Mapping pressures and impacts on the ecosystem of the Barents Sea

G. Gonzalez-Mirelis, P. Buhl-Mortensen, and L. Buhl-Mortensen

Havforskningsinstituttet
Institute of Marine Research

MESMA

Introduction

We tested the methodology suggested by the EU project 'Monitoring and Evaluation of Spatially Managed Areas' (MESMA) to create maps of pressures and impacts of the southern Barents Sea, off Norway. This area has been thoroughly mapped by MAREANO. This methodology quantifies impact as a product of total pressure from all human activities combined, and the sensitivity of each ecosystem component to the pressures. All data was loaded into a Geographic Information System (GIS), and binned into a 5x5 km grid.

We assessed impact on the following ecosystem components: **larvae/juveniles of fish** (Greenland halibut, Haddock, Capelin, Saithe, Herring, and Cod); **spawning/breeding areas of fish** (Greenland Halibut, Haddock, Capelin, Saithe, Herring, Cod, and Redfish, not shown); **high concentration of seals** (Harbour Seal and Grey Seal, not shown); **high concentration whales** (Killer Whale, Minke Whale and Sperm Whale); maximum total **abundance of seabirds** (Little Auk, Razorbill, Atlantic Puffin, Northern Fulmar, Herring Gull, Common Gull, Glaucous Gull, Great Black-backed Gull, Northern Gannet, Common Murre, and Thick-billed Murre); **coral reefs**; and particularly vulnerable epibenthic biotopes, including **Hard Bottom Coral Gardens**, **Seapens and Burrowing Megafauna**, **Soft Bottom Corals**, **Deep-sea Sponges**, and ***Umbellula* stands**.

We used data on the following human activities: Fishing (benthic trawling), Installations (oil installations, including water and gas injection, and gas production), Pipelines (presence of oil pipelines on the bottom), Seismics (seismic surveys conducted by the oil industry), Shipping (ship traffic), and Exploration Wellbores. All data layers were classified into four classes from 0 (the activity was not present) to 3. To calculate total pressure we ranked activities according to how much they accounted for each pressure, and came up with coefficients accordingly (see table below).

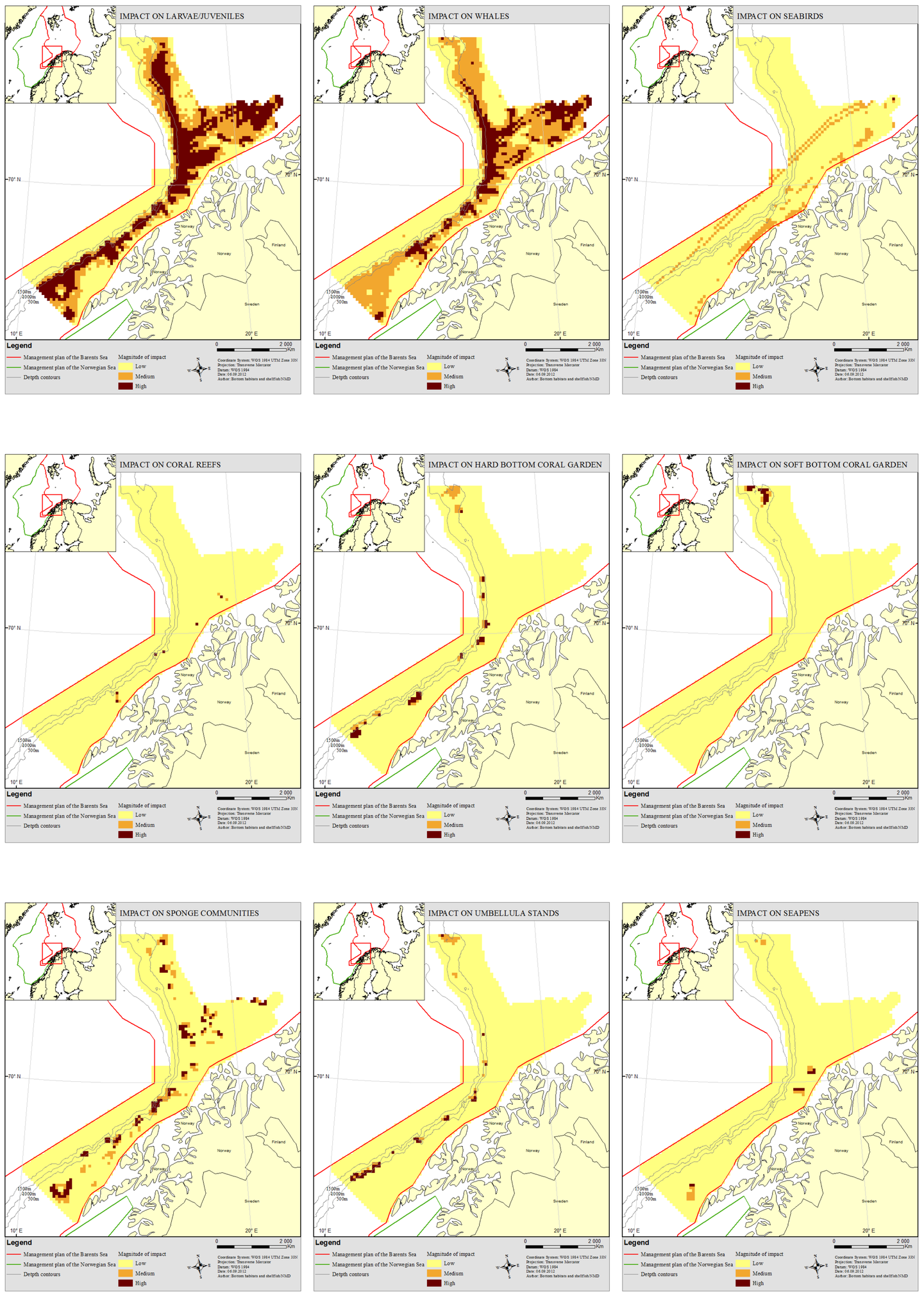
Pressures	Coefficients
Substratum loss	Pipelines (1) Wellbores (1) Installations (1)
Smothering	Fishing (1) Wellbores (2) Installations (2) Pipelines (2)
Suspension of sediment	Fishing (1) Wellbores (2) Installations (2) Pipelines (2)
Noise disturbance	Seismics (1) Shipping (2) Fishing (2)
Visual presence	Fishing (1) Shipping (1) Sellbores (1) Instalations (1)
Abrasion	Fishing (1) Wellbores (2) Installations (2) Pipelines (2)
Displacement	Fishing (1) Wellbores (1) Installations (2) Pipelines (3)
Hydrocarbon contaminants	Wellbores (1) Installations (1) Shipping (2) Pipelines (3)
Other chemical contaminants	Shipping (1) Wellbores (2) Installations (3) Pipelines (4)
Extraction of species	Fishing

For each 5x5 km cell total pressure is calculated as:

$$P_j = \sum_{i=1}^{n} \frac{A_i}{3 * R_i}$$

Where there are n activities contributing to pressure P_j, each of magnitude A and coefficient R. 3 is the maximum value on the scale for the activities (to normalize). Smothering, suspension of sediment, abrasion, and displacement are effectively the same type of pressure.

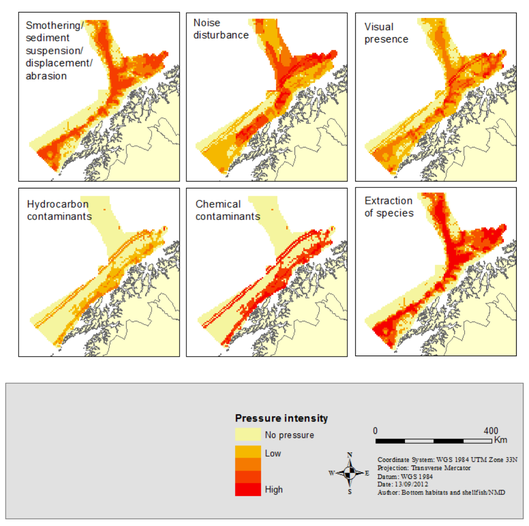
Impact maps



Calculating sensitivity

We used expert judgement to fill in a sensitivity matrix of every ecosystem component to every pressure category. Sensitivity values were assigned as follows: No Response (e.g. effect of substratum loss on seabirds), Very Low, Low, Medium, High, and Very High.

Pressure maps



Calculating impact

For the kth ecosystem component, the total impact in one grid cell is given by:

$$I_k = \sum_{j=1}^{m} P_j * S_{k,j}$$

Where $S_{k,j}$ is the sensitivity of the ecosystem component to pressure P_j, and there are are m different pressures present. We deemed it not possible to sum impact over ecosystem components.

Conclusions

While the exercise was very informative, the methods need to be further developed. For example, the pressure-impact relationship is not based on scientifically proven causal relations. Once subjectivity is removed, methods for mapping pressures and impacts should be incorporated into routine mapping activities, as they are invaluable for marine spatial planning.

Further reading: Buhl-Mortensen L, Olsen E, Røttingen I, Buhl-Mortensen P, Hoel AH, Lid Ringheim S, Grøsvik BE, Nygaard Holen S, Gonzalez-Mirelis G, Skulstad EM. 2012. Application of the MESMA Framework. Case Study: The Barents Sea. MESMA report, 138 pp.