Template for Submission of Scientific Information
to Describe Areas Meeting Scientific Criteria for
Ecologically or Biologically Significant Marine Areas

THE NORTHERN BOTHNIAN BAY

Abstract

The Bothnian Bay forms the northernmost part of the Baltic Sea. It is the most brackish part of the Baltic, greatly affected by the combined river discharge from most of the Finnish and Swedish Lapland. The sea area is shallow and the seabed consists mostly of sand. The area displays arctic conditions: in winter the whole area is covered with sea ice, which is important for the reproduction of the grey seal (*Haliochoerus grypus*) and a prerequisite nesting habitat for the ringed seal (*Pusa hispida botnica)*. In summer the area is productive and due to the turbidity of the water the primary production is compressed to a narrow photic zone (between 1 to 5 meters). Due to the extreme brackish water the number of marine species is low, but at the same time the number of endemic and threatened species is high. It is an important reproduction area for coastal fish and an important gathering area for several anadromous fish species. River Tornionjoki, which discharges into the northern part of the area, is the most important spawning river for the Baltic population of the Atlantic salmon (*Salmo salar*), a vulnerable species in the Baltic Sea.

Introduction

The Northern Bothnian Bay is a large, shallow and tideless sea area with a seabed consisting mostly of sand and silt, forming the northernmost part of the Baltic Sea. The topography is a result of the last glaciation (10,000 BP) and the isostatic land uplift is still ongoing (ca. 8 mm/year). Depth varies from 0 to 58 meters (the deepest part of the Bothnian Bay is 148 m) and the mean depth is 9 m (Fig. 7). The photic zone is narrow with annual variations depending on river discharge bringing dissolved organic matter into the sea, and on-site primary production (Fig. 9). River discharge in turn depends on precipitation (and snow melt in spring), while primary production depends on water temperature, nutrients and available sunlight. Daylight hours vary from less than 4 hours in winter to over 20 hours during summer.

The Bothnian Bay has elevated seabed geodiversity (Kaskela et al., 2012; Kaskela & Kotilainen, 2017). Crystalline bedrock dominates the coastal Bothnian Bay especially in the north, and sedimentary rocks characterise the area around Hailuoto Island and tectonic depressions of the central part (Fig. 5 & 6). The erosion of the sedimentary rocks partly contributes to the occurrence of large sandy seafloor areas typical of the area (especially in comparison with other Finnish marine areas) (Tulkki, 1977). In addition, depressed seafloor structures corresponding to continuations of the riverbeds and fault lines have been identified (Tulkki, 1977).

The whole Bothnian Bay is covered by ice during most winters. The ice thickness in the proposed area is typically 70 cm (Kronholm et al. 2005).

Regular monitoring of the ecological state of the sea takes place in the area. The Finnish Inventory Programme for Marine Underwater Environment (VELMU) has conducted extensive biodiversity inventories in the area. The inventories done in 2004-2017 have included dive lines and drop videos, benthic sampling, fish larvae sampling, and echosoundings. Observation data for hundreds of species is available. Also, species distribution models (SDMs) have been made for many species (below referred to as “VELMU data”; viewable in https://paikkatieto.ymparisto.fi/velmu). Spatial data on birdlife and seals also exist.

Location

The area is located within the Finnish national waters, and encompasses the northernmost part of the Bothnian Bay (Fig. 1 & 2). The total coverage of the proposed EBSA area is 3534 km^2 and its sea area is 3260 km^2.

The area is within the Finnish national jurisdiction.

Feature description of the proposed area

The Northern Bothnian Bay both embodies and contains the characteristics of the largest and most northern brackish sea area in the Baltic. The ecosystem resembles that of an oligotrophic lake, rather than a sea. As in lakes, the phytoplankton production is limited by availability of phosphorus, rather than nitrogen, as is the case in most other parts of the Baltic Sea. The rivers flowing into the Bay of Bothnia carry a large amount of dissolved organic carbon, which makes the water brownish, and serves as a substrate for bacterial growth. Therefore the phytoplankton production is low compared to other areas of the Baltic Sea. The secondary producers, including mesozooplankton and fish, gain energy through a food web based on microbes and microzooplankton.

While the number of species, especially that of marine species, is comparatively low, due to the combined constraints of brackish water (too low or too high salinity) and annual variations in temperature and light, the area has a comparatively high number of endemic species, several of which have vulnerable or threatened status.

The physical, chemical and climatic characteristics make the area suitable for freshwater species that can tolerate low salinities and cold water conditions. Some fish species have adapted populations that spawn either in the coastal area or migrate to rivers for spawning. Often these have also different feeding areas. Sea-spawning whitefish (*Coregonus lavaretus*) and vendace (*Coregonus albula*) spawn in the shores and reefs of Bothnian Bay. The sea-spawning grayling (*Thymallus thymallus*) that occurs in some outer islands is a unique endemic species that differs from the anadromous grayling (*Thymallus thymallus*) which feeds in the coastal area and reproduces in small creeks that run to the Bothnian Bay. The sea-spawing grayling uses the sandy or rocky shallow shores as habitat for early stage fish larvae and fry. The numerous rivers of Bothnian Bay are reproduction area of migratory whitefish (*Coregonus lavaretus*) and sea trout (*Salmo trutta*), which may use the entire Gulf of Bothnia as a feeding area. The spring spawning perch and pike use estuaries and shallow bays as reproduction area.

Part of the proposed area belongs to the Bay of Bothnia National Park, and there are several areas that are included in the Natura 2000 network.

Table 1. Number of species in different sea areas listed by HELCOM (HELCOM 2012). The total number of species in the Baltic Sea is 2730 of which 1898 species are invertebrates. Total number of species in the table excludes bird species.

	Gulf of Finland	Archipelago Sea	Kvarken Archipelago	Bothnian Sea
Macrophytes	187	68	162	116
Benthic invertebrates	482	122	96	132
Fish & lamprey	87	68	51	48
Marine mammals	3	3	2	2
Total number of species	759	261	311	298
Share of species in the Baltic Sea	27.8 %	9.6 %	11.4 %	10.9 %

Feature condition and future outlook of the proposed area

The overall condition of the area is good. The eutrophication plaguing the Baltic overall is mostly absent, due to little or no agriculture. Forest and mire drainage have increased the amount of humus particles in the water, which occasionally (during snow melt in spring) increases the turbidity.

Intense land use, river construction and dams have suppressed the natural reproduction of wild anadromous fish, such as whitefish (*Coregonus lavaretus*) and sea trout (*Salmo trutta*). Their populations are supported with vast stocking programs. In the coastal area, the stocks of sea-spawning grayling have most likely decreased due to nearshore eutrophication, fishing and predation by seals.

Assessment of the area against CBD EBSA Criteria

CBD EBSA Criteria (Annex I to decision IX/20)	Description (Annex I to decision IX/20)	Ranking of criterion relevance (please mark one column with an X)			
		No information	**Low**	**Medium**	**High**
Uniqueness or rarity	Area contains either (i) unique ("the only one of its kind"), rare (occurs only in few locations) or endemic species, populations or communities, and/or (ii) unique, rare or distinct, habitats or ecosystems; and/or (iii) unique or unusual geomorphological or oceanographic features.				X

HIGH. The Northern Bothnian Bay is unique compared to other brackish sea areas, including other areas in the Baltic Sea. The only comparable area is the Swedish part of the Bothnian Bay (immediately on the other side of the national border between Finland and Sweden). It contains several endemic and/or rare species, and facilitates the evolutionary process of adapting marine species to freshwater conditions, or alternatively freshwater species to marine conditions (Fig. 8).

- Several main marine habitats of the EU Habitats directive exist in the area: estuaries (1130), coastal lagoons (1150), large shallow inlets and bays (1160), underwater sandbanks (1110) and reefs (1170) (Fig. 3 & 4). Also, a number of EU Natura 2000 sites exist in the area.

- The critically endangered (CR) grayling (*Thymallus thymallus*) has still some few reproductive areas in the northern part of Gulf of Bothnia, both in coastal area and in small creeks (Keränen 2015). The sea-spawning grayling is endemic to the area.

- *Macroplea pubipennis* (VU/DD), a leaf beetle species of the subfamily Donaciinae that is endemic to Finland, was found to occur in the area in 2017. This represents the northernmost population in Europe. In the world, the species is only found in Finland, Sweden and China (Saari 2007; Fauna Europaea).

Special importance for life-history stages of species	Areas that are required for a population to survive and thrive.				X

HIGH. The area is an important staging area for anadromous fish, including Atlantic salmon. It is also an important staging area for bird migration, especially during spring migration. The Northern Bothnian Bay is one of two areas in the Baltic where sea ice will reliably form in the near future (according to the current IPCC status and regional 100 year predictions on effects) (Fig. 10). This makes the area of extreme importance for the grey seal (*Haliochoerus grypus*) and the ringed seal (*Pusa hispida botnica)*, both which breed on the annual ice cover (the ringed seal exclusively so).

The proposed area, and its Krunnit Islands, is an important nesting area for several marine species such as razorbill (*Alca torda*) and Caspian tern (*Hydroprogne caspia*). The Bay of Bothnia in general has a worldwide importance for the Caspian tern, because of the strong population in this area. Also, the Liminganlahti Bay is a unique 10 km wide mixture of estuaries, bays, lagoons, wetlands and sand dunes, which supports a particularly rich bird fauna and serves as an important resting area for migrating birds. Species like Eurasian bittern (*Botaurus stellaris*) and spotted crake (*Porzana porzana*), which otherwise do not thrive this far north.

As for fish, the proposed area includes important reproductive areas for whitefish (*Coregonus lavaretus*), as well as for vendace (*Coregonus albula*) and grayling (*Thymallus thymallus*) (Vanhatalo et al. 2012, Veneranta et al. 2013).

- Includes IBAs (Fig. 11)
- Migration route of waterfowl (Fig. 12)

<table>
<tr><td>Importance for threatened, endangered or declining species and/or habitats</td><td>Area containing habitat for the survival and recovery of endangered, threatened, declining species or area with significant assemblages of such species.</td><td></td><td></td><td>X</td><td></td></tr>
<tr><td colspan="6">MEDIUM. The area contains habitats where several threatened species thrive: [Hertta-lista]
• Coregonus lavaretus f. lavaretus (EN), Coregonus lavaretus f. pallasi (VU), Thymallus thymallus (in the sea and freshwater spawning populations) (CR), Salmo salar (VU), Salmo trutta (CR)
• Rare plant species (Fig. 13 & 14), e.g., Baltic water-plantain (Alisma wahlenbergii; EN), Hippuris tetraphylla (EN), and Crassula aquatica (VU) are found in shallow soft bottom bays and lagoons, especially in areas that have benefited from shoreline grazing by cattle – an activity that has drastically decreased
• High number of coastal birds are breeding in various habitats, including bays, lagoons, sandy shores, and shallow boulder islets typical to the area (Fig. 15)</td></tr>
<tr><td>Vulnerability, fragility, sensitivity, or slow recovery</td><td>Areas that contain a relatively high proportion of sensitive habitats, biotopes or species that are functionally fragile (highly susceptible to degradation or depletion by human activity or by natural events) or with slow recovery.</td><td></td><td>X</td><td></td><td></td></tr>
<tr><td colspan="6">LOW. There are habitats inside the area that are very sensitive to human disturbance, including flads and glo-lakes and bird and seal breeding areas. The area overall is, however, characterized by a comparatively annual change and additionally by fluctuations caused by river discharge, and is as such fairly resilient. There are some pressures inside the area (sand extraction, fisheries, wind farm development), but most are the result of human activities outside the area.</td></tr>
<tr><td>Biological productivity</td><td>Area containing species, populations or communities with comparatively higher natural biological productivity.</td><td></td><td>X</td><td></td><td></td></tr>
<tr><td colspan="6">LOW. The area is productive during summer (with over 20 hours of sunlight) (Distribution of flora; Fig. 22-25), but less so in winter (with annual sea ice covering the area). The benthic invertebrate biomass is rather low in the area (Fig. 21 & 26).

The area is an important reproduction area for many fish species, including pike, perch, pikeperch, Baltic herring, roach, bream, smelt, sea-spawning vendace and gobies (Fig. 27-33).</td></tr>
<tr><td>Biological diversity</td><td>Area contains comparatively higher diversity of ecosystems, habitats, communities, or species, or has higher genetic diversity.</td><td></td><td>X</td><td></td><td></td></tr>
<tr><td colspan="6">LOW. Due to the extreme characteristics of the area the species-based diversity is rather low (Fig. 16-20). On the other hand the species composition of the biotopes and ecosystems is a peculiar mix of freshwater and marine species.</td></tr>
<tr><td>Naturalness</td><td>Area with a comparatively higher degree of naturalness as a result of the lack of or low level of human-induced disturbance or degradation.</td><td></td><td></td><td>X</td><td></td></tr>
<tr><td colspan="6">MEDIUM. The human-induced pressure level is fairly low (Fig. 34-36), especially compared to other sea areas of the Baltic Sea. The population around the area is quite low (by international standards, around 200.000 inhabitants, including coastal inland areas). Pressures from fisheries can locally be quite intense, especially in and around river estuaries. Wind farm development and sand extraction could become a larger threat in the future.</td></tr>
</table>

Sharing experiences and information applying other criteria (Optional)

Other Criteria	**Description**	**Ranking of criterion relevance** (please mark one column with an X)			
		Don't Know	**Low**	**Medium**	**High**
Add relevant criteria					
Explanation for ranking					

References

HELCOM 2012. Checklist of Baltic Sea Macro-species. Baltic Sea Environment Proceedings No. 130

Kaskela, A.M., Kotilainen, A.T., Al-Hamdani, Z., Leth, J. & Reker, J. 2012. Seabed geomorphic features in a glaciated shelf of the Baltic Sea. Estuarine Coastal and Shelf Science 100, 150–161. ISSN 0272-7714, http://dx.doi.org/10.1016/j.ecss.2012.01.008.

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Keränen, P.A. 2015. Meriharjuksen hoitosuunnitelma. Osa 1. Meriharjuskannan hoidon ja suojelun tausta.] https://www.eraluvat.fi/media/dokumentit/julkaisut/meriharjuksen-hoitosuunnitelma-osa-1-meriharjuskannan-hoidon-ja-suojelun-tausta.pdf]

Kronholm, M., Albertsson, J., Lainen, A. (2005). Perämeri Life: Perämeren toimintasuunnitelma. (Bay of Bothnia Life: An Action Plan for the Bay of Bothnia; in Finnish). 234 pp. http://www.doria.fi/handle/10024/134770

Tulkki, P., 1977. The bottom of the Bothnian Bay, geomorphology and sediments. Merentutkimuslaitoksen Julkaisu 241, 1-89.

Vanhatalo, J., Veneranta, L., & Hudd, R. 2012. Species distribution modeling with Gaussian processes: A case study with the youngest stages of sea spawning whitefish (Coregonus lavaretus L. sl) larvae. Ecological Modelling, 228, 49-58.

Veneranta, L., Hudd, R., & Vanhatalo, J. 2013. Reproduction areas of sea-spawning coregonids reflect the environment in shallow coastal waters. Marine Ecology Progress Series, 477, 231-250.

Maps and Figures

Figure 1. EBSA proposal for the Northern Bothnian Bay.

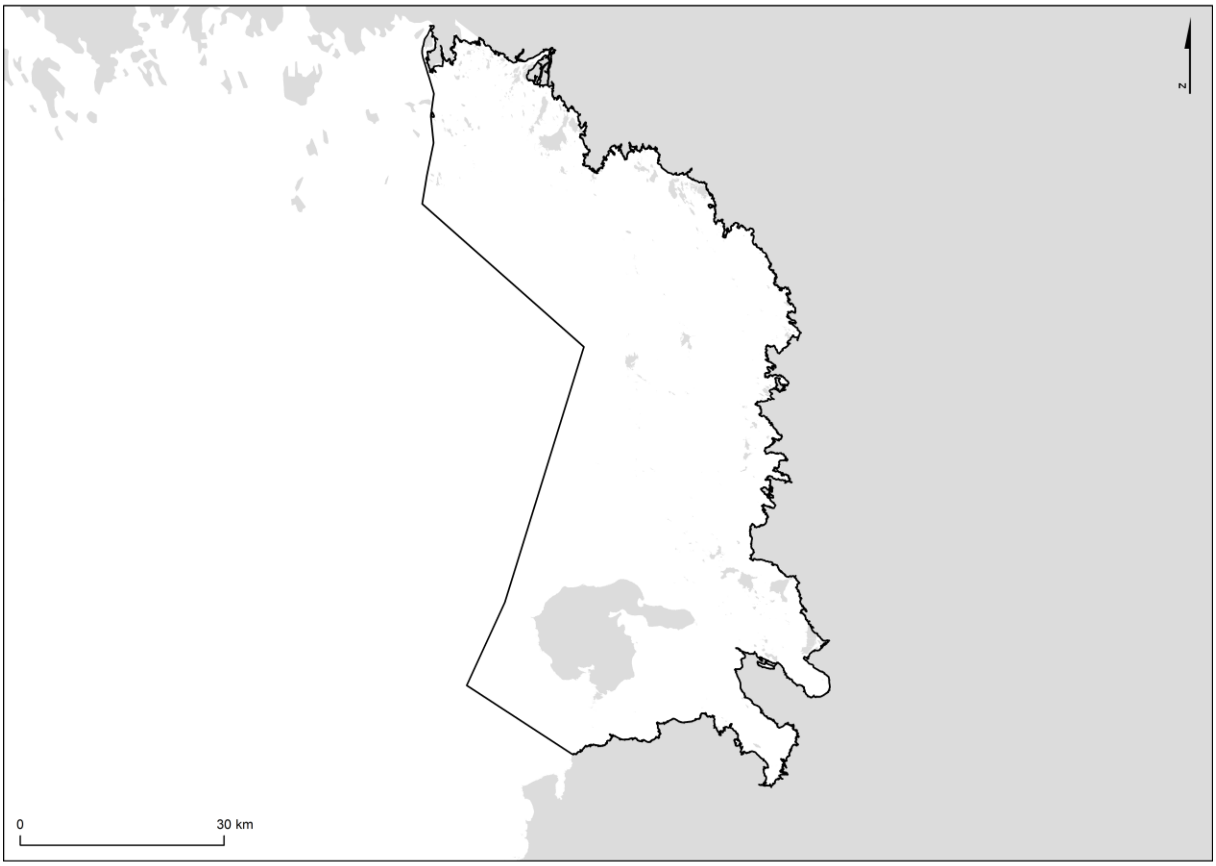

Figure 2. EBSA proposal.

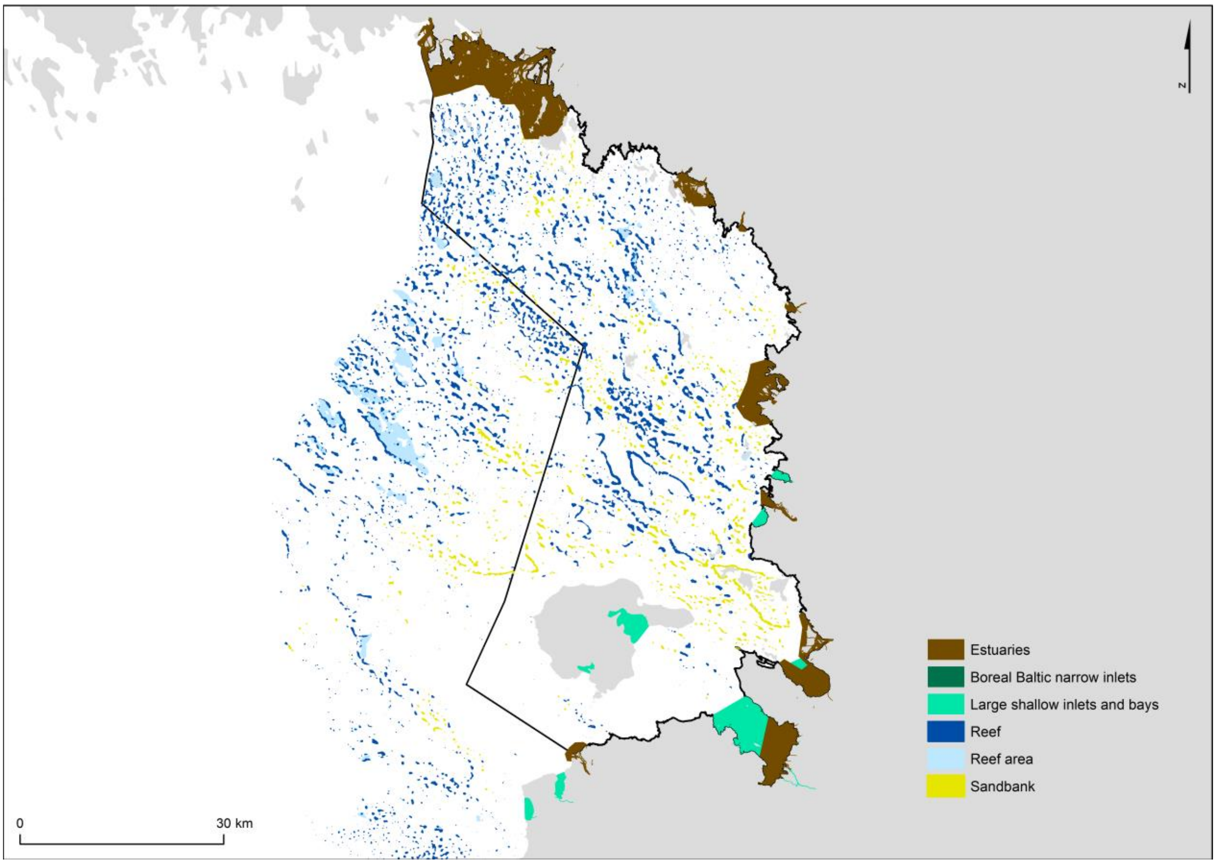

Figure 3. Potential habitats described by EU Habitats directive (92/43/EEC). Finnish Environment Institute & Geological Survey of Finland.

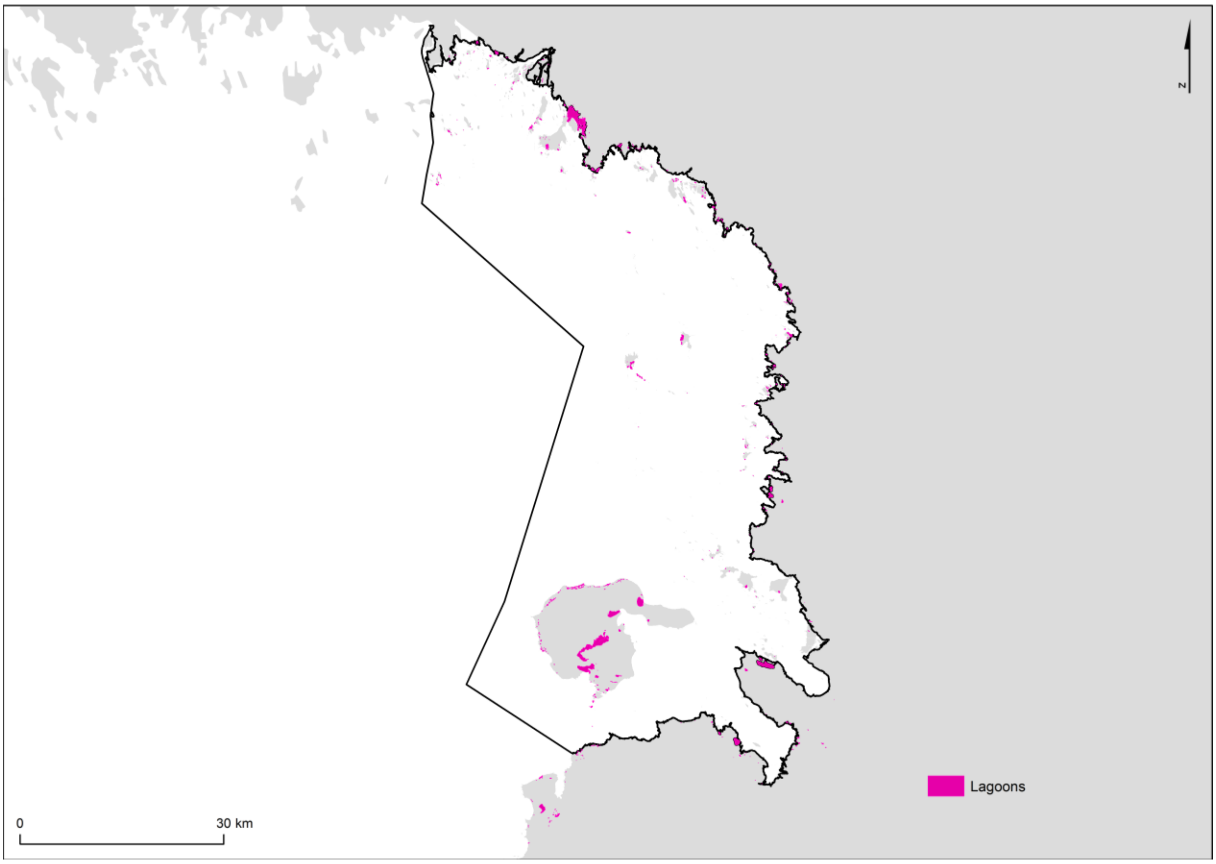

Figure 4. Potential coastal lagoons (1150) described by EU Habitats directive (92/43/EEC). Finnish Environment Institute.

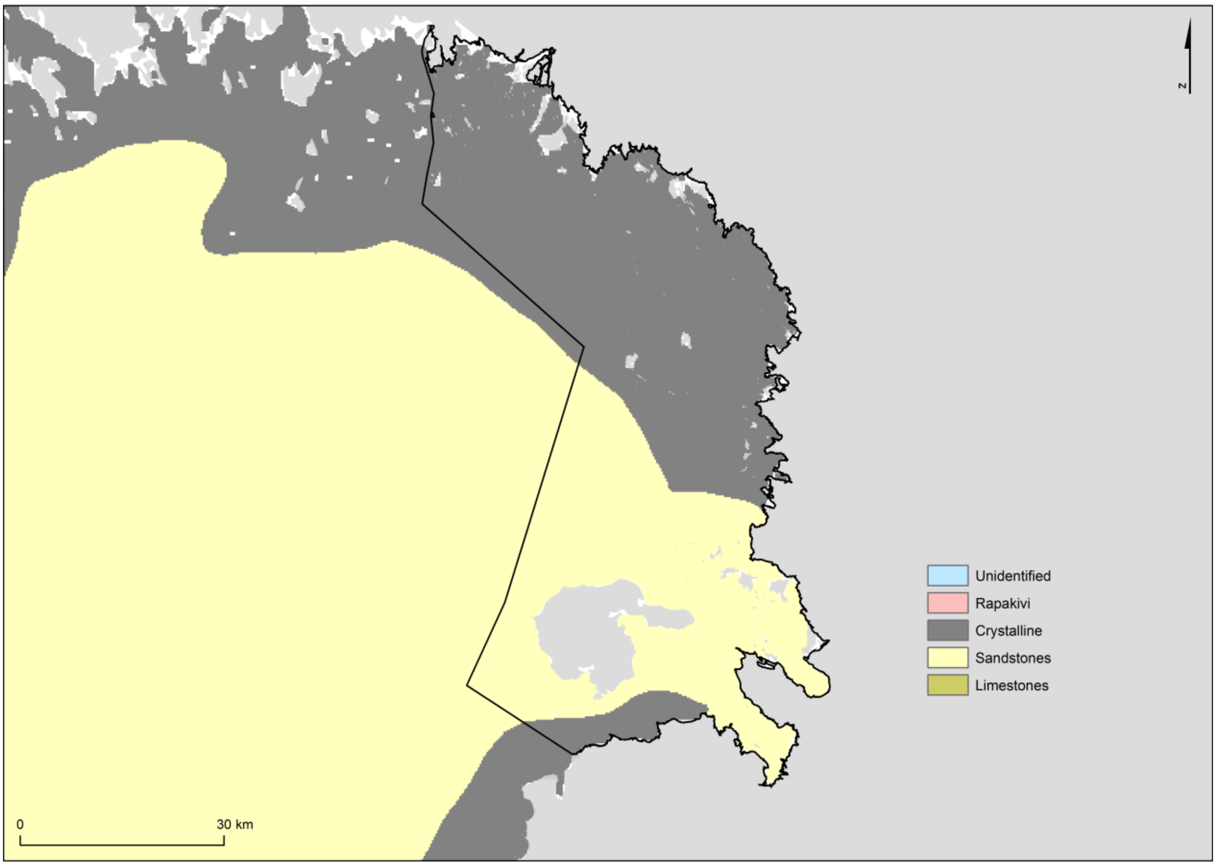

Figure 5. Rock type. Geological Survey of Finland.

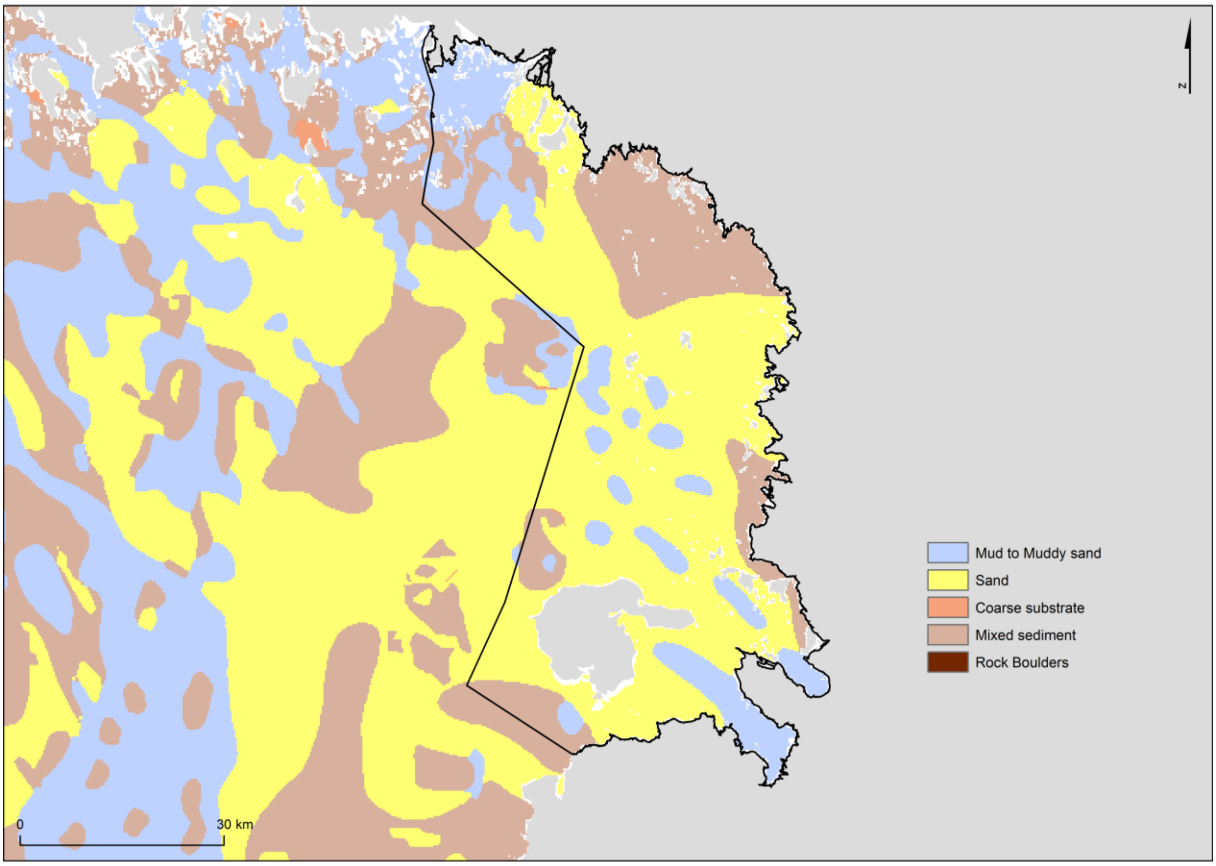

Figure 6. Seabed substrate. Geological Survey of Finland.

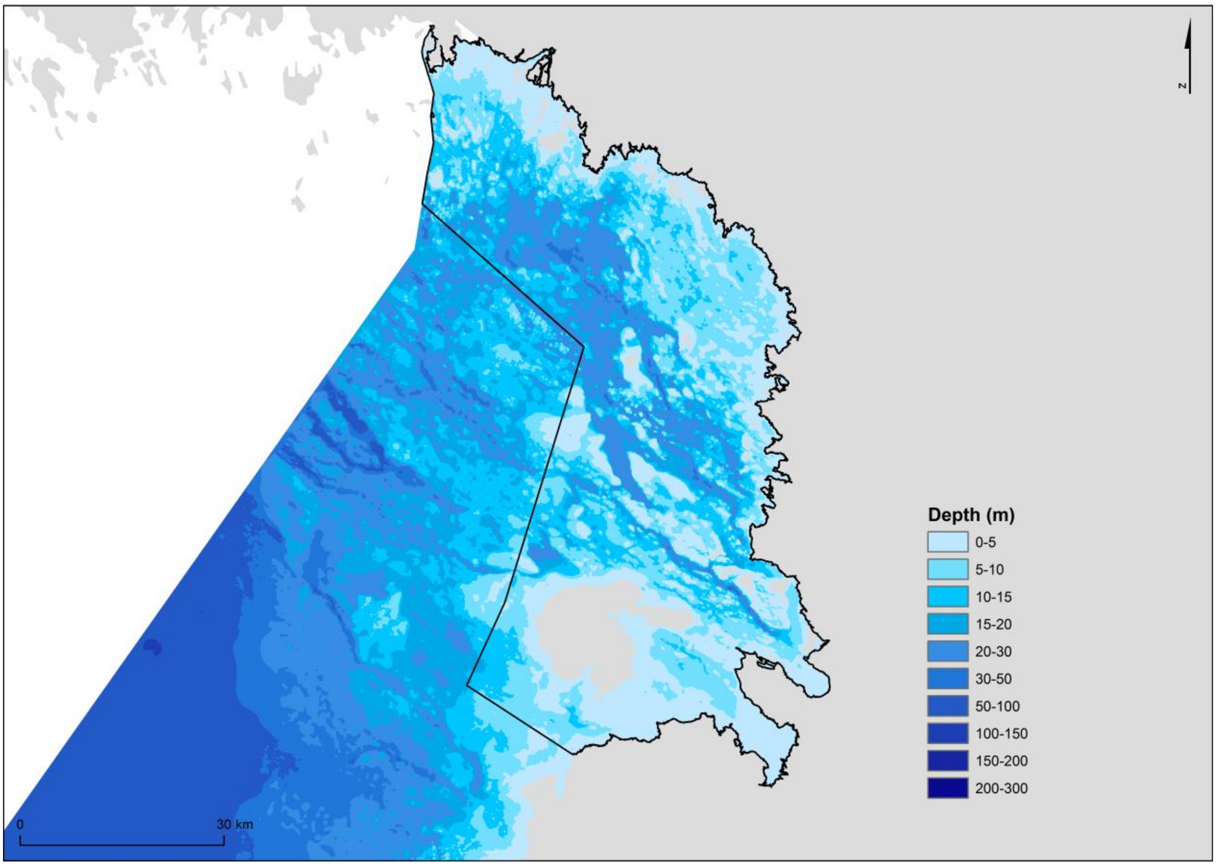

Figure 7. Water depth. VELMU / Finnish Environment Institute.

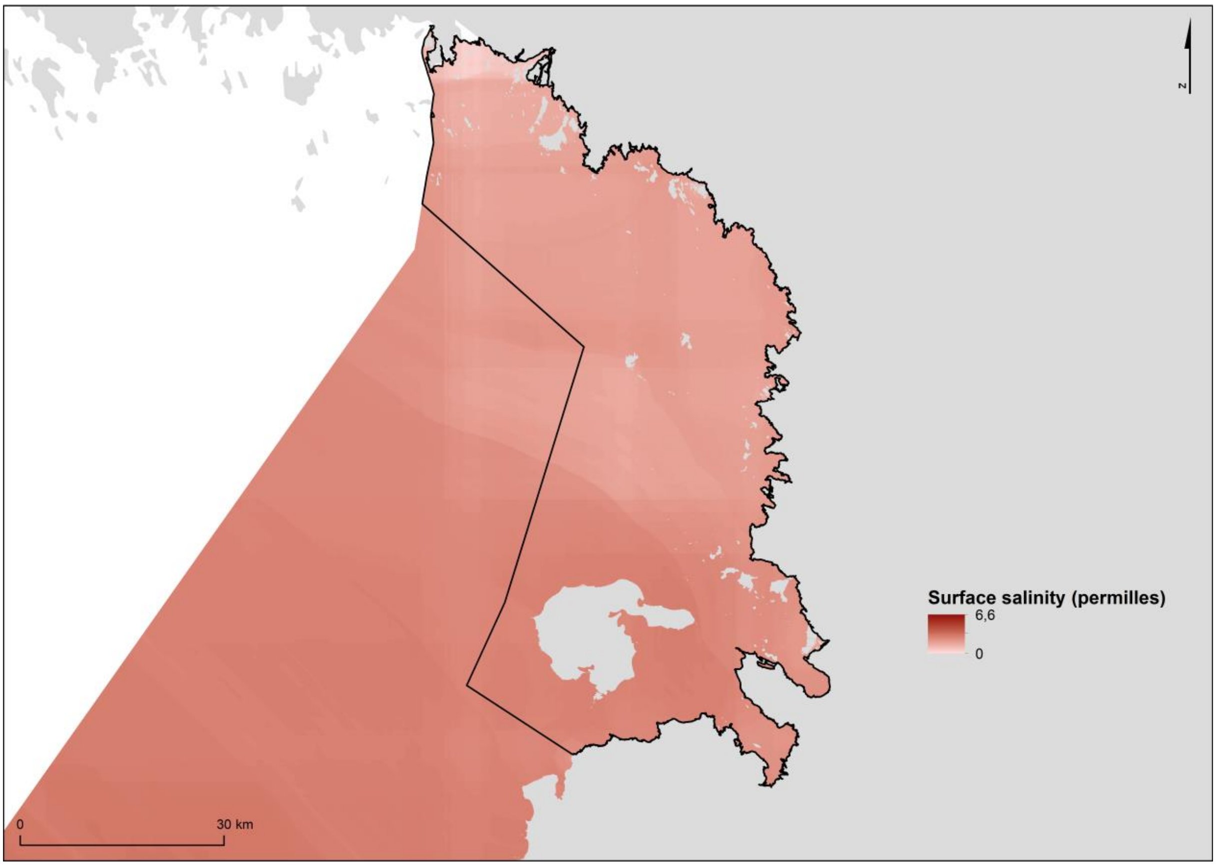

Figure 8. Surface salinity. VELMU / Finnish Environment Institute.

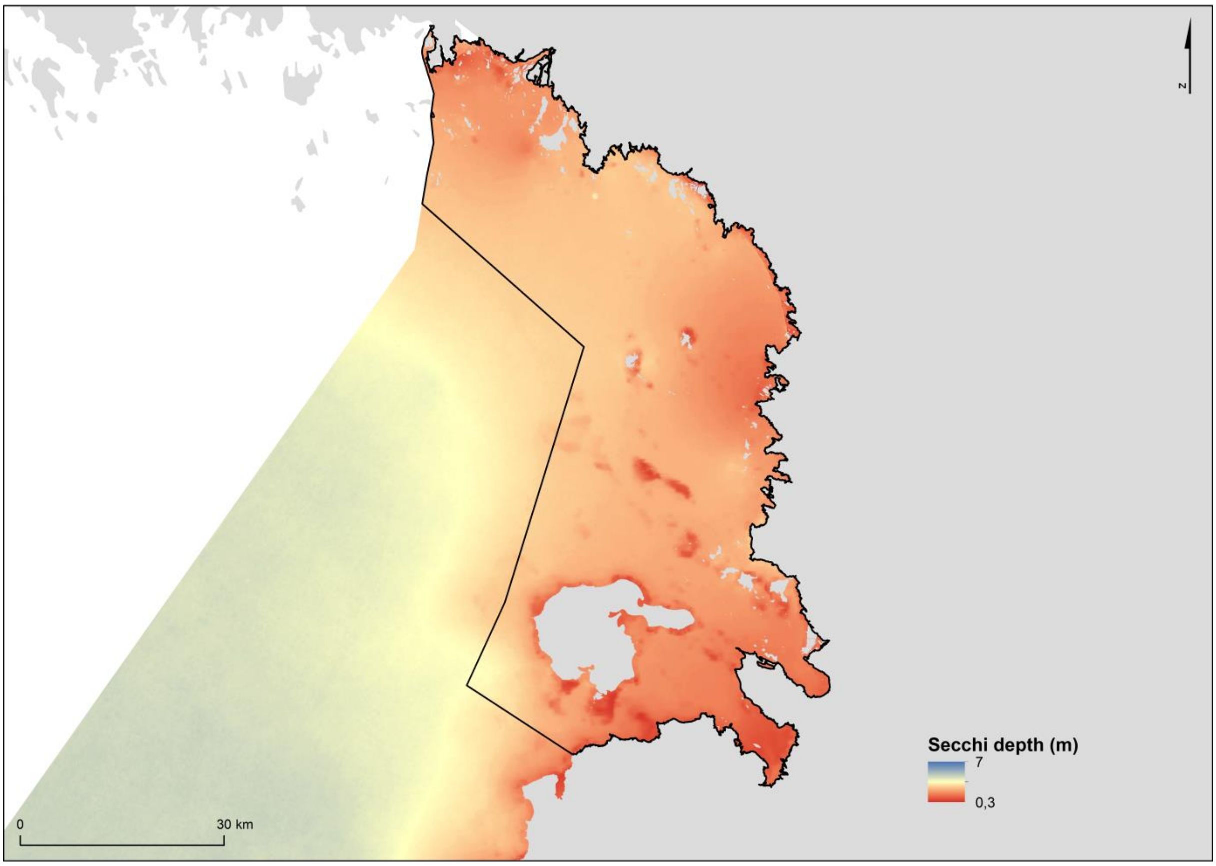

Figure 9. Secchi depth derived from Envisat-1 MERIS satellite images for the summer period 2003-2011. VELMU / Finnish Environment Institute.

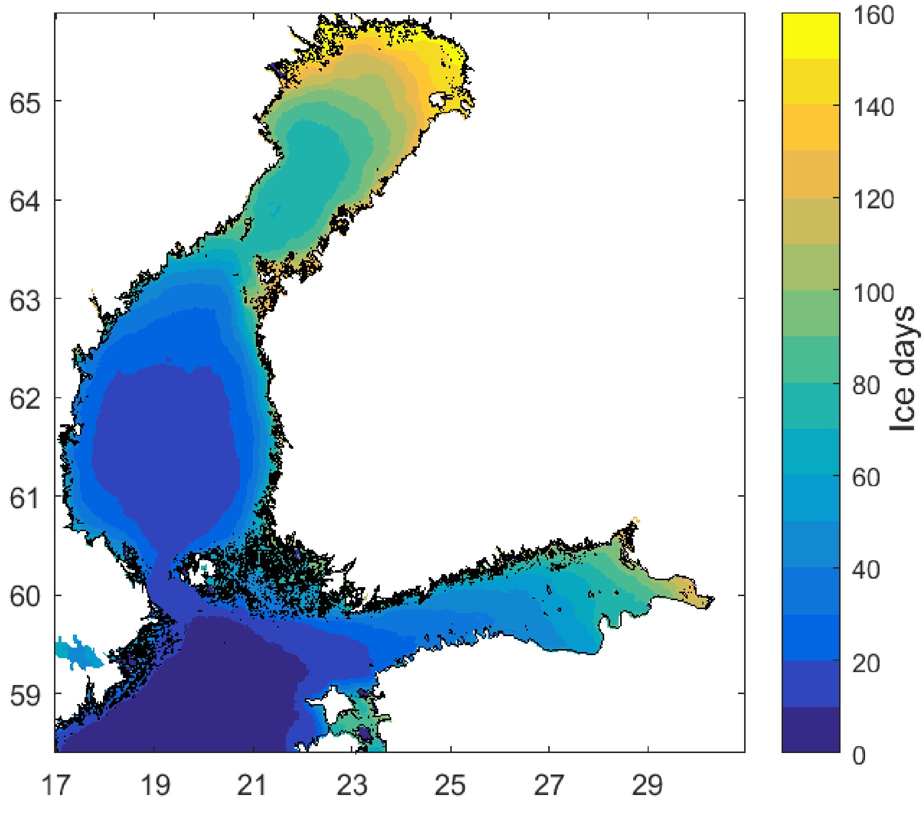

Figure 10. Average number of ice days during winters 2002/2003-2015/2016. Finnish Meteorological Institute.

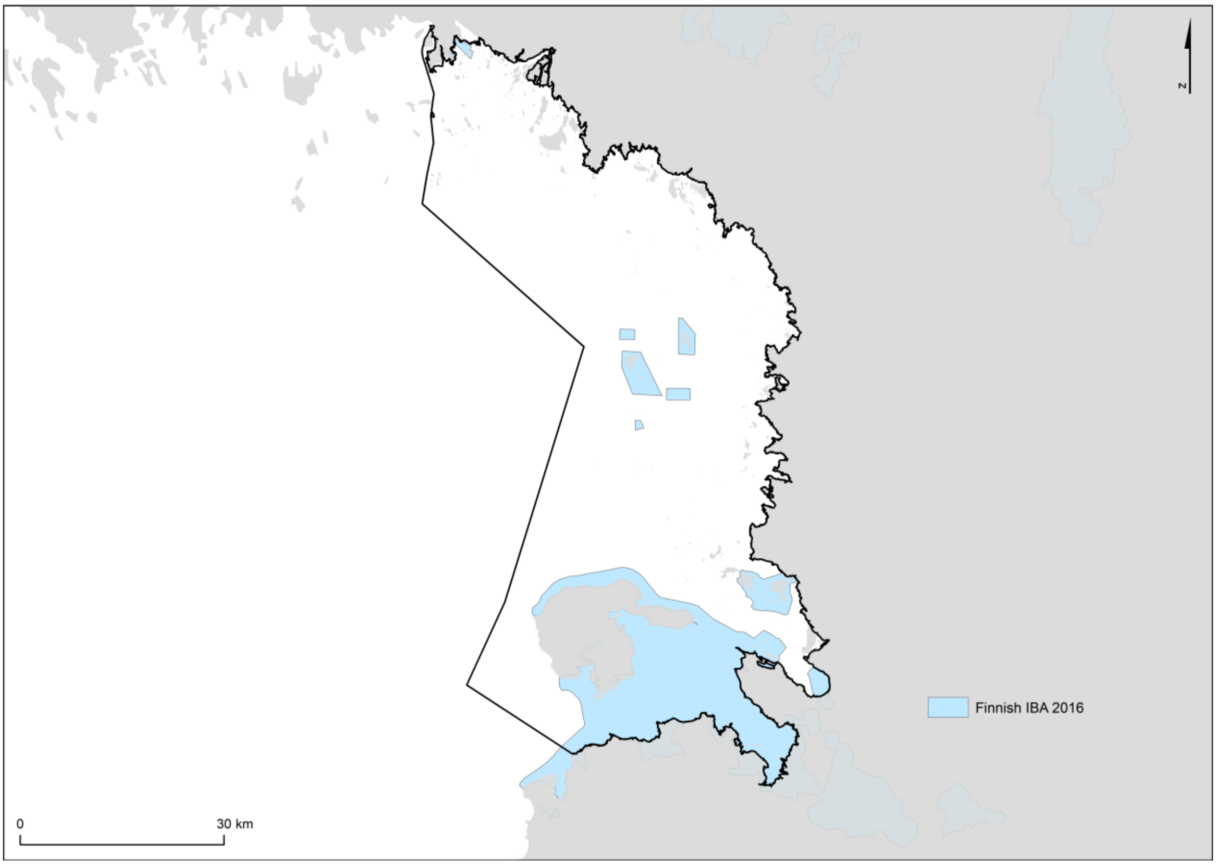

Figure 11. Important Bird and Biodiversity Areas (IBA). BirdLife Finland.

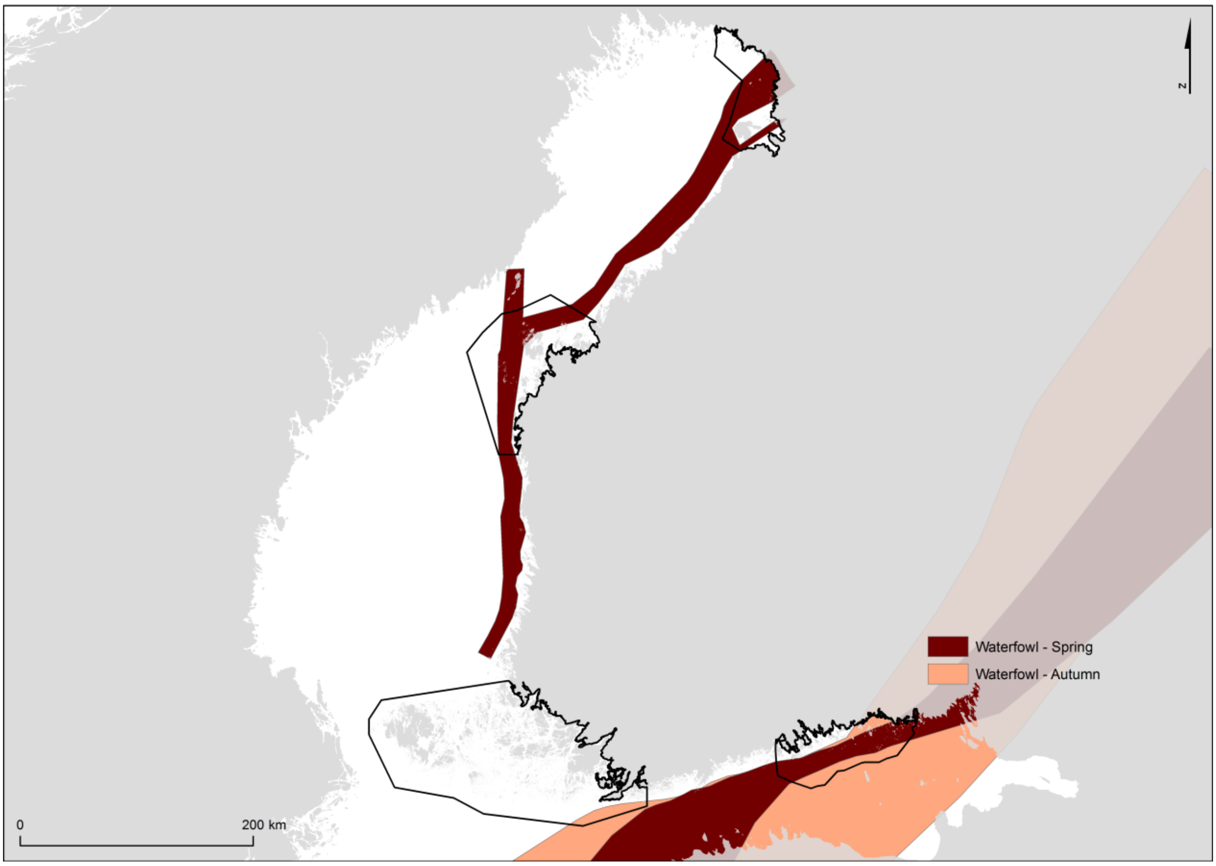

Figure 12. Migration routes of waterfowl. Birdlife Finland.

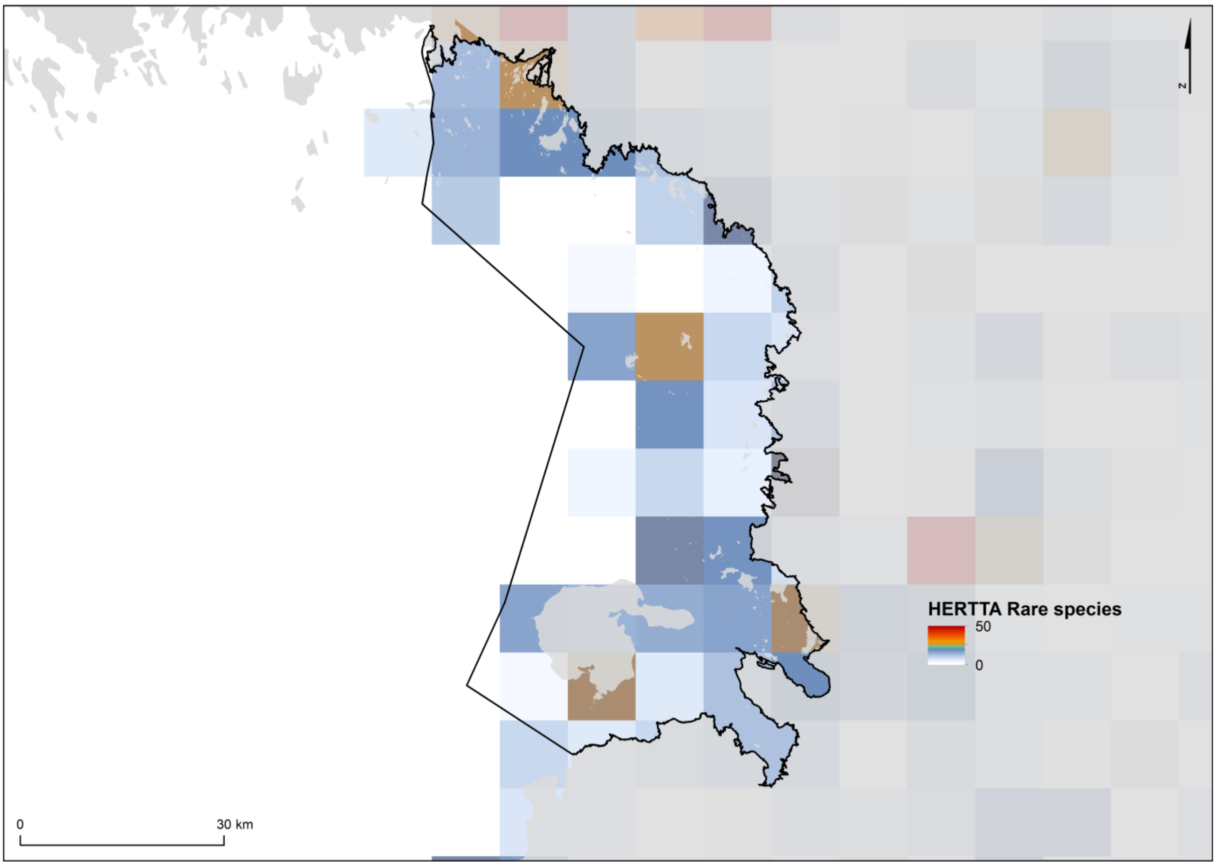

Figure 13. The number of observed rare species (Red list: RE, CR, EN, VU, NT) derived from HERTTA database for the years 1990-2015. Please note that all taxa from HERTTA database are included, also terrestrial species. Finnish Environment Institute.

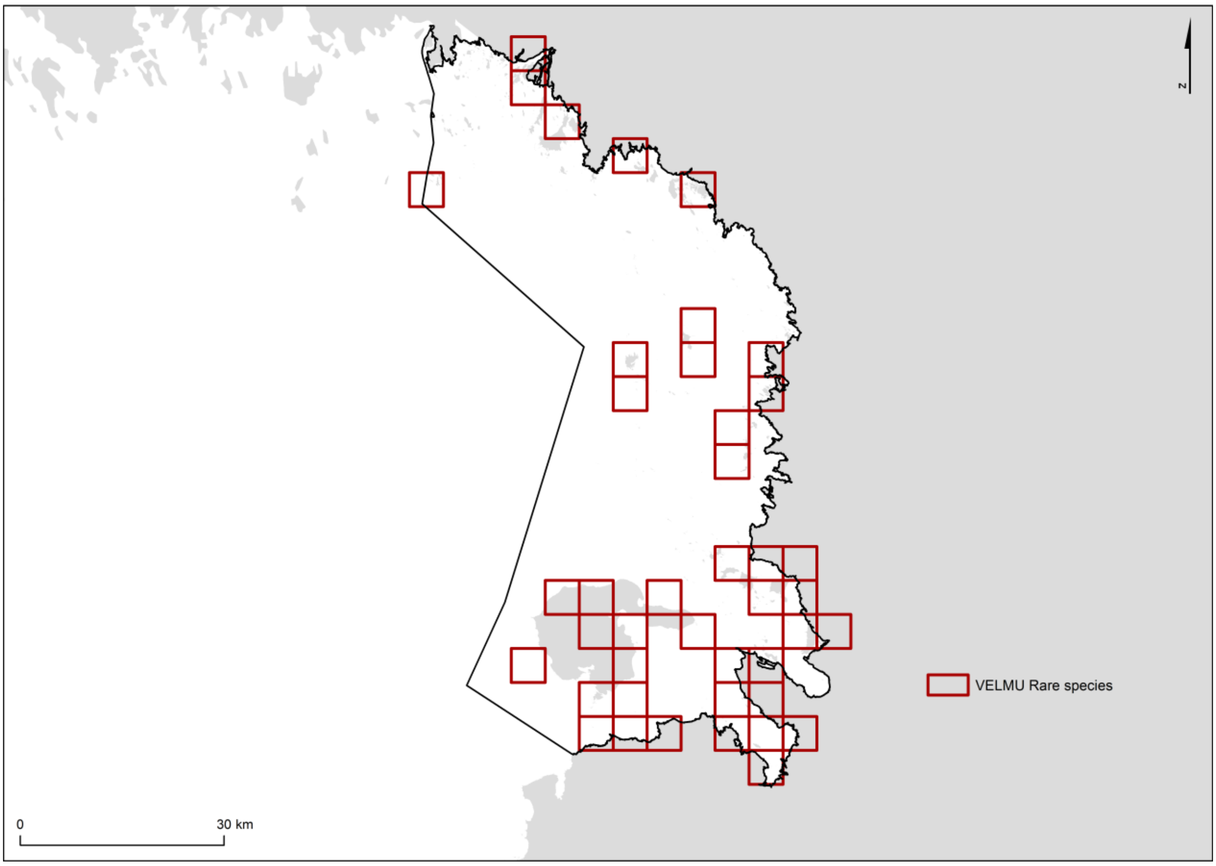

Figure 14. The occurrence of rare aquatic vascular plants and charophytes observed by VELMU programme. VELMU / Finnish Environment Institute.

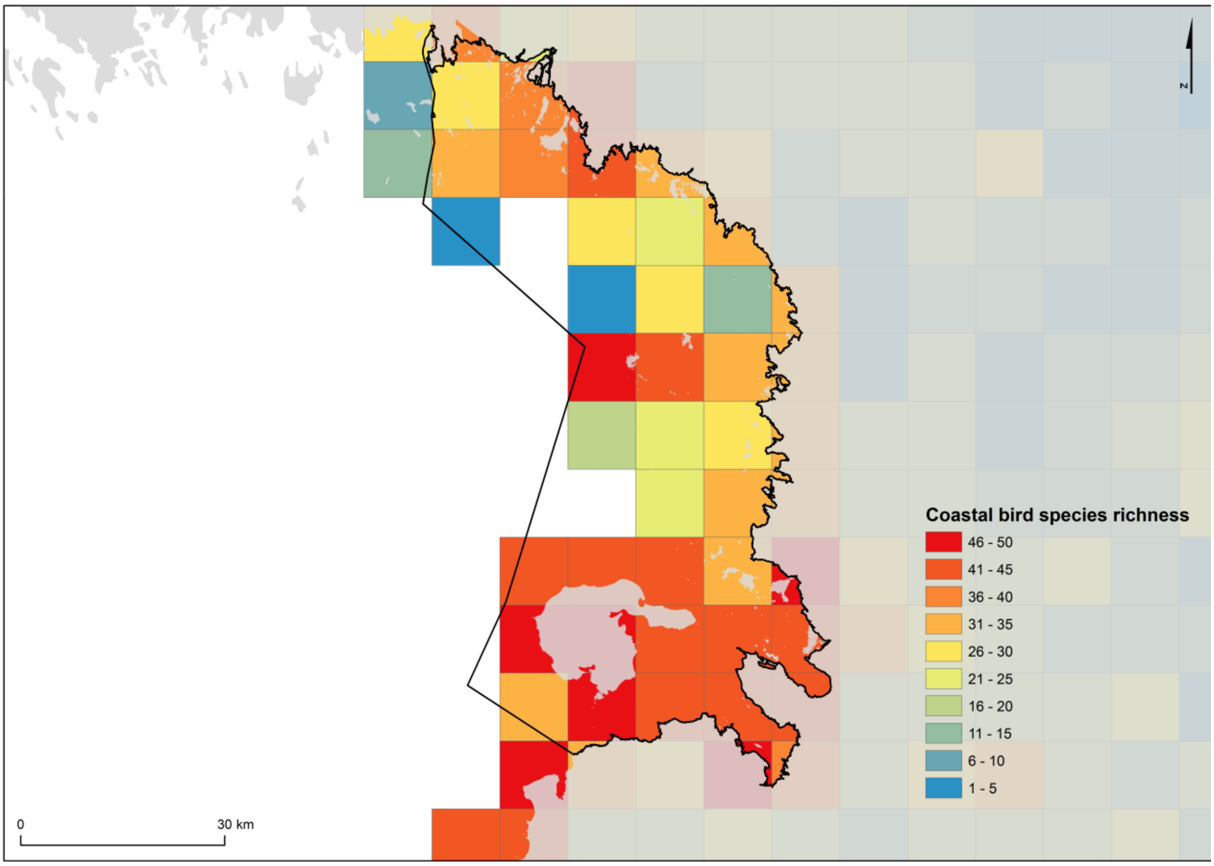

Figure 15. The number of breeding coastal birds. Finnish Bird Atlas & Metsähallitus Parks and Wildlife Finland.

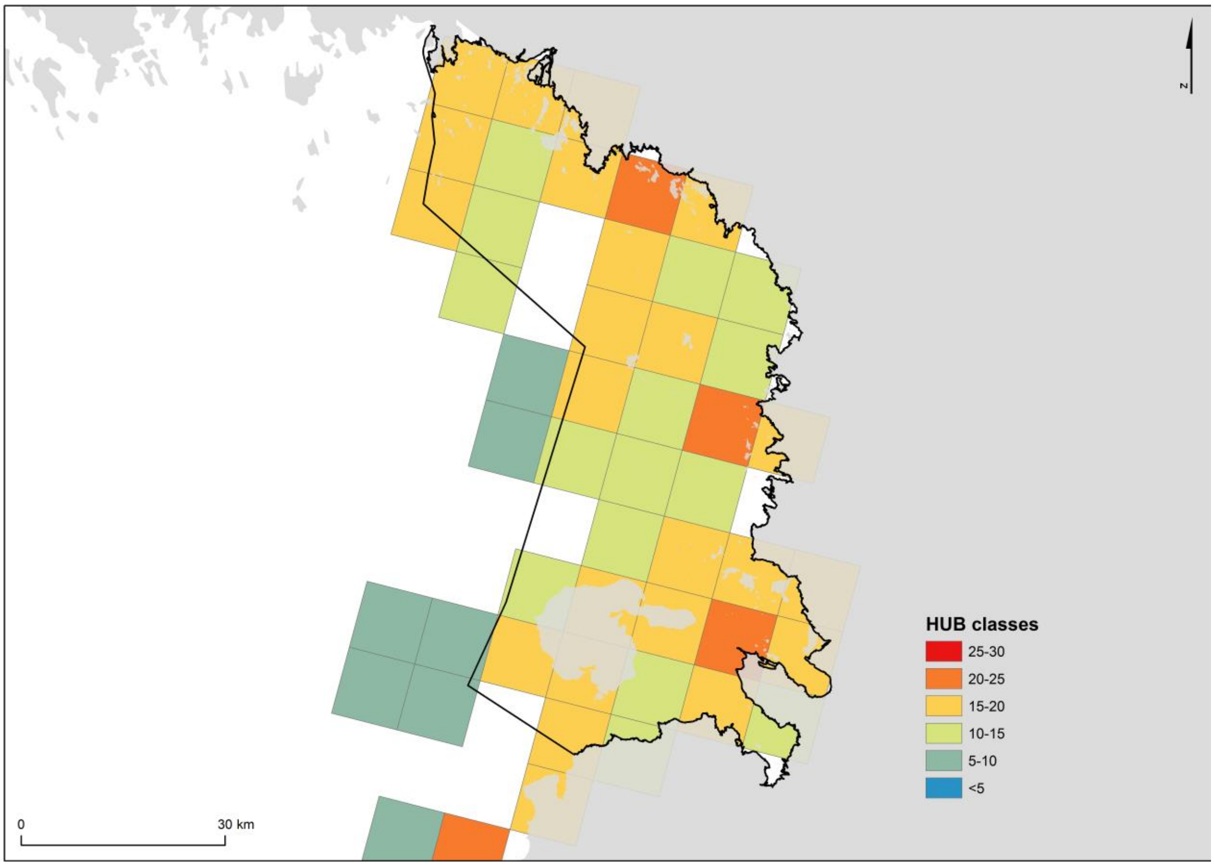

Figure 16. The number of observed HELCOM HUB classes. Based on VELMU inventories 2004-2016. Metsähallitus Parks and Wildlife Finland & Finnish Environment Institute.

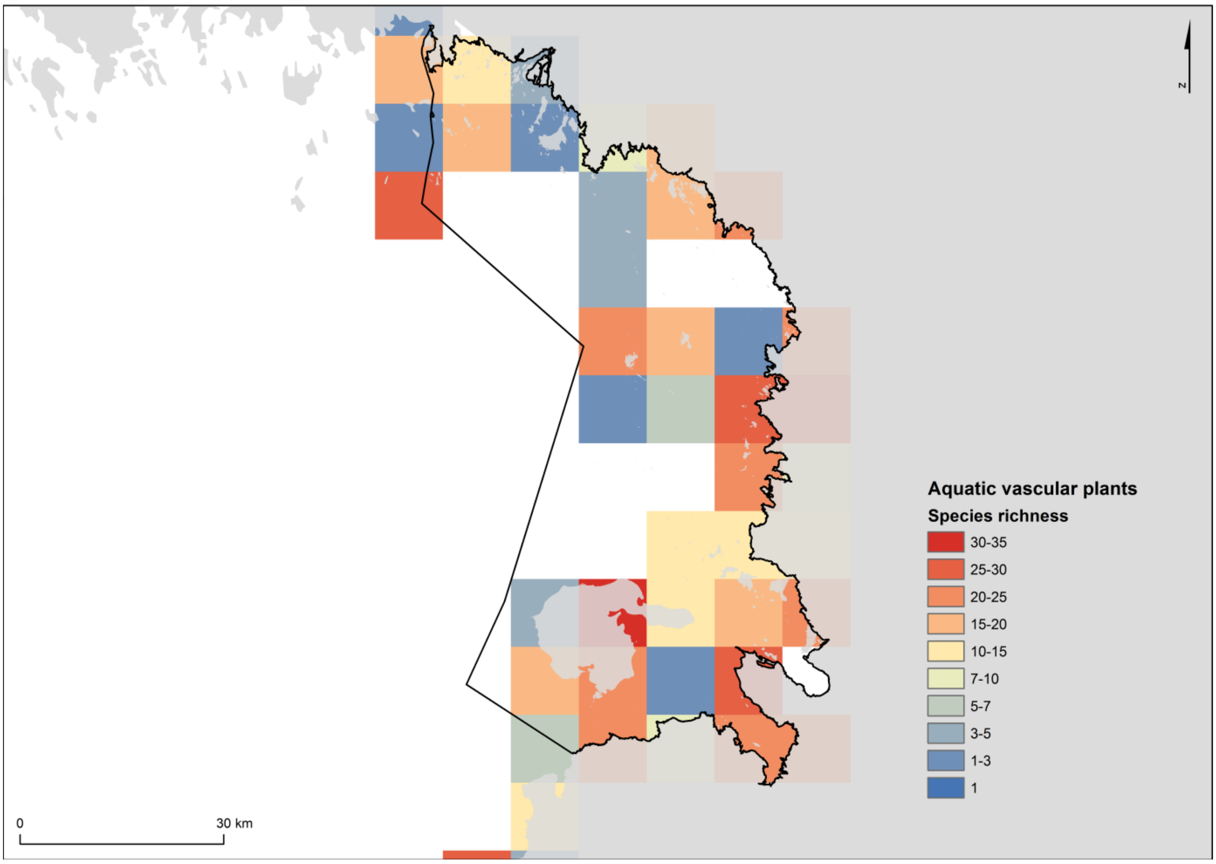

Figure 17. The species richness of aquatic vascular plants. Based on VELMU inventories 2004-2016. VELMU / Finnish Environment Institute.

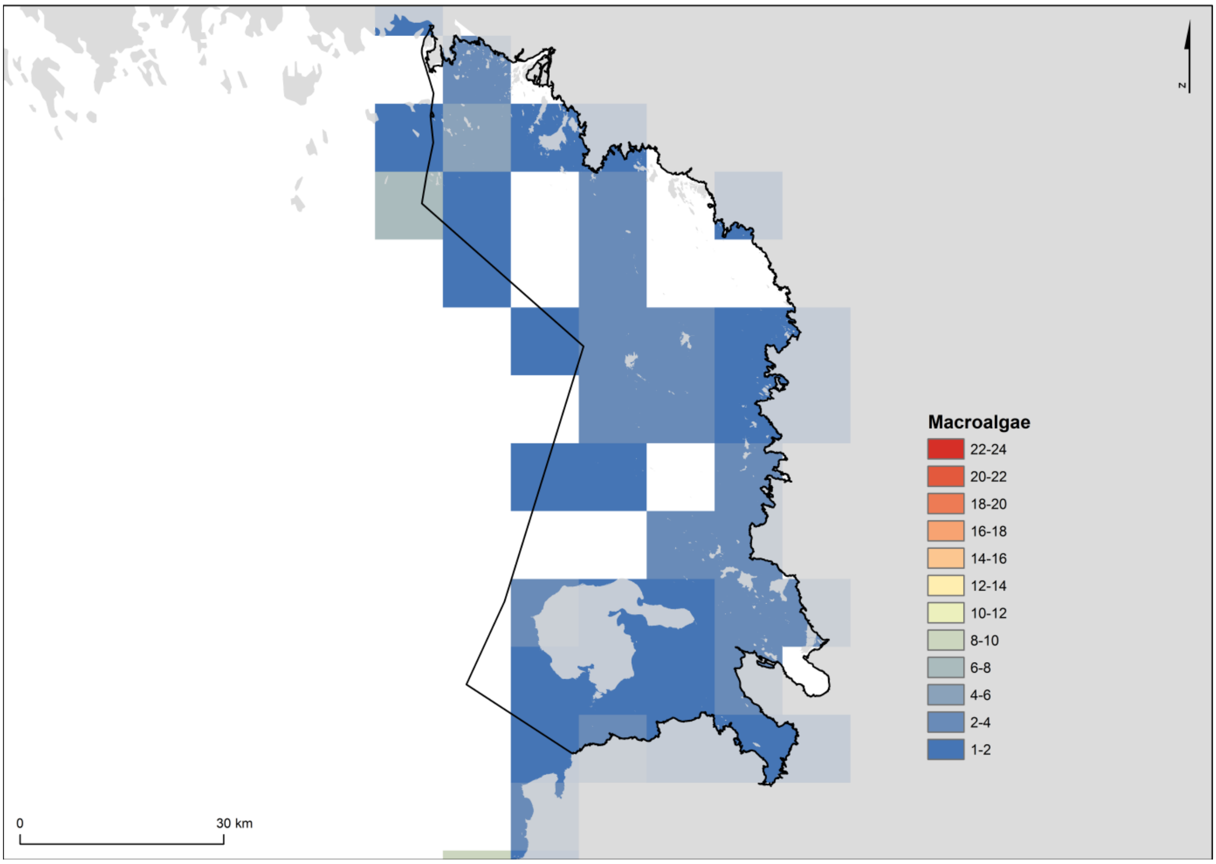

Figure 18. The species richness of macroalgae. Based on VELMU inventories 2004-2016. VELMU / Finnish Environment Institute.

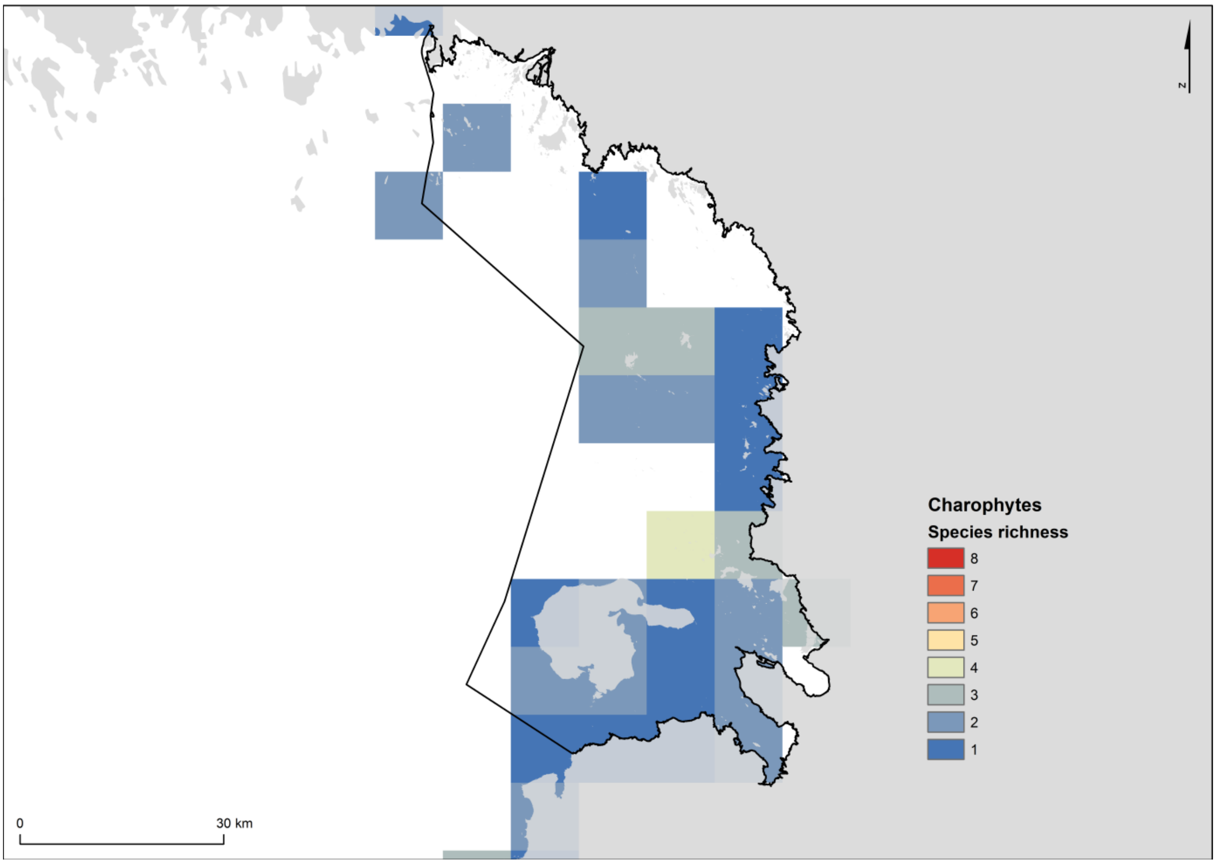

Figure 19. The species richness of charophytes. Based on VELMU inventories 2004-2016. VELMU / Finnish Environment Institute.

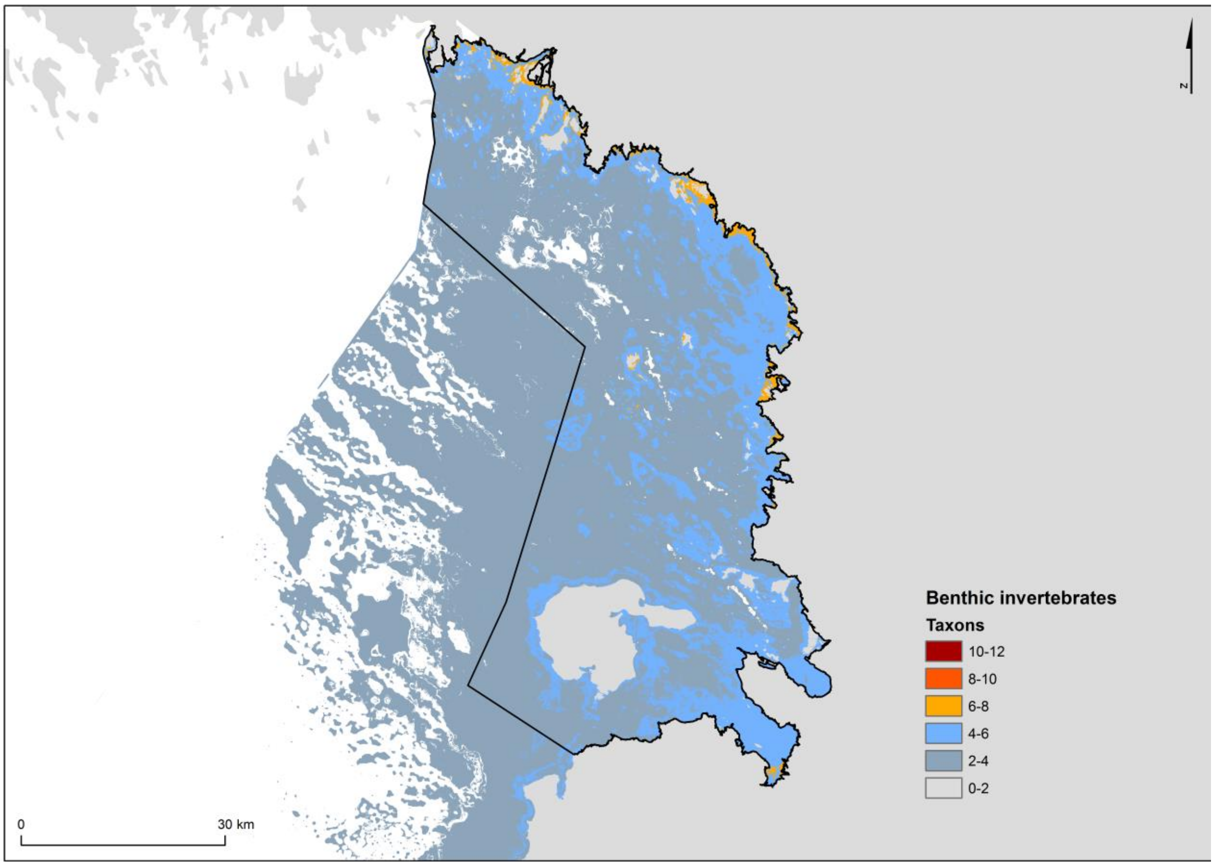

Figure 20. Modelled number of benthic invertebrate taxa. Based on VELMU inventories 2004-2016 and HERTTA Pohje database. Finnish Environment Institute.

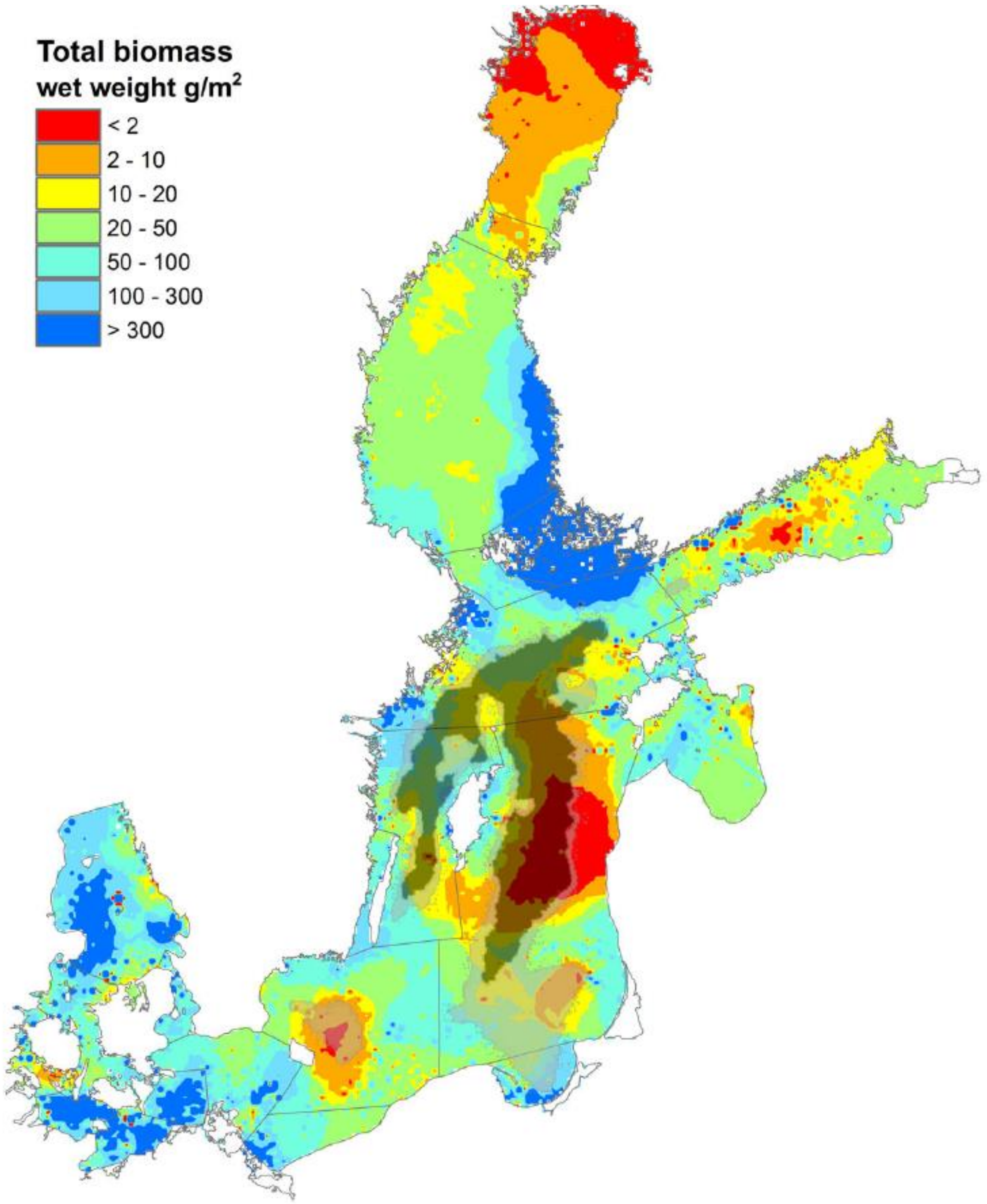

Figure 8. Distribution of interpolated total wet weight biomass, derived using ordinary kriging interpolation of available biomass data averaged per 5 × 5 km grid cell. Transparent light grey and dark grey areas mask out the deep water hypoxic and anoxic oxygen conditions. Note that at the areas where biomass data are lacking interpolation artefacts are evident, for instance, values at the shallow parts of the Eastern Gotland Basin at the west coast off Latvia are presumably too low. This figure is available in black and white in print and in colour at *ICES Journal of Marine Science* online.

Figure 21. Total biomass of benthic invertebrates. Gogina et al. 2016.

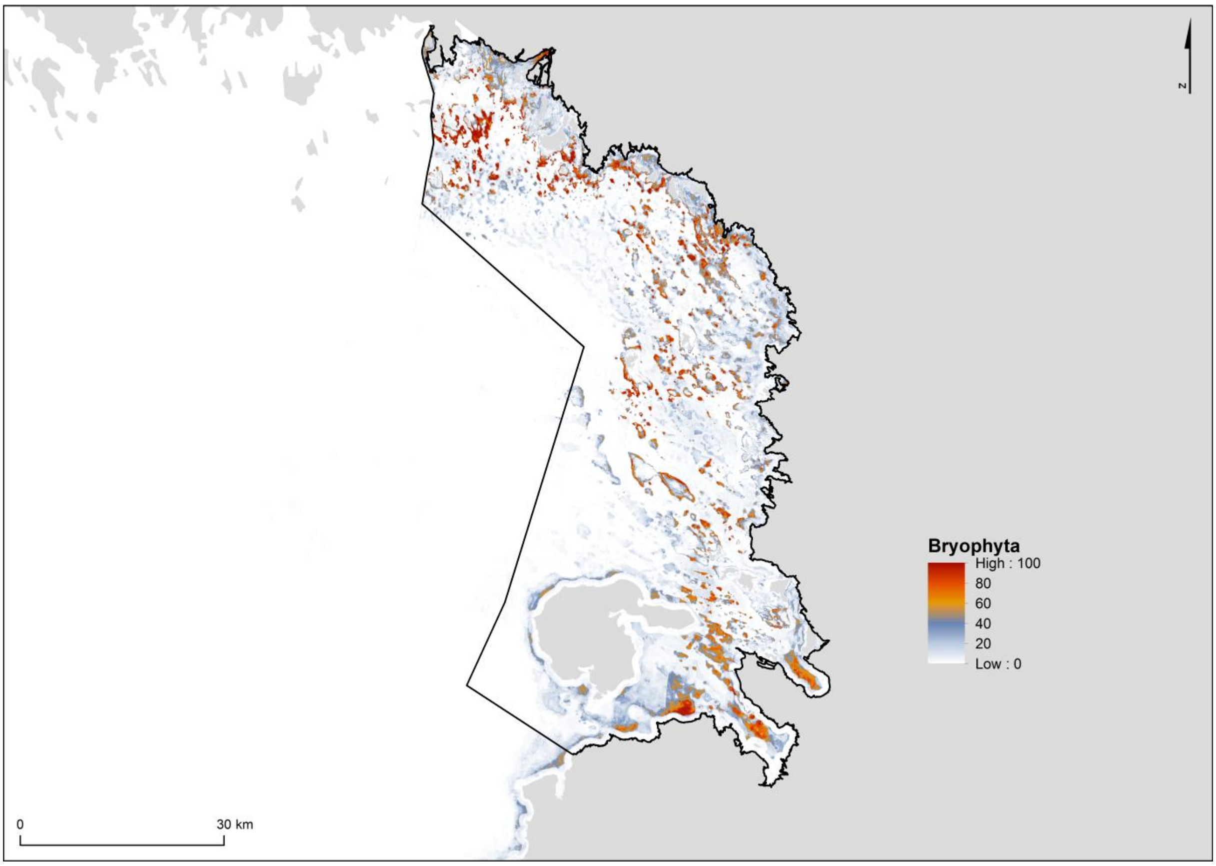

Figure 22. Modelled distribution of water mosses as probability of occurrence (0-100%). Based on VELMU inventories 2004-2016. Finnish Environment Institute.

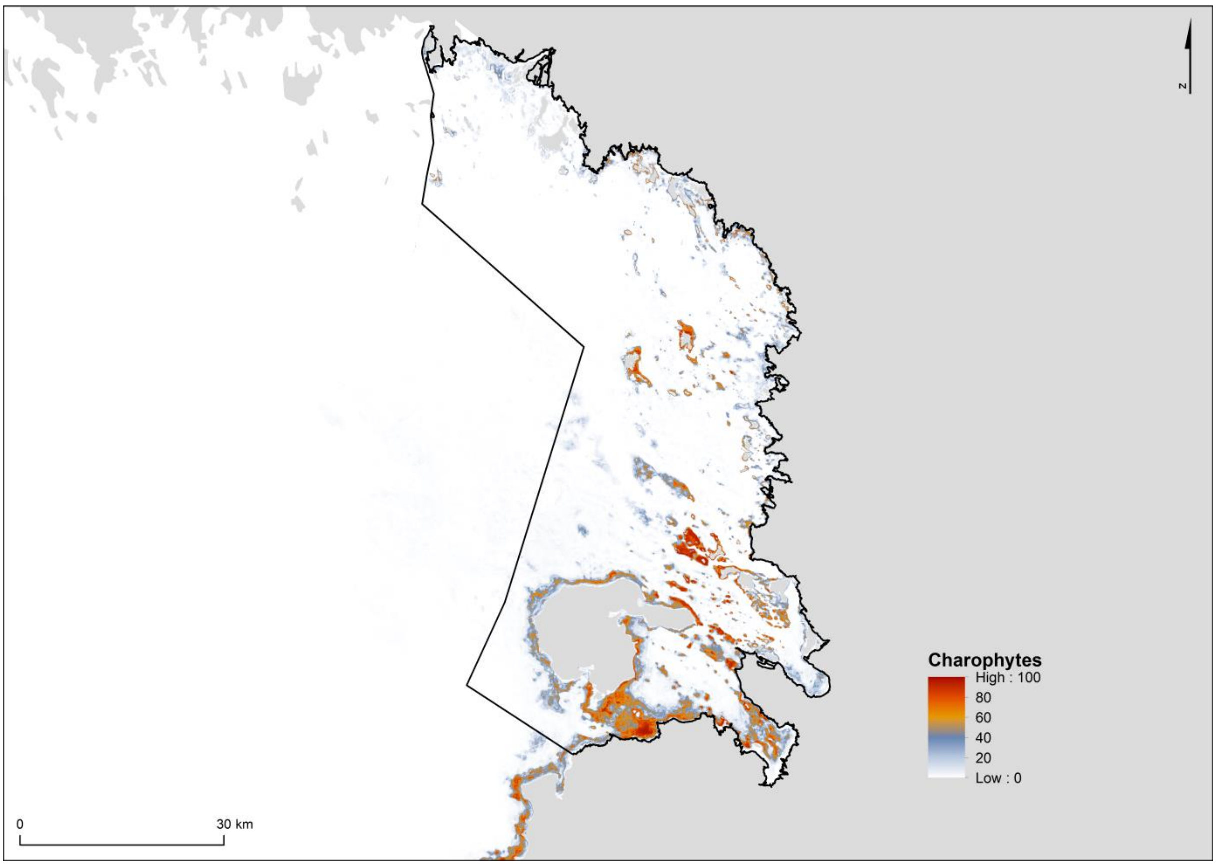

Figure 23. Modelled distribution of charophytes as probability of occurrence (0-100%). Based on VELMU inventories 2004-2016. Finnish Environment Institute.

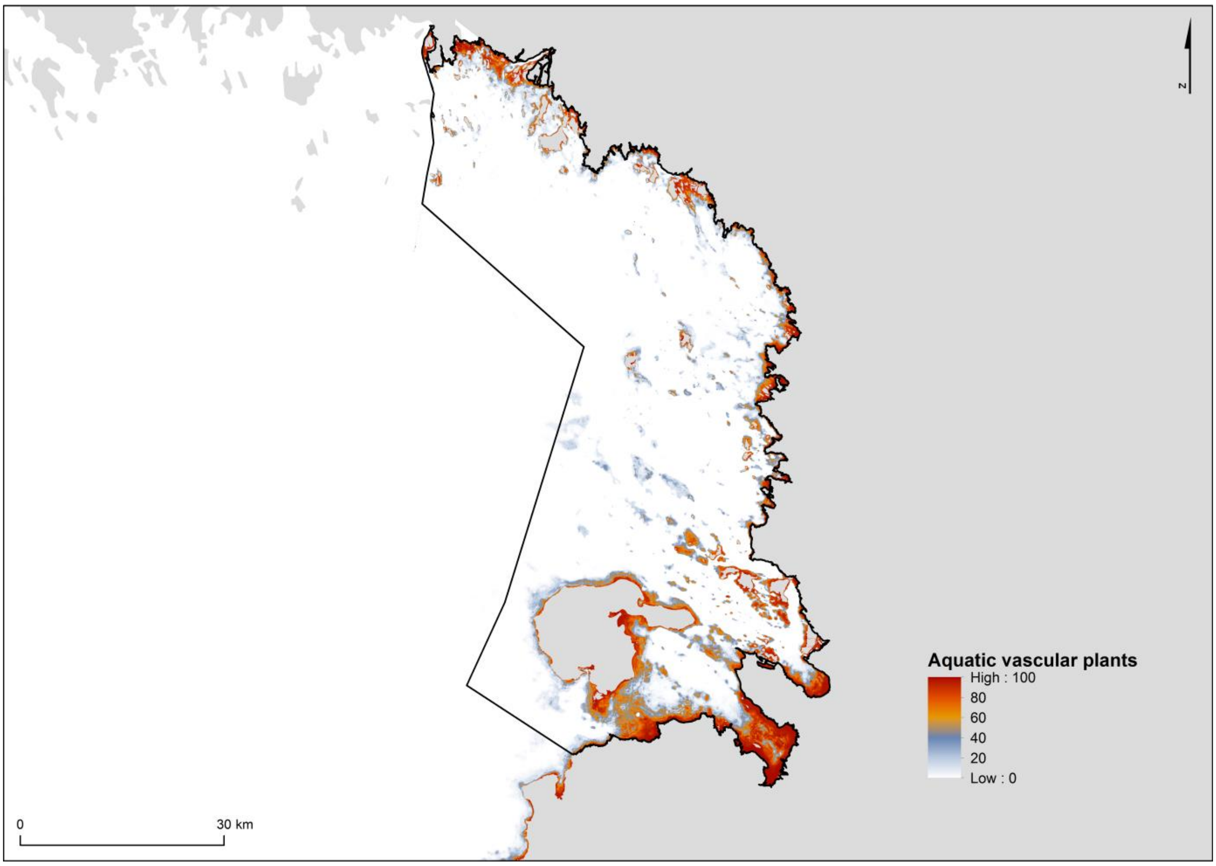

Figure 24. Modelled distribution of aquatic vascular plants as probability of occurrence (0-100%). Based on VELMU inventories 2004-2016. Finnish Environment Institute.

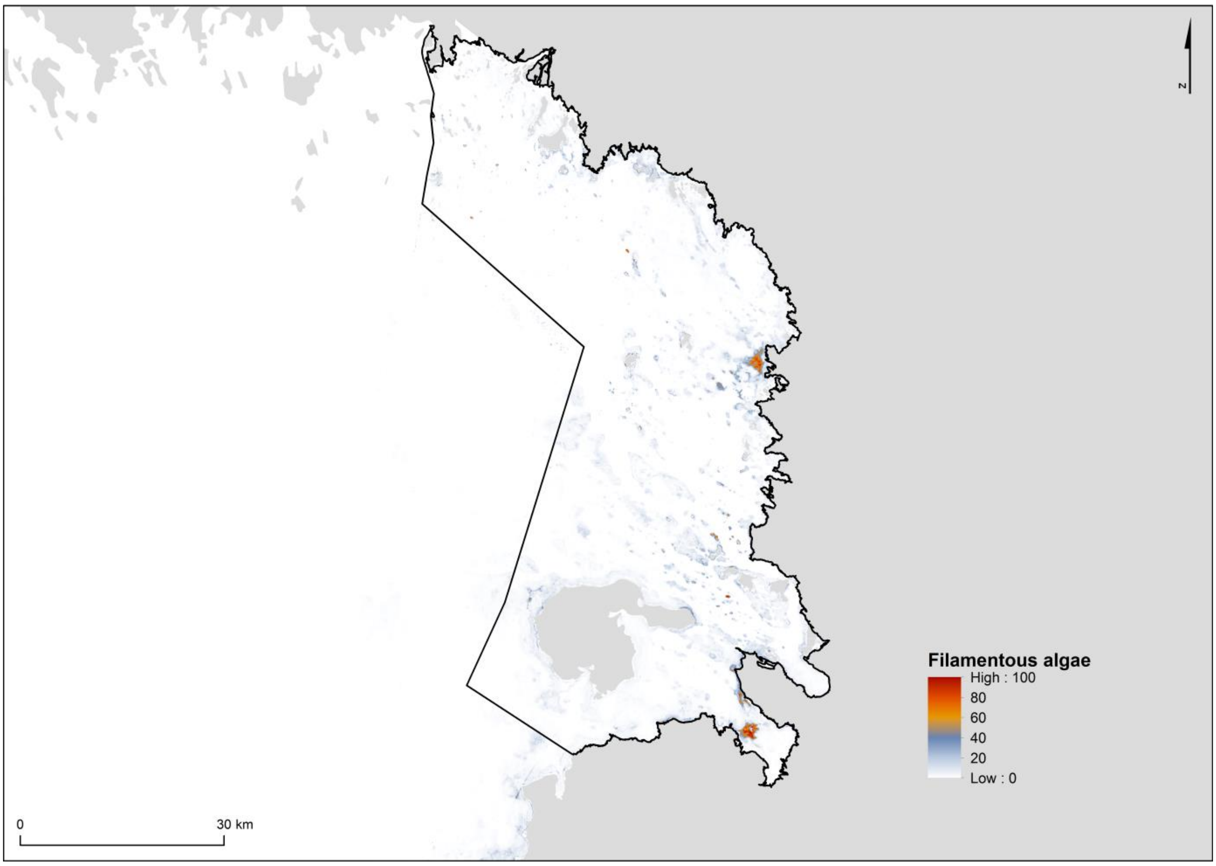

Figure 25. Modelled distribution of filamentous algae as probability of occurrence (0-100%). Based on VELMU inventories 2004-2016. Finnish Environment Institute.

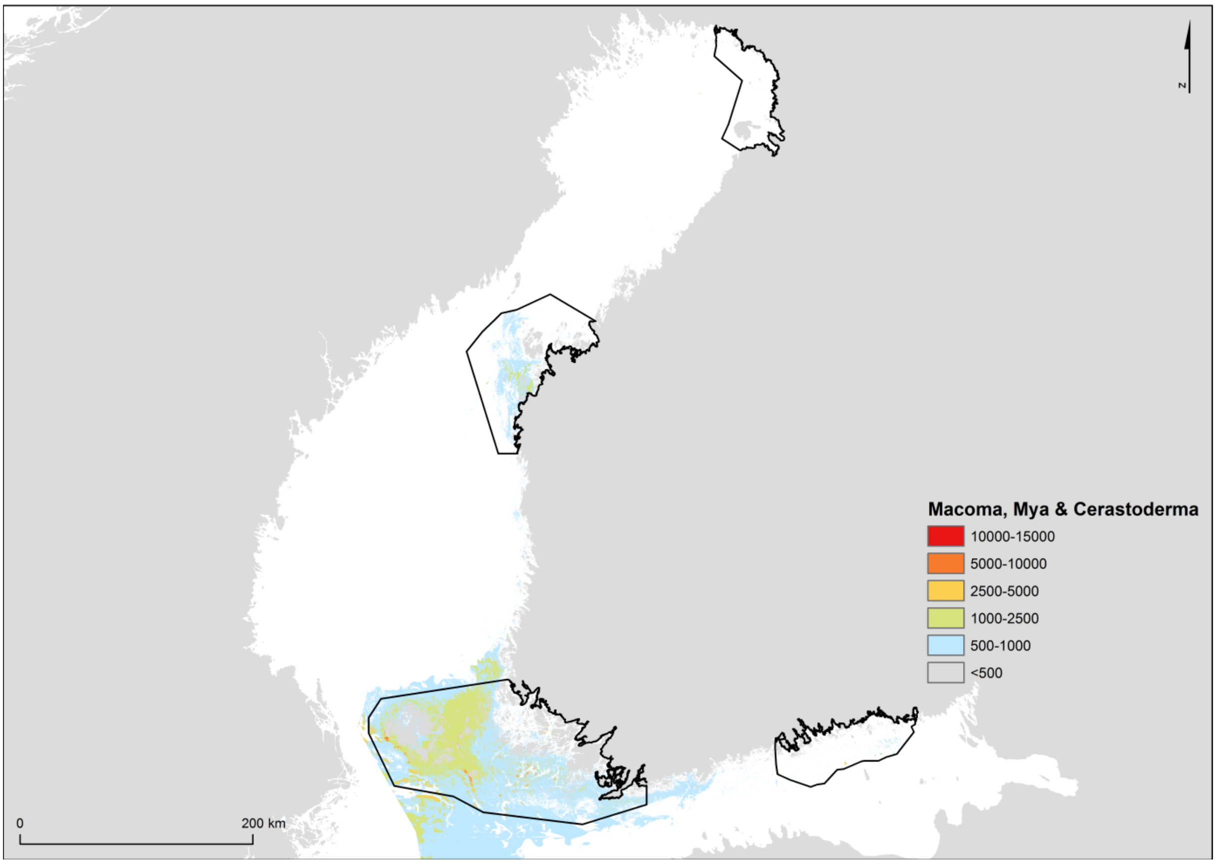

Figure 26. Modelled distribution of infaunal bivalves *Macoma baltica*, *Mya arenaria* and *Cerastoderma glaucum* as density (individuals m^{-2}). Based on VELMU inventories 2004-2016 and HERTTA Pohje database. Finnish Environment Institute.

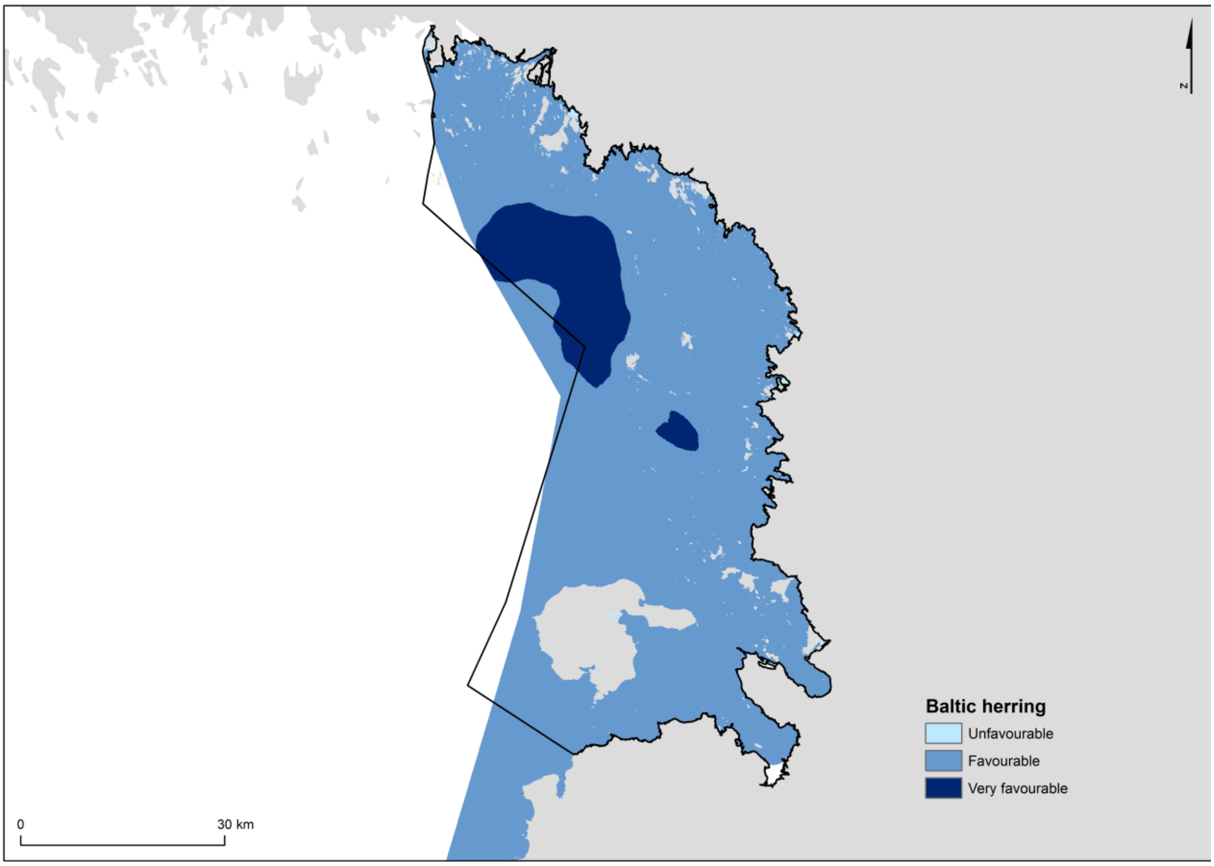

Figure 27. Reproduction area of baltic herring (*Clupea harengus membras*). National Resources Institute Finland & VELMU programme.

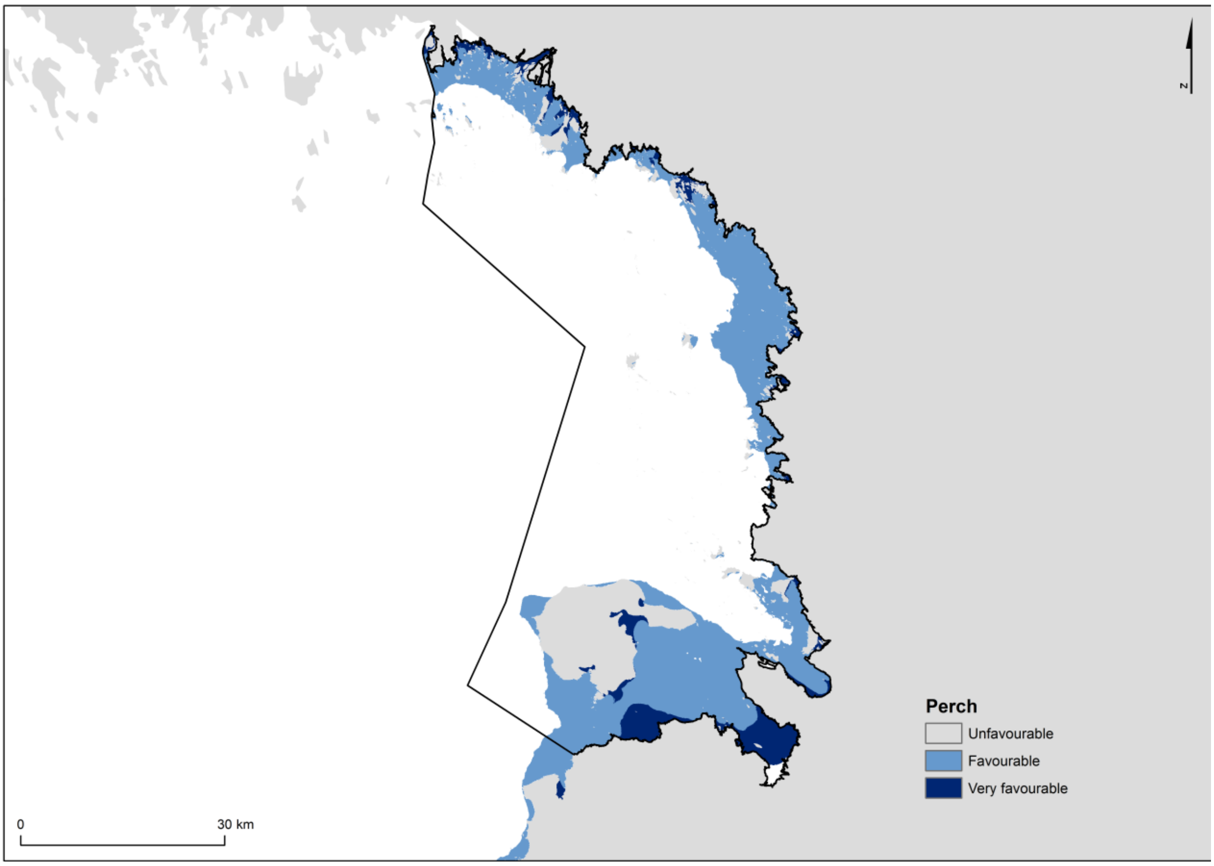

Figure 28. Reproduction area of perch (*Perca fluviatilis*). National Resources Institute Finland & VELMU programme.

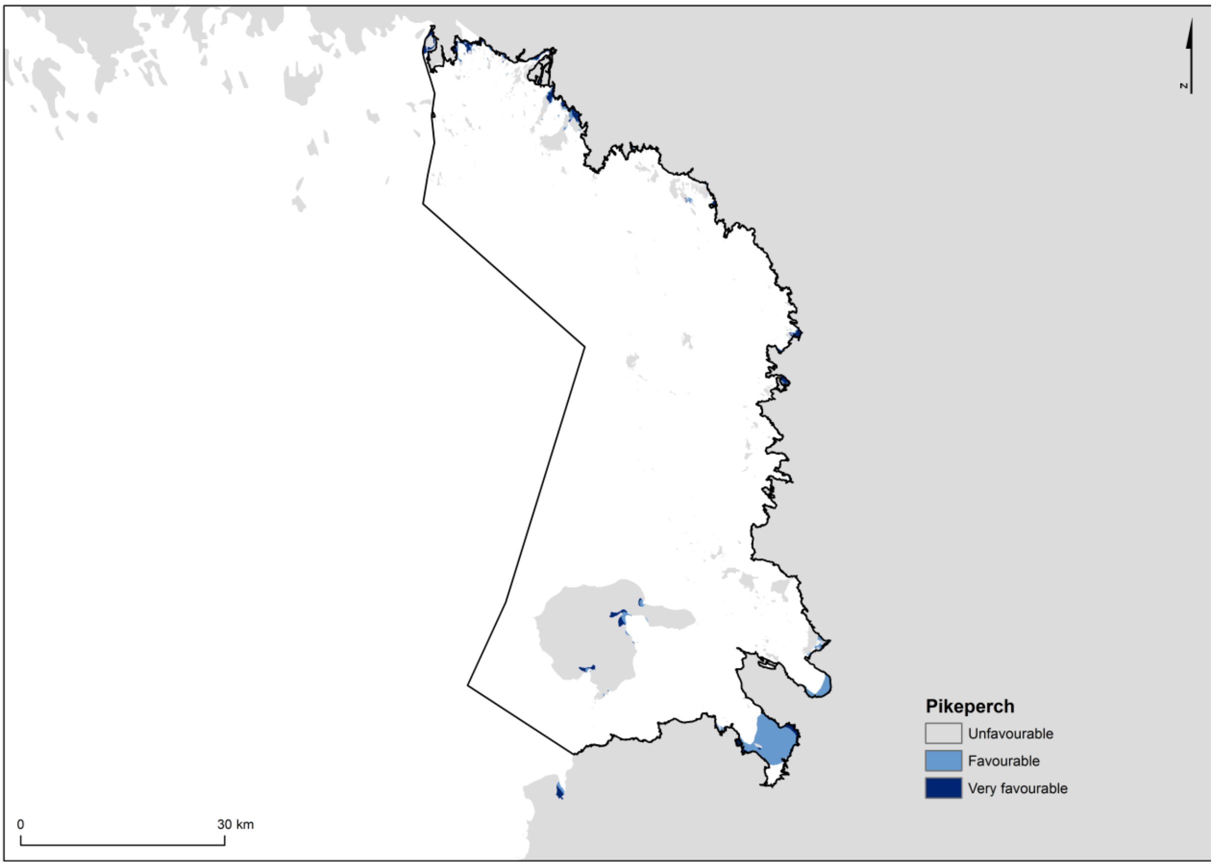

Figure 29. Reproduction area of pikeperch (*Sander lucioperca*). National Resources Institute Finland & VELMU programme.

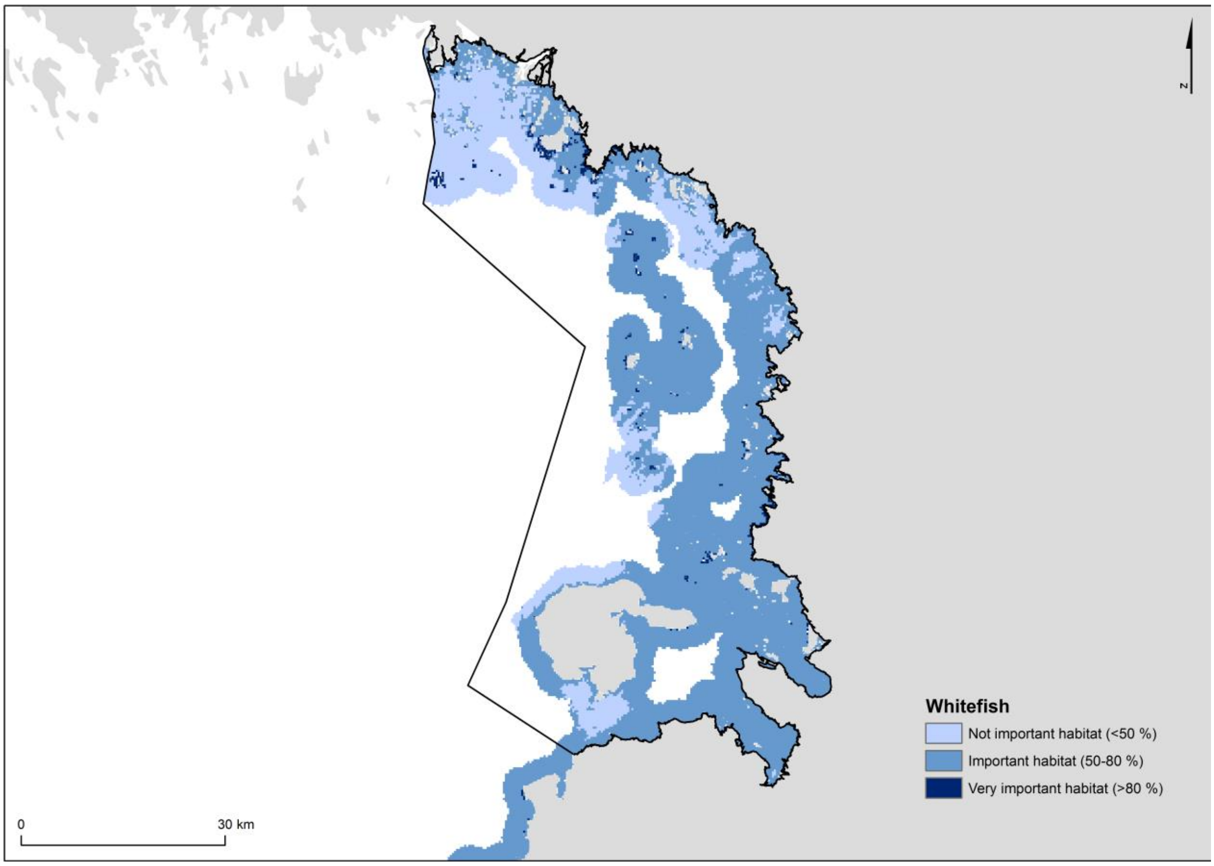

Figure 30. Potential distribution of juvenile whitefish (*Coregonus lavaretus*). National Resources Institute Finland & VELMU programme.

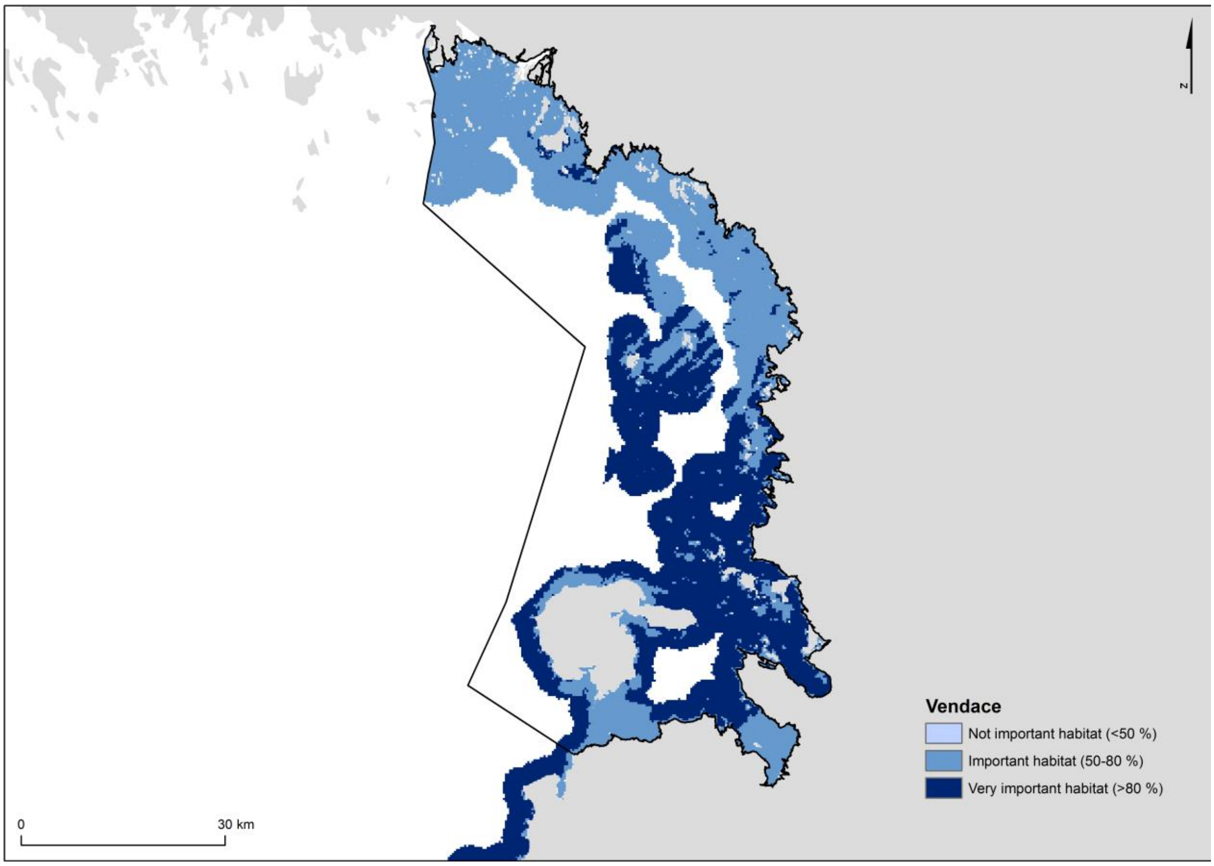

Figure 31. Potential distribution of juvenile vendace (*Coregonus albula*). National Resources Institute Finland & VELMU programme.

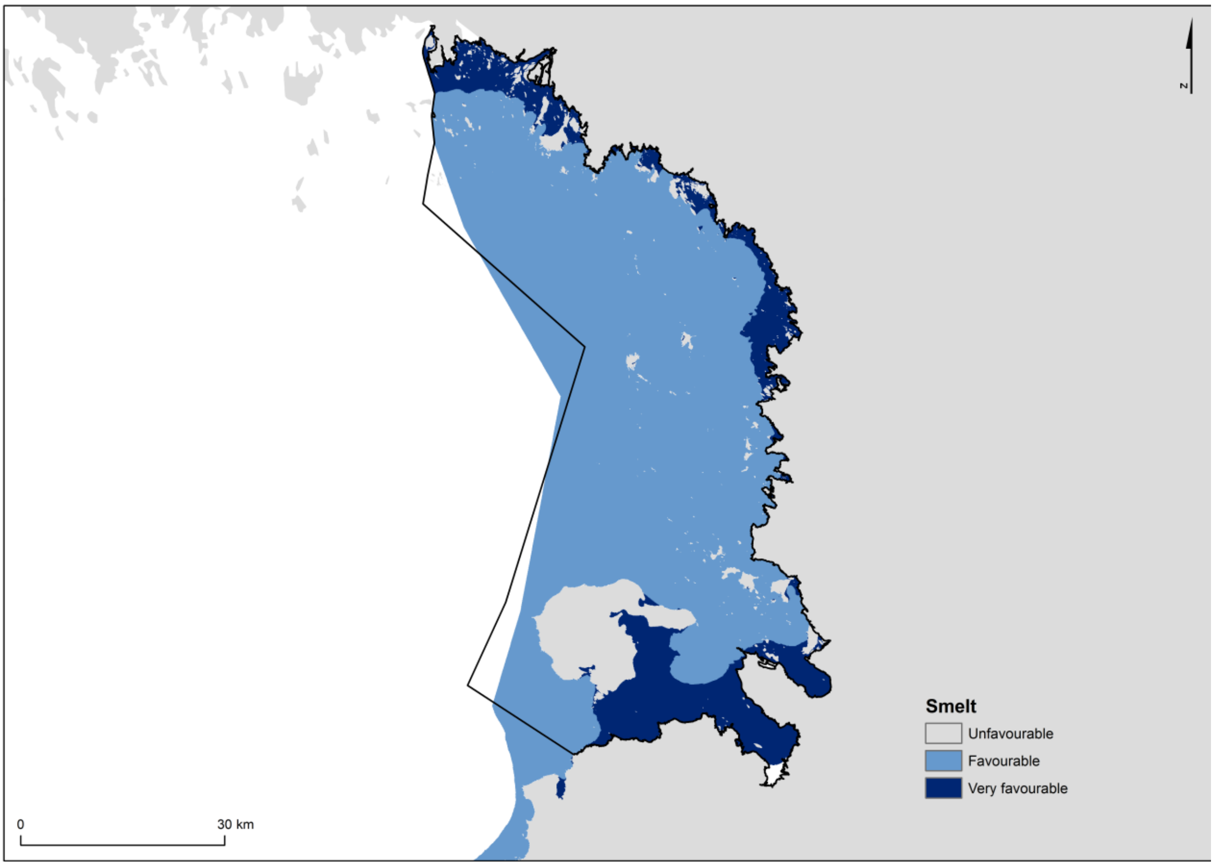

Figure 32. Reproduction area of smelt (*Osmerus eperlanus*). National Resources Institute Finland & VELMU programme.

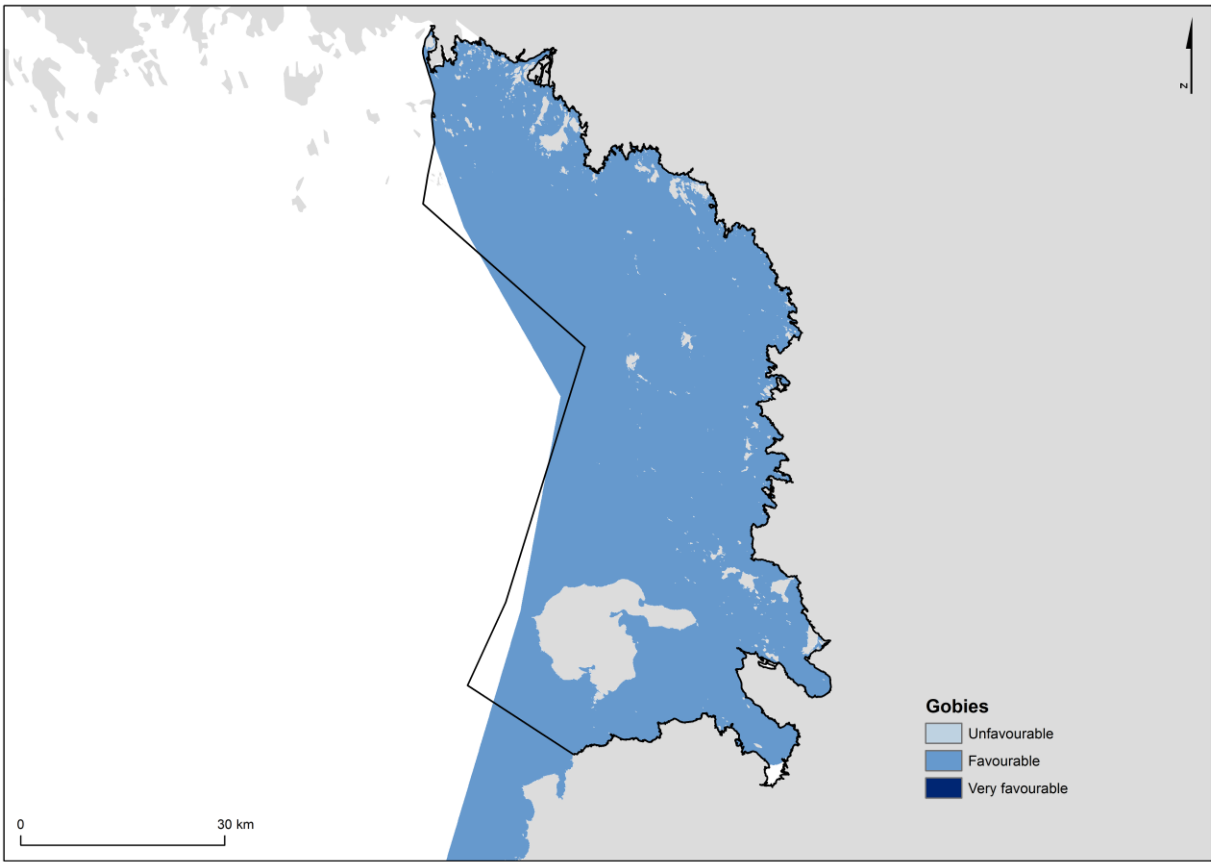

Figure 33. Reproduction area of gobies (*Pomatoschistus* spp.). National Resources Institute Finland & VELMU programme.

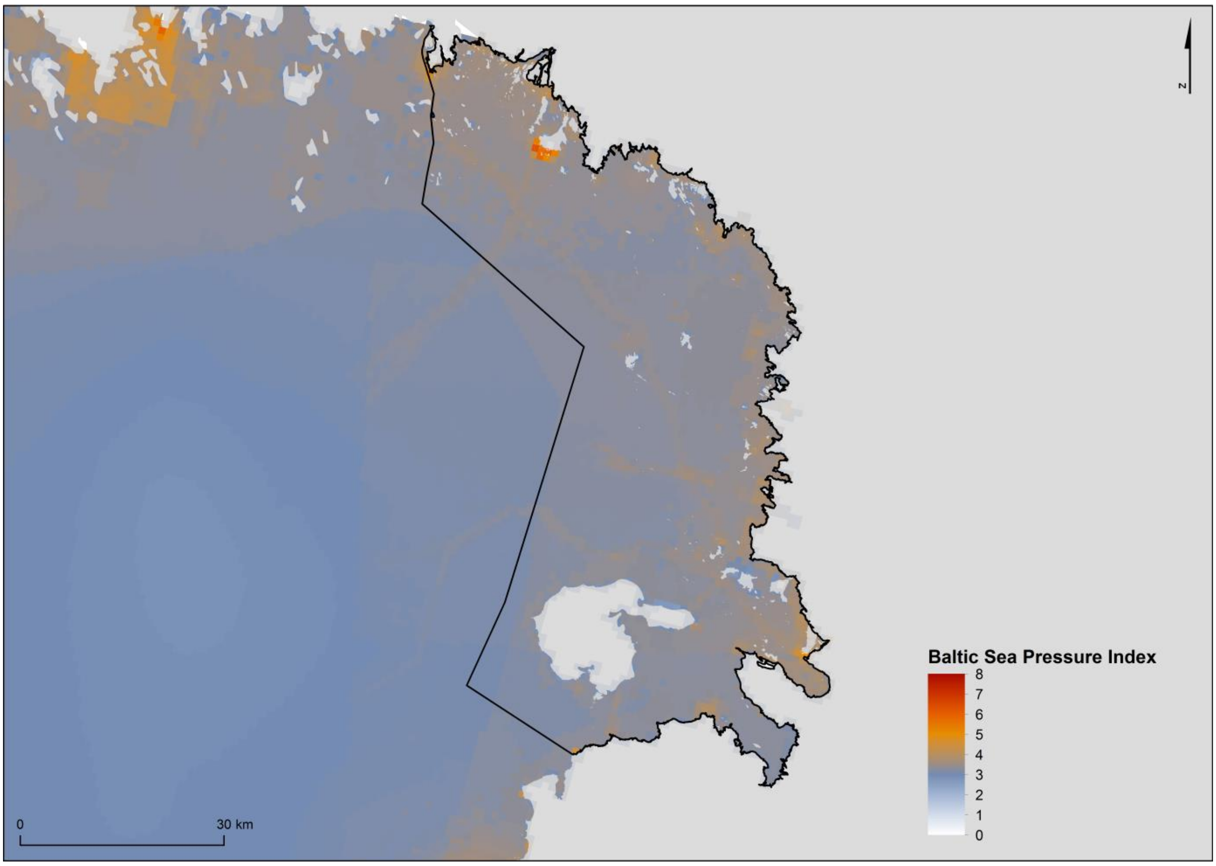

Figure 34. Baltic Sea Pressure Index. HELCOM 2016.

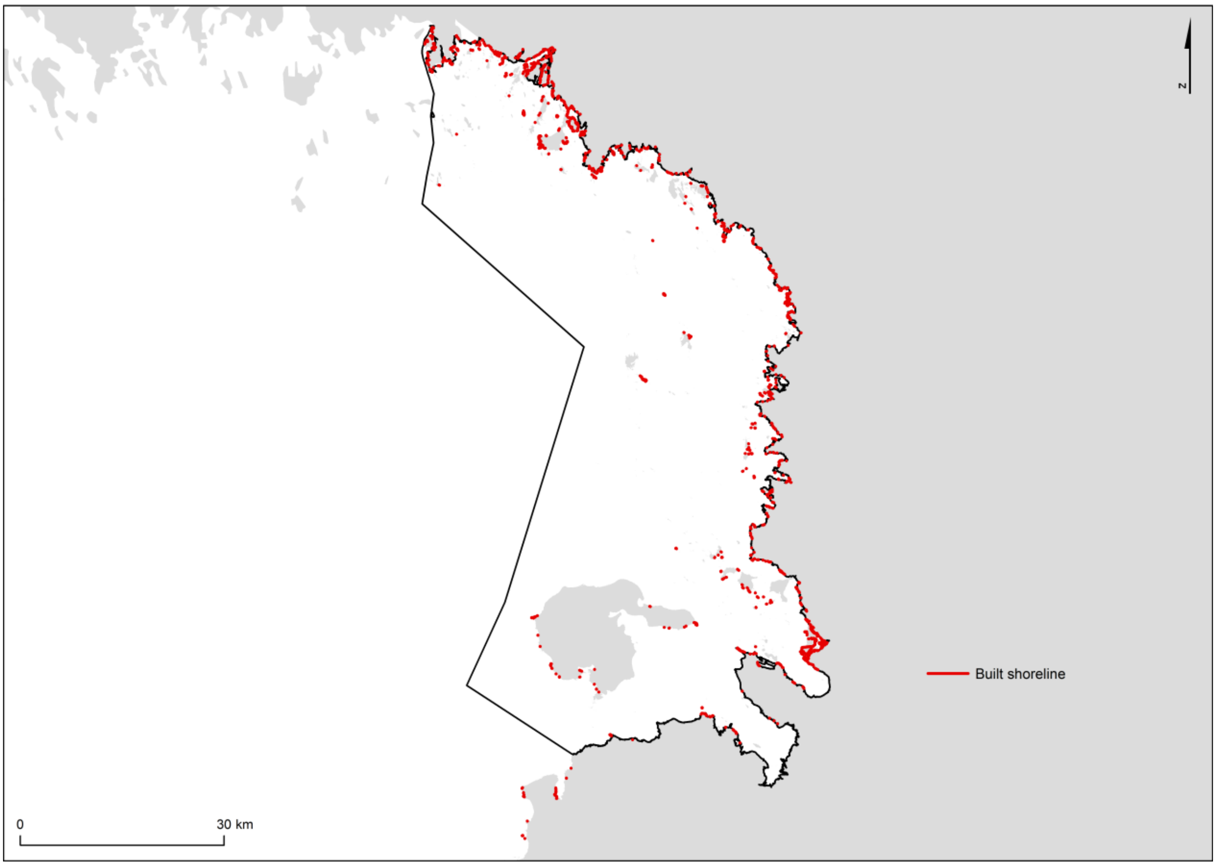

Figure 35. Built shoreline. Data was obtained from Building and Dwelling Register 2016 (BDR) by Population Register Centre. Shoreline having constructions within 100 m buffer zone was classified as built. Finnish Environment Institute.

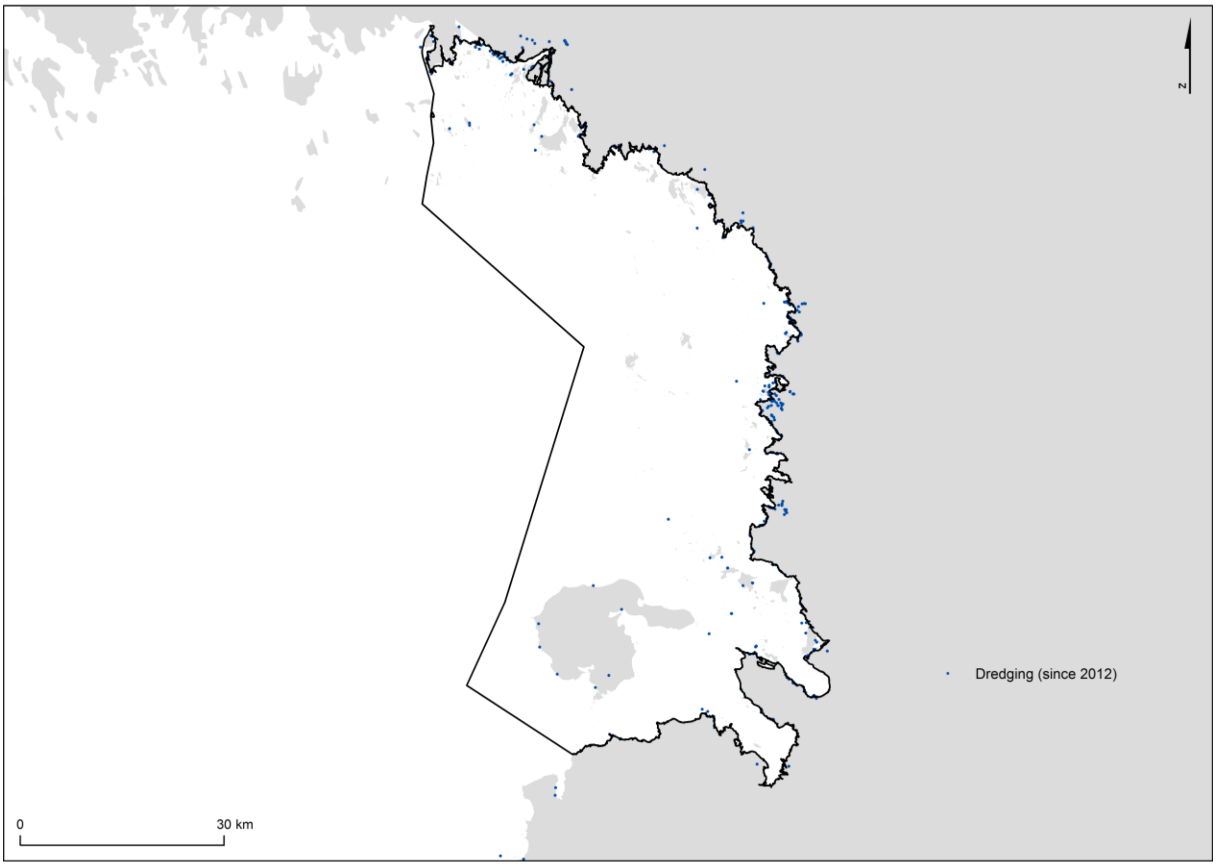

Figure 36. Dredging since 2012.

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