This work is exposed in ATLAS-EU Deliverable 3.4: "Conservation Management Issues in ATLAS. Basin-scale systematic conservation planning: identifying suitable networks for VMEs protection" (Combes et al. 2019).
Conservation scenarios were implemented using the R package Prioritizr, on a gridded area representing the North Atlantic (18°N to 76°N and 36°E to 98°W) from 0 to 3500m depth, divided in 25km * 25km planning units. Spatial prioritisation and mapping were done on an Albers equal-area conic projection centered on the Atlantic ocean (latitude 30°N; longitude 30°W).

(1) Links to spatial datasets used as inputs for scenarios:

A wide range of datasets displaying the distribution of species and habitats, human activities and current spatial management was integrated to conservation scenarios. The original datasets were degraded to the right resolution and extent on the planning grid. The resulting raster files can be downloaded on the IFREMER platform for spatial datasets (SEXTANT), each dataset being published with a metadata that details the degradation process used:

1- Planning units

Combes Magali, Vaz Sandrine (2019). Planning units layers used in ATLAS spatial prioritization on the North Atlantic. IFREMER. http://dx.doi.org/10.12770/113cd9cb-0a30-4297-b93d-5cf10124105b

2- VMEs

Combes Magali, Vaz Sandrine (2019). Unequivocal VMEs and VME likelihood on the North Atlantic. IFREMER. http://dx.doi.org/10.12770/3f14f4aa-ffaa-4152-865f-01be69048fce

The metadata for this layer is available but the original data is still in a publication process. For accessing the data, please contact the authors.

3- Suitable habitat distribution for species

Combes Magali, Vaz Sandrine (2019). Predicted present-day suitable habitat and future climatic refugia habitat for deep-sea species on the North Atlantic. IFREMER. http://dx.doi.org/10.12770/786ae295-0922-4616-b5e0-db799f387fcc

In addition to properly cite this dataset, it would be appreciated that the following work(s) be cited too, when using this dataset in a publication:

González-Irusta, J.-M. et al. (unpublished data). Habitat suitability model for the sponge species, Geodia barretti, in the North Atlantic and current and future climate conditions.

Morato, T, González-Irusta, J-M, Dominguez-Carrió, C, et al. Climate-induced changes in the suitable habitat of cold-water corals and commercially important deep-sea fishes in the North Atlantic. Glob Change Biol. 2020; 26: 2181– 2202. https://doi.org/10.1111/gcb.14996

4- Geomorphologic features

Combes Magali, Vaz Sandrine (2019). Geomophologic features (fractures, canyons, seamounts) on the North Atlantic. IFREMER. http://dx.doi.org/10.12770/66c5957b-6cb5-4fce-9ca5-1cb609fa39b5

5- Marine protected or significant areas

Combes Magali, Vaz Sandrine (2019). Marine protected or significant areas in the North Atlantic. IFREMER. http://dx.doi.org/10.12770/debcbd09-4a36-48f3-a7c8-38f313eedd1b

6- Bottom fishing catch

Combes Magali, Vaz Sandrine (2019). index of fishing catch from deep-sea impacting gears on the North Atlantic. IFREMER. http://dx.doi.org/10.12770/79f078bf-7f80-4efc-a5b4-9e01609b6a51

7- Deep-sea mining contracts

Combes Magali, Vaz Sandrine (2019). Deep-sea mining activities on the North Atlantic. IFREMER. http://dx.doi.org/10.12770/4ab2fb42-ba5b-418d-9675-a642edfaca70

(2) Scenarios scripts and associated data:

Different conservation scenarios were structured and solved using integer linear programming (ILP) on the Prioritizr package (Hanson et al., 2019b) on R (R Core Team, 2018). The Gurobi solver (Gurobi Optimization LLC, 2018) was used to solve prioritization problems. Four R scripts are published to run the final ATLAS scenarios:

1- ATLAS_1_Create_features_provinces

This script prepares the input files for scenarios based on the planning units layers and the features layers (VMEs, habitat suitability for species, geomorphologic features). The input files are published as individual raster layers, and the script computes rasterstacks from several layers to simplify the scenarios structuration in script 3.

2- ATLAS_2_Create_costs

This script prepares the cost indices from the marine protected and significant areas, the bottom fishing catch, the deep-sea mining and the VMEs layers. Original values (e.g. bottom fishing catch values per planning unit) are reclassified as a relative index between 0 and 1. The final cost layers are stored in a rasterstack to simplify the scenarios structuration in script 3.

3- ATLAS_3_Scenarios

This script uses the processed datasets resulting from scripts 1 and 2, together with the conservation target table (csv file) and the connectivity matrix (Rdata file), to run the prioritization scenarios. The first part of the script loads all the datasets involves. The second part organizes the conservation features files, by merging input files and dividing each of the features according to the 13 provinces used to ensure network replication. The third part weights the cost layers based on cost indices. The fourth and fifth parts implement the 4 conservation scenarios (base scenario, management scenario, small version of the base scenario and connectivity scenario) and store the results. In that last part, functions from the script 4 “FUNCTIONS_Scenarios_outputs” are called automatically to create the outputs (figures and maps), thus this script does not need to be opened or modified.

(3) Outputs of the final scenarios structured for ATLAS

The output corresponding to the four scenarios of the published script, complemented by a supplementary output, are published in a shapefile format. To do so, each pixel of raster outputs (corresponding to a planning unit) was transformed to a polygon. The scenarios outputs are expressed as selection frequencies of planning units, reflecting how often the 25km * 25km units were selected within the n solutions of the scenario, from 0 for units that were never selected, to n for systematically selected units.

1- The base scenario

The “base” scenario (also called “all features” scenario in Combes et al. 2019) targets VME-indicator benthic species (cold-water corals and sponge) as well as deep-water fish species, and habitat (VMEs, VME-supporting geomorphological structures) features, while replicating the conservation objectives in the different regions of the ocean basin, and considering an area-based cost. The conservation problem was solved 100 times and the 30 best solutions (with the lowest cost) were selected to evaluate the selection frequency of planning units.

2- The management scenario

The “management” scenario (also called “all management” scenario in Combes et al. 2019) targets VME-indicator benthic species (cold-water corals and sponge) as well as deep-water fish species, and habitat (VMEs, VME-supporting geomorphological structures) features, while replicating the conservation objectives in the different regions of the ocean basin, and integrating socio-economic and spatial management aspects as a varying cost and a spatial constraint. The location of areas with a legal protection or designation lowered planning units’ cost, the deep-sea fishing catch rates over the ocean increased planning units’ cost, and the location of deep-sea mining areas excluded certain planning units from solutions. A confidence index associated to the likelihood of units to host VMEs was also included in costs (lowering planning units’ cost). The conservation problem was solved 100 times and the 30 best solutions (with the lowest cost) were selected to evaluate the selection frequency of planning units.

3- The small base scenario

The small version of the “base” scenario (also called “no connectivity” scenario in Combes et al. 2019) corresponds to the “base” scenario run on a smaller study area matching with the extent of connectivity modelling. This scenario was run to compare the “base” and “connectivity” scenarios on the same extent basis. The conservation problem was solved 100 times and the 30 best solutions (with the lowest cost) were selected to evaluate the selection frequency of planning units.

4- The connectivity scenario

Connectivity data was obtained from a Langrangian particle tracking model, implemented for hypothetical benthic larvae with a 20 days pelagic larval duration (PLD) and an 80 days PLD. Connectivity scenarios were implemented on a smaller study area than others, matching with the extent of the VIKING20 ocean circulation model used to produce connectivity data (30°N to 85°N and 81°W to 21°E in the Arctic and to 8°E in the Mediterranean). The “connectivity with 20 days PLD” scenario targets VME-indicator benthic species (cold-water corals and sponge) as well as deep-water fish species, and habitat (VMEs, VME-supporting geomorphological structures) features, while replicating the conservation objectives in the different regions of the ocean basin, favouring a connected conservation network based on the modelled dispersal of 20 days PLD benthic larvae, and considering an area-based cost. The conservation problem was solved 30 times and the 11 solutions that were achieved before the solving time limit were selected to evaluate the selection frequency of planning units.

5- The supplementary scenario “all benthic regionalised”

This “all benthic regionalised” scenario is one of the outputs from Combes et al. (2019). Its difference with the “base” scenario is the absence of fish species features. It targets the VME-indicator benthic species (cold-water corals and sponge), and habitat (VMEs, VME-supporting geomorphological structures) features, while replicating the conservation objectives in the different regions of the ocean basin, and considering an area-based cost. The conservation problem was solved 100 times and the 30 best solutions (with the lowest cost) were selected to evaluate the selection frequency of planning units.