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A4 Deliverable – Maps showing MPAs under pressure

19.12.2025

BIODIVERSEA
for marine nature

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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 results for the deliverable *Maps showing MPAs under pressure.* Pressure models used in the deliverable are described in *A7 Pressure maps from the whole coast of Finland*, and a more detailed version in Virtanen et al. (2026).

Data and methods

We used high-resolution spatial data on a wide range of human activities affecting benthic habitats, including coastal infrastructure, dredging, dumping, shipping and boating routes, aquaculture, sand and mineral extraction, and other marine uses. Data were sourced from national registers, reported activity datasets, and interpretation of aerial imagery to capture both large- and small-scale activities. Most of the human activities in Finland are concentrated in the inner archipelago and close to shore, with the majority related to recreation (Fig. 1).

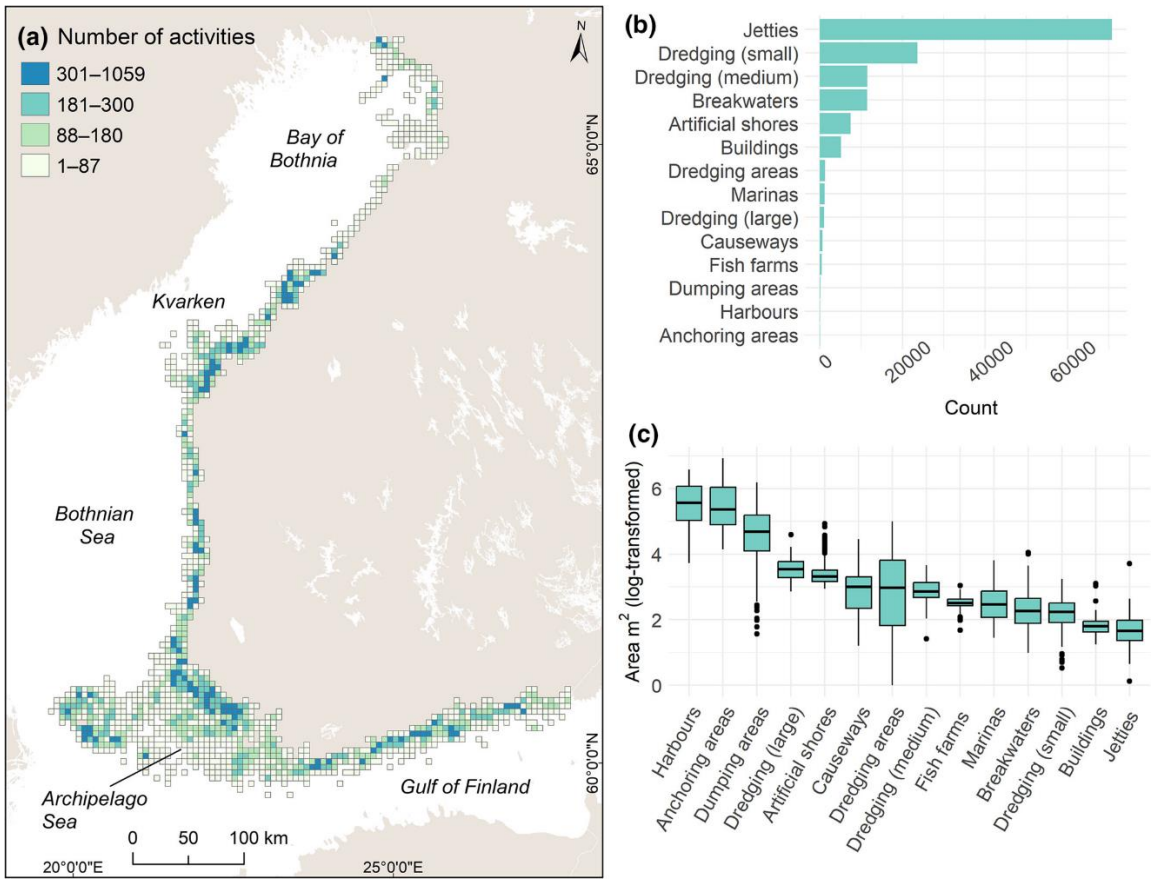


Figure 1. *Map showing the number of activities within 5 × 5 km grids visualized with quantiles (a), the number of individual activities (b), and their spatial footprints (c). Line-type activities are excluded from the figure (marine cables, boating fairways, shipping lanes).*

Based on these human activity layers, we modelled human pressures potentially affecting the seafloor by distinguishing between direct footprints and diffuse pressures. Direct footprints represent permanent habitat loss caused by structures or activities and were quantified as fractional coverage within a 20 m grid. Diffuse pressures represent ongoing or recurrent disturbances, such as sedimentation and turbidity, extending beyond activity footprints. These were modelled using

distance-decay functions parameterized using scientific literature, available regional guidelines (e.g. MSFD), and expert judgement. Separate models were developed for maritime traffic, incorporating distance to shipping lanes, shoreline proximity, and water depth to reflect spatial variation in seafloor disturbance (details for these models are available from Virtanen et al. 2026). Example of pressures is shown in Fig. 2.

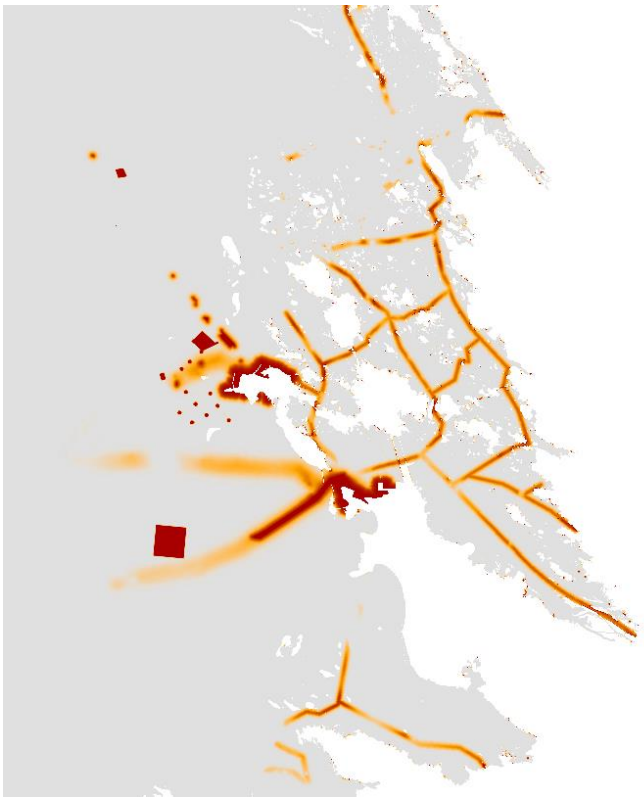


Figure 2. *Pressures in an example area the Bothnian Sea, with darker orange color indicating high pressure, and lighter orange lower pressure. Grey indicates sea areas not affected by human activities.*

We used the most recent marine protected area (MPA) data (accessed 17.12.2025) to calculate the overlap of pressures and MPAs, to evaluate how much pressures are exerted from different human activities in different type of MPAs. We additionally compared the pressure levels to the overall pressure in the Finnish sea areas, to have a broad understanding of the distribution of activities within MPAs compared to areas which are not protected. For each MPA, we calculated the maximum and minimum pressure values, and a weighted sum of pressures per MPA.

Results

If considering summed pressure levels, weighted by the size of the MPAs, pressures within MPAs are on average lower compared to areas not protected (Fig. 3A, category “marine areas”). Highest level of pressures occurred in Natura SAC areas, followed by Natura SPA areas, and Ramsar areas. Lowest pressure levels were in Natura SCI areas, although there was large variation within MPA types, especially category “private” MPAs and government-owned nature reserves. If considering MPAs without any mapped pressures, i.e. large enough that have been reported, or visually observable from aerial images, private MPAs had the largest share of MPAs where pressure levels were 0. It should be noted that pressures considered here do not take into account the level of eutrophication, which of course ameliorates water quality. We only considered human activities that can be managed with area-based measures, i.e. by management actions within the MPAs.

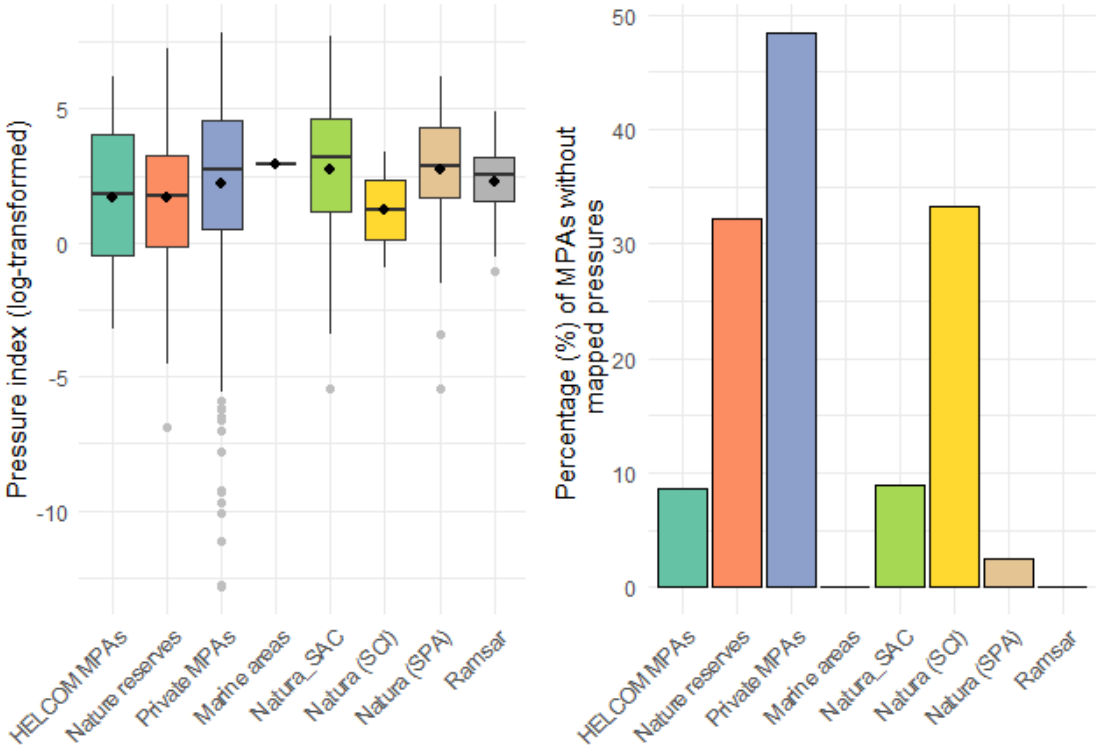
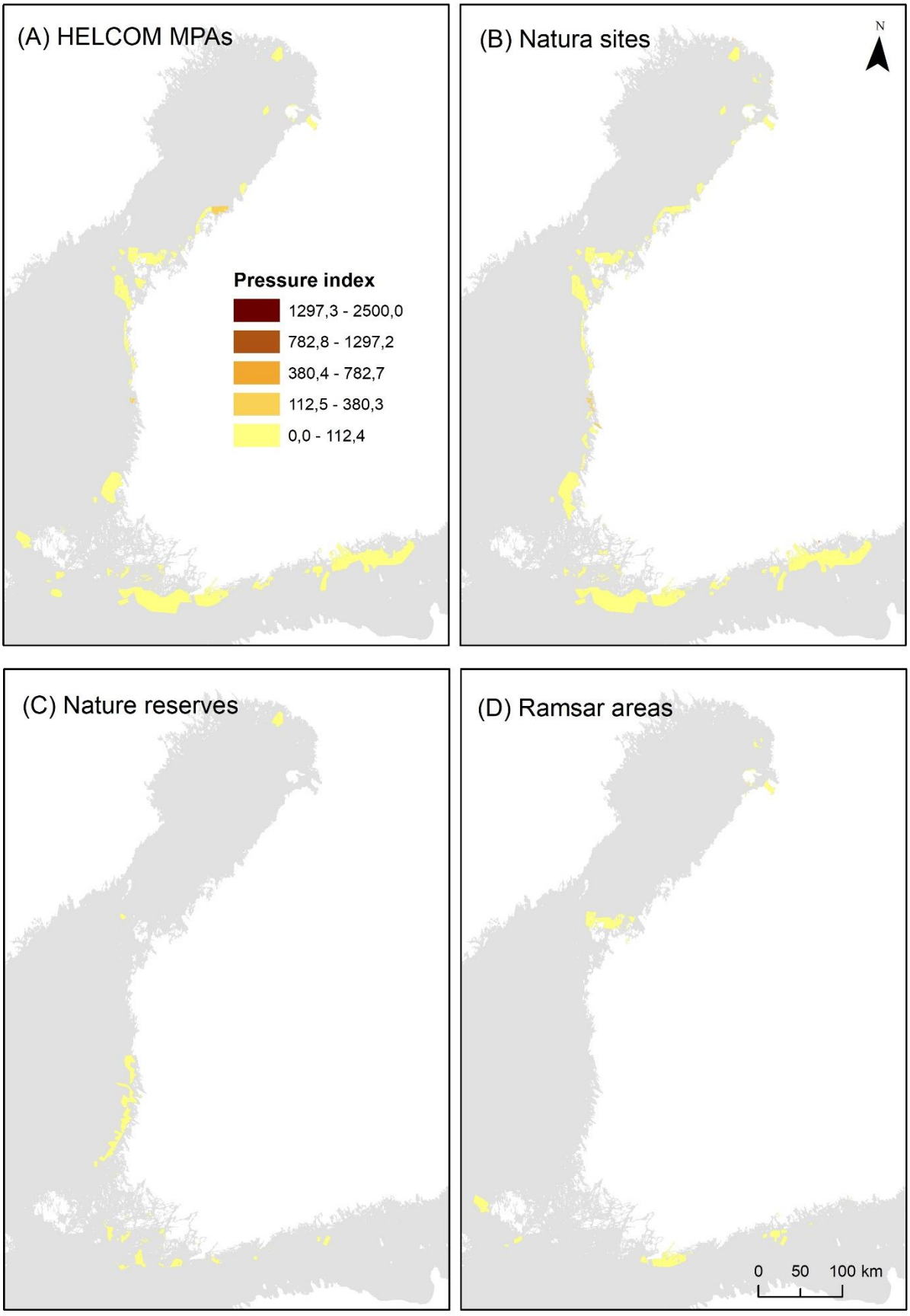


Figure 3. *Panel A shows summed pressure levels, weighted by the area of MPAs, per MPA category. Marine areas refer to pressure levels across all sea areas. Panel B shows the proportion (%) of MPAs that did not have mapped pressures.*

Pressure levels within MPA types are shown in maps described in Figure 4A-E.


(A) HELCOM MPAs
Pressure index
1297,3 - 2500,0
782,8 - 1297,2
380,4 - 782,7
112,5 - 380,3
0,0 - 112,4
(B) Natura sites
N
(C) Nature reserves
(D) Ramsar areas
0 50 100 km

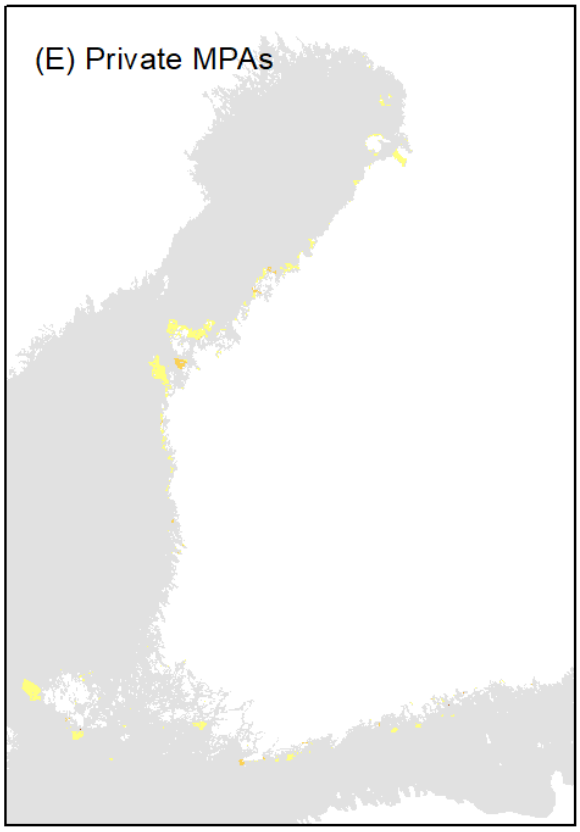


Figure 4. *Pressure levels within a MPA type, calculated as the sum of pressures, weighted by the size of MPAs.*

Reference

Virtanen, E. A., L. Forsblom, L. Kaikkonen, N. Kallio, S. Korpinen, A. Takolander, T. Wärri, and M. Viitasalo. 2026. Impacts of diffuse pressure complexes complicate conservation and management of benthic marine habitats. Journal of Applied Ecology **n/a**:e70247.