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Factors that affect the willingness to pay for kelp habitat restoration in Norway, a choice experiment approach.

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Abstract

This study attempts to analyze the factors that affect WTP for kelp habitat restoration in Norway using a choice experiment approach. The study is based on the survey data collected by the Arctic University of Norway. The data set cover 1013 respondents in 6 regions and 18 cities of northern Norway. The conditional logit model and mixed logit model is used for empirical estimations. Results of the study show that respondents are willing to pay €18.8 and €18.7 per year for high biodiversity attribute, €27.2 and €25 per year for medium biodiversity attribute, €14 and €12.4 per year for high fish attribute, €17.2 and €18 per year for medium fish attribute, €12.2 and €2.8 per year for 40000m^2 area of kelp forest that will be restored, €18 and €17.3 per year for 20000m^2 area of kelp forest that will be restored, and €26.7 and €21.4 per year for 10000m^2 area of kelp forest that will be restored. These results indicate that people are willing to pay for the different environmental attributes of restoring the kelp forest habitat restoration. Results for the socio-economics variable show that respondents who use the sea water for diving, swimming, and boating actives are willing to pay for kelp forest habitat restoration. Moreover, respondent having primary and secondary level of education for kelp forest habitat restoration. Furthermore, married and single respondents and the respondents affiliated with the environmental organizations are willing to pay for kelp habitat restoration. Students and retired respondents are willing to pay for kelp habitat restoration. Finally, respondents having annual income less than NOK 100,000 are also willing to pay for restoring medium fish abundance. Findings of this study would help the policy makers in examining the main determinants which affect the WTP of the public for kelp forests restorations and in introducing and implementing policy measures which in turn will enable them to restore kelp forests in the country.

Chapter 1: Introduction

Kelp forests have been recognized as one of the most ecologically dynamic and biologically diverse habitats on the planet (Kelly, 2005). The three-dimensional structure of the kelp forest provides habitat, nursery ground and food for a number of organisms. Kelp plants are primary producers, and they are among the most productive systems on earth. The kelp forest produced organic material throughout the year which enhances secondary production also in other surrounding communities. Various fish species heavily depend on kelp habitat for spawning, hatching, nursing and grazing (Gundersen, Bryan, Chen, & Moy, 2016). Some invertebrate and fish species exhibit egg attachment and nest-building in kelp habitats while others such as juvenile and salmon use kelp habitats as an important nursery and refuge grounds. Kelp forest also provide habitat for the prey species used as a forage base by reef fishes (Kelly, 2005).

The kelp forests are not only important for marine biodiversity but it is also import for the humans. The humans use the algae and seaweed from the kelp forest as a food. They also use the kelp alginate for hundreds of different products. In the Nordic region kelp is found along the Norwegian coast, as far west as Iceland and Greenland and east to the Swedish west coast. Norway has the capacity of cultivating 20 million tons of kelp with an annual added value of 40 billion NOK. Since kelp forests are assumed to be crucial habitats for many economic important fish species, therefore, the value creation from fishery and other sea food is high (Steen, Moy, Bodvin, & Husa, 2016).

However, for the last four decades, in the sea of northern Norway dense sea urchin populations increased which destructively grazed kelp forests in widespread areas. In these areas barrens have caused a desert-like sea bed consisting almost entirely of sea urchins (SCUBA, 2018). When urchins are gone, kelp forest could recover along the coast from Nordland, Troms, and Finnmark. We mentioned earlier that kelp forests provide habitats and shelter for a huge number of plant and animal species especially they provide shelter and feeding grounds for juvenile fish. Therefore, kelp forests have high productive marine ecosystem and provide support to a huge number of marine species. On the other hand, sea urchin barrens are low productive marine ecosystems and support few organisms other than the sea urchins themselves (Norderhaug & Christie, 2013).

The restoration of kelp forest in the coast of northern Norway is necessary. Restoring kelp forests would mean an increase in marine biodiversity and an increased contribution to coastal food chains. There are many different ways to restore kelp forests, either by dredging or adding lime to urchin dominated sea floor, or by harvesting urchins intensely (Steen et al., 2016). These approaches would however require some form of financing. One possible way to finance the kelp restoration program is to impose tax on the residents. However, the priori information that the residents are willing to pay the tax for financing such a program is necessary (Salojärvi, 2014). In this regard, the Arctic University of Norway lunched a choice experiment survey and they collected data on the attitude of the general public towards the restoration of kelp forests on the coast of Northern Norway. Using this survey data, the present study aims to identify the factors that affect willingness to pay (WTP) for kelp habitat restoration.

There are quite many studies[1] that analyze the public WTP for the restoration and conservation of the marine environment, marine resources, and beach ecosystem services. However, we hardly found a study which identified the factors that affect WTP for kelp habitat restoration. Therefore, this study provides an appropriate answer to the question: What are the main factors that affect the respondents WTP for kelp habitat restoration. The main objective of this study is to analyze the factors that affect WTP for kelp habitat restoration in Norway using a choice experiment approach. Findings of this study would help the policy makers in examining the main determinants which affect the WTP of the public for kelp forests restorations and in introducing and implementing policy measures which in turn will enable them to restore kelp forests in the country.

After detailed introduction of the study in the second chapter, relevant literature is reviewed. The methodology is discussed in third chapter while the survey design and data are given in chapter 4. Results and discussion are given in chapter 5, and conclusion is given in the last chapter.

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[1] These studies are given in the literature review chapter.

Chapter 2: Literature Review

In this chapter, I review the literature on the willingness to pay (WTP) for the restoration of ecosystem services provided by the marine environment, marine resources, beaches, impaired river, impaired lakes, and streams to identify the research gap in the existing studies and the contribution of the current study. First, I present the literature review on WTP for the restoration and conservation of the marine environment, marine resources, and beach ecosystem services, following the literature review on WTP for the restoration and protection of ecosystem services in the impaired river basin, impaired lakes, and streams. Then, I present the literature review on WTP for the restoration of the coastal reef and coastal lagoons and benefits from kelp forests and kelp habitats restorations. Finally, I discuss the research gap in the existing studies and the contribution of the current study.

2.1. WTP for the restoration and conservation of the marine environment, marine resources, and beach ecosystem services

There has been the degradation of marine ecosystem services due to human impacts. Recently, the restoration of the marine environment is gaining increasing attention of various researchers. For an instant, Frau (2010) quantified societal preferences and economic support regarding Marine protected areas (MPAs) in Wales, United Kingdom by using a choice experiment method. Results of the study indicated that 81% of the respondents supported the establishment of MPAs. Moreover, they are WTP on average £60.4 per year for the marine environment conservation program. In a similar fashion, Yu et al (2018) identified the factors that influence the stakeholders' preferences for marine environment conservation. They focused on two MPAs in Zhejiang Province, China. They used a contingent valuation method to measure the WTP for the conservation of MPAs. The results of the study showed that most of the respondents were willing to pay for the conservation of MPAs. They were willing to pay $34.3 per year and $27.4 per year for the conservation of MPAs in the Nanji Islands and Putuo Islands, respectively. Moreover, the respondent WTP was closely related to their environmental awareness, whereas the respondents' payment amount was related to their personal income.

Salojärvi (2014) carried out a study for the improvement of the ecological status in the Gulf of Finland using a choice experiment approach. He used four attributes for ecological status including populations of key species, visibility of the key species, intensity and duration of algal blooms, and possibilities for recreational fishing. He presented various management measures for the improvements of each of the four attributes and observed the choice of respondents for each attribute. He estimated the resulting benefits from the improvement in each ecological attribute by using multinomial logit and random parameters logit models. The results of the study confirmed that improvements in the environmental status of the Gulf of Finland provided certain benefits for Finns. The results also confirmed that the respondents were willing to pay more for the reduction in algal blooms (€136 per year) followed by improvements in the populations of key species (€116.2 per year), and recreational fishing possibilities (€91.4 per year), whereas the respondents were willing to pay less for visibility of key species (€24.6 per year).

Enriquez-Acevedo et al (2018) analyzed the WTP for beach ecosystem services using data from 5425 respondents at three beaches in the Colombian Caribbean Region. Results of the study showed that 70% of respondents were willing to pay for the maintenance of beach ecosystem services. At two beaches, the respondents were willing to pay on average 3.40 US$ monthly, while at the third beach they were willing to pay on average 6.80 US$ monthly. Moreover, the respondents' WTP did not depend on their income and employment, whereas variables related to perception had a determining impact on their WTP.

Ahtiainen et al (2014) extended the issue to Baltic Sea and examined the respondents' WTP for decreasing eutrophication in the Baltic Sea through Baltic Sea Action Plan. The study used a dataset consisted of 10500 respondents conducted in nine Baltic littoral countries in 2011. The results of the interval regression model indicated that the majority of respondents in the nine countries were willing to pay for the improvement of the whole Baltic Sea. The respondents' who plan to visit the Baltic Sea in future, the respondents who consider no substitute for Baltic Sea, and the respondents who are aware of the environmental problems in the Baltic Sea were willing to pay more for the Baltic Sea Action Plan. Besides, high income and high educated respondents were also willing to pay more for the Plan.

Aanesen et al (2015) focused on cold-water coral found in the Norwegian coast and analyzed the WTP for the protection of cold-water coral. They collected data from 397 respondents who participate in the workshops regarding marine resources protection. The results of the study indicated that respondents were willing to pay EUR 166 annually for the protection of fish habitats, they were willing to pay EUR 39 and EUR 16 annually, if the protected area was attractive for the fisheries or for the oil industry, and they were willing to pay EUR 53 to EUR 60 if the size of the protected area increases. The results of the mixed logit model and multinomial logit model showed that retired respondents were more willing to pay for further protection in the case of small size protection while respondents working part-time were less willing to pay for further protection. Moreover, male respondents and those with higher personal income were willing to pay more for the fish attribute, whereas students were less willing to pay for the fish attribute. Furthermore, members of an environmental organization were more willing to pay for the oil/gas and habitat attributes. Finally, respondents working in the oil industry and in the public sector and respondents living in the coastal areas were willing to pay more for the habitat attribute.

Börger & Piwowarczyk (2016) extended the issue to seagrass meadows and identified the non-market benefits provided by seagrass meadows in the Gulf of Gdansk, Poland. They collected data from 500 respondents. The results of the study showed that 50% of respondents supported active protection of seagrass and they were willing to pay €14.48 per year for a program to restore seagrass. The results from the logit model showed that middle-aged respondent and respondents with bigger household size are willing to pay less for the seagrass restoration program. Whereas the respondents have high income and the respondents having more children are willing to pay more for the seagrass restoration program.

2.2. WTP for the restoration and protection of ecosystem services in impaired river basin, impaired lakes, and streams

Improving the eco-system services is yielding certain environmental, economic, and social benefits. Therefore, restoration of eco-system is gaining increasing attention of various researchers. For an instant, Loomis et al (2000) measured the total economic value of restoring ecosystem services in an impaired South Platte river basin, United States of America. They also determined the factors influencing the WTP of households for restoring ecosystem services. They collected data by a personal interview from 100 households. Results of the study indicated that households would pay an average of $21 per month or $252 annually for the restoration of ecosystem services of impaired waters. The results from the logit model showed that those households who supporting government purchase of land along the Platte River, household belonging to an environmental group, and suburban and urban households were more willing to pay for restoring ecosystem services. Whereas the households who agreed with the right of farmers to use their entire water right and households who received high water bill were less willing to pay for restoring ecosystem services.

Grazhdani (2013) also carried out a similar study for the Buna river basin, Albania. He collected data by a survey questionnaire from 268 households. Results of the study indicated that households would pay an average of €2.1 per month or €25.2 annually for the restoration of ecosystem services. He derived almost similar results from the logit model as derived by Loomis et al (2000). On the other hand, Welle & Hodgson (2008) focused only on the total WTP of property owners for the restoration of water quality in impaired lakes within two watersheds Sauk COL and Lake Margaret-Gull. They used the contingent valuation method to estimate the WTP of property owners for water quality improvements resulting from reduced nutrient loads. For the purpose, they collected data from property owners and for empirical estimation they employed a logistic regression. The results of the study showed that property owners were willing to pay $267 for the restoration of Margaret-Gull water quality, whereas they were willing to pay only $17 for the restoration of Sauk COL water quality. The extreme differences in WTP result from huge differences in the mean values for the variables between the watersheds. The Margaret-Gull has a high degree of surface water as a percentage of watershed land compared to Sauk COL, and consequently a high proportion of lakeshore owners relative to the overall population of property owners in the watershed. The Margaret-Gull also has many highly-valued lake properties owned by people with high incomes and a large amount of recreational use by lake owners and visitors.

Instead of analyzing the individuals or households WTP for water quality improvements, Marsh et al (2011) investigated a community's WTP for water quality improvements in streams by employing a mixed logit model. They collected data from 173 respondents through questionnaire by employing choice experiment approach for five water quality attributes namely, suitability of water for swimming, the ecology of the water, native, number of fish and eels in the water, amount of trout in the water, and water clarity. The results of the study revealed that respondents were willing to pay more for suitable for swimming and trout attributes of the water, whereas they were willing to pay less for ecology, native, and number of fish and eels attributes of the water.

Sarkar (2011) extended the issue to lake conservation and examined the shoreline residents WTP for participating in lake conservation. He used a contingent valuation survey of shoreline residents on two lakes with different water qualities: East Pond and North Pond. He carried out a non-parametric analysis and concluded that income, age, lake association membership, and water quality perceptions were the most significant determinants of willingness-to-pay for lake conservation. In a similar fashion, Huang et al (2013) examined public demand for ecosystem improvement at Hongze Lake by employing contingent valuation method. They collected data from 520 respondents living around the lake about their WTP for a hypothetical improvement in the water quality of Hongze Lake and their willingness to accept (WTA) certain compensation if the hypothetical improvements were not carried out. The results of the study revealed that respondents are willing to pay and willing to accept $1981.56 per year and $9696.96 per year, respectively for the ecological restoration program. This great disparity between WTP and WTA largely drive by the differences in the respondents' income and education. The results of the econometric analysis indicated that WTP increased along with an increase in income, while WTA decreased as education increased. Moreover, the ratio of WTP and WTA increased as income increased and decreased as education increased.

Moore et al (2015) shifted their analysis from Lakes water quality improvement to Bay water quality improvement. They used a discrete choice experiment response system to examine households' WTP for water quality improvements in the Chesapeake Bay. They collected data from the households in the 17 states of the eastern U.S. and the District of Columbia. The results of the study showed that benefits from improving water quality in freshwater lakes in the watershed are an important ancillary benefit likely to result from reducing pollution in the Bay.

2.3. WTP for the restoration of the coastal reef and coastal lagoons

Coastal reefs and lagoons in marine protected areas provide habitat for biodiversity, therefore the conservation of coastal reef and lagoons is the agenda of various researchers. Kirkbride-Smith et al (2016) investigated the consumer surplus associated with visitor use of a marine protected area in Barbados. They collected data from 250 visitors' on perceptions of artificial reefs, reef material preferences, and reef conservation awareness. They found that the visitors are willing to pay US$18.33 daily for natural reef and US$17.58 daily for the artificial reef. They also found that the age of respondent, familiarity with the Folkestone Marine Reserve, and level of environmental concern are the main determinants that significantly affect the WTP for reefs. The results of the regression analyses indicated that visitors were willing to pay a significant amount to view marine life. On the basis of the results of the study, they suggested that marine park user fees could provide a considerable source of income to aid reef conservation in Barbados.

De Wit et al (2017) focused on coastal lagoons and analyzed the WTP for the ecological restoration of coastal lagoons. They used multiple contingent valuations for four different management options for the Méjean lagoon. They conducted face-to-face interviews with 159 respondents. The results of the study showed that local populations were willing to pay €25 per year for ecological restoration, whereas they were willing to pay only €5 for additional footpaths and hides. On the other hand, Li et al (2018) analyzed the factors influencing inn operators' WTP for Erhai Lake Resource Protection Fee. The results of the study showed that institutional trust, payment for environmental services cognition, and attitudes toward support significantly affected inn operators' WTP for Erhai Lake Resource Protection Fee.

2.4. Benefits from kelp forests and kelp habitats restorations

Coastal ecosystems of the Nordic countries provide a number of supporting, provisioning, regulating and cultural ecosystem services to both the local communities as well as the wider population who benefit from them. The aim of Gundersen et al (2016) study was to give an overview of the available information on the benefits and values of ecosystem services in the coastal zone of the Nordic countries, through illustrations and selected examples. They selected four ecosystem services such as kelp forests, eelgrass meadows, blue mussel beds, and shallow bays and inlets. The study specified a number of benefits associated with the kelp forests. For an instant, the kelp forest provides habitat, nursery ground, and food for a myriad of mobile pelagic and benthic organisms. Moreover, human uses kelp as a fertilizer, and as a biofuel. Furthermore, kelp forests are amazingly resilient to natural disturbances such as wave impacts, storm surges, and other extreme oceanographic events. Finally, kelp forest provides certain ecosystem services related to tourism such as scuba diving, whereby people actually enjoy watching a healthy kelp forest with its associated biodiversity.

Since kelp forests support various ecosystem functions and provide several ecosystem services. Therefore, various researchers considered that the restoration of kelp forests is necessary.

For an instant, for the restoration of kelp beds, Watanuki et al (2010) introduced citizens volunteer divers for the removal of sea urchin near Kamoenai Fishing Port on the southern coast of Shakotan Peninsula in September 2005. After removing the sea urchin they found a significant increase in the kelp bed. Therefore, they suggested that the removal of sea urchin by citizens' volunteer divers programs can help the restoration of kelp beds. Claisse et al (2013) extended the issue to kelp habitat restoration and investigated the potential of kelp forest habitat restoration in California by using a generalized linear model. Results of the study indicated that kelp forest habitat restoration could increase gonad biomass available to the fishery by 864%, and increase reproductive potential per unit area of urchin barren restored to kelp forest by 132%. This result indicated that kelp forest habitat restoration has the potential to play an important role in ecosystem services provided by kelp forests. On the other hand, Houston (2017) extended the issue to the growth of kelp forest and kelp forest habitat. He developed a geographic model for the prediction of future kelp growth in British Columbia, Canada. He found that in the future 92824 ha of the temperate rocky reef and stable mixed substrates will be a shift from urchin barrens to kelp forests. This represents 80% of the total area of suitable habitat for kelp forest growth. The remaining 20% of the total area represents non-affected urchin barrens areas of potential kelp forest habitat.

Kelp forest ecosystems provide important habitats for various invertebrates, fish, seabirds, and sea mammals. The humans harvested kelp forests for industrial purposes on a global scale without knowing about the multi-trophic consequences of this habitat removal. Some researchers identified the adverse impact of kelp forest harvesting. For an instant, Lorentsen et al (2010) investigated how kelp fisheries influence local food webs and the availability of food to a marine top predator. They conducted experimental harvesting of the canopy-forming kelp from 2001 to 2003 in an area at the coast of Central Norway. The results of the study showed that kelp harvesting affects fish abundance and diminishes coastal seabird foraging efficiency. In a similar fashion, Krumhansl et al (2017) examined the ecosystem consequences of an artisanal kelp fishery and found that small scale harvest of kelp has a little adverse impact on the economic benefits provided by these ecosystems, and on their inherent, spiritual, and cultural value to humans. However, they pointed out that in the future there is possible that the small scales harvest may lead to an increase in the global ocean temperature.

2.5. Research gap in the existing studies and contribution of the current study

The results of the above studies showed that respondents were willing to pay for the restoration and conservation of the marine environment, marine resources, and beach ecosystem services. Moreover, respondents are also willing to pay for the restoration and protection of impaired river basin eco-system services, impaired lakes, streams, coastal reef, and coastal lagoons. For assessing the respondents' WTP, most of these studies used a choice experiment approach and contingent valuation approach. These studies also identified a wide range of factors that significantly affect the respondents' WTP using binary logit, multinomial logit, mixed logit, random parameters logit, Tobit, and interval regression models. Besides, some studies identified the adverse impact of kelp forests harvesting while others highlighted the main benefits of the restoration of kelp forests and kelp habitats. However, none of these studies identified the factors that affect WTP for kelp habitat restoration. Therefore, in this study, I identify the factors that affect WTP for kelp habitat restoration in Norway using a choice experiment approach.

Chapter 3: Methodology

In this chapter, we provide complete information on the methodology used in this study. In the first section of this chapter, we discuss the choice experiment method. In the second section, we explain the empirical model based on the random utility model, and in the last section, we specified the empirical model that is used in this study.

3.1. Choice experiment method

Lancaster (1966) provided conceptual foundations for the choice experiment method. He used a consumer utility maximization theory and developed a characteristics-based approach to analyzing product demand (Bennett & Blamey, 2001; Salojärvi, 2014). Hansen (1969), Louviere & Hensher (1982) and Louviere & Woodworth (1983) were applied the choice experiment method to analyze consumer choice behavior. Adamowicz et al (1998) used the choice experiment method for environmental valuation. Today this is the most popular method widely used by environmental valuation practitioners in their studies (Bennett & Adamowicz, 2001; Hanley et al., 2001; Salojärvi, 2014). The choice experiment method is an attribute-based technique in which respondents are presented with different alternatives defined in terms of environmental attributes and cost. They are then asked to select their preferred alternative. The tradeoffs that they reveal during this exercise between the cost of the proposed options and their environmental attributes are used to derive an implicit estimate of monetary value, under a set of well-qualified assumptions (Marsh et al, 2011). Since the choice experiment method is an attribute-based method, therefore, it allows the separation of values gained from the different attributes of the environmental asset which can bring some advances when considering the valuation of ecosystem services. The choice experiment method is founded on microeconomic theory. The goal of this method is to find out how the wellbeing of society changes when the supply of an environmental good change. To achieve this, in this method the hypothetical change in the provision of the environmental good is defined with the survey instrument and the stated preferences of the respondents are used to derive the welfare estimates (Salojärvi, 2014). In the next sections, we discussed the empirical model and specification of the empirical model.

3.1.2. Empirical model

The choice experiment method is based on random utility theory which derives from McFadden (1974). This theory assumes that an individual knows his/her preferences and the choice behavior of an individual is deterministic. However, from the researcher's point of view, the choice behavior is stochastic, because only part of the individual's preferences can be observed. The random utility model assumes that the utility function (V) of an individual consists of systematic (v) and random error components (μ). Assume individual n obtains utility V_{nj} from choosing option j out of a set of choice alternative $j = 1, \dots \dots . \dots, J$ according to:

$$V_{nj} = v\left(x_{nj}, p_{nj}, \beta\right) + \mu_{nj} \quad (1)$$

where, x_{nj} is the vector of attributes associated with alternative j, p_{nj} is the cost of alternative j, β is the vector of parameters, and μ_{nj} is the random error term not observable to the researcher. The systematic (v) component can be parameterized as follows:

$$V_{nj} = \alpha + \sum_{k=1}^{Z} \beta_k x_{njk} + \beta_p p_{nj} + \mu_{nj} \quad (2)$$

where α is constant, β_k is the preference parameter associated with attribute k, x_{njk} is the attribute k in choice alternative j, and β_p is the parameter on the cost of choice alternative. From equation (2), the willingness to pay for a particular attribute k can be calculated as:

$$WTP_k = -\frac{\partial V_{nj}/\partial x_{njk}}{\partial V_{nj}/\partial p_{jn}} = -\frac{\beta_k}{\beta_p} \quad (3)$$

The marginal willingness to pay shows that how much money a respondent is willing to pay for the improvement of a certain level of an environmental attribute.

For the estimation of the parameters in the random utility function, we use the conditional logit and mixed logit models[2]. Let the individual n have two alternatives i and j in the choice set C the random utility model for each alternative is given as:

$$V_{ni} = v_{ni} + \mu_{ni}, \forall i \in C \quad (4)$$

[2] Mixed logit model is also known as random parameters logit model or error-components logit model.

$$V_{nj} = v_{nj} + \mu_{nj}, \forall j \in C \quad (5)$$

The probability that individual n chooses alternative i in choice set C can be expressed as:

$$Prob(i| C) = Prob(V_{ni} > V_{nj}), \forall j \in C \quad (6)$$

$$Prob(i| C) = Prob(v_{ni} + \mu_{ni} > v_{nj} + \mu_{nj}), \forall j \in C \quad (7)$$

$$Prob(i| C) = Prob(v_{ni} - v_{nj} > \mu_{nj} - \mu_{ni}), \forall j \in C \quad (8)$$

As indicated by McFadden (1974) and McFadden & Train (2000), using the probability function (8), assuming that the preference structure is homogenous over respondents, the choices are independent of irrelevant alternatives, and the error terms are independently and identically distributed leads to the conditional logit model where the probability of individual n to choose alternative i in choice set C is:

$$Prob(i| C) = \frac{\exp(v_{ni})}{\sum_{j \in C} \exp(v_{nj})} \quad (9)$$

The function for the probability that individual n chooses choice alternative i from choice set C can be written as:

$$Prob(i| C) = \frac{e^{\sum_{k=1}^{Z} \beta_k x_{nik} + \beta_p p_{ni}}}{e^{\sum_{k=1}^{Z} \beta_k x_{njk} + \beta_p p_{nj}}} \quad (10)$$

The parameters of the probability function can be estimated through a maximum likelihood procedure. If N represents the sample size, we define that $y_{in} = 1$ if individual n choose alternative i, and $y_{in} = 0$ if otherwise, then the likelihood function for the conditional logit model can be written as:

$$L = \sum_{n=1}^{N} \sum_{i \in C} P_n(i)^{y_{in}} \quad (11)$$

By substituting equation (10) into equation (11) and taking a natural logarithm, the conditional logit model is estimated by finding the values of the $\beta's$ that maximize the log-likelihood function:

$$lnL = \sum_{n=1}^{N} \sum_{i \in C} y_{in} (\sum_{k=1}^{Z} \beta_k x_{nik} + \beta_p p_{ni} - ln \sum_{j \in C} (\sum_{k=1}^{Z} \beta_k x_{njk} + \beta_p p_{nj})) \quad (12)$$

The conditional logit model is based on two assumptions. The first one is the preference structure is homogenous over all individuals, and the second one is the choice of an individual is independent of irrelevant alternatives. The first assumption implies that every individual in the population has the same preferences and thus the same beta coefficients. The second assumption implies that adding other alternatives into a choice set does not affect the ratio of probabilities between any two alternatives (Holmes & Adamowicz, 2003; Salojärvi, 2014). However, these assumptions do not often hold. Therefore, the econometric literature provides two methods to relax the first assumption. The first method is to include the interaction effects of the socio-economic characteristics of the respondents into the conditional logit model, but in this method, the researcher needs to know which characteristics cause preference heterogeneity which is a difficult task. Another option is to use the mixed logit model that adds the possibility of preference heterogeneity into the estimated model and allows each individual to have unique preferences (Revelt & Train, 1998). The mixed logit model captures heterogeneity in the sample by estimating the mean and variance (Hynes et al., 2008). To construct a mixed logit model, equation (1) is modified to include an individual r specific stochastic component for each β:

$$V_{rj} = D_{rj} + \mu_{rj} \tag{13}$$

$$V_{rj} = x_{rj}(\beta + \eta_{rj}) + \mu_{rj} \tag{14}$$

where V_{rj} is the utility of individual r from option j, D_{rj} is the deterministic part of utility captured by the vector of attributes x_{rj}, $(\beta + \eta_{rj})$ is the sum of parameter estimate β and individual specific stochastic parameter component η, and μ_{rj} is the error term. Using this formation equation (9) becomes the mixed logit model where the probability of an individual to choose alternative i in choice set C is:

$$Prob(i| C) = \frac{e^{x_{ri}(\beta+\eta_{ri})}}{\sum_{j\in C} e^{x_{rj}(\beta+\eta_{rj})+\mu_{rj}}} \tag{15}$$

In contrast to the conditional logit model, the stochastic part of utility now may be correlated among alternatives and across the sequence of choices through the common influence of η_r (Banzhaf et al, 2001). In the mixed logit model, since the probability is conditional on the random terms the unconditional probability is obtained by multiple integrations and there exists no closed form expression of (15). Instead, it can be simulated by averaging over D draws from the assumed distributions (Revelt & Train, 1998). As a result, the simulated log-likelihood function becomes:

$$lnL = \sum_{r=1}^{R} ln \frac{1}{D} \sum_{d=1}^{D} \frac{e^{x_{ri}(\beta+\eta_{ri})}}{\sum_{j\in C} e^{x_{rj}(\beta+\eta_{rj})+\mu_{rj}}} \quad (16)$$

The specific form of the model is given in the next section.

3.2. Model specification

In the choice experiment method respondent n were asked to make six choices between the given environmental scenarios offered at various prices. The choices were analyzed with conditional and mixed logit models with choice attributes, a cost variable, socio-economic variables, and demographic variables. The estimated model is specified as:

$$\begin{aligned} V_{nj} = {} & \alpha + \beta_{1j}Biod\_hig_n + \beta_{2j}Biod\_med_n + \beta_{3j}Fish\_hig_n + \beta_{4j}Fish\_med_n \\ & + \beta_{5j}Kelp\_area1_n + \beta_{6j}Kelp\_area2_n + \beta_p p_{nj} + \beta_{7j}Wateruser_n \\ & + \beta_{8j}Edu\_prim_n + \beta_{9j}Edu\_sec_n + \beta_{10}\ Married_n + \beta_{11j}Single_n \\ & + \beta_{12j}Single_n + \beta_{13j}HHsize_n + \beta_{14j}Environment_n + \beta_{15j}Fulltime_n \\ & + \beta_{16j}Parttime_n + \beta_{17j}Student_n + \beta_{18}\ Retired_n + \beta_{19j}unemployment_n \\ & + \beta_{20j}Income_n + \beta_{21j}Age_n + \beta_{22}\ Male_n + \mu_{nj} \end{aligned} \quad (17)$$

where $Biod\_hig_n$ is a binary variable which is equal to 1 if respondent choose a high abundance biodiversity attribute and 0 otherwise, $Biod\_med_n$ is a binary variable which is equal to 1 if respondent choose a medium abundance biodiversity attribute and 0 otherwise, $Fish\_hig_n$ is a binary variable which is equal to 1 if respondent choose a high abundance juvenile fish attribute and 0 otherwise, $Fish\_med$ is a binary variable which is equal to 1 if respondent choose a medium abundance juvenile fish attribute and 0 otherwise, $Kelp\_area1_n$ is a binary variable which is equal to 1 if respondent choose 40000m^2 area of kelp forest that is restored and 0 otherwise, $Kelp\_area2_n$ is a binary variable which is equal to 1 if respondent choose 20000m^2 area of kelp forest that is restored and 0 otherwise. p_{nj} is the cost of alternative j. $Wateruser_n$ is a binary variable which is equal to 1 if the respondent sea water for swimming, diving, boating etc., 0 otherwise. Edu_prim_n is a binary variable which is equal to 1 if the education level of respondent is primary and 0 otherwise, Edu_sec is a binary variable which is equal to 1 if the education level of respondent is secondary and 0 otherwise, $Married_n$ is a binary variable which is equal to 1 if the respondent is married and 0 otherwise. $Single_n$ is a binary variable which is equal to 1 if respondent is single and 0 otherwise, $HHsize_n$ is the household size of the respondent, $Environment_n$ is a binary variable which is equal to 1 if respondent is affiliated to the environmental organization and 0 otherwise. $Fulltime_n$ is a binary variable which is equal to 1 if respondent is full-time employed and 0 otherwise. $Parttime_n$ is a binary variable which is equal to 1 if respondent is part-time employed and 0 otherwise. $Student_n$ is a binary variable which is equal to 1 if respondent is student and 0 otherwise. $Retired_n$ is a binary variable which is equal to 1 if respondent is retired and 0 otherwise. un$employment_n$ is a binary variable which is equal to 1 if respondent is unemployed and 0 otherwise, $Income_n$ is personal income of the respondent. Age_n is the age of the respondent, and $male_n$ is a binary variable which is equal to 1 if respondent is male and 0 otherwise. α is constant, β_j, s is the parameter associated with attribute, socio-economic, and demographic variables, β_p is the parameter on the cost of choice alternative, and μ_{nj} is the random error term. To analyze the factors that affect willingness to pay for kelp habitat restoration, we estimate the above model using conditional logit and mixed logit regressions.

Chapter 4: Survey Design and Data

In this chapter, the survey process and data collection method are explained. First, the survey process and questionnaire structure are explained. Then choice attributes and experimental design is discussed. Finally, the sample size, the name of region, and cities where data is collected are discussed.

4.1. The survey

In this study, we use the survey data collected by the Arctic University of Norway. The university designed the survey questionnaire in April 2017, and the data collection process took place between 21st March till 3rd April 2018. The objective of the survey was to assess the attitude of the general public towards the restoration of kelp forests on the coast of Northern Norway. In this survey, respondents are presented with hypothetical kelp forests restoration scenarios, which will lead to changes in scenarios. It is also explained that each kelp forest restoration action can only be implemented at a certain cost. Respondents were then asked to indicate their preferred option from a set of kelp forest restoration scenarios. The choice options were described with a set of three choices attributes specifying the effects that the hypothetical restoration scenario will have. Finally, the values respondents attach to the different attributes are considered as their willingness to pay (WTP).

The final questionnaire consisted of four sections. Section one contained some questions pertaining to the respondent's interest in visiting the seaside, their awareness of marine protected areas (MPAs), marine restoration activities, invasive species, endangered species, and their awareness of kelp beds/forests. This section also evaluates the respondents' support for marine eco-system restoration and the damage caused by humans to marine eco-system. Section two introduced the valuation framework and the hypothetical kelp forests restoration program. This included the description of the choice attributes and their associated cost. Section three contained the actual choice experiment as well as several debriefing questions regarding choice certainty, and whether the respondent considered all or just some choice attributes when making his/ her choices. Section four had a series of socio-economic questions, which are needed to characterize potential subgroups of respondents who exhibit differing valuations of the choice attributes. The overall structure of the questionnaire is shown in table 4.1 whereas the complete questionnaire is given in the Appendix.

Table 4.1: Structure of the questionnaire

Section	Content
	Pre-survey questions: The respondent's age, gender, zip code, city, region, and municipality.
A	General attitude: The respondent visit to the seaside and the purpose of this visit. His/her awareness of Marine Protected Areas (MPAs), marine restoration activity, invasive species endangered species, and his/her knowledge of kelp beds/forests. The satisfaction level of the respondent from the general environmental quality of water bodies such as fjords, coastal waters, and deep sea. The respondent support for ecosystem restoration. The respondent view on the damaged caused by human activities to the marine ecosystem.
B	Valuation scenario of kelp forest restoration characteristics
C	Follow-up questions
D	Socio-economic characteristics: The respondent's education level, marital status, number of children, work status, personal income, and household size. The affiliation of the respondent or his/her family member to the environmental organization

4.2. Choice attributes

Each scenario contained four attributes; biodiversity, nurseries for juvenile fish, and area of kelp forest restored, and the associated costs. The first attribute was biodiversity, which refers to the species diversity and abundance in an area of kelp forest that will be restored and is defined by the number of species present per m^2, as well as the composition of the abundance. The biodiversity attribute was described by three different levels such as low abundance means maximum 10 species present, medium abundance means maximum 75 species present per m^2, and high abundance means up to 200 species or more present per m^2 in the area of kelp forest that will be restored. The second attribute was nurseries for juvenile fish, which refers to the number of juvenile fish present per m2 in the area of kelp forest that will be restored. The nurseries for juvenile fish was described by three different levels such as low abundance means maximum 10 juveniles present per m^2, medium abundance means maximum 20 juveniles present per m2, and high abundance means maximum 30 juveniles present per m^2 in the area of kelp forest that will be restored. The third attribute was the area of kelp forest that will be restored. Area of kelp forest was described by three different levels such as $40000m^2$, $20000m^2$, and $10000m^2$ that will be restored.

The annual income tax paid during 2018–2028 (10 years) was chosen as the payment vehicle. An income tax was chosen because it is easy to understand by the respondents, and it is a fairly simple money collection method. The income taxes were also considered to be rather well approved in Norway so it was expected that it would not yield too many protests. All the attributes, their levels, and description are shown in table 4.2.

Table 4.2: Choice attributes

Attribute	Description	Level
Biodiversity	Abundance of macroinvertebrate species per m2	Low abundance: Maximum 10 species present per m^2 Medium abundance: Maximum 75 species present per m^2 High abundance: Up to 200 species or more present per m^2
Nurseries for juvenile fish	Juvenile fish abundance per m2	Low abundance: Maximum 10 juveniles present per m^2 Medium abundance: Maximum 20 juveniles present per m2 High abundance: Maximum 30 juveniles present per m^2
Total area of kelp forest restored	Area of kelp forest that is restored	$10000m^2$, $20000m^2$, $40000m^2$
Price	Increase in annual personal income tax until 2028	€0, €5, €10, €20, €30, €45, €60

4.3. Experimental design

In the experiment, the respondents were first divided into two blocks. In each block, six cards were presented to the respondents. In each card different combinations of the restoration scenarios and the associated cost in term of an annual increase in personal income tax were presented. Each choice card included two generic scenarios with associated cost and a status quo (no change) option without further restoration actions implemented and a zero cost. In each block, on the six choice cards with three options a total of 18 pair-wise comparisons of alternative restoration scenarios were constructed. The respondents are requested to select option A, option B or no change option in the presented six cards. An example of a choice card is given in figure 4.1.

Figure 4.1: Choice Card

	Option A	Option B	No Change
Biodiversity (abundance of macroinvertebrate species)	Medium abundance (approx. 75 species).	Low abundance (approx. 10 species)	Low abundance (approx. 10 species)
Nurseries for juvenile fish: Juvenile fish abundance per m2	Low abundance	High Abundance	Low abundance
Total area of kelp forest restored	20,000m2 (3 soccer pitches)	40,000m2 (5.5 soccer pitches),	None
Annual increase in personal income tax	€5	€45	€0
Register choice:			

4.4. Data collection

The data was collected in 6 regions and 18 cities of Norway. The data was collected from 1013 respondents' through a random sampling technique. The name of regions and cities where the data was collected is given in table 3 and table 4, respectively.

Table 4.3: Name of regions where data is collected

No	Region name	No	Region name
1	Midt-Norge	4	Sørlandet inkludert Telemark
2	Nord-Norge	5	Vestlandet
3	Oslo	6	Østlandet

Table 4.4: Name of cities where data is collected

No	City name	No	City name
1	Akershus	10	Oslo
2	Aust-Agder	11	Rogaland
3	Buskerud	12	Song og Fjordane
4	Finnmark	13	Telemark
5	Hedmark	14	Troms
6	Hordaland	15	Trøndelag
7	Møre og Romsdal	16	Vest-Agder
8	Nordland	17	Vestfold
9	Oppland	18	Østfold

Chapter 5: Results and Discussions

In this chapter, we present the empirical results of conditional and mixed logit models. In the first section of this chapter, we discuss the desciptive statistics and definitions of the variables used in the regression models. In the second section, we discuss the results of the conditional and mixed logit models and its corresponding willingness to pay (WTP). In the last section we discuss the results of the conditional and mixed logit models with socio-economic characteristics of the respondent.

4.1. Descriptive statistics

Table 5.1 presents the descriptive statistics and definition of the important variables used in regression models. In the first section of the table we define the variables specific to the scenarios/options. However, we do not provide the mean and standard deviation of these variables in the table. In the second section of the table we define the variables specific to socio-economic characteristics of the respondent and also their mean and standard deviation. We find that about 55% respondents use the sea water for diving, swimming, boating etc. It is observed that the share of respondents with secondary level education (0.3040) is higher than that of the share of respondents with primary level education (0.0434). We also find that the share of the married respondent is also higher than that of the share of the respondent who are single. we find that 58% of the respondents have children. We find that the mean household size of the respondents is 2.3. The shares of environment show that relatively lower number of respondents are affiliated with the environmental organizations. The share of the employed status of the respondents shows that about 46% of the respondents are full employed while the remaining respondents are retired, students, part-time employed, and few of them are unemployed. It is found that the share of respondents having income less than NOK 100,000 is 4.7%. Mean age of the respondents is 46.8 years. The share of male show that about 47% of the respondents are male.

4.2. Results of the conditional and mixed logit models

In this section, we present the results of conditional and mixed logit regression to examine factors that affect WTP for kelp habitat restoration. Since the data is divided into two blocks, each block

Table 5.1: Descriptive statistics of variables use in the regression models

Variables	**Definition**	
Variables specific to scenarios/options		
Biod-hig	1 if respondent choose a high abundance biodiversity attribute, 0 otherwise	
Biod-med	1 if respondent choose a medium abundance biodiversity attribute, 0 otherwise	
Fish-hig	1 if respondent choose a high abundance juvenile fish attribute, 0 otherwise	
Fish-med	1 if respondent choose a medium abundance juvenile fish attribute, 0 otherwise	
Kelp-area1	1 if respondent choose 40000m^2 area of kelp forest that is restored, 0 otherwise	
Kelparea2	1 if respondent choose 20000m^2 area of kelp forest that is restored, 0 otherwise	
Kelparea3	1 if respondent choose 10000m^2 area of kelp forest that is restored, 0 otherwise	
P	Price/Cost of alternative *j* for kelp habitat restoration	
Variables specific to the socio-economic characteristics of the respondent	**Definition**	**Mean and standard deviation**
Water user	1 if the respondent sea water for swimming, diving, boating etc., 0 otherwise	0.549 (0.497)
Edu-prim	1 if the education level of respondent is primary, 0 otherwise	0.0434 (0.2039)
Edu-sec	1 if the education level of respondent is secondary, 0 otherwise	0.3040 (0.46023)
Married	1 if the respondent is married, 0 otherwise	0.4195 (0.4937)
Single	1 if respondent is single, 0 otherwise	0.2369 (0.4254)
Children	1 if the respondent have children, 0 otherwise	0.5807 (0.4934)
HHsize	Household size of the respondent	2.3366 (1.1721)
Environment	1 if respondent is affiliated to the environmental organization, 0 otherwise	0.0967 (0.2957)
Fulltime employed	1 if respondent is full employed, 0 otherwise	0.4582 (0.4982)
Part time employed	1 if the respondent is part time employed, 0 otherwise	0.0970

		(0.2960)
Student	1 if the respondent is student, 0 otherwise	0.1143 (0.3182)
Retired	1 if the respondent is retired, 0 otherwise	0.1896 (0.3920)
Unemployed	1 if the respondent is unemployed, 0 otherwise	0.0154 (0.1232)
Income	1 if annual income of the respondent is less than NOK 100,000, 0 otherwise	0.0473 (0.2125)
Age	Age of the respondent	46.764 (17.58089)
Male	1 if respondent is male, 0 otherwise	0.4689 (0.4992)
Sample size		1013

Note: Standard deviations are in the parentheses consists of six choice cards. However, we combine two choice cards into one data set such as choice card 1 of the first block and choice card 1 of the second block and so on. On this way we established six data set. After, we merge all the six data sets into one file where each respondent faces 18 choice scenarios/options. After arranging the data, we applied conditional and mixed logit regression on this new data set. The conditional logit model considers homogeneous preference for all individuals. This implies that every individual in the population has the same preferences and thus the same beta coefficients. However, individual preferences are not always homogeneous it is heterogeneous such as each individual has different preferences. For the purpose we estimate mixed logit model that adds the possibility of preference heterogeneity into the estimated model and allows each individual to have unique preferences. The mixed logit model captures heterogeneity in the sample by estimating the mean and variance. Therefore, we estimate both models, conditional logit model for preference homogeneity while mixed logit model for preference heterogeneity.

Table 5.2 presents the coefficient estimates of conditional and mixed logit regressions with variables specific to scenarios/options and their corresponding WTP estimates. We derived the WTP estimate manually by using the formula given in equation (3) of chapter 3. The reason behind this manual derivation is since we use seven environmental attributes in the estimated regressions, Therefore, we need WTP estimate for each regression, therefore, we estimate WTP for each attribute manually using equation (3). The results of diagnostic tests of the two models are reported in the last panel of table 2. Results of LR chi-squared test show that the regression models are overall statistically significant at 1 percent level for each of two regressions.

The results of the variables specific to scenarios/options are given in the first panel of table 5.2. We find that Biod-high and Biod-med are statistically significant at 1 percent level and signs of the estimated coefficients are positive. This indicates that if biodiversity increases from low to medium or from low to high, (one-unit increase), the probability of that option being chosen increases, and consequently the probability of other options being chosen increases. Whereas, Fish-high and Fish-med are also statistically significant at 1 percent level and the signs of the estimated coefficients are positive. This indicates that if the nurseries of juvenile fish increase from low to medium or low to high, the probability of that option being chosen increases, and consequently the probability of other options being chosen decreases. The coefficient of kelp-area1 is statistically insignificant. Moreover, we find that Kelp-area2, and Kelp-area3 are statistically significant at 1 percent level and the sign of the estimated coefficients are positive. This indicates that if the area of total area of kelp forests increases from 10000m^2 to 20000m^2, the probability of that option being chosen increases, and consequently the probability of other options being chosen decreases. In addition, we find that P is statistically significant at 1 percent level and the sign of the estimated coefficient is negative. This indicates that if the price of kelp forests restoration scenarios increases the probability that the respondents' willingness to pay for kelp forests habitat restoration decreases.

Using the estimated coefficients of variables specific to the choice scenarios and the estimated coefficient of the cost we estimate the respondent willingness to pay (WTP) per year for the seven choice attributes. The second, and fourth column of table 5.2 presents the results of the respondents' WTP for kelp forest habitat restoration. Comparing the results of the conditional and fixed logit model, we find that respondents are willing to pay €18.8 and €18.7 per year for high biodiversity attribute that contains maximum 200 species or more present per m^2 in the area of kelp forest that will be restored. We find that respondents are willing to pay €27.2 and €25 per year for medium biodiversity attribute that contains maximum 75 species or more present per m^2 in the area of kelp forest that will be restored. Moreover, we find that respondents are willing to pay €14 and €12.4 per year for high fish attribute that contains maximum 30 juveniles present per m^2 in the area of kelp forest that will be restored. Furthermore, we find that respondents are willing to pay €17.2 and €18 per year for medium fish attribute that contains maximum 20 juveniles present per m2 in the area of kelp forest that will be restored. In addition, we find that respondents are willing to pay €-0.7 and €2.8 per year for $40000m^2$ area of kelp forest that will be restored. We find that respondents are willing to pay €18 and €17.3 per year for $20000m^2$ area of kelp forest that will be restored. Finally, we find that respondents are willing to pay €26.7 and €21.4 per year for $10000m^2$ area of kelp forest that will be restored.

Mixed logit model also provides standard deviation for the seven environmental attributes. The sign and significance of these standard deviation help to check heterogeneity in the respondents preferences. We find that the standard deviations of all the seven environmental attributes are positive and significant. This means that there is heterogeneity in the respondents preferences. This means that respondents choose different option/scenarios containing different environmental attributes.

Table 5.2: Results of the conditional and mixed logit models with

	Conditional logit model		Mixed logit model	
Variables	**Coefficients**	**WTP (€)**	**Coefficients**	**WTP (€)**
Biod-hig	0.409***	18.8	0.597***	18.7
	(0.0453)		(0.0722)	
Biod-med	0.593***	27.2	0.796***	25
	(0.0430)		(0.0911)	
Fish-hig	0.307***	14	0.396***	12.4
	(0.0446)		(0.0715)	
Fish-med	0.375***	17.2	0.573***	18
	(0.0424)		(0.0828)	
Kelp-area1	-0.0152	-0.7	0.0899	2.8
	(0.0626)		(0.0920)	
Kelp-area2	0.392***	18	0.555***	17.3
	(0.0622)		(0.0958)	
Kelp-area3	0.538***	26.7	0.684***	21.4
	(0.0646)		(0.118)	
Price	-0.0218***		-0.0320***	
	(0.00128)		(0.00183)	
Standard deviation of coefficients				
Biod-hig			1.050***	
			(0.0969)	
Biod-med			2.021***	
			(0.112)	
Fish-hig			0.826***	
			(0.124)	
Fish-med			1.358***	
			(0.126)	
Kelp-area1			0.987***	
			(0.121)	
Kelp-area2			1.285***	
			(0.0947)	
Kelp-area3			2.263***	
			(0.119)	
Observations	19,836		19,836	
LR χ^2 statistics	818.16***		1397.94***	
Log likelihood	-6854.9437		-6155.9747	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Note: Standard errors are in the parentheses

4.3. Results of the conditional and mixed logit models with socio-economic characteristics of the respondents

In the previous section we provide the results of conditional and mixed logit model without including the socio-economic characteristics of the respondents. However, in this section we include the interaction effects of the socio-economic characteristics of the respondents into the conditional and mixed logit models. For the purpose we interacted environmental attributes to the socio-economic characteristics. The results of the conditional and mixed logit model with interaction effect of socio-economic characteristics of the respondents are given in table 5.3. Since we discuss and interpret the results of the environmental attributes, standard deviations of the environmental attributes, price, and WTP in detailed in the previous section. Therefore, in this section we are going to discuss the results of the interaction effects of socio-economic characteristics of the respondents.

We find that all the four coefficients of the interacted wateruser are statistically significant at 5 and 1 percent level and the signs of the estimated coefficients are positive. This indicate that the respondents who use the sea water for diving, swimming, and boating actives are willing to pay for restoring medium biodiversity attribute, and for restoring 10000m^2, 20000m^2, and 40000m^2 of kelp area. We find that Edu-prim* Kelp-area2 is statistically significant at 5 percent level and the sign of the estimated coefficient is negative. This indicates that the respondent having primary level of education is less willing to pay for restoring 20000m^2 kelp area. The coefficient estimates of both the interacted secondary level of education are statistically significant at 1 percent. This indicates that the respondent with secondary level of education is less willing to pay for restoring 10000m^2 and 20000m^2 kelp area. Married* Kelp-area3 is statistically significant at 1 percent level for and the sign of the estimated coefficient is positive. This indicates that married respondents are willing to pay for restoring 10000m^2 of kelp area.

Moreover, we find that the coefficient of Single* Kelp-area1is statistically significant at 10 percent level and the sign of the estimated coefficient is positive. This indicates that the respondents who are single are willing to pay for restoring 40000m^2 of kelp area. The coefficient estimates of Children* Kelp-area1 is statistically significant at 10 percent level and the sign of the estimated coefficient is positive. This indicates that the respondents having children are willing to pay for restoring 40000m^2 of kelp area. The coefficient of the interaction term of household size is statistically insignificant. We find positive and statistically significant coefficients for the four environment intersection variables. This indicates that the respondents affiliated with the environmental organizations are willing to pay for restoring high and medium biodiversity, for medium fish abundance, and for restoring 10000m^2 of kelp area. We find insignificant coefficient for fulltime and part-time interaction variables. Student* Fish-hig is statistically significant at 1 percent level and the sign of the estimated coefficient is positive. This indicate that students are willing to pay for restoring the high fish abundance. Retired* Kelp-area1 is statistically significant at 1 percent level and the sign of the estimated coefficient is positive. This indicate that retired respondents are willing to pay for restoring the 40000m^2 of kelp area. The coefficient of

Unemployed* Kelp-area1 is statistically insignificant. We find that Income* Fish-med is statistically significant at 1 percent level and the sign of the estimated coefficient is positive. This indicate that respondents having annual income less than NOK 100,000 are willing to pay for restoring medium fish abundance. Finally, we find insignificant coefficients for the age and male intersection variables.

Table 5.3: Results of the conditional and mixed logit models with socio-economics characteristics of the respondents

	Conditional logit model		Mixed logit model	
Variables	**Coefficients**	**WTP (€)**	**Coefficients**	**WTP (€)**
Biod-hig	0.358***	16	0.501***	15.2
	(0.0473)		(0.0750)	
Biod-med	0.511***	22.8	0.635***	26.6
	(0.0450)		(0.0935)	
Fish-hig	0.270***	11	0.325***	10
	(0.0484)		(0.0759)	
Fish-med	0.189**	8.4	0.340**	10.3
	(0.0750)		(0.149)	
Kelp-area1	0.282***	12.6	-0.310	-9.4
	(0.0858)		(0.199)	
Kelp-area2	0.372***	16.6	0.475**	14.4
	(0.124)		(0.216)	
Kelp-area3	0.282***	12.6	0.121	3.7
	(0.0858)		(0.169)	
Price	-0.0224***		-0.0329***	
	(0.00130)		(0.00185)	
Standard deviation of coefficients				
Biod-hig			1.046***	
			(0.0908)	
Biod-med			1.935***	
			(0.109)	
Fish-hig			0.642***	
			(0.132)	
Fish-med			1.311***	
			(0.127)	
Kelp-area1			1.034***	
			(0.113)	
Kelp-area2			1.315***	
			(0.0937)	
Kelp-area3			2.205***	
			(0.115)	
Socio-economics characteristics of the respondents				
Wateruser* Biod-med	0.166**		0.246*	
	(0.0690)		(0.139)	
Wateruser* Kelp-area3	0.436***		0.852***	
	(0.0757)		(0.162)	
Wateruser* Kelp-area2	0.340***		0.472***	
	(0.0779)		(0.135)	
Wateruser* Kelp-area1	0.339***		0.417***	
	(0.0829)		(0.127)	
Edu-prim* Kelp-area2	-0.428**		-0.393	
	(0.182)		(0.305)	
Edu-sec* Kelp-area3	-0.327***		-0.652***	
	(0.0730)		(0.165)	
Edu-sec* Kelp-area2	-0.329***		-0.382***	

	(0.0763)	(0.136)
Married* Kelp-area3	0.215***	0.583***
	(0.0662)	(0.155)
Single* Kelp-area1	0.116	0.300*
	(0.0992)	(0.164)
Children* Kelp-area1	0.162*	0.333**
	(0.0913)	(0.148)
HHsize* Kelp-area1	-0.0377	-0.0682
	(0.0349)	(0.0559)
Environment* Biod-hig	0.963***	1.417***
	(0.124)	(0.255)
Environment* Biod-med	0.618***	0.930***
	(0.130)	(0.204)
Environment* Fish-med	0.351***	0.707***
	(0.112)	(0.221)
Environment* Kelp-area3	0.537***	0.786***
	(0.111)	(0.255)
Fulltime* Fish-med	-0.0557	-0.0714
	(0.0651)	(0.130)
Parttime*Fish-hig	0.177	0.222
	(0.108)	(0.179)
Student* Fish-hig	0.271***	0.489***
	(0.101)	(0.170)
Retired* Kelp-area1	0.283***	0.490***
	(0.0994)	(0.162)
Unemployed* Kelp-area1	0.121	0.392
	(0.257)	(0.395)
Income* Fish-med	0.174***	0.159
	(0.0642)	(0.131)
Age* Kelp-area2	-0.000491	6.46e-05
	(0.00196)	(0.00359)
Male* Fish-med	0.0449	0.00928
	(0.0645)	(0.131)
Observations	19,836	19,836
LR χ^2 statistics	1105.12***	1308.41***
Log likelihood	-6711.4669	-6057.2637

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Note: Standard errors are in the parentheses

Chapter 6: Conclusions

This study attempts to analyze the factors that affect WTP for kelp habitat restoration in Norway using a choice experiment approach. The study is based on the survey data collected by the Arctic University of Norway. The data set cover 1013 respondents in 6 regions and 18 cities of northern Norway. The STATA package has been used or estimations. The conditional logit model and mixed logit model is used for empirical estimations. At the first stage of estimation the conditional and mixed logit models are estimated only with seven environmental attributes whereas in the second stage of estimation we include socio-economic characteristics of the respondents to these models.

Comparing the results of the conditional and fixed logit model with environmental attributes, we find that respondents are willing to pay €18.8 and €18.7 per year for high biodiversity attribute, €27.2 and €25 per year for medium biodiversity attribute, €14 and €12.4 per year for high fish attribute, €17.2 and €18 per year for medium fish attribute, €-0.7 (€12.2 in the second model) and €2.8 per year for 40000m^2 area of kelp forest that will be restored, €18 and €17.3 per year for 20000m^2 area of kelp forest that will be restored, and €26.7 and €21.4 per year for 10000m^2 area of kelp forest that will be restored. These results indicate that people are willing to pay for the different environmental attributes of restoring the kelp forest habitat restoration. This is an impetus for policy makers to start project for restoration of kelp forest because peoples are ready to finance such a project.

Results from conditional and mixed models show that respondents who use the sea water for diving, swimming, and boating actives are willing to pay for restoring medium biodiversity attribute, and for restoring 10000m^2, 20000m^2, and 40000m^2 of kelp area. Respondent having primary and secondary level of education is less willing to pay for restoring 20000m^2 kelp area, and 10000m^2 kelp area, respectively. Married respondents are willing to pay for restoring 10000m^2 of kelp area. Respondents who are single and respondents having children are willing to pay for restoring 40000m^2 of kelp area. Respondents affiliated with the environmental organizations are willing to pay for restoring high and medium biodiversity, for medium fish abundance, and for restoring 10000m^2 of kelp area. The students and retired respondents are willing to pay for restoring the high fish abundance and for restoring the 40000m^2 of kelp area, respectively. Respondents having annual income less than NOK 100,000 are also willing to pay for restoring medium fish abundance. These results lied responsibility on the policy makers to devise appropriate kelp forest restoration policy by considering the socio-economic characteristics of the peoples. Findings of this study would help the policy makers in examining the main determinants which affect the WTP of the public for kelp forests restorations and in introducing and implementing policy measures which in turn will enable them to restore kelp forests in the country.

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Appendix

KELP SURVEY QUESTIONNAIRE

Pre-survey questions

What age are you? _________

Are you Male ☐ Female ☐

What is your zipcode? _______

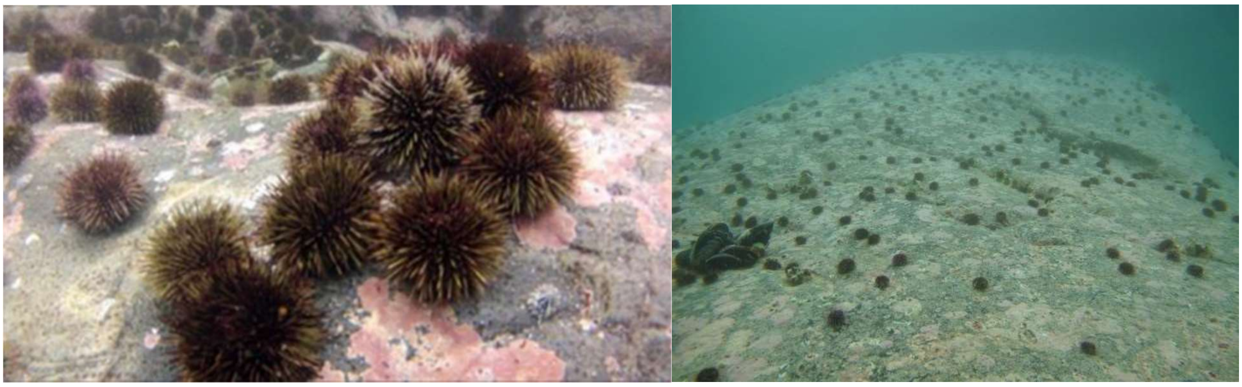
What county do you live in? _________

What region do you live in? _________

What municipality do you live in? _________

UiT The Arctic University of Norway is conducting a survey in relation to the general public's attitudes towards the restoration of kelp forests on the coast of Northern Norway. We would like to ask you a few questions – it will take about 10 to 15 minutes. The answers you give will be completely confidential; your answers will be amalgamated with those of others.

For the last four decades, dense sea urchin populations have destructively grazed kelp forests in extensive areas in northern Norway. In these areas barrens have resulted - a desert-like sea bed consisting almost entirely of sea urchins. When urchins are gone, kelp forest could recover along the coast from Nordland, Troms and Finnmark.



Urchin dominated sea floor

Kelp forests create habitats and shelter for a high number of plant and animal species and provide shelter and feeding grounds for juvenile fish. In contrast, sea urchin barrens are low productive marine ecosystems and support few organisms other than the sea urchins themselves. Restoring kelp forests would mean an increase in marine biodiversity and an increased contribution to coastal food chains.

Kelp Forest

Restoration in other natural environments has been demonstrated to function well. There are many different ways to restore kelp forests, either by dredging or adding lime to urchin dominated sea floor, or by harvesting urchins intensely. These approaches would however require some form of financing.

SECTION A: GENERAL ATTITUDES

Q.A1 HAVE YOU VISITED THE SEASIDE IN THE LAST 12 MONTHS?

Yes / No

Q.A2 IF YES, APPROXIMATELY HOW MANY TIMES DID YOU VISIT FOR THE FOLLOWING PURPOSES IN THE PAST 12 MONTHS?

	No. of **VISITS** in last 12 months
1. For shore side activities such as beach visits, walks, bird watching, etc.	
2. For in water activities such as swimming, snorkelling, diving, etc.	
3. For on water activities such as sailing, boating, canoeing, kayaking, etc.	

Q.A3 AWARENESS

	Yes	No
1. Are you aware of any Marine Protected areas (MPA) in Norway?		
2. Are you aware of any marine restoration activity in Norway?		
3. Are you aware of aware of any invasive species in Norwegian waters?		
4. Are you aware of any endangered species in Norwegian waters?		
5. Do you know of any kelp beds/forests		

Q.A3b FOR EACH OF THE AREAS IN QA3, IF ANSWERED YES:

CAN YOU NAME THE MPA, INVASIVES, RESTORATION, ENDAGERED SPECIES (MORE THAN ONE ANSWER ALLOWED)

	Answer
1. MPA	
2. Location of marine restoration activity	
3. Invasive Species	
4. Endangered Species	
5. Location of Kelp beds/forests	

Q.A4 HOW WOULD YOU DESCRIBE THE GENERAL ENVIRONMENTAL QUALITY OF THESE WATER BODIES IN NORWAY?
Choose one level in each case

	Fjords	Coastal waters	Deep Sea
Very satisfactory			
Satisfactory			
Neither satisfactory nor satisfactory			
Unsatisfactory			
Very unsatisfactory			
Don't know			

Q.A5 SUPPORT FOR ECOSYSTEM RESTORATION?
Choose one level in each case

	Yes	No	Don't Know
Would you pay to support a national ecosystem restoration fund financed by increased tax?			
Would you pay to support a targeted local marine ecosystem restoration project?			
Would you participate in a crowdfunding campaign towards a local marine ecosystem restoration project?			

Q.A6 SUPPOSE A MARINE ECOSYSTEM HAS BEEN DAMAGED BY SOME HUMAN ACTIVITY. IN THIS CASE HOW WOULD YOU RESPOND TOTHE FOLLOWING STATEMENTS:

	Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree	Don't know
A part of marine ecosystems should be restored (e.g. by replanting corals, seagrass or kelp)						
The complete marine ecosystems should be restored in situ.						
A marine ecosystem restored elsewhere that is considered of equal value would also be OK.						

SECTION B: VALUATION SCENARIO OF KELP FOREST RESTORATION CHARACTERISTICS

INTERVIEWER, READ OUT:
This survey is concerned with your opinions about the characteristics of kelp forest restoration in Norwegian waters.For the purposes of this study, we think about kelp forest restoration in terms of **five** characteristics:

The first characteristic is **Biodiversity.**Biodiversity refers to the species diversity and abundance in an area, and is defined by the number of species present per m^2, as well as the composition of the abundance.Low abundance means maximum 10 species present. Medium abundance means maximum 75 species present per m^2. High abundance means up to200 species or more present per m^2 in an area.

Another characteristic is **Nurseries for juvenile fish** which refers to the number of juvenile fish present per m2. Low abundance means maximum 10 juveniles present per m^2. Medium abundance means maximum 20 juveniles present per m2. High abundance means maximum 30 juveniles present per m^2.

Finally, the **Area that is restored** is an important characteristic in our study. In this restoration project we assume the area to be restored will be either 40,000m^2 (approx. 5.5 soccer pitches), 20,000m^2 (approx. 3 soccer pitches) or 10,000m^2 (approx. 1.5 soccer pitches).

Soon you will be presented with six cards. In each card different combinations of the restoration's characteristics are shown describing how the kelp beds might change in the future if restoration actions are taken to improve matters. The cards also show the associated cost on you and your household of such actions. Please consider your own budget and ability to pay when considering each option.

SHOWCARD

Q.B1 Here is **an example** of such a choice card.

INTERVIEWER: PRESENT SHOW CARD AND TALK THROUGH THE CHOICES

	Option A	Option B	No Change
Biodiversity (abundance of macroinvertebrate species):	Medium abundance (max. 75 species).	Medium abundance (max. 75 species).	Low abundance (max. 10 species)
Nurseries for juvenile fish: Juvenile fish abundance per m2	Medium Abundance (max 20 juveniles)	High Abundance (max 30 juveniles)	Low abundance (max 10 juveniles)

Total area of kelp forest restored	20,000m2 (3 soccer pitches)	40,000m2 (5.5 soccer pitches)	None
Annual increase in personal income tax	€5	€45	€0

- In each of the cards like this one you will be given the choice of making no change or selecting one of two alternatives for improvement, which are called Option "A" and Option "B".
- The option of "No Change" remains the same in all the cards and it never involves a payment. It describes the current situation.
- However, choosing Options "A" or "B" would mean an improvement and a cost to you each year for the next 10 years.

For example, Option "A" in this card:

- Represents an option which would lead to a situation where all characteristics are improved (biodiversity, nursery service, total area restored) at a cost of NOK 450 per year.

Option "B":

- Represents an option which would lead to an even higher improvement in nursery services and area restored but the same level of biodiversity as option A. The expected annual cost of this option to you is NOK 600 per year.

Which of the three options would you prefer?

INTERVIEWER, MAKE SURE THE PARTICIPANT UNDERSTANDS THE CHOICE SET. GO THROUGH IT AGAIN IF NECESSARY.

INTERVIEWER, PLEASE READ OUT THE FOLLOWING INFORMATION

You will now be presented with a series of similar choice sets.

- I would like you to identify the option you most prefer for each choice card.
- Remember to consider each of the six choice cards separately and the options presented as if they are real and the only ones available.
- ***There are no wrong or right answers.***We are just interested in your opinion.
- If you think that the amount of money involved with an improvement is too much,***simply choose the "No Change" option.***

Finally, we would like to mention that some people say they are willing to pay more in surveys for these types of improvements in ecosystems than that they actually would pay if the situation were real. This is because when people actually have to part with their money, they take into account that there are other things they may want to spend their money on.

For this reason, please consider:

- The impacts on you and your family of improving the kelp bed ecosystems
- Imagine yourself **actually paying**the amounts specified **for the next 10 years**

USEBLOCK 1 OR 2 SHOWCARDS HERE

SECTION C: FOLLOW-UP QUESTIONS

Q.C1a Thinking about how you made your choice in the abovechoice cards, please indicate which of the following statements are true or false in describing the way you came up with your choice?

		True	False
a)	I considered all characteristics ………………………………………...		
b)	I ignored the biodiversity characteristic		
c)	I ignored the nursery characteristic		
d)	I ignored the total area characteristic		
e)	I ignored the increase in my annual household income tax ...		

Q.C1bIF YOU CHOSE THE "NO CHANGE" OPTION FOR ALL CHOICE CARDS, WHAT WERE YOUR REASONS FOR DOING SO?

Choose One

I cannot afford to pay	
I object to paying taxes	
The restorations are not important to me	
The "No Change" optionis satisfactory	
The Government/Council/other body should pay	
I don't believe the restorations will actually take place	
I didn't know which option was best, so I stayed with the "No Change" option	
I don't use the marine environment	
Other (please specify(________________________)	

Q.C2 The results of this survey will provide information to the authorities such that they can make decisions whether to restore kelp forests or not. Do you think the results from this survey will impact the authorities' decisions?

	Highly agree	Agree	Neither agree or disagree	Disagree	Highly disagree	Don't know
Put in x:						

Q.C3 We are interested in exploring whether levels of self-reported life satisfaction impact the responses in the survey. Could you therefore tell us how happy you are at the moment?

	Very Happy	Happy	Neither Happy or Unhappy	Unhappy	Very Unhappy
Put in x:					

SECTIONF: SOCIO – ECONOMIC CHARACTERISTICS.

Finally, in order to provide us with a profile of the people who have participated in this survey and to make sure that those we are surveying are from a wide range of backgrounds, I'm going to ask you some general questions about yourself. All of the information will be kept anonymous and confidential.

INTERVIEWERS PLEASE ENSURE EVERY QUESTION IS ANSWERED.

F.3 What is your education level to date?

Primary level ☐ Secondary level ☐ Third level ☐ Do not wish to disclose☐

F.4 What is your marital status?

Married	1
Living with partner	2
Single	3
Separated/divorced/widowed	4
Do not wish to disclose	5

F.5 Do you have any children?

Yes	1

No	2

F.6 Including you, how many persons in your household are?

Below 5 years	
Between 5 and 15 years old	
Between 16 and 60 years old	
Over 60 years old	

F.7 Are you or anyone in your household a member of an environmental organisation?
You ☐ Household Member ☐ Neither ☐

F.8 Can you please indicate your current work status? **CIRCLE ONLY ONE**

Working full-time (occupation/paid job of 30+ hours per week)	
Working part-time (occupation/paid job of 18-29 hours per week)	
Working part-time (occupation/paid job of 17 or less hours per week)	
Student	
Home maker	
Retired	
Unemployed	
Unable to work due to sickness or disability	
Other **()**	

F.9 Could you please indicate the number that best describes your total personal income per year (whether from employment, pensions, state benefits, investments or any other sources) before deduction of tax.

Less than NOK 100,000	
NOK 100,001 – 200,000	
NOK 200,001 – 300,000	
NOK 300,001 – 400,000	
NOK 400,001 – 500,000	
NOK 500,001 - 600,000	
NOK 600,001 - 700,000	
NOK 700,001 - 800,000	
GreaterthanNOK 800,000	
Refused	

Please indicate household size ____ **Thank you for your time**