which the current budget does not allow for. When taking these issues into account it seems more likely that development trust funds could work as a future instrument for encouraging conservation among municipalities in Norway, as the use of development funds already are established within Norwegian politics.

8.4 Voluntary Conservation for Forest Owners

An alternative to the command and control approach of conservation is protection through voluntary conservation. Solutions where forest owners voluntarily give up parts of their property for conservation is being used more and more. This could have been a possibility in one of the suggested plans for TRNR, which was termed the "forest owner accepted" alternative, in which about 99 km^2 was proposed to be conserved as opposed to the 148 km^2 that was the final outcome. The problem with this solution is that it was not regarded as comprehensive enough to give adequate protection of biodiversity, since the area was simply not big enough.

Voluntary and traditional conservation is supposed to yield the same amount of compensation to the forest owners. However, there is some information that voluntary conservation leads to more generous payments. In a contingent valuation survey Lindhjem and Mitani (2012) asked private forest owners their annual willingness to accept (WTA) to give up parts of their land for conservation, and found an estimate mean WTA of 180 NOK per daa per year. As this WTA was stated as an annual payment one cannot simply compare these estimates to a one-time payment, but the values could be taken as an indication of the range in which WTA estimates lie. When looking at the compensations made in the TRNR case the mean calculated sum based on foregone timber earnings per daa was 744 NOK. The accepted compensation only covers about four years of compensation with the stated WTA. Based on this it seems that voluntary conservation would be more costly than command and control approach in terms of compensation of forest owners. Nonetheless, one cannot draw any conclusions based upon this result, as the WTA also included non-timber benefits, which was only considered to a small degree in the compensation calculation. There are also several factors that would need to be corrected for in order to compare the payments, such as errors in transforming payments into mean values and case specific factors.

In areas of a size where voluntary conservation is possible, it seems unnecessary to compensate municipalities with a development fund. This is under the assumption that forest owners consider conservation more profitable than alternative use on the property. In this analysis the municipal costs have been based mostly on lost tax revenue from foregone income from forestry and cabin building. If the forest owner does not see any profitability in doing this it is difficult to justify loss for the municipalities.

8.5 Regulation

As showed throughout the analysis the municipalities have different priorities than the government when it comes to land use. This could be dealt with through economic instruments, such as the ones mentioned in this paper. Another approach to this would simply be to regulate the land use by law. In the TRNR case the government could have just conserved the area without compensating the municipalities at all. This would arguably be cheaper than using economic measures, but there are some issues related to this method. The Nature Diversity Act and Forestry Act already mandate the municipalities with several environmental tasks that are not currently being followed through (Riksrevisjonen, 2012). This indicates that regulation may not be enough to reach the level of environmental consciousness that is required to reach set goals. Additionally, increased regulation takes away the autonomy of the municipalities in these matters, leaving more decisions to be made on the centralized level. This is not desired from the municipal or the centralized level of government.

9 Conclusion and Policy Recommendation

Through this analysis I have found that the hypothesis that the development fund in the TRNR case has compensated the municipalities for their costs from conservation cannot be rejected. In the main alternative in the local CBA the development trust fund did not cover the full cost to municipalities from conserving. However, when sensitivity analysis was performed on the main results of the local CBA they were not robust to changes in interest rate and time horizon. Increasing the discount rate and/or reducing the time horizon reduced the municipal costs such that the development trust fund would cover them. Still, when considering the main alternative, the size of the development trust fund (30 MNOK) does not deviate much from the estimated costs (33 MNOK).

The national CBA showed that benefits by far exceeded costs when allowing for compensation of the municipal costs. This fulfills the Kaldor-Hicks criterion of the beneficiaries being able to compensate the cost inflicted. According to the analysis the excess benefit could sustain high compensation payments for both municipalities and forest owners (and other affected parties), which then could lead to a Pareto improvement. However, the benefit found in the analysis is much larger than the funds actually allocated to forest conservation in the government budget.

The development trust fund is in many ways a preferred instrument by the municipalities as they can spend the funds on measures that are of priority to them. Still, if the fund was without restrictions on spending, this would yield an even higher utility to the municipalities and better preserve their autonomy.

The fund is found to have the highest relevance in conserving larger conjoining areas, where voluntary conservation is made difficult. Reasoning from an opportunity cost perspective a fund seems unfounded in areas where forest owners decide that the best use of their property is to voluntarily conserve it. As an increasing number of conservation cases are solved through voluntary conservation and fewer areas are being conserved in the traditional way, it seems better to consider a development fund in each individual case rather than incorporating it structurally. Assuming that the areas that are most easily (voluntarily) conserved will be conserved first, a fund would be useful in reaching a high enough percentage of conserved productive forest when conservation becomes more problematic. Hence, a policy mix is recommended; using voluntary conservation when possible and using a development trust fund in combination with forest owner compensation in non-voluntary conservation.

Given that high local costs among both municipalities and forest owners are preventing the necessary increase in biodiversity protection, providing a development trust fund can be recommended as a policy that can deal with these costs. In combination with compensation to forest owners it can be a useful instrument in conserving areas that otherwise would prove difficult to protect.

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11 Appendices

11.1 Appendix A

This appendix gives a picture of the plans the municipalities had for the TRNR area before conservation, see Figure 11.1 and explanation below.

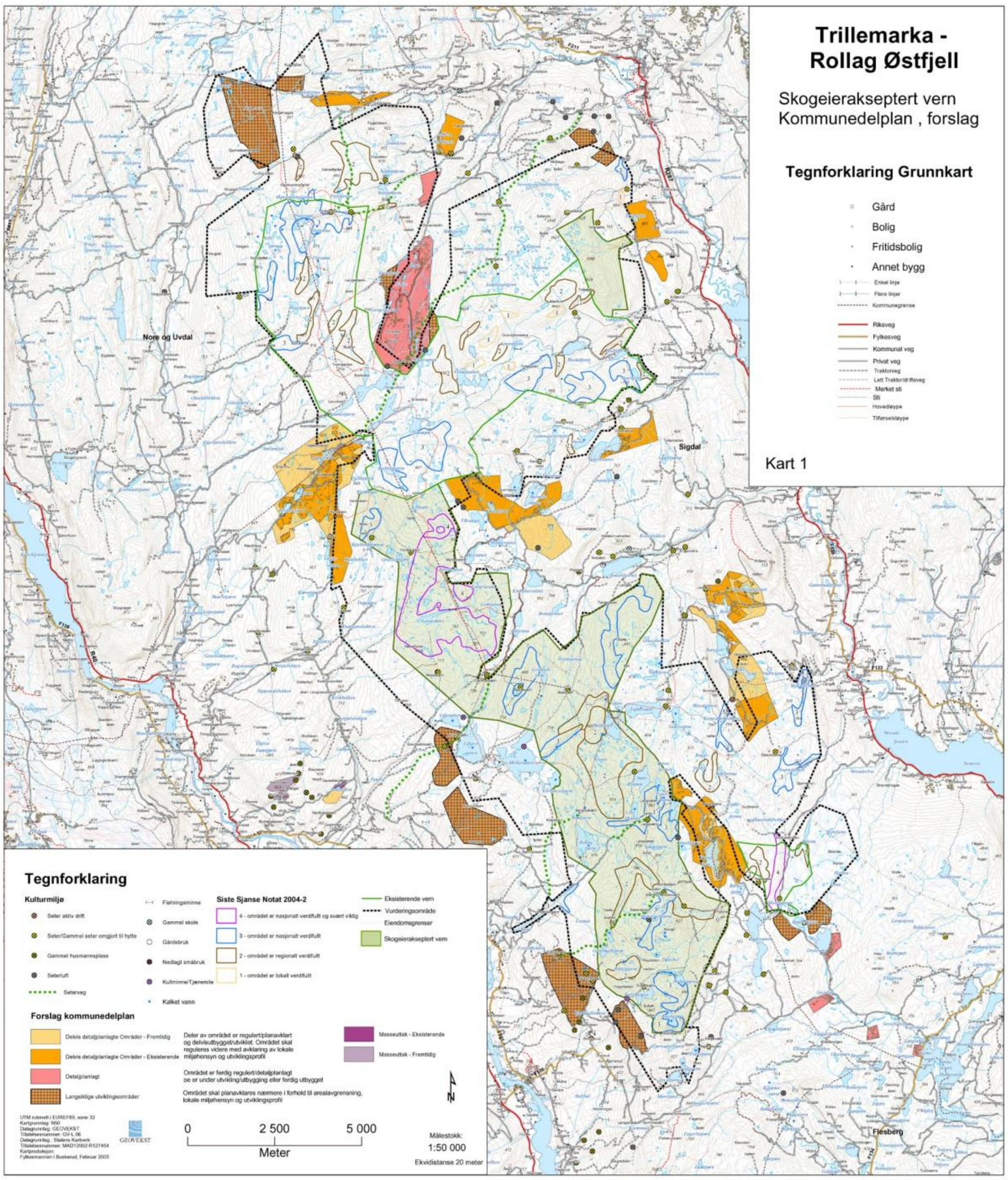

Figure 11.1. Map showing municipal plans in the area in and around TRNR from the assessment of the reserve in 2005 (County Governor of Buskerud, 2005).

The darker orange parts were existing cabin sites at the time, while the lighter orange represented future plans for building. The brown parts represent areas set off for what was termed “long term development”, but it was not explicitly stated what the specific plans for development were. The black dotted line was the environmental activists proposed size of the reserve, while the green dotted line shows the forest owner and municipal suggestion of conservation. Several of the areas for planned development and cabin sites are adjacent to the borders of the reserve. These areas are assumed to have had a natural expansion into the reserve if it had not been conserved.

11.2 Appendix B

This appendix contains a detailed overview of the EFT system where municipalities are awarded for both quantity and quality of their conserved areas.

There are variations on how the EFT system works, but it usually is carried out in the following way (Ring, 2008). Each municipality has an Ecological Index (EI), which is a number between 0 and 1:

$$EI_i = \frac{MCF_i}{NCF}$$

EI_i consists of a municipal conservation factor (MCF_i) which is divided by the national conservation factor (NCF).

$$NCF = \sum_{i=1}^{z} MCF_i$$

The national conservation factor is the sum of all municipal conservation factors.

$$MCF_i = \frac{CU_i}{Total\ area}$$

The municipal conservation factor (MCF_i) consists of the area of conservation units in a municipality divided by the total area of the municipality.

$$CU_i = \sum_{1}^{n} protected\ area_n \times conservation\ weight$$

The conservation unit is the sum of all protected areas in the municipality each multiplied with a conservation weight.

The conservation weights, which range from 0.1 to 1 are decided upon how well an area is protected. An area that is very well protected, such as a nature reserve, would have a high conservation weight of e.g. 1. An area that is only protected to some degree, such as a buffer zone, would have a low conservation weight of e.g. 0.1. By conserving an area a municipality would then get an increase in conservation units, which again would lead to an increase in their municipal conservation factor, yielding a higher Ecological Index, which leads to receiving a higher proportion of funds. This way the municipality that conserves the largest areas of the highest quality will get the largest grant.

11.3 Appendix C

This appendix contains tables and information on data used in the estimation of lost tax income from forestry.

Difficulties

As mentioned in note 11, I tried to obtain information on the tax income from forestry to the municipalities to check if my calculations were within a realistic range, but this proved much more difficult than expected. None of the local treasurers nor those responsible for forest statistics from Statistics Norway had received a request for this type of information earlier. Everyone referred me to each other, and no one seemed to know where the information could be obtained. The conclusion seemed to be that the tax assessment office had the information, but they do not have a phone number. Both I and one of the local treasurers emailed them, and after more than two months they replied that the local treasurer should have this information.

Table 11.1. Average income from forestry sorted by year and size of productive forest area (daa) for Norwegian forest owners with more than 25 daa of productive forest. Prices in parenthesis are 2008 prices, CPI adjusted.

	2008	**2009 (2008 prices)**	**2010 (2008 prices)**	**2011 (2008 prices)**	**Average (in 2008 prices)**
	Forestry income in NOK	Forestry income in NOK	Forestry income in NOK	Forestry income in NOK	Forestry income in NOK
25-99 dekar	23000	14000 (13710)	16000 (15291)	17000 (16048)	17012
100-249 dekar	19000	18000 (17627)	20000 (19114)	21000 (19824)	18891
250-499 dekar	23000	22000 (21545)	23000 (21982)	25000 (23600)	22532
500-999 dekar	33000	37000 (36235)	33000 (31539)	33000 (31152)	32982
1 000-1 999 dekar	47000	41000 (40152)	44000 (42052)	48000 (45312)	43629
2 000-4 999 dekar	79000	74000 (72470)	80000 (76459)	80000 (75521)	75863
5 000-19 999 dekar	193000	176000 (172359)	182000 (173945)	201000 (189747)	182263
20 000 dekar or more	551000	504000 (493575)	471000 (453575)	434000 (409703)	476109

Table 11.2. Distribution of forest properties by size in absolute numbers and percentages for Norway, Buskerud County and TRNR respectively.

Area (daa)	**25 - 20 000**	**25-99**	**100-249**	**250-499**	**500-999**	**1 000-1 999**	**2 000-4 999**	**5 000-19 999**	**20 000-**
Norway	131,785	45,904	34,663	22,605	15,773	8,015	3,585	1,009	231
%	100%	35%	26%	17%	12%	6%	3%	1%	0.2%
Buskerud	7,738	2,137	1,873	1,325	1,169	678	408	136	12
%	100%	28%	24%	17%	15%	9%	5%	2%	0.2%
TRNR	91	22	24	19	14	10	1	1	-
%	100%	24%	26%	21%	15%	11%	1%	1%	-

Table 11.3. Timber price development in nominal prices and 2011 prices, 1965-2011.

Year	Nominal NOK	2011 NOK	Year	Nominal NOK	2011 NOK
1965	101	921	**1988**	326	541
1966	98	858	**1989**	350	557
1967	87	727	**1990**	362	553
1968	87	709	**1991**	333	497
1969	93	697	**1992**	282	411
1970	100	697	**1993**	293	421
1971	96	632	**1994**	373	522
1972	99	612	**1995**	336	466
1973	130	734	**1996**	329	450
1974	160	812	**1997**	344	459
1975	164	761	**1998**	340	443
1976	183	780	**1999**	334	426
1977	181	705	**2000**	322	398
1978	176	650	**2001**	327	392
1979	190	657	**2002**	301	356
1980	220	661	**2003**	296	342
1981	227	609	**2004**	305	351
1982	222	541	**2005**	318	360
1983	247	565	**2006**	313	347
1984	261	565	**2007**	375	412
1985	282	576	**2008**	364	386
1986	308	575	**2009**	307	318
1987	335	584	**2010**	355	359
			2011	364	364

11.4 Appendix D

This appendix contains questionnaire questions from the CV survey and STATA (statistics program, version 11) commands used for analysis.

WTP question

What is the most your household almost certainly is willing to pay in an extra annual tax earmarked to a public fund for increased forest protection from today's level of 1.4% to 2.8% of productive forest area? Choose the highest amount, if anything, your household almost certainly will pay.

(Check one)

- ☐ 0
- ☐ 25
- ☐ 50
- ☐ 100
- ☐ 300
- ☐ 500
- ☐ 700
- ☐ 900
- ☐ 1100
- ☐ 1400
- ☐ 1800
- ☐ 2200
- ☐ 2700
- ☐ 3200
- ☐ 3800

- ☐ 4400
- ☐ 5100
- ☐ 5800
- ☐ 7000
- ☐ 8500
- ☐ 10000
- ☐ 13000
- ☐ 15000
- ☐ More than 15000
- ☐ Don’t know

Specify amount in kr per year (if higher than 15000)

____

Revealing protest answers

Choose the statements below that best describe why you were not willing to pay anything to increase forest protection.

(Check no more than two statements)

- ☐ It is the government's responsibility to protect forests
- ☐ I cannot afford to pay anything for this*[25]
- ☐ The tax level is high enough as it is
- ☐ What I say will not affect whether the plans will be carried out or not
- ☐ Today's level of forest protection is good as it is*
- ☐ It is too difficult to give an amount
- ☐ I feel it is not right to value vulnerable and threatened species in monetary terms in this way
- ☐ Those who destroy the habitat where these plant and animal species live should pay
- ☐ The species can be preserved through environmentally cautious forestry - more protection is not necessary*
- ☐ We already pay enough to the farmers owning the forests
- ☐ I don't know*

[25] Answers characterized as true zeros are marked with an asterisk (*).

STATA commands in WTP estimation[26]

cd C:\Users\Aina\Dropbox\Masteroppgave\Statistikk

use skogdata.dta, clear

* spm11a represents payment card for all respondents (household)

sum spm11a

histogram spm11a

* dropping oslo samples, to not mix the two populations Oslo and Norway

drop if utvalg2 == 2

drop if utvalg2 == 10

* running the command keep if fylke == 6 shows that 152 of the respondents

* are from buskerud county in original dataset without any alterations: no significant difference in WTP

* dropping "failed to respond to WTP" respondents from mail survey

drop if spm11a == 26

* recoding spm11a, midpoint between intervals represent wtp, set do not know as 0

recode spm11a (1=0) (2=37.5) (3=75) (4=200) (5=400) (6=600) (7=800) (8=1000) (9=1250) (10=1600) (11=2000) (12=2450) (13=2950) (14=3500) (15=4100) (16=4750) (17=5450) (18=6400) (19=7750) (20=9250) (21=11500) (22=13000) (23=15000) (24=25167.5) (25=0), generate (wtpb)

sum wtpb, detail

[26] Note that any command starting with an asterisk (*) is a comment

* finding protest answers and dropping them (from original dataset all together 1251 observations deleted)

* out of 1429 people answering 0 or do not know, 1251 were categorized as protests

* after the criteria of ticking off reason 1,3,4,6,7,8 or 10 in question 17.

drop if spm17c01 ==1, drop if spm17c03 ==1, drop if spm17c04==1, drop if spm17c06 ==1

drop if spm17c07 ==1, drop if spm17c08 ==1, drop if spm17c10 ==1

sum wtpb, detail

sktest wtpb

* sktest shows that wtpb is significantly non-normal in skewness and kurtosis, large difference in median and mean

11.5 Appendix E

This appendix contains extended information on calculations made in the cost-benefit analyses. Table 11.8 through Table 11.11 reach over several pages and contains details on the calculation of net present values.

Table 11.4. Result of sensitivity analysis on local CBA with respect to interest rate, given in NPV with time horizon of 100 years. Low discount rate of 2%, medium discount rate declining from 4% to 2%, high discount rate of 4%.

Discount rate	**2%**	**4%-2%**	**4%**
Costs			
Forestry tax loss	12,513,123	9,204,182	7,097,992
Labor tax loss	13,577,532	13,577,532	13,577,532
Real estate tax+ municipal fees	39,026,674	27,570,311	18,217,559
Administration	44,290,669	31,934,866	25,638,800
Sum	109,407,998	82,286,892	64,531,883
Benefits			
WTP	16,223,939	11,933,719	9,202,930
Adm	49,772,595	37,175,965	30,879,898
Sum	65,996,535	49,109,683	40,082,828
Net costs (in NPV)	**43,411,464**	**33,177,208**	**24,449,055**

Table 11.5. Result of sensitivity analysis of local CBA with respect to time. Given in NPV, with declining discount rate. Time horizons of 25, 50 and 100 years.

Years	**25**	**50**	**100**
Costs			
Forestry tax loss	4,810,929	6,774,910	9,204,182
Labor tax loss	13,577,532	13,577,532	13,577,532
Real estate tax+ municipal fees	8,839,677	15,814,861	27,570,311
Administration	16,755,881	23,541,567	31,934,866
Sum	43,984,019	59,708,870	82,286,892
Benefits			
WTP	6,237,628	8,784,036	11,933,719
Administration	21,996,979	28,782,665	37,175,965
Sum	28,234,608	37,566,701	49,109,683
Net costs (in NPV)	**15,749,411**	**22,142,169**	**33,177,208**

Table 11.6. Result of sensitivity analysis on local CBA with uncorrected WTP with respect to interest rate, given in NPV with time horizon of 100 years. Low discount rate of 2%, medium discount rate declining from 4% to 2%, high discount rate of 4%.

Discount rate	**2%**	**4%-2%**	**4%**
Costs			
Forestry tax loss	12,513,123	9,204,182	7,097,992
Labor tax loss	13,577,532	13,577,532	13,577,532
Real estate tax+ municipal fees	39,026,674	27,570,311	18,217,559
Administration	44,290,669	31,934,866	25,638,800
Sum	109,407,998	82,286,892	64,531,883
Benefits			
WTP	11,547,140	8,493,642	6,550,044
Adm	49,772,595	37,175,965	30,879,898
Sum	65,996,535	49,109,683	40,082,828
Net costs (in NPV)	**48,088,262**	**36,617,285**	**27,101,940**

Table 11.7. Result of sensitivity analysis of local CBA with uncorrected WTP with respect to time. Given in NPV, with declining discount rate. Time horizons of 25, 50 and 100 years.

Years	**25**	**50**	**100**
Costs			
Forestry tax loss	4,810,929	6,774,910	9,204,182
Labor tax loss	13,577,532	13,577,532	13,577,532
Real estate tax+ municipal fees	8,839,677	15,814,861	27,570,311
Administration	16,755,881	23,541,567	31,934,866
Sum	43,984,019	59,708,870	82,286,892
Benefits			
WTP	4,439,536	6,251,903	8,493,642
Administration	21,996,979	28,782,665	37,175,965
Sum	28,234,608	37,566,701	49,109,683
Net costs (in NPV)	**17,547,503**	**24,674,302**	**36,617,285**

Table 11.8. Detailed NPV calculations for forestry tax loss.

Year (t)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Declining discount rate (4%-2%)	1	1.04	1.0816	1.124864	1.169859	1.216653	1.265319	1.315932	1.368569	1.423312	1.480244	1.539454	1.601032	1.665074	1.731676	1.800944	1.872981
Negative growth (2%)	1	0.98	0.9604	0.941192	0.922368	0.903921	0.885842	0.868126	0.850763	0.833748	0.817073	0.800731	0.784717	0.769022	0.753642	0.738569	0.723798
Low tax loss (negative growth)	289430	283641	277969	272409	266961	261622	256389	251262	246236	241312	236485	231756	227121	222578	218127	213764	209489
Medium tax loss	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430
High tax loss	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432
PV tax loss low	289430	272732	256998	242171	228199	215034	202628	190938	179922	169542	159761	150544	141859	133675	125963	118696	111848
PV tax loss medium	289430	278298	267594	257302	247406	237890	228741	219943	211484	203350	195529	188008	180777	173824	167139	160710	154529
PV tax loss high	486432	467723	449734	432436	415804	399812	384434	369648	355431	341761	328616	315977	303824	292138	280902	270098	259710
Year (t)	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
Declining discount rate (4%-2%)	1.9479	2.025817	2.106849	2.191123	2.278768	2.369919	2.464716	2.563304	2.665836	2.77247	2.883369	2.998703	3.118651	3.243398	3.373133	3.508059	3.648381
Negative growth (2%)	0.709322	0.695135	0.681233	0.667608	0.654256	0.641171	0.628347	0.61578	0.603465	0.591395	0.579568	0.567976	0.556617	0.545484	0.534575	0.523883	0.513405
Low tax loss (negative growth)	205299	201193	197169	193226	189361	185574	181863	178225	174661	171168	167744	164389	161102	157880	154722	151627	148595
Medium tax loss	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430
High tax loss	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432
PV tax loss low	105395	99315	93585	88186	83098	78304	73786	69530	65518	61738	58176	54820	51657	48677	45869	43223	40729
PV tax loss medium	148586	142871	137376	132092	127012	122127	117429	112913	108570	104394	100379	96518	92806	89237	85804	82504	79331
PV tax loss high	249721	240117	230881	222001	213463	205253	197358	189768	182469	175451	168703	162214	155975	149976	144208	138661	133328
Year (t)	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Declining discount rate (4%-2%)	3.794316	3.946089	4.103933	4.26809	4.438813	4.616366	4.801021	3.359899	3.460696	3.564517	3.671452	3.781596	3.895044	4.011895	4.132252	4.256219	4.383906
Negative growth (2%)	0.503137	0.493075	0.483213	0.473549	0.464078	0.454796	0.4457	0.436786	0.428051	0.41949	0.4111	0.402878	0.39482	0.386924	0.379185	0.371602	0.36417
Low tax loss (negative growth)	145623	142711	139856	137059	134318	131632	128999	126419	123891	121413	118985	116605	114273	111987	109748	107553	105402
Medium tax loss	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430
High tax loss	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432
PV tax loss low	38379	36165	34079	32113	30260	28514	26869	37626	35799	34062	32408	30835	29338	27914	26559	25270	24043
PV tax loss medium	76280	73346	70525	67813	65204	62697	60285	86142	83633	81198	78833	76536	74307	72143	70042	68002	66021
PV tax loss high	128200	123269	118528	113969	109586	105371	101318	144776	140559	136465	132490	128631	124885	121247	117716	114287	110959

Table 11.8. Detailed NPV calculations for forestry tax loss (continues)

Year (t)	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67
Declining discount rate (4%-2%)	4.515423	4.650886	4.790412	4.934125	5.082149	5.234613	5.391651	5.553401	5.720003	5.891603	6.068351	6.250402	6.437914	6.631051	6.829983	7.034882	7.245929
Negative growth (2%)	0.356886	0.349749	0.342754	0.335899	0.329181	0.322597	0.316145	0.309822	0.303626	0.297553	0.291602	0.28577	0.280055	0.274454	0.268964	0.263585	0.258313
Low tax loss (negative growth)	103294	101228	99203	97219	95275	93369	91502	89672	87878	86121	84398	82710	81056	79435	77846	76289	74764
Medium tax loss	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430
High tax loss	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432
PV tax loss low	22876	21765	20709	19703	18747	17837	16971	16147	15363	14618	13908	13233	12590	11979	11398	10844	10318
PV tax loss medium	64098	62231	60419	58659	56950	55292	53681	52118	50600	49126	47695	46306	44957	43648	42376	41142	39944
PV tax loss high	107727	104589	101543	98585	95714	92926	90219	87592	85041	82564	80159	77824	75557	73357	71220	69146	67132
Year (t)	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84
Declining discount rate (4%-2%)	7.463307	7.687206	7.917822	8.155357	8.400017	8.652018	8.911578	9.178926	4.504152	4.594235	4.68612	4.779842	4.875439	4.972948	5.072407	5.173855	5.277332
Negative growth (2%)	0.253147	0.248084	0.243123	0.23826	0.233495	0.228825	0.224249	0.219764	0.215368	0.211061	0.20684	0.202703	0.198649	0.194676	0.190782	0.186967	0.183227
Low tax loss (negative growth)	73268	71803	70367	68960	67580	66229	64904	63606	62334	61087	59866	58668	57495	56345	55218	54114	53031
Medium tax loss	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430
High tax loss	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432
PV tax loss low	9817	9341	8887	8456	8045	7655	7283	6930	13839	13297	12775	12274	11793	11330	10886	10459	10049
PV tax loss medium	38780	37651	36554	35490	34456	33452	32478	31532	64258	62999	61763	60552	59365	58201	57060	55941	54844
PV tax loss high	65176	63278	61435	59646	57908	56222	54584	52994	107996	105879	103803	101767	99772	97816	95898	94017	92174
Year (t)	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	
Declining discount rate (4%-2%)	5.382879	5.490536	5.600347	5.712354	5.826601	5.943133	6.061996	6.183236	6.3069	6.433038	6.561699	6.692933	6.826792	6.963328	7.102594	7.244646	
Negative growth (2%)	0.179563	0.175972	0.172452	0.169003	0.165623	0.162311	0.159064	0.155883	0.152765	0.14971	0.146716	0.143782	0.140906	0.138088	0.135326	0.13262	
Low tax loss (negative growth)	51971	50931	49913	48915	47936	46978	46038	45117	44215	43331	42464	41615	40782	39967	39167	38384	
Medium tax loss	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	289430	
High tax loss	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	486432	
PV tax loss low	9655	9276	8912	8563	8227	7905	7595	7297	7011	6736	6471	6218	5974	5740	5515	5298	
PV tax loss medium	53769	52714	51681	50667	49674	48700	47745	46809	45891	44991	44109	43244	42396	41565	40750	39951	
PV tax loss high	90367	88595	86857	85154	83485	81848	80243	78669	77127	75615	74132	72678	71253	69856	68487	67144	

	25 years		50 years		100 years			Sensitivity Discount Rate		
NPV Low	NOK	3,946,656	NOK	4,881,778	NOK	5,440,291		NPV Medium 4% discount	NOK	7,097,992
NPV Medium	NOK	4,810,929	NOK	6,774,910	NOK	9,204,182		NPV Medium 2% discount	NOK	12,513,123
NPV High	NOK	8,085,512	NOK	11,386,286	NOK	15,469,056				

Table 11.9. Detailed NPV calculations for foregone property tax and municipal fees[26]

Year (t)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Discount rate (4%-2%)	1	1.04	1.0816	1.124864	1.1698586	1.2166529	1.265319	1.3159318	1.3685691	1.4233118	1.4802443	1.5394541	1.6010322	1.6650735	1.7316764	1.8009435	1.8729812
Low	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925
Medium	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	599,704	599,704	599,704	599,704	599,704	599,704	599,704
High	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	599,704	599,704	599,704	599,704	599,704	599,704	599,704
PV Low	409,925	394,158	378,998	364,421	350,405	336,928	323,969	311,509	299,528	288,008	276,930	266,279	256,038	246,190	236,721	227,617	218,862
PV Medium	409,925	394,158	378,998	364,421	350,405	336,928	323,969	311,509	299,528	288,008	405,139	389,557	374,574	360,167	346,314	332,995	320,187
PV High	409,925	394,158	378,998	364,421	350,405	336,928	323,969	311,509	299,528	288,008	405,139	389,557	374,574	360,167	346,314	332,995	320,187

Year (t)	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
Discount rate (4%-2%)	1.9479005	2.0258165	2.1068492	2.1911231	2.2787681	2.3699188	2.4647155	2.5633042	2.6658363	2.7724698	2.8833686	2.9987033	3.1186515	3.2433975	3.3731334	3.5080587	3.6483811
Low	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925
Medium	599,704	599,704	599,704	789,484	789,484	789,484	789,484	789,484	789,484	789,484	789,484	789,484	789,484	979,264	979,264	979,264	979,264
High	599,704	599,704	599,704	789,484	789,484	789,484	789,484	789,484	789,484	789,484	789,484	789,484	789,484	979,264	979,264	979,264	979,264
PV Low	210,444	202,350	194,568	187,084	179,889	172,970	166,317	159,920	153,770	147,855	142,169	136,701	131,443	126,387	121,526	116,852	112,358
PV Medium	307,872	296,031	284,645	360,310	346,452	333,127	320,315	307,995	296,149	284,758	273,806	263,275	253,149	301,925	290,313	279,147	268,411
PV High	307,872	296,031	284,645	360,310	346,452	333,127	320,315	307,995	296,149	284,758	273,806	263,275	253,149	301,925	290,313	279,147	268,411

Year (t)	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Discount rate (4%-2%)	3.7943163	3.946089	4.1039326	4.2680899	4.4388135	4.616366	4.8010206	3.3598989	3.4606959	3.5645168	3.6714523	3.7815958	3.8950437	4.011895	4.1322519	4.2562194	4.383906
Low	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925
Medium	979,264	979,264	979,264	979,264	979,264	979,264	1,169,044	1,169,044	1,169,044	1,169,044	1,169,044	1,169,044	1,169,044	1,169,044	1,169,044	1,169,044	1,400,575
High	979,264	979,264	979,264	979,264	979,264	979,264	1,169,044	1,169,044	1,169,044	1,169,044	1,169,044	1,169,044	1,169,044	1,169,044	1,169,044	1,169,044	1,400,575
PV Low	108,036	103,881	99,886	96,044	92,350	88,798	85,383	122,005	118,451	115,001	111,652	108,400	105,243	102,177	99,201	96,312	93,507
PV Medium	258,087	248,161	238,616	229,439	220,614	212,129	243,499	347,940	337,806	327,967	318,415	309,140	300,136	291,394	282,907	274,667	319,481
PV High	258,087	248,161	238,616	229,439	220,614	212,129	243,499	347,940	337,806	327,967	318,415	309,140	300,136	291,394	282,907	274,667	319,481

Year (t)	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67
Discount rate (4%-2%)	4.5154232	4.6508859	4.7904125	4.9341248	5.0821486	5.234613	5.3916514	5.553401	5.720003	5.8916031	6.0683512	6.2504017	6.4379138	6.6310512	6.8299827	7.0348822	7.2459287
Low	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925
Medium	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575
High	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,548,604	1,548,604	1,548,604	1,548,604	1,548,604	1,548,604	1,548,604
PV Low	90,783	88,139	85,572	83,079	80,660	78,310	76,029	73,815	71,665	69,578	67,551	65,584	63,674	61,819	60,018	58,270	56,573
PV Medium	310,176	301,142	292,371	283,855	275,587	267,560	259,767	252,201	244,856	237,724	230,800	224,078	217,551	211,215	205,063	199,090	193,291
PV High	310,176	301,142	292,371	283,855	275,587	267,560	259,767	252,201	244,856	237,724	255,193	247,761	240,544	233,538	226,736	220,132	213,721

[26] As mentioned in the main text the amount of cabins in the low, medium and high scenario are increasing over the years to simulate a real life building situation. In the medium alternative it is assumed that about 50 extra cabins are built every 10 years until year 50 where 261 additional cabins have been built. In the high alternative the same procedure is used, but here the building stops in year 80, when 392 additional cabins have been built compared to the initial level.

Table 11.9. Detailed NPV calculations for foregone property tax and municipal fees (continues)

Year (t)	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84
Discount rate (4%-2%)	7.4633065	7.6872057	7.9178219	8.1553566	8.4000173	8.6520178	8.9115783	9.1789257	4.5041522	4.5942352	4.6861199	4.7798423	4.8754392	4.9729479	5.0724069	5.173855	5.2773321
Low	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925
Medium	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575
High	1,548,604	1,548,604	1,738,384	1,738,384	1,738,384	1,738,384	1,738,384	1,738,384	1,738,384	1,738,384	1,738,384	1,738,384	1,897,799	1,897,799	1,897,799	1,897,799	1,897,799
PV Low	54,925	53,326	51,772	50,264	48,800	47,379	45,999	44,659	91,010	89,226	87,476	85,761	84,080	82,431	80,815	79,230	77,676
PV Medium	187,662	182,196	176,889	171,737	166,735	161,878	157,164	152,586	310,952	304,855	298,877	293,017	287,272	281,639	276,117	270,702	265,395
PV High	207,496	201,452	219,553	213,159	206,950	200,922	195,070	189,389	385,951	378,384	370,964	363,691	389,257	381,624	374,142	366,806	359,613
Year (t)	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	
Discount rate (4%-2%)	5.3828788	5.4905364	5.6003471	5.712354	5.8266011	5.9431331	6.0619958	6.1832357	6.3069004	6.4330384	6.5616992	6.6929332	6.8267918	6.9633277	7.1025942	7.2446461	
Low	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	409,925	
Medium	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	1,400,575	
High	1,897,799	1,897,799	1,897,799	1,897,799	1,897,799	1,897,799	1,897,799	1,897,799	1,897,799	1,897,799	1,897,799	1,897,799	1,897,799	1,897,799	1,897,799	1,897,799	
PV Low	76,153	74,660	73,196	71,761	70,354	68,974	67,622	66,296	64,996	63,722	62,472	61,247	60,046	58,869	57,715	56,583	
PV Medium	260,191	255,089	250,087	245,184	240,376	235,663	231,042	226,512	222,070	217,716	213,447	209,262	205,159	201,136	197,192	193,326	
PV High	352,562	345,649	338,872	332,227	325,713	319,326	313,065	306,926	300,908	295,008	289,224	283,553	277,993	272,542	267,198	261,959	

	25 years	50 years	100 years
NPV Low	NOK 6,813,798	NOK 9,595,417	NOK 13,036,037
NPV Medium	NOK 8,839,677	NOK 15,814,861	NOK 27,570,311
NPV High	NOK 8,839,677	NOK 15,814,861	NOK 30,064,874

Sensitivity: Discount Rate	
NPV Medium 4%	NOK 18,217,559
NPV Medium 2%	NOK 39,026,674

Table 11.10. Detailed NPV calculations for administration costs and grants

Year (t)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Discount rate (4%-2%)	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2
Administrative cost	0	731883	2090299	1396529	1036324	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000
PV Administrative cost	0	703734	1932599	1241509	885854	821927	790315	759918	730690	702587	675564	649581	624597	600574	577475	555265	533908
Administrative grant	0	4000000	2000000	2000000	2000000	2000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000
PV Administrative grant	0	3846154	1849112	1777993	1709608	1643854	790315	759918	730690	702587	675564	649581	624597	600574	577475	555265	533908
Year (t)	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
Discount rate (4%-2%)	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	4	4
Administrative cost	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000
PV Administrative cost	513373	493628	474642	456387	438834	421955	405726	390121	375117	360689	346817	333477	320651	308319	296460	285058	274094
Administrative grant	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000
PV Administrative grant	513373	493628	474642	456387	438834	421955	405726	390121	375117	360689	346817	333477	320651	308319	296460	285058	274094
Year (t)	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Discount rate (4%-2%)	4	4	4	4	4	5	5	3	3	4	4	4	4	4	4	4	4
Administrative cost	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000
PV Administrative cost	263552	253415	243669	234297	225285	216621	208289	297628	288959	280543	272372	264439	256737	249259	241999	234950	228107
Administrative grant	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000
PV Administrative grant	263552	253415	243669	234297	225285	216621	208289	297628	288959	280543	272372	264439	256737	249259	241999	234950	228107
Year (t)	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67
Discount rate (4%-2%)	5	5	5	5	5	5	5	6	6	6	6	6	6	7	7	7	7
Administrative cost	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000
PV Administrative cost	221463	215013	208750	202670	196767	191036	185472	180070	174825	169733	164789	159990	155330	150806	146413	142149	138009
Administrative grant	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000
PV Administrative grant	221463	215013	208750	202670	196767	191036	185472	180070	174825	169733	164789	159990	155330	150806	146413	142149	138009
Year (t)	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84
Discount rate (4%-2%)	7	8	8	8	8	9	9	9	5	5	5	5	5	5	5	5	5
Administrative cost	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000
PV Administrative cost	133989	130086	126297	122619	119047	115580	112214	108945	222017	217664	213396	209212	205110	201088	197145	193279	189490
Administrative grant	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000
PV Administrative grant	133989	130086	126297	122619	119047	115580	112214	108945	222017	217664	213396	209212	205110	201088	197145	193279	189490
Year (t)	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	
Discount rate (4%-2%)	5	5	6	6	6	6	6	6	6	6	7	7	7	7	7	7	
Administrative cost	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	
PV Administrative cost	185774	182132	178560	175059	171627	168261	164962	161728	158556	155448	152400	149411	146482	143609	140794	138033	
Administrative grant	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	
PV Administrative grant	185774	182132	178560	175059	171627	168261	164962	161728	158556	155448	152400	149411	146482	143609	140794	138033	

	25 years	**50 years**	**100 years**	**2% interest**	**4% interest**
NPV Administration grant	NOK 21,996,979	NOK 28,782,665	NOK 37,175,965	NOK 49,772,595	NOK 30,879,898
	25 years	**50 years**	**100 years**	**2% interest**	**4% interest**
NPV Administration cost	NOK 16,755,881	NOK 23,541,567	NOK 31,934,866	NOK 44,290,669	NOK 25,638,800

Table 11.11. Detailed NPV calculations for WTP for conservation

	Medium	Low (- 20 percent)	High (+20 percent)
Average WTP per household per year (survey)	1,176	941	1,411
Increase in conservation in daa from 1,4-2.8 % (survey)	1,050,000	1,050,000	1,050,000
WTP per daa per household	0.0011200	0.0008960	0.0013440
Households in Norway (2008)	2,104,531	2,104,531	2,104,531
WTP per daa all households per year	2,357	1,886	2,828
TRNR (daa)	105,000	105,000	105,000
National benefit per year (TRNR 105 daa)	247,492,846	197,994,276	296,991,415
WTP per household for TRNR	118	94	141
WTP for forest owners per year (2008)	13,524	10,819	16,229
WTP for municipalities per year (2008)	375,262	300,209	450,314
WTP for Buskerud per year (2008)	13,100,522	10,480,418	15,720,627

Table 11.11. Detailed NPV calculations for WTP for conservation (continues)

Year (t)	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Discount rate (4%-2%)	1	1.04	1.0816	1.124864	1.16985856	1.216652902	1.265319018	1.315931779	1.36856905	1.423311812	1.480244285	1.539454056	1.601032219	1.665073507
National WTP	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846
PV National WTP	247492846	237973890	228821048	220020239	211557922	203421079	195597191	188074222	180840598	173885190	167197299	160766633	154583301	148637790
Buskerud WTP	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522
PV Buskerud WTP	13100522	12596656	12112169	11646317	11198381	10767674	10353533	9955320	9572423	9204253	8850244	8509850	8182548	7867834
Municipal WTP	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262
PV Municipal WTP	375262	360828	346950	333606	320775	308438	296575	285168	274200	263654	253513	243763	234387	225372
Year (t)	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Discount rate (4%-2%)	1.731676448	1.800943506	1.872981246	1.947900496	2.025816515	2.106849176	2.191123143	2.278768069	2.369918792	2.464715543	2.563304165	2.665836331	2.772469785	2.883368576
National WTP	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846
PV National WTP	142920952	137423992	132138454	127056205	122169428	117470604	112952504	108608177	104430939	100414365	96552274	92838725	89268005	85834620
Buskerud WTP	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522
PV Buskerud WTP	7565225	7274255	6994476	6725458	6466786	6218064	5978907	5748949	5527836	5315227	5110795	4914226	4725217	4543478
Municipal WTP	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262
PV Municipal WTP	216704	208369	200355	192649	185240	178115	171264	164677	158344	152254	146398	140767	135353	130147
Year (t)	28	29	30	31	32	33	34	35	36	37	38	39	40	41
Discount rate (4%-2%)	2.998703319	3.118651452	3.24339751	3.37313341	3.508058747	3.648381097	3.794316341	3.946088994	4.103932554	4.268089856	4.43881345	4.616365988	4.801020628	3.359898926
National WTP	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846
PV National WTP	82533288	79358931	76306664	73371793	70549801	67836347	65227257	62718516	60306265	57986794	55756532	53612050	51550048	73660801
Buskerud WTP	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522
PV Buskerud WTP	4368729	4200701	4039136	3883784	3734408	3590777	3452670	3319875	3192188	3069411	2951357	2837843	2728695	3899082
Municipal WTP	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262
PV Municipal WTP	125141	120328	115700	111250	106971	102857	98901	95097	91440	87923	84541	81289	78163	111688
Year (t)	42	43	44	45	46	47	48	49	50	51	52	53	54	55
Discount rate (4%-2%)	3.460695894	3.56451677	3.671452273	3.781595842	3.895043717	4.011895028	4.132251879	4.256219436	4.383906019	4.515423199	4.650885895	4.790412472	4.934124846	5.082148592
National WTP	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846
PV National WTP	71515341	69432370	67410068	65446667	63540454	61689761	59892972	58148516	56454870	54810554	53214130	51664204	50159421	48698467
Buskerud WTP	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522
PV Buskerud WTP	3785517	3675259	3568213	3464284	3363383	3265420	3170311	3077972	2988322	2901283	2816780	2734738	2655085	2577753
Municipal WTP	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262
PV Municipal WTP	108435	105277	102211	99234	96343	93537	90813	88168	85600	83107	80686	78336	76054	73839
Year (t)	56	57	58	59	60	61	62	63	64	65	66	67	68	69
Discount rate (4%-2%)	5.234613049	5.391651441	5.553400984	5.720003014	5.891603104	6.068351197	6.250401733	6.437913785	6.631051199	6.829982735	7.034882217	7.245928683	7.463306544	7.68720574
National WTP	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846
PV National WTP	47280065	45902976	44565996	43267957	42007725	40784199	39596310	38443020	37323320	36236233	35180809	34156125	33161286	32195424
Buskerud WTP	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522
PV Buskerud WTP	2502673	2429779	2359009	2290300	2223592	2158827	2095949	2034902	1975633	1918090	1862223	1807984	1755324	1704198
Municipal WTP	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262
PV Municipal WTP	71689	69600	67573	65605	63694	61839	60038	58289	56592	54943	53343	51789	50281	48816

Table 11.11. Detailed NPV calculations for WTP for conservation (continues)

Year (t)	70	71	72	73	74	75	76	77	78	79	80	81	82	83
Discount rate (4%-2%)	7.917821912	8.155356569	8.400017267	8.652017785	8.911578318	9.178925668	4.504152164	4.594235208	4.686119912	4.77984231	4.875439156	4.972947939	5.072406898	5.173855036
National WTP	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846
PV National WTP	31257693	30347275	29463373	28605217	27772055	26963160	54947710	53870304	52814023	51778454	50763190	49767834	48791994	47835288
Buskerud WTP	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522
PV Buskerud WTP	1654561	1606370	1559583	1514158	1470056	1427239	2908543	2851513	2795601	2740785	2687045	2634357	2582703	2532062
Municipal WTP	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262
PV Municipal WTP	47395	46014	44674	43373	42109	40883	83315	81681	80079	78509	76970	75461	73981	72530
Year (t)	84	85	86	87	88	89	90	91	92	93	94	95	96	97
Discount rate (4%-2%)	5.277332137	5.382878779	5.490536355	5.600347082	5.712354024	5.826601104	5.943133126	6.061995789	6.183235705	6.306900419	6.433038427	6.561699196	6.69293318	6.826791843
National WTP	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846	247492846
PV National WTP	46897341	45977785	45076260	44192412	43325894	42476367	41643497	40826958	40026429	39241597	38472154	37717798	36978233	36253170
Buskerud WTP	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522	13100522
PV Buskerud WTP	2482414	2433739	2386019	2339234	2293367	2248399	2204312	2161091	2118716	2077173	2036444	1996514	1957366	1918987
Municipal WTP	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262	375262
PV Municipal WTP	71108	69714	68347	67007	65693	64405	63142	61904	60690	59500	58333	57190	56068	54969
Year (t)	98	99	100											
Discount rate (4%-2%)	6.96332768	7.102594234	7.244646118											
National WTP	247492846	247492846	247492846											
PV National WTP	35542324	34845415	34162172											
Buskerud WTP	13100522	13100522	13100522											
PV Buskerud WTP	1881359	1844470	1808304											
Municipal WTP	375262	375262	375262											
PV Municipal WTP	53891	52834	51798											

Interest rate	**2%**		**4%-2%**		**4%**	
NPV WTP Municipalities	NOK	16,223,939	NOK	11,933,719	NOK	9,202,930
NPV WTP Nation	NOK	10,700,026,013	NOK	7,870,536,193	NOK	6,069,523,826
Years	**25**		**50**		**100**	
NPV WTP Municipalities	NOK	6,237,628	NOK	8,784,036	NOK	11,933,719
NPV WTP Nation	NOK	4,113,845,865	NOK	5,793,254,569	NOK	7,870,536,193