

D2 Deliverable - Initial levels and BAU scenarios for socio-economic indicators

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Initial levels and BAU scenarios for socio-economic indicators

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Introduction: Impact chain framework

The objective of action D2 is to monitor the socio-economic impacts of the implemented project activities. Achieving this goal includes multiple steps from selecting indicators, evaluating their baseline and business-as-usual (BAU) status and monitoring them during the project implementation. This deliverable builds on the previous deliverable “Descriptions of the socio-economic indicators” which presented a shortlist of candidate socio-economic indicators which could be used to monitor the socio-economic impacts of the project.

To account for the wide range of the impacts that the project measures may have on society, we applied theory of change (Belcher et al. 2020). According to this framework, project activities result in outputs (project results) that form a sphere of control. Outside of the controlled area is a sphere of influence which includes outcomes influenced by the project outputs. The outcomes may have additional impacts on society that belong to the sphere of interest (Belcher et al. 2020). We combined the theory of change with the corresponding accounts of the System of Environmental-Economic Accounting Ecosystem Accounting (SEEA EA) (United Nations et al. 2021) to develop a framework for identifying the impact chains of various project measures and how they propagate through ecosystems, society, and the economy. Furthermore, we integrated this framework with the elements of the driver-activity-pressure-impact-response (DAPSIR) approach (Elliott et al. 2017), which has been frequently used in recent marine assessments (Figure 1).

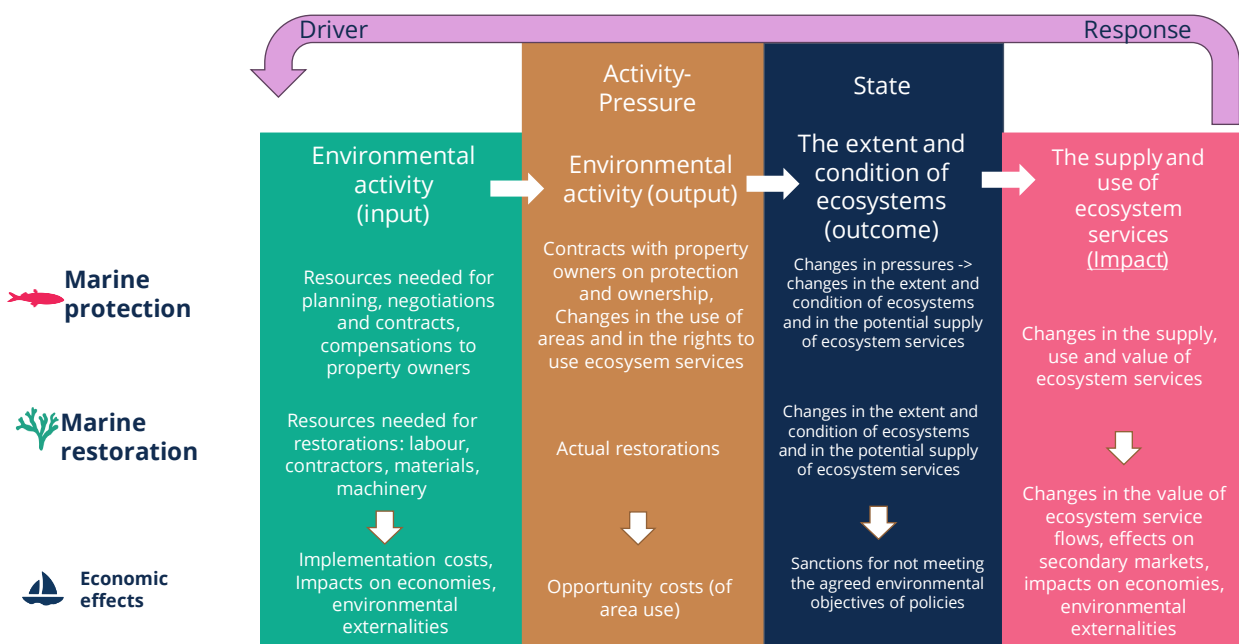


Figure 1. Framework adapted from SEEA EA, DAPSIR and theory of change frameworks.

Environmental activity (input): Resources and employment

The indicators for measuring the resource use of the project are: 1) employment and jobs created, and 2) funding/realized costs. The baseline level and BAU (business-as-usual) scenario are the same for both of these indicators. Without the implementation of the project measures, there would be no additional costs or new employment created.

Environmental activity (output): Implementing project measures

Biodiversea project aims at improving the protection of marine biodiversity in Finnish marine and coastal areas by implementing conservation measures and promoting the sustainable use of marine resources. Project measures include developing the MPA network, restoring habitats and species and mitigating impacts of pressures. Implemented project measures, which are the project's outputs, will result in outcomes: changes in the state of the ecosystem i.e. pressures, extent and condition of the ecosystem. Action D2 will monitor these outcomes and particularly socio-economic impacts during the project. Impact chains have already been identified based on the above-described framework and these will be further developed in the upcoming workshop held during the project annual meeting (18th of September 2024).

Extent and condition of ecosystems & supply and use of ES (outcome & impact): Regulating ecosystem services

This section gives an overview of the current known status of regulating services, specifically carbon and nutrient storage and sequestration in Finnish marine waters. The deliverable builds on previous projects (MAREA and Meri-TV) and explores how well the current Finnish MPA network covers the areas that have been identified as important for regulating services and discusses shortly about the potential of restoration activities to improve the supply of these services. In later stages of the project, the socio-economic impacts of the project measures such as the roadmap of the MPA network will be analyzed and compared to the results of the current deliverable. Overall, the current and future analysis conducted within Biodiversea will support the implementation of the Biodiversity strategy and the Nature restoration law and support the inclusion of ecosystem services into decision-making processes.

Carbon & nutrient storage and sequestration

There is a growing interest worldwide in identifying and protecting blue carbon stocks that produce benefits through climate change mitigation. Seagrass meadows, saltmarshes and mangroves are carbon-rich habitats, and they have been estimated to sequester and store half of the carbon buried in the ocean even though they cover only less than 0,2 % of the ocean floor (Duarte et al. 2005, Nellemann et al. 2009). There are also carbon rich habitats in the Baltic Sea, although the scale is different from the oceans. For example, seagrass meadows in the Baltic store 5-times less carbon than their representatives in the ocean, the difference is visible already in the entrance of the Baltic Sea (Kattegat & Skagerrak) (Billmann et al. 2023).

Nutrient storage and sequestration are important regulating services in areas that suffer from excess amounts of nutrients and eutrophication such as the Baltic Sea. Species and habitats that store nutrients in their biomass and sediment buffer against the effects of eutrophication and maintain the environment in a condition that is more suitable for example for recreational activities.

Because of the specific characteristics of the Baltic Sea (brackish water, seasonal ice cover etc.) the habitats differ from those found in the oceans; alongside marine habitats there are also many typically freshwater habitats characterized by perennial rooted plants that have potential to contribute to carbon and nutrient sequestration and storage. In general, all habitats characterized by vegetation produce carbon and nutrient storage and sequestration services in the Baltic Sea area (Jernberg et al. 2024). Such areas have been modelled in previous projects (Forsblom et al. 2022, Paulus et al. 2024). These maps are utilized further in this project to estimate how well they are covered by the current MPA network.

Material and methods

The supply of carbon and nutrient storage and sequestration has been modelled for the Finnish coastal and open sea waters (Forsblom et al. 2022, Paulus et al. 2024). These models are based on species distribution

models which have been produced using the extensive dataset gathered within the Finnish Inventory Programme for Underwater Marine Diversity (VELMU). The species distribution models were produced using the methodology described in Virtanen et al. (2018). Species models were adjusted by multiplying the continuous probability layers for occurrence by the median observed species cover and adjusted further by the median observed plant height to produce volume estimates (Forsblom et al. 2022). The estimation of the volume of species is an important step as many regulating services are dependent on the species biomass but the data of biomasses is scarce. Jernberg et al. (2024) identified linkages between habitats and species, and ecosystem services. This information was used when Individual species models including the volume estimates were summed together to form an overall estimate of the contribution of aquatic vegetation to the carbon and nutrient storage and sequestration services (Forsblom et al. 2022). The summed maps were scaled between 0 and 1 to allow comparison of different services. For more details on the service modelling methodology, see Forsblom et al. 2022 & Paulus et al. 2024.

These ecosystem service maps were utilized to estimate the BAU scenarios of conservation status of the ecosystem service supply i.e. how well the current MPA network protects the areas that have been identified to generate regulating services provided by aquatic vegetation. As the same species and habitats were identified important for both carbon and nutrient sequestration and storage (Jernberg et al. 2024), the produced maps of these services do not differ from each other. As such, we treated them as one, and the produced results apply to both services. The analysis included all MPA types in Finland, including national parks, Natura 2000 areas, HELCOM MPAs, seal sanctuaries, private conservation areas, Ramsar sites, the Quark UNESCO World Heritage site, the Archipelago Sea biosphere site and other state-owned nature conservation sites. First, the maps describing the supply of carbon and nutrient sequestration services were compared to the coverage of MPA network. Then only the areas with the highest supply values were compared to the MPA coverage and examined separately for each sea area (Gulf of Finland, Archipelago Sea, Bothnian Sea, the Quark and the Bothnian Bay).

Results and discussion

According to the current data and models, only 7,12 % of the entire marine area of Finland (including the EEZ) has any (e.g. above zero) potential to supply carbon and nutrient storage and sequestration services (provided by aquatic vegetation): relatively shallow bays, lagoons, estuaries and shallows around islands, where aquatic plants, algae and reeds grow. Of this small slice, 28,2 % is under some kind of protection.

However, there are differences in coverage of protective status when it comes to the areas with highest supply potential (e.g. top 50 / 30 / 10 %) and / or different marine areas. At the Archipelago Sea and Bothnian Sea, none of the most valuable top 10 % areas are protected (Figure 2 & 3)). In general, Archipelago Sea is extremely poorly protected when it comes to these ecosystem services: only around ten percent of all areas that are even slightly important (e.g. above zero) to the ES supply are currently protected. The Quark and the Gulf of Finland have a better showing, as we found a sudden jump to above 80 % coverage in the protected status of the top 10 % valuable areas.

These results describe the current conservation status of regulating ecosystem services provided by aquatic vegetation. Without any additional conservation or restoration measures, the situation can be expected to remain as it is or get worse if the habitats degrade. Using this data, we can estimate changes in the carbon and greenhouse gas stocks as result of the project's conservation and restoration measures. The preliminary results especially highlight the importance of data-based decision making in nature conservation and restoration: the top 10 % valuable areas for sequestration of carbon and nutrients account for only 0,00072 % of all marine areas in Finland and their conservation status varies wildly. Concentrated effort to protect or restore the most vital areas can be a very cost-effective way to greatly improve or safeguard ecosystem service supplies.

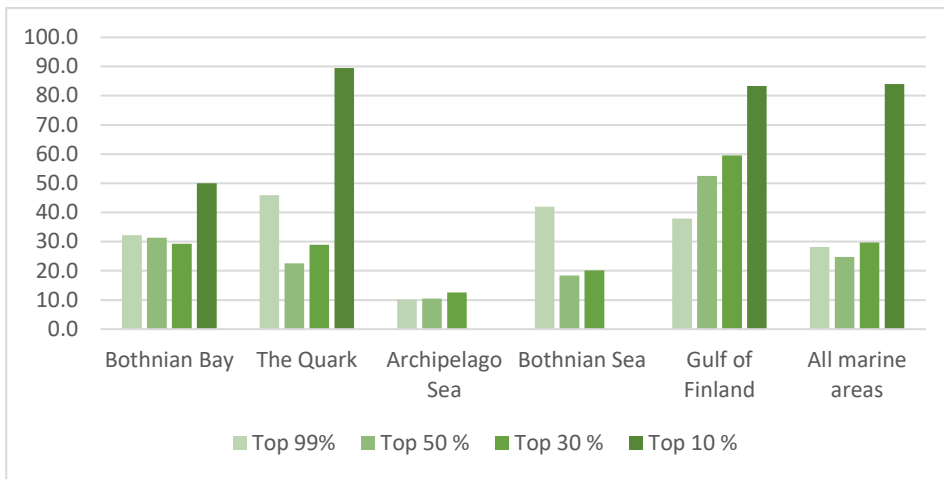


Figure 2. Percentage of most valuable areas for carbon / nutrient sequestration services in Finnish MPAs

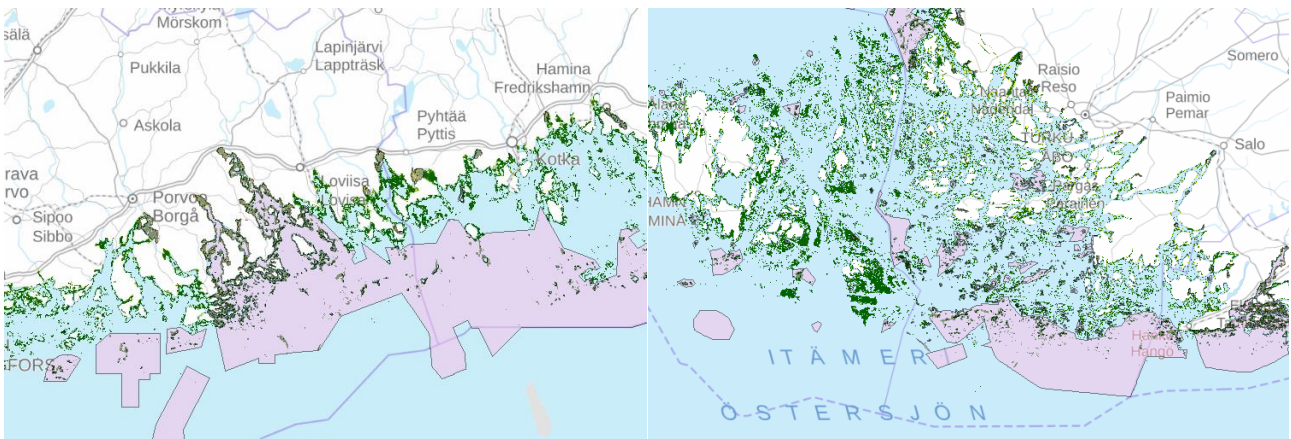


Figure 3. Distribution of MPAs and carbon/nutrient ES supply areas in the Gulf of Finland and the Archipelago Sea

The beneficiaries, users, markets and values of regulating services

Globally, most people benefit from carbon sequestration and storage, as these functions contribute to the regulation of the global climate. From an economic (accounting) perspective, global climate regulation, as a non-market ecosystem service, is collectively consumed by governments on behalf of society (including individuals, households, and businesses globally), making the government the primary user (United Nations et al., 2021). However, one could argue that if markets existed for the protection and enhancement of carbon sequestration and storage services, then the users of these services would be the suppliers of these protections and improvements. Nutrient sequestration and storage, on the other hand, benefits those whose welfare depends on the ecological status and water quality of the Baltic Sea.

Carbon sequestration and storage occurring in marine areas are not included in national EU LULUCF (Land Use, Land-Use Change, and Forestry) greenhouse gas statistics. Additionally, the proposed amendments to EU Regulation 691/2011 on ecosystem accounts do not mandate the reporting of global climate regulation services provided by marine areas. As stated in the handbook on the updated EU LULUCF Regulation (EU 2018/841), there remains limited information on the amounts of carbon stored in marine ecosystems, the quantification of human activities' impacts on these ecosystems, and how damaged marine ecosystems can be regenerated.

Finnish Nature Conservation legislation provides a procedure for voluntary ecological compensation and criteria for offsetting, which also apply to marine habitats. However, it remains to be seen whether these compensations and criteria will guarantee compensation for different ecosystem services, such as global climate regulation and nutrient storage and sequestration. Most of the nutrient reduction measures included in river basin management plans and the Marine Strategy Framework Programme of Measures focus on nutrient loading, rather than the potential of marine ecosystems to sequester or store nutrients.

The monetary value of carbon sequestration and storage per unit of carbon can be based on the EU Emission Trading System allowance price or estimates of the social cost of carbon. These values are highly dependent on current and predicted climate policies and scenarios, and such valuation requires sufficient information on the capacity of marine ecosystems to sequester and store carbon. Similar limitations apply to the valuation of carbon storage and sequestration ecosystem services.

Currently, carbon sequestration and storage in marine areas are not included in national GHG inventories or other inventories, nor are they considered in climate policies and regulations. Also, the nutrient storage and sequestration of marine ecosystems have not been the focus of nutrient reduction policies. Therefore, in addition to assessing and monitoring the protection of areas that contribute to the supply of ecosystem services, Biodiversea D2 will primarily monitor the development of policies, regulations, economic incentives, and governance innovations regarding blue carbon, as well as nutrient storage and sequestration, through at least a qualitative approach.

The supply and use of services (impact): Recreational use

Both the MPA network development and restoration measures have potential impacts to supply and use of recreational services. Supply of suitable environmental conditions supporting recreational activities may increase if ecosystems are restored, protected and ecosystem state improves in general. On the other hand, strict protection may set limits to certain recreational activities such as fishing, boating and anchoring which may decrease the number of recreational visitors in some areas.

The number of recreational visitors is followed for selected marine sites where the monitoring of visitors is already taking place. The selected sites include at least the marine national parks, where the following numbers of visits were recorded in 2023 (Table 1.).

Table 1. Visits in marine national parks

Eastern Gulf of Finland National Park	15 800
Ekenäs Archipelago National Park	53 200
Archipelago Sea National Park	78 800
Bothnian Sea National Park	79 400
The Kvarken World Heritage Site	91 200
Bothnian Bay National Park	6 400

Source: [Käyntimäärät maastossa | Metsähallitus \(metsa.fi\)](#)

According to the original project plan, social media data was considered a potential source for monitoring socio-economic impacts, particularly in relation to recreational and other cultural ecosystem services. However, due to the changes in ownership of the social media platform "Twitter" (now "X"), this plan is no longer feasible.

The supply and use of services (impact) & opportunity costs/trade-offs: Citizens' values and preferences on overall impacts of marine protection and restoration measures

Introduction

This section presents citizens' views and values related to marine protection and restoration measures and their impacts, based on an online survey conducted in June-July 2024. The assessment is set within the context of European Union and global biodiversity policies, which advocate for the expansion of marine protected areas (MPAs), and is particularly relevant given the upcoming EU restoration law aimed at reviving marine habitats.

At the core of this assessment is a choice experiment designed to capture citizens' preferences and values regarding various marine conservation strategies and their potential impacts. The study explores several key attributes, including the preservation of endangered habitats, which provide important ecosystem services, and the enhancement of scientific knowledge about marine environments, particularly in offshore areas. This knowledge is essential for spatial planning that balances ecological needs with economic activities such as offshore wind energy development and marine mineral extraction.

The assessment also examines the broader benefits and opportunity costs associated with MPAs, as well as the potential for increasing sustainable marine recreation opportunities. An annual tax attribute is included to quantify the economic value citizens place on different marine conservation measures and their impacts. The findings provide valuable insights into public preferences and the economic importance of marine conservation, contributing to the ongoing discussion on sustainable marine use in Finland and beyond. The results can be used as indicators of citizens' values and preferences regarding the overall impacts of marine protection and restoration measures and their effects on ecosystem services.

Methods

The assessment is based on an online survey conducted in June-July 2024 using a probability-based internet panel managed by a professional survey company (Taloustutkimus Oy). The target group for the survey was the adult population of Finland. An email invitation was sent to 15,166 panel members representing the target group, and 2,038 panelists responded to the survey, resulting in a response rate of 13.4%. However, the survey was closed once the number of respondents exceeded ~2,000, so the final response rate does not fully represent the number of invitees who might have eventually participated. Of those who opened the survey, 81.5% completed it. A pilot study (N=208) was conducted in May 2024.

The survey consisted of five parts:

1. Connection to the Baltic Sea
2. Use of in-situ and ex-situ marine ecosystem services and environmental factors affecting their use
3. Future of marine protection
4. Views and attitudes toward the marine environment and its protection
5. Background questions.

To make informed decisions about protecting the Baltic Sea, it is essential to understand which aspects people prioritize and how much they value these priorities. To evaluate public preferences and estimate their willingness to pay (WTP) for various marine protection measures and their impacts on marine ecosystems and ecosystem services, we employed a choice experiment (CE) method. This approach allows us to quantify how people value different aspects of marine ecosystems and protection strategies, providing crucial insights for policymakers.

The choice experiment method requires that the change being valued be divided into several factors, ideally independent of one another, and simplified into key attributes with varying levels. In this case, one of the attributes is the proportion of protected areas in coastal waters, presented at three levels: 25%, 45%, and 65%. Respondents were presented with several hypothetical scenarios, each combining different levels of protection and other factors, and were asked to choose their preferred policy scenario. This approach enables us to assess the value people place on increasing the proportion of protected coastal areas and to evaluate the trade-offs they are willing to make between different levels of marine protection and other factors.

Choice experiment design

A choice experiment study was conducted to assess citizens' values and preferences regarding marine protection and restoration measures and their impacts. The experiment was designed by a team of economists and marine biologists. A test survey (N=37) was first conducted in December-January 2023 among colleagues and acquaintances. Based on this, a pilot survey (N=208) was designed, and data were collected in May 2024 using an internet panel. The final survey (N=2023) was conducted via an internet panel in June-July 2024.

Each respondent was presented with 8 choice tasks (see Figure 4 for an example of a choice task), selected from 24 tasks in the test survey and 48 tasks in the pilot and final surveys. The choice experiment designs were based on a Bayesian D-efficient design, using Ngene software¹. An iterative approach was applied, where the results from the Multinomial Logit (MNL) and Mixed Logit (MXL) models from the test survey data were used as priors for the pilot design, and the pilot survey results were used as priors for the final design.

The choice tasks consisted of three options showing different levels of attributes describing hypothetical impacts of marine protection and restoration measures, as well as a tax attribute. One of the options represented the business-as-usual (BAU) scenario, assuming no new measures. Respondents were asked to choose their most preferred option for each of the choice tasks.

¹ [Ngene User Manual \(choice-metrics.com\)](https://www.choice-metrics.com)













	Vaihtoehto A	Vaihtoehto B	Ei uusia suojelutoimia
Uhanalaisten luontotyyppien osuus	5% 	24% 	33% 
Puutteellisesti tunnettujen luontotyyppien osuus	33% ?? 	0% 	33% ?? 
Suojelualueiden osuus rannikkovesialueista	25% 	65% 	25% 
Virkistyskohteiden saavutettavuus: käyntimäärien kasvu	40% 	0% 	0% 
Lisäys vuosittaiseen verotukseesi 2025-2040	20 €	50 €	0 €

Figure 4. An example of a choice task

Description of the choice experiment setting and attributes

General description: The Future of Marine Protection

Biodiversity loss is evident in Finland's marine areas through the deterioration of habitats and the simplification of species composition. Climate change, eutrophication, dredging, and other pressures are burdening marine ecosystems. Finland is committed to increasing marine protection and restoring degraded habitats and species.

New regional conservation measures could help safeguard marine ecosystems and improve their condition. These measures may include establishing new protected areas, as well as restoring species and habitats. Additionally, efforts to reduce littering, the spread of invasive species, and other environmental pressures could be implemented. Effective and comprehensive marine protection also requires marine research and continuous monitoring of the marine environment. Alongside new regional conservation measures, reducing nutrient loads from land-based sources remains crucial for improving the condition of marine ecosystems. The new conservation measures would be implemented between 2025 and 2040, with their impacts expected to materialize by 2040. These measures would be funded by an annual tax collected from Finnish citizens.

The proportion of endangered habitats

A habitat is an area characterized by specific environmental conditions and a distinctive plant and animal community. Many of the Baltic Sea habitats are under threat. If conservation measures are insufficient and the pressure on these habitats is not reduced adequately, the marine environment is at risk of becoming homogenized. This could lead, for example, to the degradation of marine landscapes, depletion of fish

stocks, and increased water turbidity. Currently, about a quarter of the marine habitats in our territorial waters are classified as endangered (10 out of 42 habitats).

Levels (BAU, share can increase if inadequate measures): 33%, 24%, 12%, 5%

Choice of levels: Based on the red list of habitats. 24% is the current state, 33% represents scenario where “near threatened habitats” become “endangered habitats”, 12% and 5% represent scenarios where protection measures are effective and where land-based pressures (mainly nutrient loading) are reduced significantly.

Associated ecosystem services: In-situ ecosystem services for respondents who have visited the Baltic Sea or its coast. For others Ex-situ services.

The proportion of poorly known habitats

A third of the marine habitats in our territorial waters are poorly known (14 out of 42, or 33%). Information is especially lacking regarding benthic fauna, as well as the deeper seabed and open sea areas. Without research, we do not know whether the habitats in these areas are endangered or what their significance is for the marine ecosystem. Offshore and deep-sea areas have been proposed for wind farms, and their metal deposits have attracted the interest of the mining industry. By increasing research on these habitats, their ecological values could be better considered in the planning of marine area usage and conservation efforts.

Levels (BAU): 33%, 17%, 0%

Choice of levels: 33% is the current state, scenarios 17% and 0% are possible if research resources are increased.

Associated ecosystem services: Ex-situ ecosystem services, regulating services. Knowledge for sustainable marine spatial planning.

The proportion of protected areas in coastal waters

From the perspective of marine conservation, protected areas should primarily be located along the coast. However, a significant portion of coastal marine areas is subject to human activities and private ownership. Currently, about a quarter of Finland’s coastal waters, or inner territorial waters, are protected (25%, approximately 8,000 km²). New protected areas would limit activities such as heavy marine traffic, dredging, as well as the construction of fish farms, wind power installations, and infrastructure. About one-third of the area of the protected zones would be strictly protected, meaning there would also be restrictions on movement and recreational use in the most sensitive areas. The protection of privately owned areas would be based on voluntary participation, with restrictions negotiated in cooperation with land and water area owners.

Levels (BAU): 25%, 45%, 65%

Choice of levels: 25% is the current state, 65 is the scenario where the 30/30 target is met and the share of protected areas in the coastal waters of all protected areas is approximately same as currently. 45% is between these values and represents a more conservative scenario.

Associated ecosystem services: In-situ services. Trade-offs and opportunity costs of restricting the use of protected areas and their ecosystem services vs. increase in the condition of ecosystems and their potential to provide services.

Accessibility of Marine Recreational Sites

The state maintains several marine recreational sites that offer public tourism services and even small-scale tourism businesses. By improving the accessibility of these sites, more Finns could enjoy the marine environment. Additionally, protecting natural values becomes easier when recreational visits are directed to areas where sustainable recreation can be organized. It is estimated that marine recreational sites maintained by the state receive approximately 600 000 visits annually.

Levels (BAU): 600 000 visits (0%increase), 720 000 visits (20% increase), 840 000 (40% increase)

Choice of levels: The national strategy for the recreational use nature aims at improving access to recreational areas and increasing public awareness to ensure that nature is equally available to everyone for recreational use. Means to improve sustainable recreation and tourism are investigated in BIODIVERSEA project Action C3.

Associated ecosystem services: In-situ services (especially recreational) for citizens who currently have limited access to marine recreation, altruistic values and the well-being of others for citizens who currently have good access to marine recreation. Trade-offs and opportunity costs of increasing the non-excludability of marine recreation.

Increase in annual Taxation

Levels (BAU): 0€, 10€, 20€, 50€, 100€, 200€, 400€

Choice of levels: Based on previous assessments and to capture the range of citizens' willingness to pay for protection and restoration measures and their impacts.

Data

Table 2 presents the descriptive statistics for the survey respondents and compares them to the target population using the latest statistical data. The respondents represent the target population quite well in most respects, with the exception of a higher proportion of people with higher education.

Table 2. Descriptive statistics and representativeness of the survey respondents

	Sample population: Respondents	Target population: Finnish adult population
Sample size (N)	2038	4 557 045
Respondents who have spent time at the Baltic Sea or along its coast during past 12 months	1106	-
Mean age of adult population	52 years	51 years
Gender		
Female	49.5%	50.9%
Male	49.9%	49.1%
Non-binary	0.7%	-
Household size	2.0 persons	1.9 persons
High Education	52.6%	34.5%
Mean monthly net income	2451€	2532€
Mean distance to the Baltic Sea (Based on centroids of postal code areas)	60.2 km	56.8 km

Figure 5 shows the spatial distribution of the respondents compared to the spatial distribution of the target population², using postal code areas based on the first two digits of the postal codes. The spatial distribution of the respondents corresponds reasonably well to the actual distribution of citizens. However, the largest cities are slightly overrepresented in the survey data.

² [Paavo – Open data by postal code area | Statistics Finland](#)

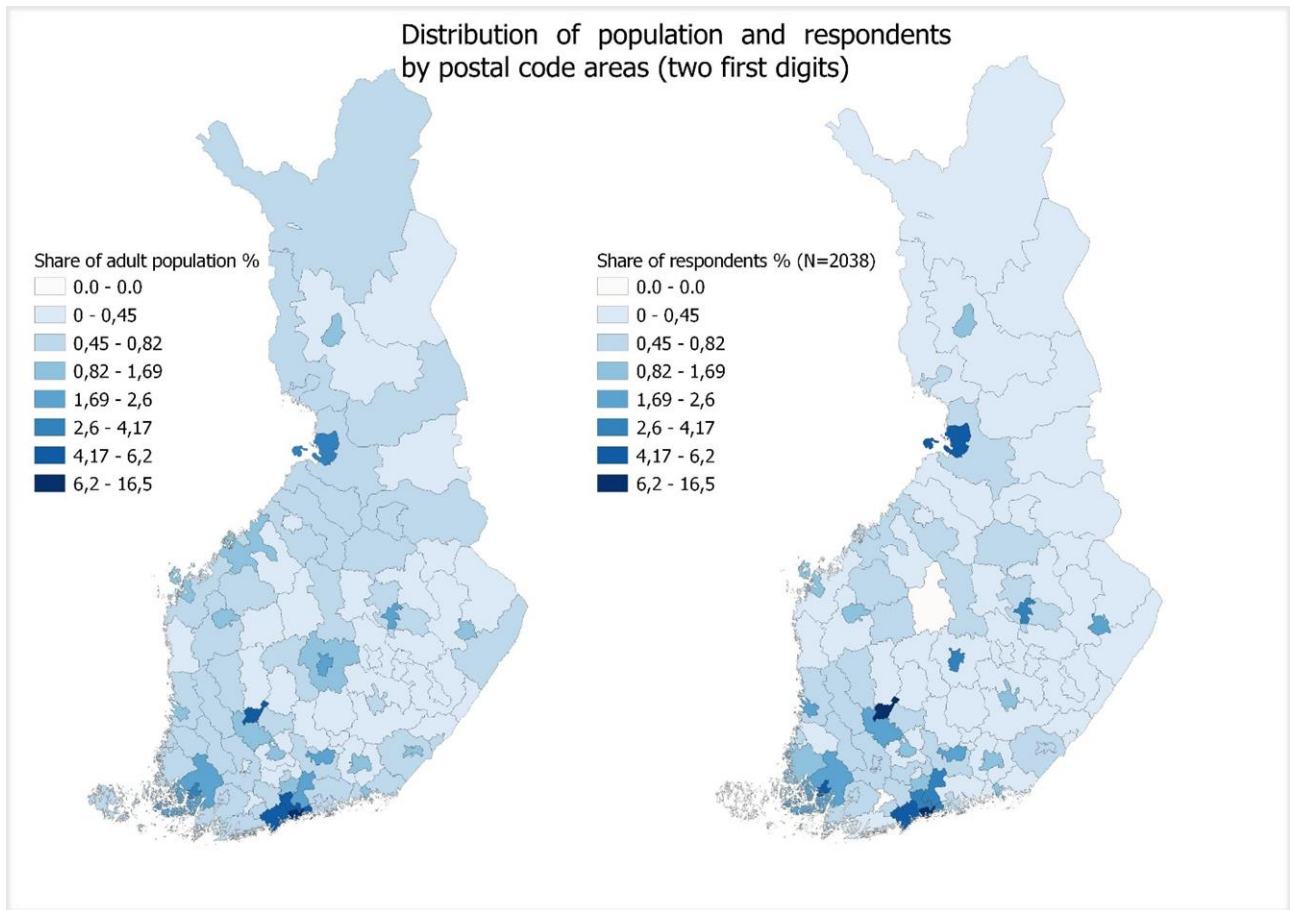
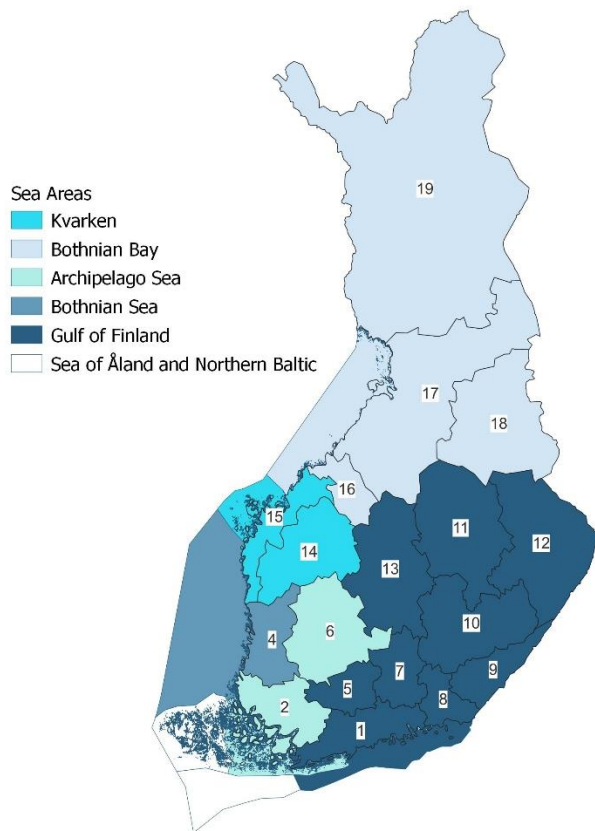


Figure 5. spatial distribution of the respondents compared with the spatial distribution of the target population

Figure 6 shows the most visited marine areas by province in Finland, based on the survey responses. The Gulf of Finland appears to be the most visited marine area, likely due to the fact that Helsinki, the capital of Finland, is located along its coast. For other marine areas, it seems that citizens tend to visit the marine areas closest to their place of residence.

Most visited sea areas by provinces



Province	Province name	Province	Province name
1	Uusimaa	11	Pohjois-Savo
2	Varsinais-Suomi	12	Pohjois-Karjala
4	Satakunta	13	Keski-Suomi
5	Kanta-Häme	14	Etelä-Pohjanmaa
6	Pirkanmaa	15	Pohjanmaa
7	Päijät-Häme	16	Keski-Pohjanmaa
8	Kymenlaakso	17	Pohjois-Pohjanmaa
9	Etelä-Karjala	18	Kainuu

Figure 6. Most visited Baltic Sea marine areas by province

Figures 7 and 8 show citizens' opinions on the statements about marine protection and restoration measures. Although these figures indicate general support for marine protection and restoration, citizens' preferences may shift when they are asked to choose between specific measures and their outcomes. Particularly, if these measures involve trade-offs, such as varying impacts on ecosystems or additional costs like higher taxes, their support could become more selective or conditional.

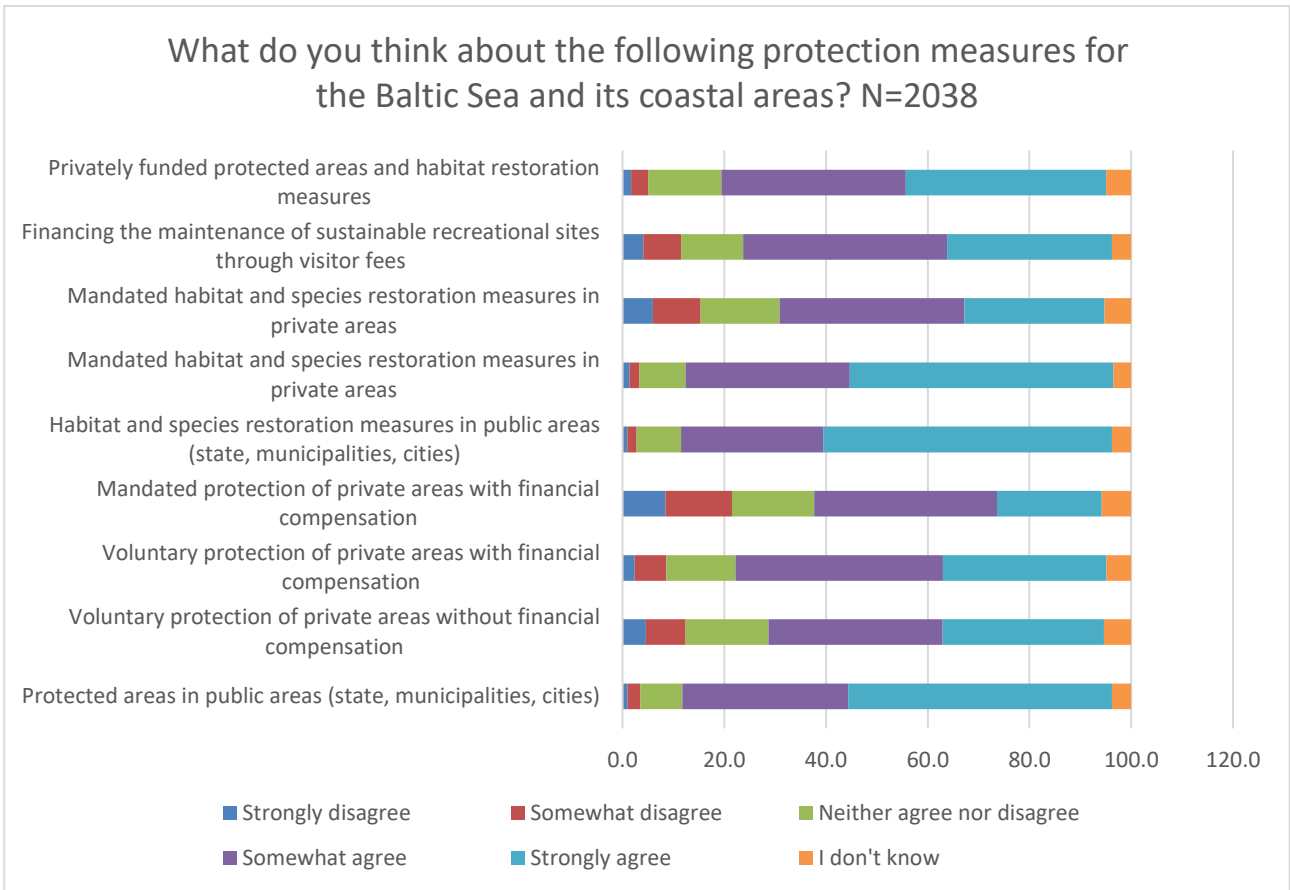


Figure 7. Citizens' opinions on marine protection measures

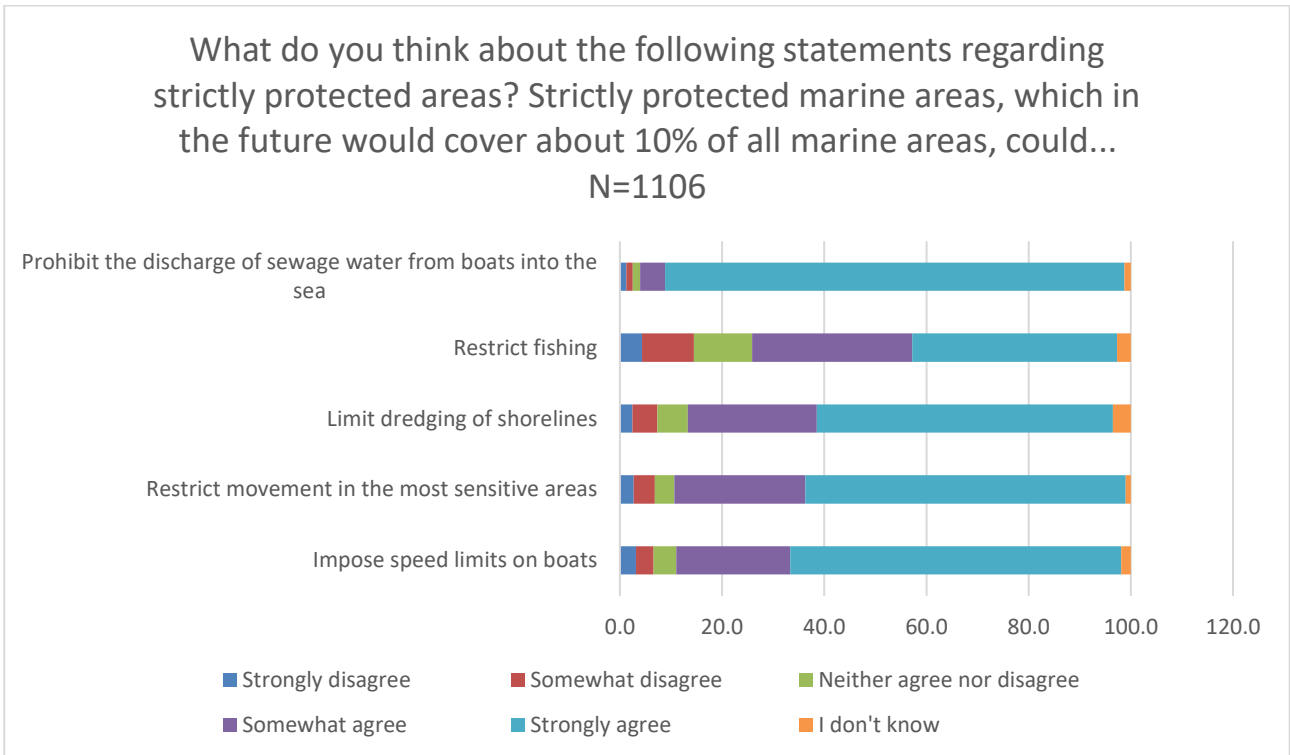


Figure 8. Citizens' opinions on restrictions of strictly protected areas

Results

To better capture the nuanced preferences, we employ both multinomial logit (MNL) and mixed logit (MXL) models (Train, 2009) on the choice experiment data. These models allow us to account for individual variation in choices and provide a more detailed understanding of how citizens value different aspects of marine protection and restoration measures, considering the potential trade-offs and costs. In the standard multinomial logit model (MNL) the utility of an individual n for alternative i is

$$U_{ni} = \beta x_{ni} + \varepsilon_{ni}, \quad (1)$$

where ε_{ni} is an independently and identically distributed extreme value, x_{ni} is a vector of attributes including a specific constant for the “no new measures” alternative, and β is a vector of estimated parameters for attributes. For the mixed logit model (MXL) the individual specific coefficients β_n are allowed to be random so that they follow a distribution $\beta_n \sim f(\beta_n | \theta)$, where θ are the parameters of the distribution such as mean, standard deviation and covariation. Mixed logit specification allows for random preference variation across individuals, and therefore is able to capture the heterogeneity in preferences. The mixed logit utility model in preference space is defined as:

$$U_{ni} = \beta_n x_{ni} + \varepsilon_{ni}. \quad (2)$$

Redefining the MXL specification of utility in the Willingness to pay (WTP) space means that the estimated parameters can be interpreted as willingness to pay values:

$$U_{ni} = \sigma_n (\gamma_n x_{ni} + p_{ni}) + \varepsilon_{ni}, \quad (3)$$

where p_{ni} is the tax attribute which is included in x_{ni} in preference space (2) and $\gamma_n = \frac{\beta_n}{\sigma_n}$ is the marginal willingness to pay for an attribute x_{ni} .

In addition to these models, a latent class multinomial logit model (LC-MNL) is also applied. The LC-MNL model assumes that the population is heterogeneous and can be divided into a finite number of classes, each with its own set of preferences and behaviors. The utility for an individual n belonging to a class s for alternative i is defined as:

$$U_{ni} = \beta_s x_{ni} + \varepsilon_{ni}, \quad (1)$$

where β_s is the vector of class specific parameters for the attributes. The LC-MNL model estimates the probability of an individual belonging to a specific latent class based on observable characteristics or preferences, and assigns different utility functions to different classes. This allows the model to account for preference heterogeneity across distinct groups, rather than treating it as continuous random variation as in the mixed logit model. The latent class model can identify distinct classes within the population that have systematically different preferences for the attributes under study. This classification is useful for understanding varying preferences across different types of individuals and for policy design that targets specific subgroups.

The models were estimated using Apollo package (0.3.2) in R (Hess & Palma, 2019a; Hess & Palma, 2019b). A negative log-normal distribution was applied for the coefficient of tax attribute in the WTP space MXL-model. The other parameters were assumed to be normally distributed.

Notations used in the results:

NNM= Intercept/value of no new measures (BAU-scenario)

EH= The proportion of endangered habitats

PNH= The proportion of poorly known habitats

MPA= The proportion of marine protected areas in coastal waters

MR= Accessibility of Marine Recreational Sites

CO = Increase in annual tax

Table 3 shows the results of the MNL model and the derived WTP values for changes in the attributes. The results indicate that, overall, Finnish citizens prefer the well-being of marine habitats and the protection of coastal areas. However, citizens oppose improving access to marine recreational sites if it leads to an increase in visitor numbers. The coefficient for the number of poorly known habitats was not statistically significant, meaning no conclusions can be drawn regarding values and preferences for increased knowledge of marine habitats.

Table 3. Results of MNL model with continuous attributes. Significance:***1%,**5%,*10%.

Observations: 16 304, McFadden's R²: 0.0678, LL(C): -17533.7,LL(F): -16697.38, AIC/N:2.05, BIC/N:2.05

	Estimate	WTP €/1% increase ¹	Rob.std.err.	Rob.t-ratio(0)	Rob.p-val(0)
NNM	-0.8218***	(-205.45)	0.0515	-15.9492	0.0000
EH	-0.0057***	-1.43	0.0011	-5.2779	0.0000
PNH	-0.0004	-	0.0008	-0.5186	0.6041
MPA	0.0068***	1.70	0.0006	10.5890	0.0000
MR	-0.0012*	-0.30	0.0007	-1.7534	0.0795
CO	-0.0040***	-	0.0001	-27.5721	0.0000

1) For NNM the WTP-value in parentheses represents the "No new measures" BAU-alternative compared to alternatives with new measures.

Table 4 presents the results of the MXL model, which better accounts for differences in preferences compared to the MNL approach. These results reinforce the conclusions drawn from the MNL model regarding the values and preferences related to the well-being of marine habitats and coastal protection. The MXL model results also indicate that people place value on gaining new knowledge about poorly known marine habitats. Additionally, the results highlight significant variation in preferences and values across individuals.

Table 4. Results of MXL model in WTP-space with continuous attributes. Significance:***1%,**5%,*10%.

Observations: 16 304, McFadden's R²: 0.2856 , LL(C): -17533.7 ,LL(F): -12796.06, AIC/N:1.57, BIC/N:1.58

	Estimate	WTP €/1% increase ¹	Rob.std.err.	Rob.t-ratio(0)	Rob.p-val(0)
Mean NNM	-3.9326***	(-39.33)	0.1850	21.2628	0.0000
S.D. NNM	5.2535***	(52.53)	0.2635	19.9351	0.0000
Mean EH	-0.1300***	-1.30	0.0218	5.9556	0.0000
S.D. EH	0.5774***	5.74	0.0362	15.9279	0.0000
Mean PNH	-0.0361**	-0.36	0.0145	2.4846	0.0130
S.D. PNH	0.2683***	2.68	0.0216	12.4038	0.0000
Mean MPA	0.1614***	1.61	0.0145	-11.1511	0.0000
S.D. MPA	0.3449***	3.45	0.0220	-15.6665	0.0000
Mean MR	-0.0257*	-0.26	0.0136	1.8933	0.0583
S.D. MR	0.3709***	3.71	0.0281	-13.2098	0.0000
Mean CO	-0.0821*	-	0.0492	-1.6683	0.0953
S.D. CO	0.8047***	-	0.0529	15.2204	0.0000

1) For NNM the WTP-value in parentheses represents the "No new measures" BAU-alternative compared to alternatives with new measures.

The results of the 2-class latent class model presented in Table 5 show that the respondents can be divided into two distinct groups based on their preferences and values regarding the studied attributes. The first group, called the “Greenish Libertarians,” values the well-being of marine habitats but opposes increasing the protected area in coastal regions and shows no preference for expanding knowledge on poorly known habitats. Approximately 22% of citizens belong to this group.

The second group, the “Green Regulation Enthusiasts,” places a higher value on the well-being of marine habitats than the Greenish Libertarians. They support expanding protection in coastal areas and increasing research on poorly known habitats, even if it leads to increased public spending and higher taxes. Approximately 78% of citizens belong to the Green Regulation Enthusiasts.

Table 5. Latent class MNL model with continuous attributes. Significance:***1%,**5%,*10%.

Observations: 16 304, McFadden’s R²: 0.2401 , LL(C): -17533.7,LL(F): -13611.94, AIC/N:1.67, BIC/N:1.68

Group 1: Greenish libertarians (22.4% of citizens)					
	Estimate	WTP €/1% increase¹	Rob.std.err.	Rob.t-ratio(0)	Rob.p-val(0)
NNM	0.5882***	(-31.85)	0.2230	2.6373	0.0084
EH	-0.0081**	-0.44	0.0038	-2.1277	0.0334
PNH	0.0046	-	0.0035	1.3206	0.1866
MPA	-0.0117***	-0.63	0.0025	-4.7355	0.0000
MR	-0.0119***	-0.65	0.0034	-3.4682	0.0005
CO	-0.0185**	-	0.0078	-2.3780	0.0174
Group 2: Green regulation enthusiasts (77.6% of citizens)					
	Estimate	WTP/1% increase¹	Rob.std.err.	Rob.t-ratio(0)	Rob.p-val(0)
NNM	-2.2318***	(-450.49)	0.0703	-31.7584	0.0000
EH	-0.0078***	-1.57	0.0012	-6.3554	0.0000
PNH	-0.0020**	-0.41	0.0009	-2.3459	0.0190
MPA	0.0109***	2.19	0.0008	14.3829	0.0000
MR	0.0004	-	0.0008	0.4395	0.6603
CO	-0.0050***	-	0.0002	-22.6725	0.0000

1) For NNM the WTP-value in parentheses represents the “No new measures” BAU-alternative compared to alternatives with new measures.

Conclusions and the BAU-scenario

The results presented here are still preliminary and have not been peer-reviewed. The models could potentially be improved by, for example, accounting for correlations, incorporating non-linear effects for the attributes, adjusting the settings of the latent class models, etc. Further investigation is also needed into the demographic and other background factors affecting values and preferences. However, the estimated model coefficients and WTP (Willingness to Pay) values can be used as indicators to monitor citizens' preferences and values regarding the impacts of protection and restoration measures piloted and developed in the BIODIVERSEA project.

The BAU (business-as-usual) scenario for all attributes, except for “The proportion of endangered habitats” (EH), assumes the current situation remains unchanged. However, under the BAU scenario, it is assumed that the proportion of endangered habitats could increase from 24% to 33% if no new protection or restoration measures are implemented. This would result in a welfare loss for Finnish citizens, which could be monetarily approximated as $(33\% - 24\%) * -€1.43/\% = -€12.87$ annually per person. While monetary values provide limited context when presented on their own, comparing these values between attributes or across different groups of people reveals relative differences in values and preferences.

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