A4.1 Deliverable - Maps showing potential new MPA candidates

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Introduction

This deliverable is part of the BIODIVERSEA Action 4: Analysing the sufficiency of the marine protected area network and presents preliminary results of sub-action 4.1. Maps showing potential new MPA candidates.

The sufficiency of the Finnish marine protected area network (MPA) was evaluated previously in 2018 (Virtanen et al. 2018), and for the Åland Sea areas in the Åland Seamap project (Weckström et al. 2024). Based on the assessment, it was concluded that the performance of the MPA network could be considerably improved with relatively small additions to the MPA network. Under the BIODIVERSEA sub-action 4.1., these analyses have now been redone with updated data (see Forsblom et al. 2024) and new tools (Moilanen et al. 2022), to identify optimal MPA network covering 30% of the Finnish marine areas, of which one third strictly protected. At present the Finnish MPA covers 11% of the marine areas so considerable gaps still exist.

Species distribution models were updated between 2021 and 2023, based on new data collected from offshore areas, mainly from reefs, depth data acquired through satellites from shallow areas (Kulha et al. 2024), and new high-resolution bathymetry data received from the Finnish EEZ areas (Traficom). These updated models that are full-coverage maps of species occurrence probabilities, were used in this sub-action to identify locations where efforts to increase MPA network coverage should be directed. Additionally, the development of new threat models (available through Action 7; Virtanen et al. in prep) has allowed for a more realistic description of areas in potentially degraded condition, and where conservation actions, such as establishment of an MPA may be less effective.

Data and methods

To identify areas of high conservation value, Parks & Wildlife Finland arranged expert workshops to identify species that would particularly benefit from strict protection. From the species known to occur in Finnish marine areas, species conservation importance was ranked based on the following criteria:

- *i)* species was legally protected,
- *ii)* species belonged to a threatened habitat type as defined by the Finnish Red List of Ecosystems (Kotilainen et al. 2018),
- *iii)* species was associated with Habitats Directive Annex I threatened habitat types, and/or,
- *iv)* species would benefit from the establishment of MPAs, based on whether area-based protection could stop or alleviate the threats facing the species, as identified by the latest threatened status assessments (Kotilainen et al. 2018, Kostamo et al. 2019).

Each species was assigned a conservation score based on its classification under these criteria. Additionally, species were weighted according to their current threatened status (EN=3, VU=2, NT=1). With the scoring system, higher scores were given to species meeting multiple criteria, and with increased risk of extinction. Species list is provided in Supplementary Table 1.

The criteria used for other protected areas, i.e. less strict protection, were areas of ecological importance, as identified in the BIODIVERSEA deliverable A4.1 (Fig. 1). We also used additional criteria based on geological importance, based on marine geological data that has only recently been released for the use of environmental administration. Based on it, geologically important areas have been identified by the Geological Survey of Finland (Fig. 2). These areas also served as a criterion for establishing marine protected areas, as areas with geological importance may also hold value for biodiversity.

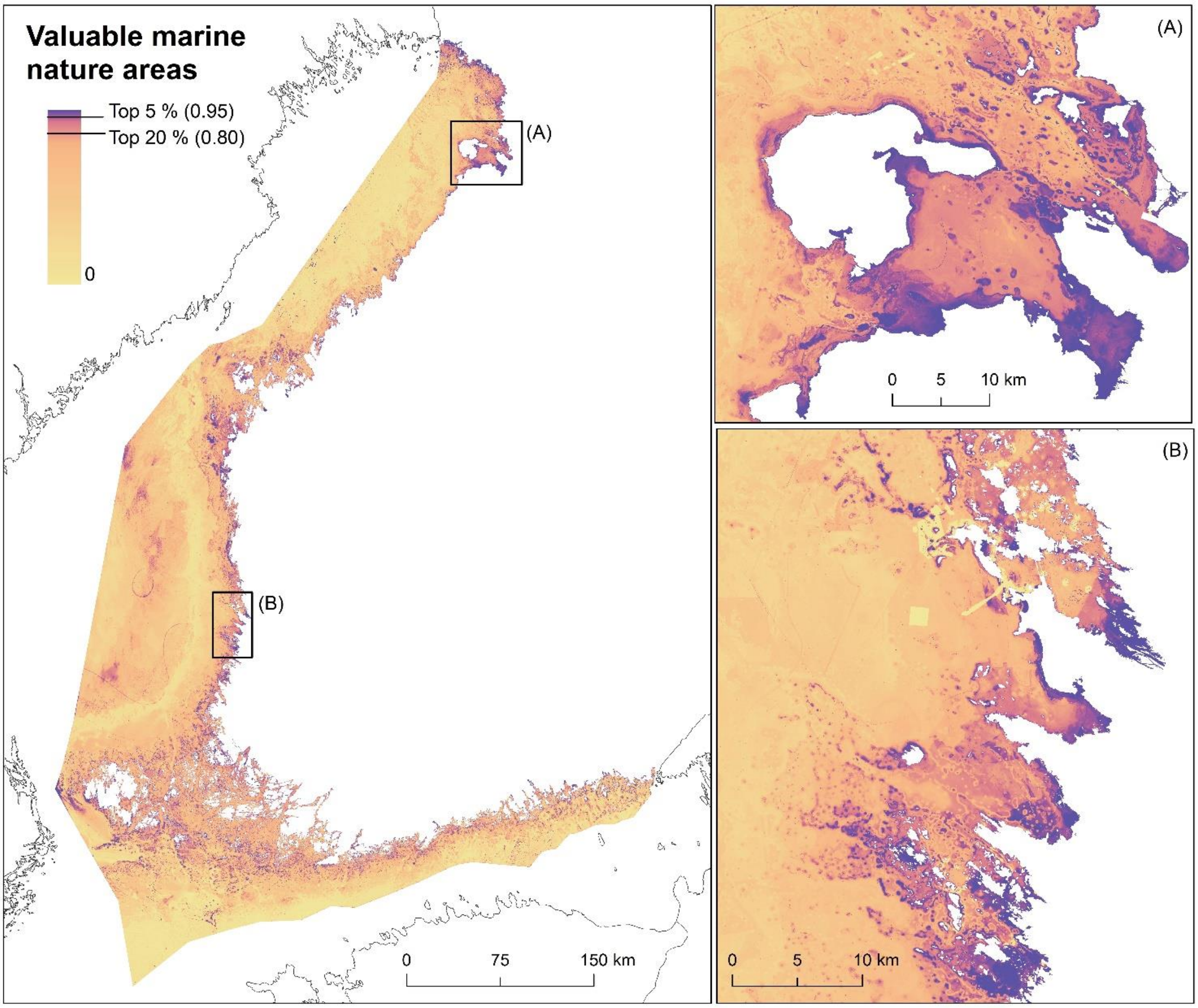

Figure 1. Valuable marine nature areas identified based on the spatial prioritization software Zonation 5. Purple color indicates top 5% of important areas, darker orange top 20% and yellow values close to 0 higher human impact, with less importance for biodiversity. For example, the yellow geometric areas in panel B show lower conservation importance for the Tahkoluoto offshore windfarm area, commercial harbour, dredging area for the shipping lane, as well as for the dedicated area for dumping dredged material.

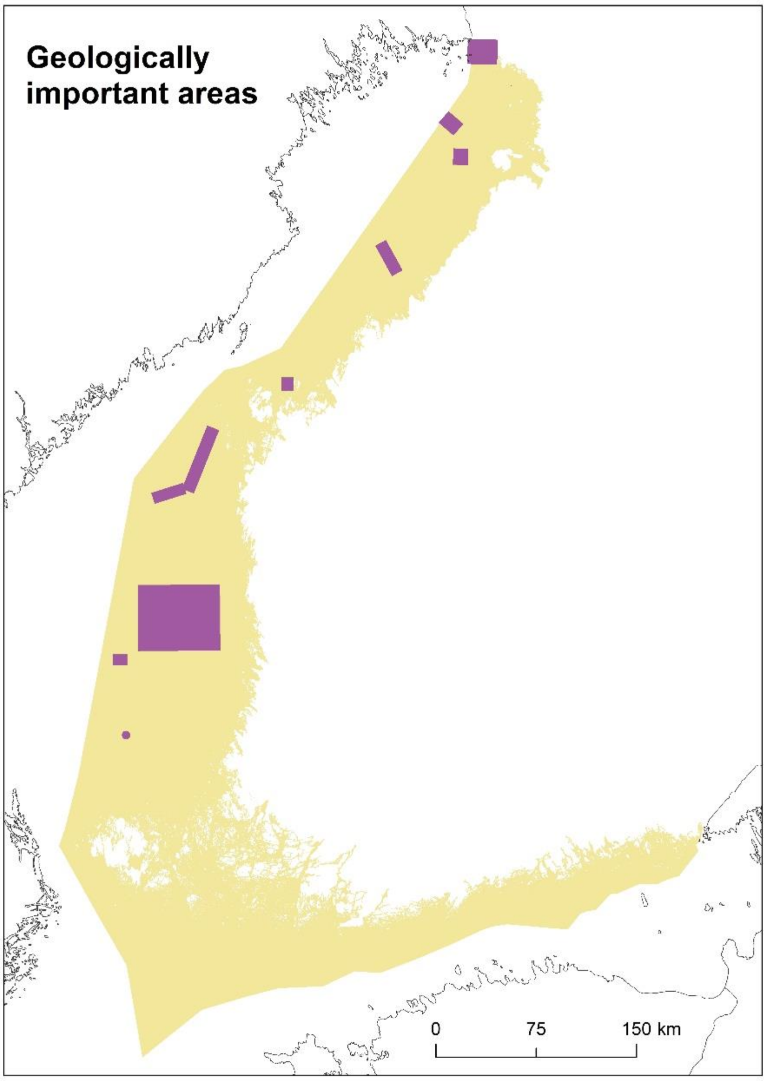

Figure 2. Geologically important marine areas in Finland.

To identify potential expansion candidates, we used the spatial prioritization tool Zonation 5 (Moilanen et al. 2022), developed for conservation and ecologically informed land-use planning. We used a hierarchic mask analysis, in which the priority ranking is developed constrained by the present MPA network. Zonation does a gap analysis and identifies locations that would fill gaps in protection in balanced and area efficient manner.

As data inputs we used the species the species distribution models developed for algae, vascular plants, water mosses and invertebrates (*n*=208) together with threat models (*n*=23, Supplementary Table 2), which describe in detail coastal infrastructure and land use (e.g. dredging) that have likely contributed to the loss and disturbance of marine habitats. These were available from BIODIVERSEA Action 7 (Virtanen et al. in prep.), developed based on aerial image interpretations and object detection methods (Kuismanen and Husa 2020, Sahla et al. 2020, Mäyrä et al. in review). For all other species and geological features, we used a weight of 1.

Zonation ranks areas based on conservation importance, with values closer to 1 having more importance for conservation, while pixels receiving values close to 0 lower value (e.g. ecologically deteriorated areas). Zonation has in-built meta-algorithm, which orders how cells are removed from the landscape, and sub-algorithms where user can control how pixels are valued and therefore removed from the analyses. We used the Core Area Zonation CAZ2 as marginal loss rule, to emphasize relatively high average coverage of features (Moilanen et al. 2022). We did two separate analyses: one for identifying strictly protected areas, and other for less strict protection. We assigned weights for the first analysis based on the species scoring system, and for the second we gave equal positive weights (w=1) for all species and geological features. For both analysis we included also human activities that might exert pressures on marine ecosystem, with mild negative weights, adjusted based on expert judgment regarding the detrimental impact of activities (Virtanen et al. in prep.).

Results and discussion

Maps of valuable marine nature areas that would benefit from conservation are presented in Figure 3. Dark purple indicates high-priority sites for species benefitting particularly from area-based conservation. The areas show relative conservation index, which was achieved by multiplying the relative conservation order with range-size rarity, both standard outputs from Zonation analyses. The lighter orange and yellow colors indicate lower conservation importance for these species.

Zooming in the map shows first that the areas where these species are located, are small and in relatively shallow areas, representing lagoons and sheltered bays. For these areas restricting coastal land use, such as dredging, would be crucial. In general, human activities exert more pressures on marine biodiversity in shallower areas and in coastal areas (results from A7, Virtanen et al. in prep.), while the offshore areas have lower human influence.

It should be noted that the analysis lacks information on habitat use of fishes, mammals, and important seabird areas, for which detailed spatial information is not presently available. Combined with the results from the other deliverable, A4.1. (Fig. 1), analysis of the most valuable marine areas, and with geologically important sites (Fig. 2) we were able to identify potential expansion MPA candidates that would fill gaps in the present MPA network (Fig. 4). Suitable candidates for strictly protected areas are located for instance around Åland Islands, Kvarken area, and Gulf of Finland, while other areas are located along the coast of Finland, even in offshore areas. With new marine geological information acquired, Bothnian Sea and Bothnian Bay both host valuable geological areas, worth conserving in the offshore areas.

These results will be potentially useful for conservation planners and managers for directing conservation actions. This information will also be valuable especially in the Åland Islands, where the conservation coverage is at the moment less than 4%. The deliverable will also inform Action C2 that concentrates on the development of strategic roadmap for expanding the Finnish MPA network. Results will also be used in Action 9, which concentrates on designing future restoration efforts for underwater species and habitats.

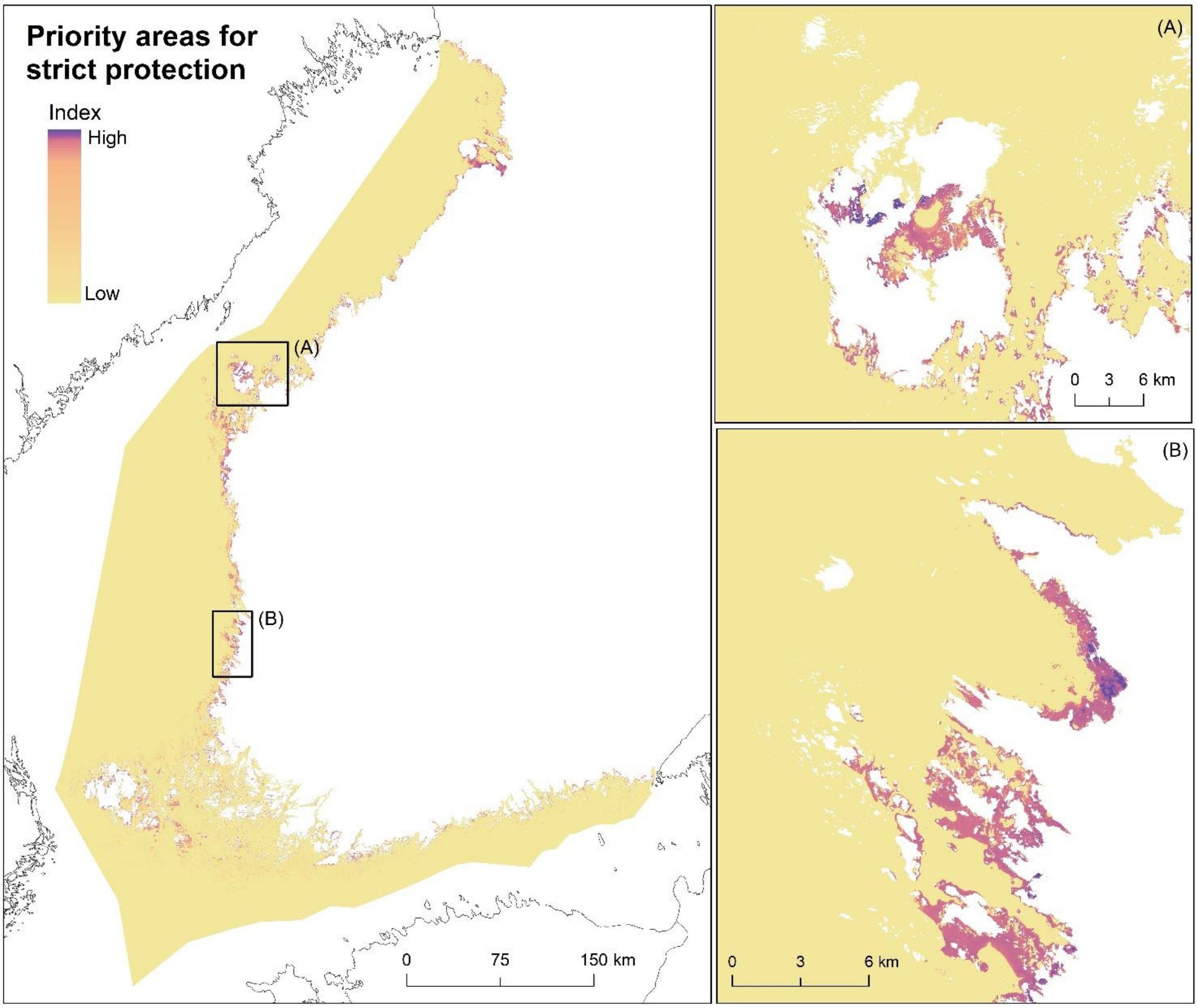

Figure 3. High-priority conservation sites for species identified benefitting particularly from area-based conservation.

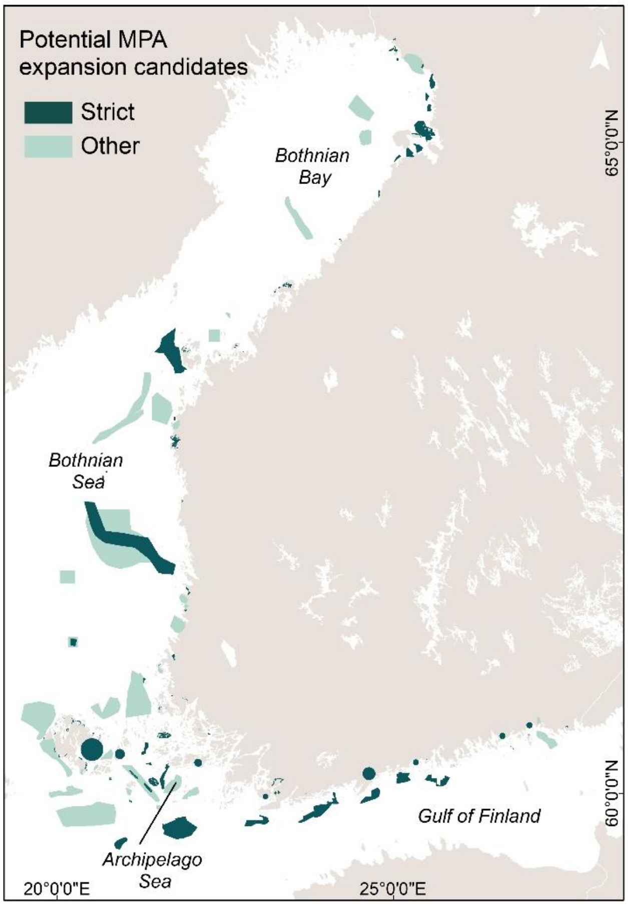

Figure 4. Potential MPA candidates that would fill gaps in present protection, improving the conservation of species that particularly benefit from area-based protection, valuable areas of underwater nature, as well as geologically important areas.

References

Forsblom, L., E. A. Virtanen, H. Arponen, R. Boman, J. Haapamäki, J. Hoikkala, N. Kallio, V.-J. Karvinen, A. Kaskela, and E. Keskinen. 2024. Finnish inventory data of underwater marine biodiversity. Scientific data **11**:1297.

Kuismanen, L., and S. Husa. 2020. Coastal human activity on the Åland Islands interpreted using aerial photographs. Marine Research Centre, Finnish Environment Institute, Helsinki, Finland and ….

Kulha, N., L. Ruha, S. Väkevä, S. Koponen, M. Viitasalo, and E. A. Virtanen. 2024. Satellite bathymetry estimation in the optically complex northern Baltic Sea. Estuarine, Coastal and Shelf Science **298**:108634.

Moilanen, A., P. Lehtinen, I. Kohonen, J. Jalkanen, E. A. Virtanen, and H. Kujala. 2022. Novel methods for spatial prioritization with applications in conservation, land use planning and ecological impact avoidance. Methods in Ecology and Evolution **13**:1062-1072.

Mäyrä, J., E. Virtanen, A.-P. Jokinen, J. Koskikala, S. Väkevä, and J. Attila. in review. Mapping Recreational Marine Traffic from Sentinel-2 Imagery with Yolov8. Available at SSRN 4827287.

Sahla, M., T. Turkia, A. Nieminen, T. Räsänen, J. Haapamäki, J. Hoikkala, F. Suominen, and J. Kantanen. 2020. Ilmakuvakartoitus ihmispaineista Suomen rannikon merialueilla. Meriluonnonsuojelu, Luontopalvelut, Metsähallitus. URL: https://ckan. ymparisto. fi/dataset/ihmispaineiden-ilmakuvakartoitus-suomen-ja-ahvenanmaanrannikon-merialueilla.

Virtanen. et al. in prep. Impacts of human activities on benthic biodiversity for marine conservation and management in Finland.

Virtanen, E. A., M. Viitasalo, J. Lappalainen, and A. Moilanen. 2018. Evaluation, gap analysis, and potential expansion of the Finnish marine protected area network. Frontiers in Marine Science **5**:402.

Weckström, K., H. Rinne, M. Häggblom, and S. Salovius-Laurén. 2024. Rapport no 169: Marine inventories to support ecosystem-based management and the expansion of the MPA network in the Åland Islands–Final report of the ÅlandSeaMap project (2019–2023).

Supplementary Table 1. Species identified as those that would benefit from area-based conservation.

Chara horrida
Najas tenuissima
Chara baltica
Chara canescens
Chara tomentosa
Nitella hyalina
Chara aspera
Nitellopsis obtusa
Zostera marina
Ruppia maritima
Chara
Chara globularis
Charales
Najas marina
Potamogeton perfoliatus
Nitella
Anodonta anatina
Nitella flexilis
Nitella wahlbergiana
Persicaria foliosa

Alisma wahlenbergii
Chara braunii
Tolypella
Potamogeton friesii
Stuckenia pectinata
Myriophyllum sibiricum
Ceramium virgatum
Mya arenaria
Stuckenia filiformis
Potamogeton praelongus
Ranunculus circinatus
Potamogeton pusillus
Ranunculus baudotii
Myriophyllum spicatum
Ruppia spiralis
Hippuris vulgaris
Zannichellia palustris
Zannichellia palustris var palustris
Zannichellia palustris var pedicellata
Zannichellia
Ceratophyllum demersum
Chara connivens
Myriophyllum alterniflorum
Myriophyllum
Myriophyllum verticillatum
Potamogeton obtusifolius
Fucus
Schoenoplectus tabernaemontani
Nuphar lutea
Nymphaea alba
Potamogeton natans
Vaucheria sp
Dictyosiphon chordaria
Alderia modesta
Macroplea pubipennis
Rhodomela confervoides
Potamogeton berchtoldii
Potamogeton compressus
Potamogeton gramineus
Ajelehtiva Fucus elossa
Hippuris
Hippuris tetraphylla
Ranunculus confervoides
Ranunculus schmalhausenii
Zannichellia major

Chara virgata
Potamogeton alpinus
Potamogeton crispus
Potamogeton lucens
Schoenoplectus
Schoenoplectus lacustris
Turbellaria
Typha
Callitriche cophocarpa
Callitriche hamulata
Callitriche hermaphroditica
Callitriche palustris
Lemna trisulca
Eleocharis acicularis
Eleocharis
Eleocharis mamillata
Eleocharis palustris
Eleocharis uniglumis
Sparganium
Sparganium emersum
Ceramium tenuicorne
Cladophora glomerata
Pylaiella littoralis
Chorda filum
Stuckenia vaginata
Dictyosiphon foeniculaceus
Furcellaria lumbricalis
Mytilus trossulus
Polysiphonia fucoides
Sphacelaria
Ulva
Aglaothamnion roseum
Cladophora rupestris
Coccotylus truncatus or Phyllophora pseudoceranoides
Fontinalis antipyretica
Fontinalis
Fontinalis dalecarlica
Fontinalis hypnoides

Supplementary Table 2. Human activities and pressures used in the analysis.

Anchoring areas
Areas reserved for dumping of dredged materials
Breakwaters with two size classes
Bridges and causeways
Built, artificial shores
Coastal infrastructure
Commercial harbors
Dredging footprints with three size classes
Dredging of shipping lanes
Extraction areas for marine minerals
Jetties with two size classes
Marinas
Offshore windfarms
Underwater cables with three different cable types