Projects WESA and Wave Energy in Swedish Seawaters

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Project WESA – Wave Energy for a Sustainable Archipelago

Project WESA (Wave Energy for a Sustainable Archipelago) is an international scientific research project headed by Uppsala University aimed at developing and investigating the performance of a wave energy converter (WEC) system designed for surviving operations in an archipelago environment with ice interference during winter conditions. The project is the first step in a research strategy aimed at investigating to potential of utilizing wave energy in the Baltic Sea. Project WESA was funded to 75 % by the European Regional Development Fund and included in the Central Baltic INTERREG IVA programme 2007-2013. Project WESA introduced full-scale sea trials of a WEC system in the Baltic Sea. Experiments were conducted outside Hammarudda on the island of Åland. The experimental setup and results are presented in figures 1 – 5, including the ice-adapted buoy developed within the project. Two types of WEC buoys were tested and the results show that the WEC system could handle ice-interaction of the kind encountered at the temporary test site during two winter seasons. The system survived drifting ice fields up to a maximum ice thickness of 15 cm according to satellite radar (SAR) of the area. The results indicate good survivability characteristics for a WEC system in icy conditions, which may open up large parts of the Baltic Sea for wave energy utilization.

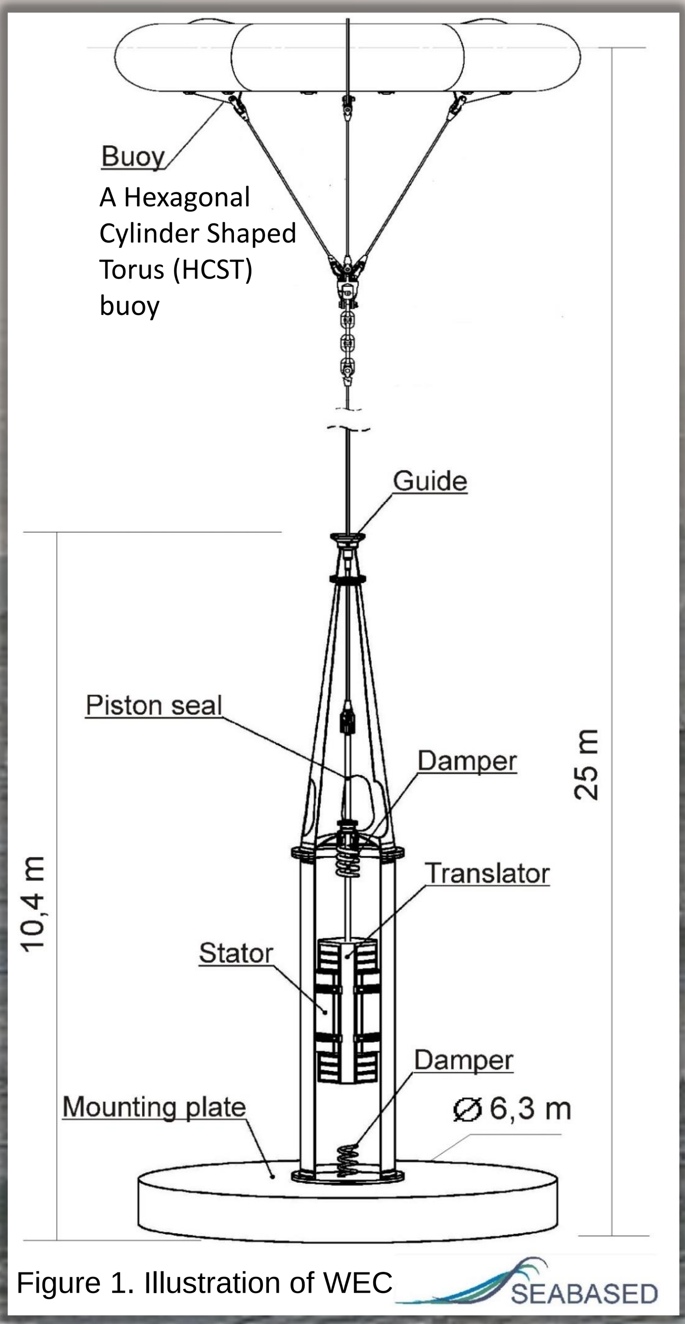

Figure 1. Illustration of WEC

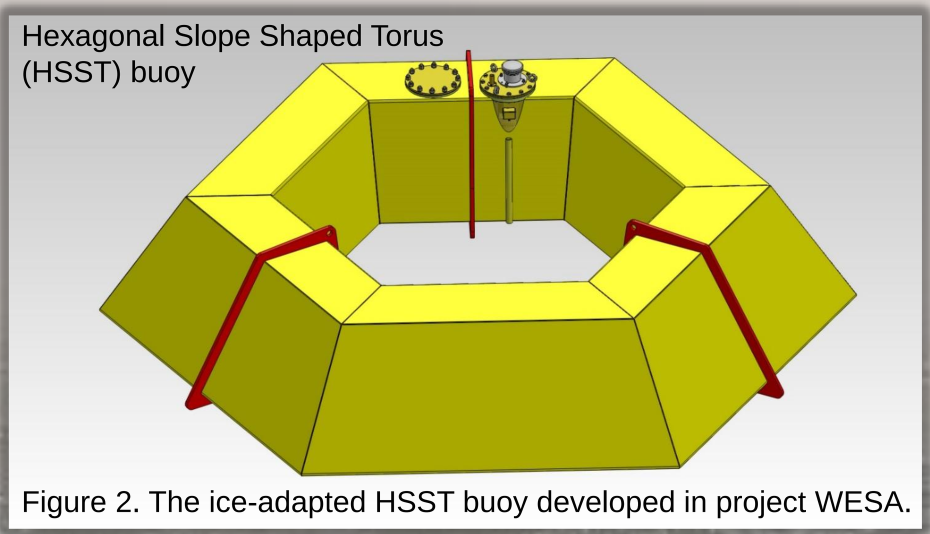

Figure 2. The ice-adapted HSST buoy developed in project WESA.


Figure 4a. The HCST buoy.


Figure 4b. The HSST buoy.


Figure 4c.

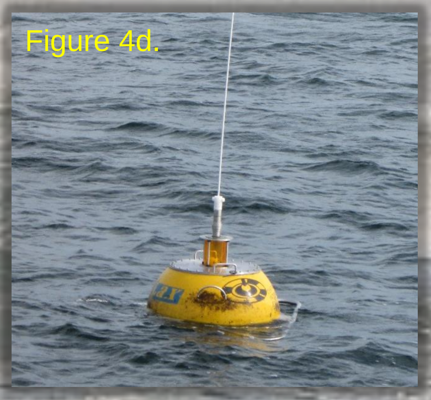
Figure 4d.

Figures 4a-f. (a-b) WEC buoys. (c) Measuring station with resistive loads. (d) Wave measuring buoy 35 m from WEC. (e-f) Surveillance photos of WEC buoys surviving ice interaction.

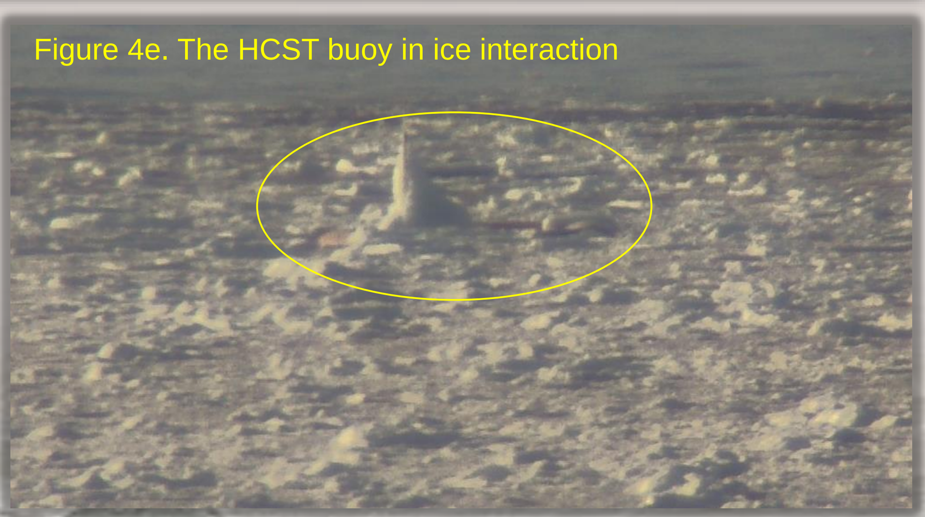
Figure 4e. The HCST buoy in ice interaction


Figure 4f. The HSST buoy in ice interaction

Figure 3. WEC during deployment outside the Åland islands; see fig 5a.

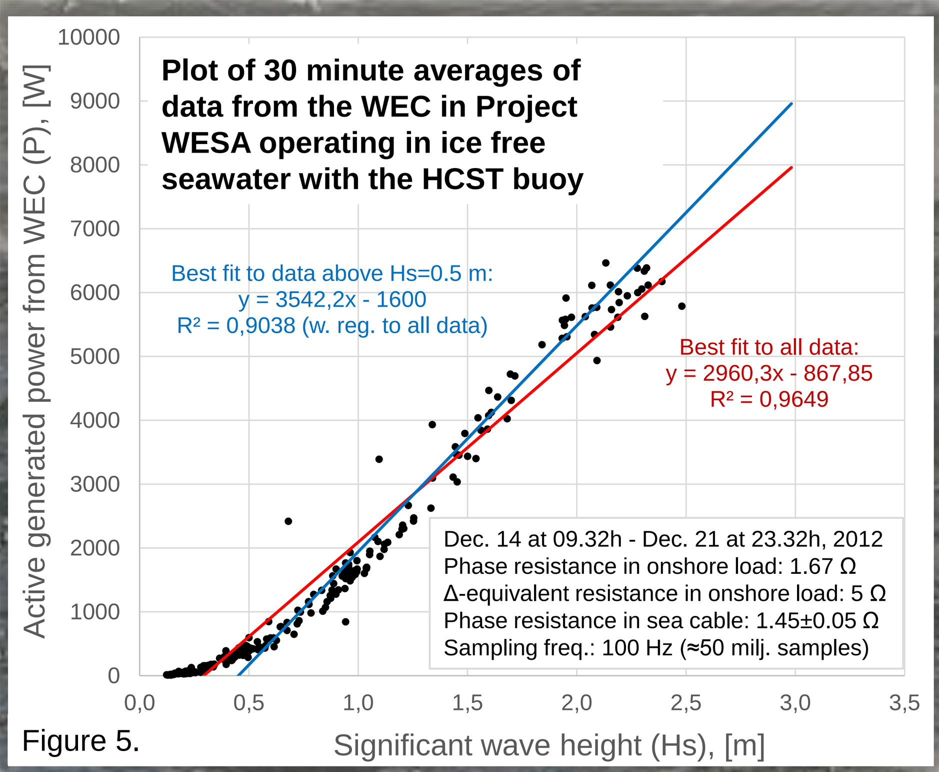

Figure 5.

Defining Wave Energy Pilot Sites in Swedish Seawaters

The next step after Project WESA (above) and the establishment of a research strategy for the Baltic Sea is to identify the most suitable pilot sites by applying a holistic and systematic approach to the entire region. A recently started national Swedish project, funded by the Swedish Energy Agency, has recently been initiated for this purpose. The project focuses on Swedish seawaters, including the Swedish Exclusive Economic Zone (EEZ); see blue area in figure 6a. The first objective is to use available data and state-of-the-arts modelling to map conditions of relevance and to predict power production through simulations of farms size clusters of generic point absorber type wave energy converters. Mapping will include geological (e.g. figure 6b), meteorological (e.g. figure 7) and oceanographic (e.g. figure 8) variables in high resolution corresponding to the size of a pilot site for a wave energy farm installation with arrays of point absorbers (e.g. figure 9). Mapping will also include ecosystem components (e.g. figure 10), maritime activities and regulated areas. Figures 5 – 9 represent parts and methodology in the project for a selected focus area outside the Swedish east coast in the Baltic Sea. The final objective is to identify, classify and recommend the most favourable pilot site areas for wave energy utilization in Swedish seawaters.

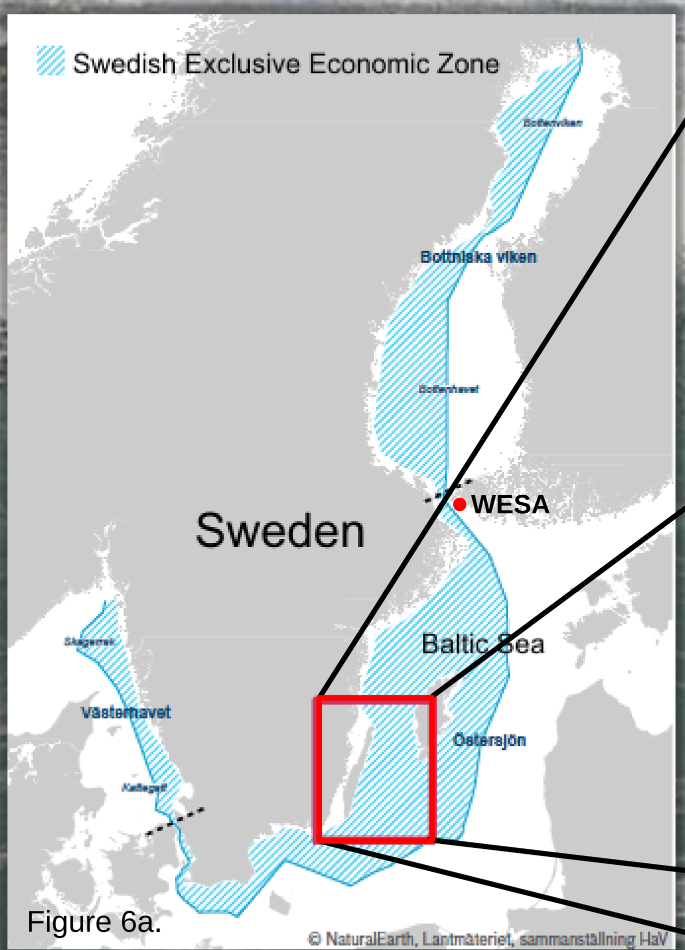

Figure 6a.

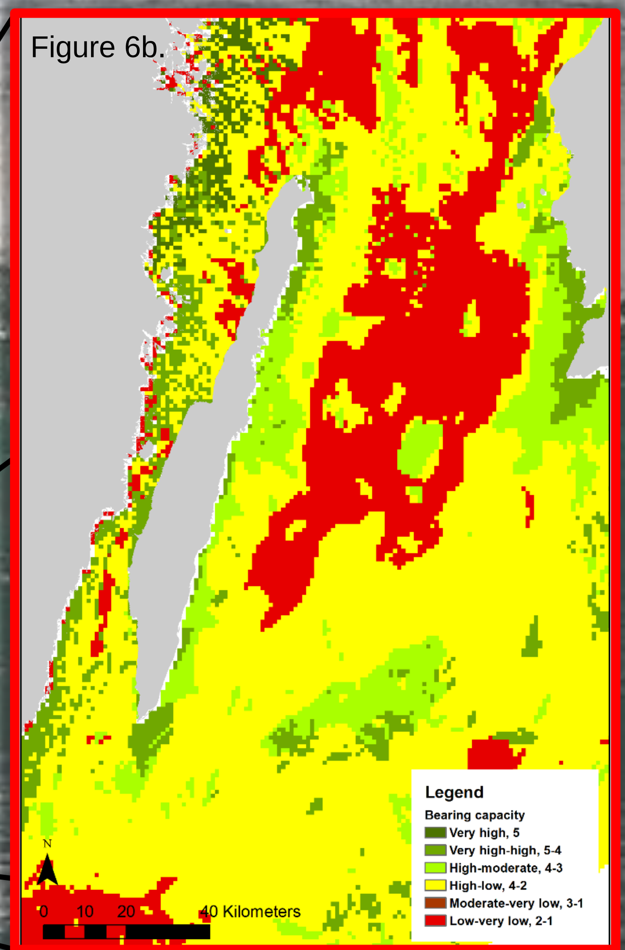

Figure 6b.

Figure 6a-b. (a) Studied area within Swedish exclusive economic zone; example area within red frame. (b) The bearing capacity of the upper meter of the seabed divided into five different levels, derived from marine geological information and terminology. The seabed is gridded into 1 x 1 km large grids to better correlate geographically with e.g. significant wave height data.

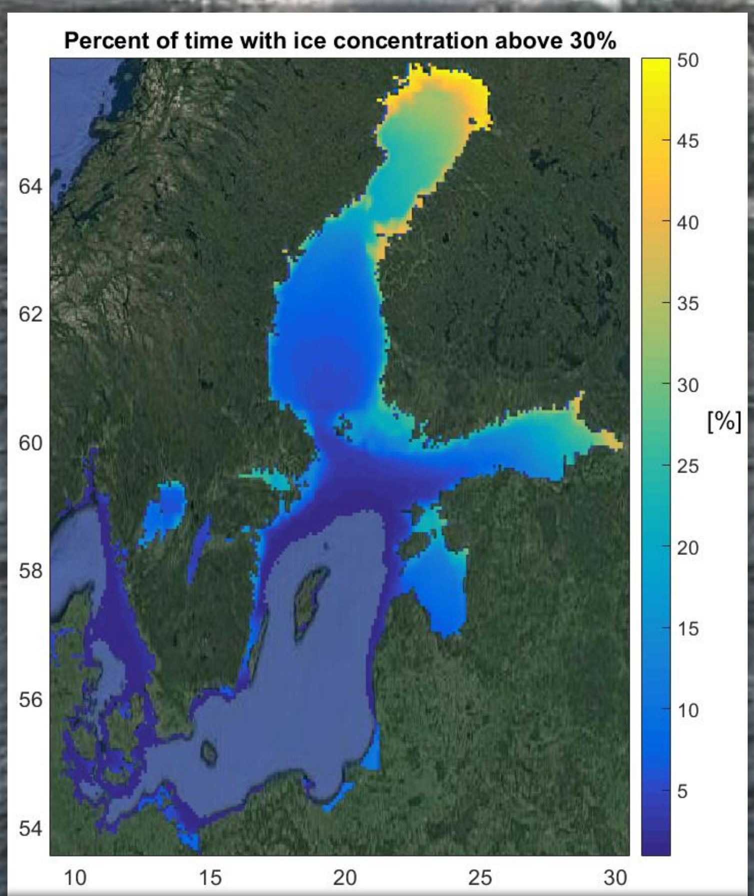

Figure 7. Percent of time with ice fraction above 0.3 based on 34 years of ice data from 1980 to 2014 interpolated using the same method as used by the WAM model. (Hasselmann et al. 1988).

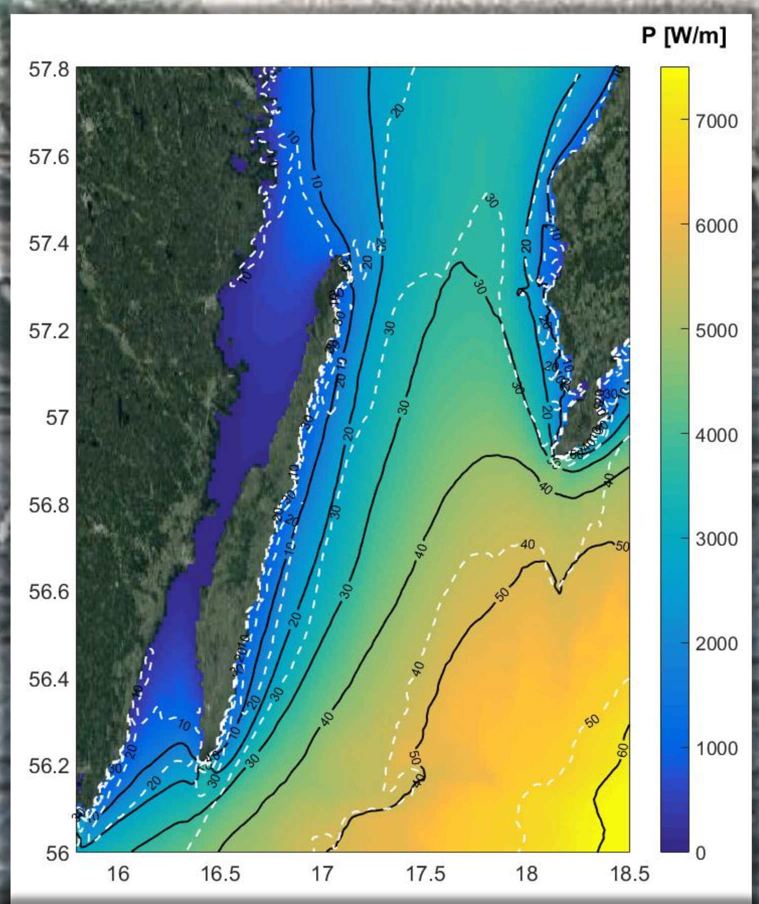

Figure 8. Wave energy per m wave front is shown in colour for ice-free conditions in the focus area in fig. 6a. Black isolines (for 10 to 60) indicate the average amount of time (in days per year) with significant wave height above 2 m. White dashed isolines indicate the average occurrence (in days per year) with energy periods above 6 seconds.

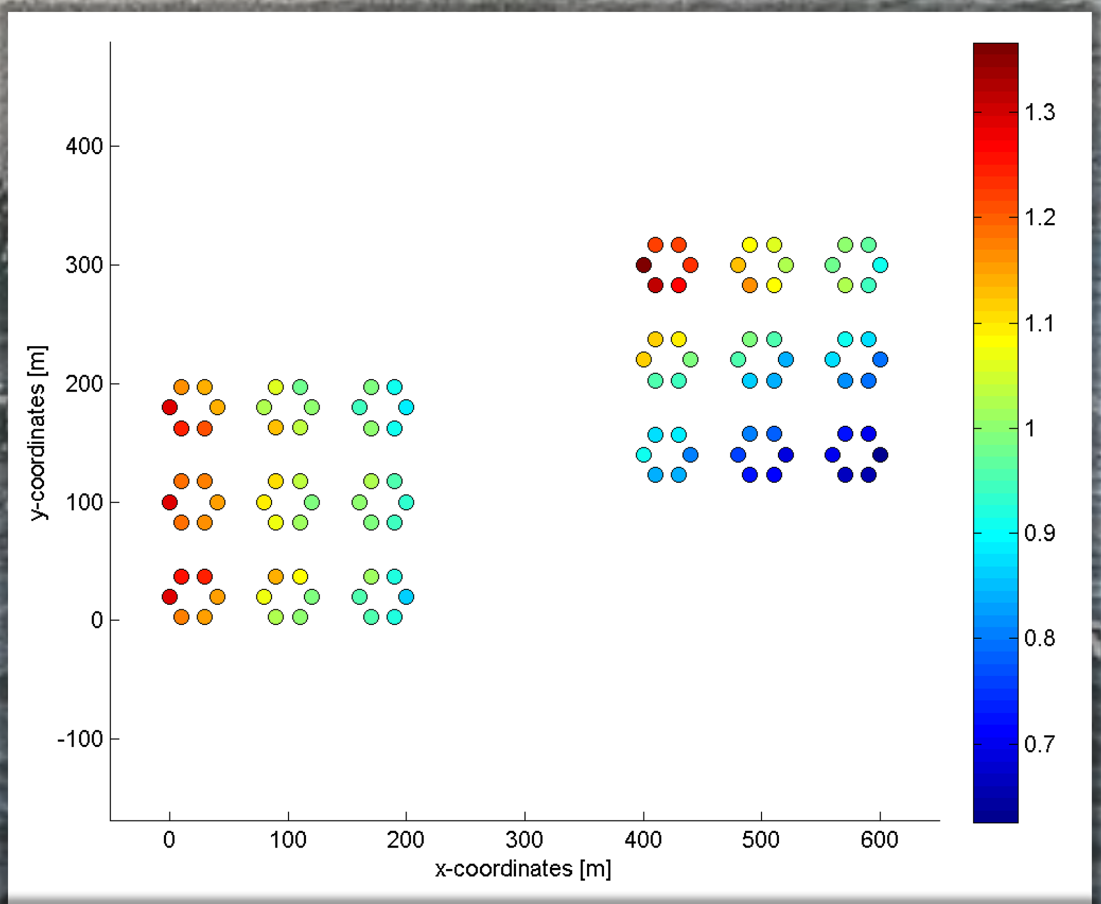

Figure 9. Simulation of two clusters show that the clusters experience destructive hydrodynamic interaction due to scattered and radiated waves. The colour for each WEC shows the ratio between the power absorbed by the device and the average power absorbed by all devices in the park.

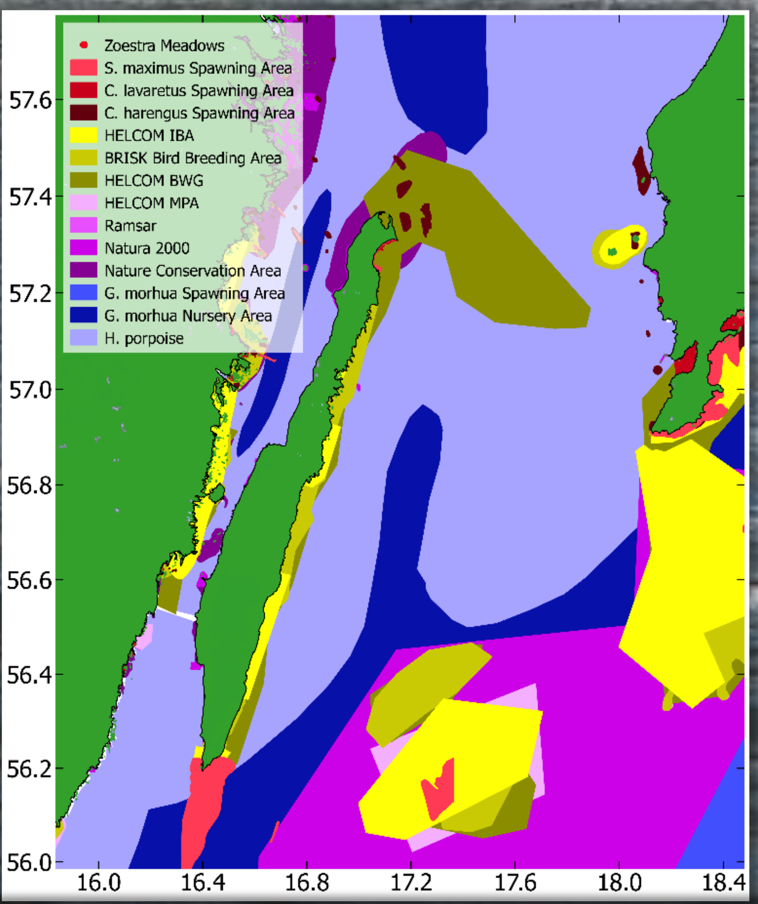

Figure 10. Mapping of areas of interest (AOIs) within the focus area in fig. 6a. Both ecosystem components and nature conservation areas are included. Spatial data for Natura 2000, Ramsar, Important Bird Areas (IBA), Bird Wintering Grounds (BWG), Bird Breeding Areas, Marine Protected Areas (MPA), G. morhua spawning and nursery areas and location of Zoestra meadows have been retrieved from HELCOMS online data and map service.

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