Supplementary Material to the manuscript:

Applying the China's marine resource-environment carrying capacity and spatial development suitability approach to the Bay of Biscay (North-East Atlantic)

Authors: Angel Borja, Sarai Pouso, Ibon Galparsoro, Eleonora Manca, Mickael Vasquez, Wenhai Lu, Lu Yang, Ainhize Uriarte

Frontiers in Marine Science, DOI: 10.3389/fmars.2022.972448

Supplementary Material

SM1: Technical guidance on evaluation of Marine Resource-Environment Carrying Capacity and Spatial Development Suitability (official version). Official document provided by the EMODPACE China partners and translated by Xiaoyu Fang and Jun She

1. Scope

This technical guideline specifies the objectives, technical processes, indicator systems, and evaluation methods in evaluating Marine Resource-Environment Carrying Capacity and Spatial Development Suitability. It is applicable to the preparatory research work of marine spatial planning. This standard is region specific, meaning that different regions can refine and add relevant requirements and contents given specific local conditions to make evaluation targeted and practical.

2. Terms and definitions

2.1 Marine Resource-Environment Carrying Capacity

Marine Resource-Environment Carrying Capacity refers to the maximum and feasible volume of marine exploitation activities which can be supported by marine resources and environment in a given sea areas, which is associated with (based on) levels of development, economy and technology, production and lifestyle and goals for ecological protection.

2.2 Suitability for Marine Spatial Development

Suitability for Marine Spatial Development refers to level of suitability for exploitation activities (e.g. marine aquaculture, port construction, offshore wind power development, offshore oil and gas development) in a given ocean space, with the premise of national security and maintaining marine ecosystem health.

3. Evaluation aims

The evaluation aims are to:

- Analyse regional conditions on marine resource and environment;
- Identify and investigate problems and risks in development and utilization of marine space
- Identify key areas for ecological importance (including ecosystem service function areas, ecologically vulnerable areas)
- Clarify resource and environmental carrying capacity and suitable space for marine development and utilization
- Define and identify environmental limits for sustainable development
- Establish basic rules for marine spatial planning, optimizing the marine sector strategy (e.g. development and protection patterns) and regional positioning of main functions, and delineation of areas of ecological importance, red line areas, etc.

4. Methods for implementation aspect

4.1 Data collection

It is important to collect accurate, complete, relevant and timely data. With regard to marine resource and spatial planning, essential data includes marine environmental data (i.e. geography, marine space resources, marine environment, marine ecology, marine disasters, climate and meteorology), as well as status of marine development and utilization, coastal socioeconomics, marine spatial planning and zoning, etc.

4.2 Evaluation of areas of ecological importance

The evaluation of areas of ecological importance includes assessment to ecosystem services and ecological sensitivity of marine ecosystem. Ecosystem service is assessed by levels of importance of marine biodiversity and coastal protection. The sensitivity of marine ecosystem is evaluated based on vulnerability of coastal erosion and sand loss. As a first step, the above factors will be evaluated individually, amongst which the highest level of importance is identified as the regional ecological importance level; secondly, important/highly important ecological functional areas are identified.

4.2.1 Marine biodiversity importance areas

The importance of marine biodiversity is evaluated at three levels: species, ecosystem and genetics. The evaluation is carried out following three steps:

(1) Identify regional patches through field surveys, remote sensing, and topographical and oceanographic features;

(2) Determine the specific evaluation indicators and identify the importance of each patch considering the main ecological functions of various regions;

(3) The highest grade of each patch is the evaluation result of the importance of marine biodiversity.

Table 1 Classification system of marine biodiversity importance

Level	Area	Identification and delineation method	Specific indicators	Areas of high importance	Areas of importance
Species Level	Species distribution area	Carry out field survey or refer to relevant protected areas to identify targeted areas of species distribution, breeding, migratory, living	Population size	Endangered / critical	Vulnerable
			Importance of distribution area	Centralized distribution area / breeding area	Migratory area
Ecosystem level	Coral reef	Remote sensing and field investigation	Habitat area and coverage	Identify as high-importance	
	Mangrove	Remote sensing interpretation and field investigation	Habitat area and coverage	Identify as high-importance	
	Seagrass bed	Remote sensing and field investigation	Habitat area and coverage	Identify as high-importance	
	Seaweed habitat	Field investigation	Habitat area	$<50^{th}$ percentile	$>50^{th}$ percentile
			Primary productivity or chlorophyll	High	Medium and low
			Biodiversity (fish, mammals, etc.)	High	Medium and low
	Coastal marsh	Remote sensing and field investigation	Scale formation	$<50^{th}$ percentile	$>50^{th}$ percentile
			Life history (i.e. migration and habitat of birds)	Importance	Average
			Vegetation coverage	High	Medium and low
	Tidal flats and shallow waters	Tidal flat refers to the area that is above water level at low tide and underwater at high tide; shallow water refers to areas from high tide to -6m isobath.	Habitat area	$<50^{th}$ percentile	$>50^{th}$ percentile
			Diversity of benthos	High	Medium and low

Level	Area	Identification and delineation method	Specific indicators	Areas of high importance	Areas of importance
			Life history (i.e. migration and habitat of birds)	Important	Average
	Estuary	Remote sensing, landscape, water depth	Primary productivity or Chlorophyll	High	Medium and low
			Diversity (Swimming species)	High	Medium and low
			Life history (Mainly migration and inhabitation for birds, spawning and migration for fish)	High importance	Average
	Island	Remote sensing to identify islands, based on which the area is extended along 6m water depth; islands distributed in a concentrated manner can be grouped	Life history (Mainly for the migration and habitat of birds)	High importance	Average
			Diversity (Mainly for species only occur on the island and fishery resources in adjacent area)	High	Medium and low
			Vegetation coverage	>75%	<75%
			Importance of rights	Islands within the territorial sea baseline	—
	Fishery resources growing area	Field survey or refer to relevant protected areas	Importance of life history (fishery resources)	Spawning ground	Important fishing ground, Wintering field, Migratory channels, etc.
			Population importance	Key species,	Common species
	Other unique habitats	Other areas with unique and rare populations, ecosystems, topography, landforms or oceanographic characteristics, are decided onsite or by physical geographic boundaries, oceanographic characteristics (such as upwelling).	Unique	High	Medium and low
			Diversity	High	Medium and low
Genetic level	Aquatic genetic resources	Field survey or determination with reference to aquatic germplasm resource protection areas	Importance of area	Important (such as nature reserve, core area)	Average

4.2.2 Importance of coastal protection function

The relative importance of the coastal protection function is assessed by identifying biological protection areas (i.e. coastal forests, mangroves, salt marshes), and physical protection areas (i.e. bedrock coast, sandy shore).

Table 2 Classification system of coastal protection function

Area		Identification and delineation method	Specific indicators	Areas of high-importance	Areas of importance
Biological protection area	Mangroves, salt marshes, coastal forests (shelterbelts)	Remote sensing and field survey to identify distribution areas of mangroves, salt marshes and coastal forests	Habitat area, vegetation coverage, belt width of coastal forests	Concentrated patch, high vegetation coverage, large width	Others
Physical protection area	Bedrock coast	The distance from coastline to the land ranges up to 100 meters	Shore length	Large scale and complete; >1km	Other

Area		Identification and delineation method	Specific indicators	Areas of high-importance	Areas of importance
	Sandy shore	The distance from coastline to land and delineated towards sea by geographical boundaries	Shore length, width, slope	gently sloping, large scale, complete and quite flat	Other

4.2.3 Assessment of coastal vulnerability: coastal erosion and sand loss

Coastal erosion and sand loss are assessed via parameters such as coastal sediment types and storm surge and erosion rate, as well as identification of vulnerable natural coast and restored sandy/silty/muddy coasts. Area is defined by geographic boundary from shoreline to land.

Coastal erosion vulnerability is calculated as (N+M)/2, in which N is Natural factors of coastal erosion and M is the dynamic factor of coastal erosion.

N=(g×a1+h×a2+Hw×a3)/3, in which g is Coastal sediment type, h is water-level rise cause by storm surge, Hw is average wave height, M is Coastal erosion rate and a is weighting factor (please refer to below table3 a1, a2, and a3 are valued at 0.5, 0.4 and 0.1 respectively). Areas with calculated scores 3.5-5, 1.5-3.5 and <1.5 are identified as very vulnerable, vulnerable and average respectively.

Table 3 Parameters for assessment of classification and evaluation of coastal erosion vulnerability

Parameters		Scores for different types		
		5	3	1
Types		Sandy/silty/muddy coasts	Natural shorelines with ecological functions	Artificial shorelines/bedrock shores
Water-level increase by storm surge (m)		≥3.0	1.5~3.0	<1.5
Average wave height (m)		≥1.0	0.4~1.0	<0.4
Erosion rate m/yr	Silty/muddy coast	≥10	1-10	<1
	Sandy coast	≥2.0	0.5-2	<0.5

4.3 Suitable marine development and utilization

Suitability of marine development and utilization is assessed via marine development and utilization functions, considering the potential of marine resources and the status of development and utilization. Individual elements (e.g. sea resources, environment, ecology, location, etc.) are evaluated as a first step. Secondly, the individual elements are integrate. Suitability of marine development and utilization is classified into five levels: suitable, more suitable, generally suitable, less suitable and unsuitable.

4.3.1 Suitability for marine aquaculture

Step 1: Individual evaluation index is selected based on factors such as regional topographical features, hydrodynamic conditions, environmental conditions, biological resources, and natural disaster risk, specific breeding varieties and breeding methods.

(1) Marine environment

Seawater quality indicator reflects the limiting effect of seawater environment on aquaculture.

Seawater quality is classified into 5 levels according to the "Seawater Quality Standards" (GB3097-1997), "Technical Regulations for Evaluation of Seawater Quality" (Trial) (Haihuanzi [2015] No. 25): 1st, 2nd, 3rd, 4th class and worse than 4th class. Factors analysed for the assessment include regional seawater quality monitoring data, regional pollution problems, pH, chemical oxygen demand, dissolved oxygen, petroleum and heavy metals (except for inorganic nitrogen, phosphate, silicate and other nutrients).

The suitability for marine aquaculture is classified into five grades: good, better, fair, poor, and poor.

(2) Marine disasters

Impact of marine disasters on marine aquaculture activities is evaluated by indexing risks of sea wave, sea ice and red tide disasters. Assessments to wave disaster risk is performed by referring to "Sea Wave Disaster Risk Assessment and Zoning Technical Guidelines" and historical wave data. It is quantified as wave disaster risk index based on the effective wave height during the typical recurrence period and classified into very low, low, medium, high and very high.

(3) Marine resources and physical/chemical conditions

The conditions are classified into three grades (i.e. high, medium and low) based on specific breeding species and breeding methods, water depth, bottom sediment types (i.e. bedrock, gravel, sand, mud, etc.), flow velocity, water temperature, salinity and biological resource conditions of marine aquaculture.

Step 2: Integrated evaluation

Integration of individual evaluation to develop a comprehensive marine aquaculture suitability grading system.

(1) Integrated evaluation of marine disasters

The highest grade evaluated from wave disaster, sea ice disaster and red tide disaster is identified as the integrated index of marine disasters. The risks are classified into five grades: very low, low, medium, high and very high.

(2) Integrated evaluation of marine resources and physical/chemical conditions

The various marine resources and physical and chemical conditions are integrated by discriminant matrix method according to the requirements of marine aquaculture. The conditions are divided into three levels: high, medium and low.

(3) Comprehensive evaluation of suitability

The suitability level for marine aquaculture is finally decided based on the results of integrated evaluation of marine disasters and integrated evaluation of marine resources and physical/chemical conditions:

The suitability level is reduced to a lower grade in an area with high/very high risk of marine disasters, and the suitability level is identified to low in an area with seawater environmental conditions worse than 2nd class.

4.3.2 Suitability for port construction

Step 1: Individual evaluation

Evaluation of the suitability for port construction activities is based on appropriate individual evaluation index. These indexes are decided by factors such as regional spatial resources, hydrodynamic conditions and natural disaster risks.

(1) Evaluation of onshore area

Onshore area move towards land (~2km) from the shoreline, conditions of which are characterized by slope and relief height. Slope is calculated from digital elevation models and a slope map is created by categorizing slopes into ≤3°,3~8°,8~15°,15~25° and >25°.

Revision of the categorization according to relief height: in an area with relief height >200m, the grade decreases two levels; in an area with relief height between 100m and 200m, the grade decreases one level.

The averaged value is calculated within 2km region applying neighbourhood tool and categorised into five grades: very high (≥ 5), high (4 ~ 5), medium (3 ~ 4), low (2 ~ 3), and very low (< 2).

(2) Evaluation of bottom conditions

The impact of port construction is categorized into three levels based on sediment types: bedrock (good), silty/muddy shoreline (medium) and sandy shoreline (bad).

(3) Evaluation of water depth

According to the standards for the deep water coastline of a port, formulated by the administrative department of communications under the State Council, the conditions of water depth are divided into 5 levels dependent on the distances from 10m isobaths: ≤1.5km (Good), 1.5~3km (above average), 3~4.5km (average), 4.5~6km (below average), >6km (bad).

(4) Assessment to risks of marine disasters

The risks of marine disasters are categorized into four levels (i.e. very low, low, high, very high) with reference to Guideline for risk assessment and zoning of storm surge disaster. Annual average risk index of storm surge disasters at each tide (water) station is determined by factors such as water level increase caused by storm surge and storm alert.

(5) Water width

Water width is considered in the areas with narrow waterways and islands dependent on the distance to shoreline >600m (good), 300-600m (medium), <300m (bad).

(6) Evaluation of transportation infrastructure

The condition for port construction is characterized by public transport accessibility from main roads and transportation hubs. Public transport accessibility from the main roads is analysed by distances between grid cells and roads/railways and categorized into five levels: very good, good, average, bad, very bad. Public transport accessibility from transportation hubs is dependent on the travel time from grid cells to transportation hubs and categorized into five levels: very good, good, average, bad, very bad.

Step 2: Integrated valuation

(1) Integration of shoreline bottom type and water depth is used to evaluate conditions of shoreline resource utilization with reference to the discriminant matrix table below. The conditions are classified into 5 levels: very high, high, medium, low and very low.

Table 4 Discriminant matrix.

Conditions of water depth	**Conditions of sediment types**		
	Good	**Medium**	**Bad**
Good	Very High	High	Medium
Above average	High	Medium	Low
Average	Medium	Low	Very Low
Below average	Low	Very Low	Very Low
Bad	Very Low	Very Low	Very Low

The evaluation result is adjusted based on onshore area and water width. For areas with onshore area grades “very low” and “low”, the final grades are reduced two levels and one level as the final results, respectively. For area with water width grade “very low”, the final grade is reduced one level.

(1) Suitability for port construction

Initial evaluation is performed based on grade results of shoreline resource utilization and risk of marine disasters. It is further adjusted to grade “medium” for areas with shoreline resource utilization evaluated as “high” and “very high”. For areas whose shoreline resource utilization evaluated as “very high” and risk of marine disaster evaluated as “high”, the final grade is adjusted to “high”.

Final evaluation is done by integrating transportation infrastructure grade, i.e. port construction suitability grade is adjusted to “very low” and reduced one level in areas with transportation infrastructure evaluated as “very bad” and “bad” respectively.

4.3.3 Suitability for Development and Construction of Offshore Wind Power

Step 1: Individual evaluation

(1) Evaluation of wind energy potential

Wind energy potential is evaluated by wind power density at 100m height and classified into five grades i.e. very high, high, medium, low, very low correspondent to $\geq$450W/m^2,400-450 W/m^2, 350-400 W/m^2,300-350 W/m^2,<300 W/m^2.

Step 2: Integrated evaluation on suitability for development and construction of offshore wind power

(1) Suitability is categorized into 5 levels in accordance with evaluation of wind energy potential, i.e. very high, high, medium, low, very low.

(2) Adjustment made to the integrated evaluation based on offshore distance and water depth. With reference to Measures for the Administration of the Development and Construction of Offshore Wind Power (No. 394 [2016] of the National Energy Administration), suitability is adjusted to “very low” for areas with offshore distance <10km and reduced one level in areas with water depth >50m where offshore wind power is difficult to be developed and constructed.

4.3.4 Offshore oil and gas development suitability

Step 1: Individual evaluation

(1) Evaluation of oil and gas resources

Area resource abundance index (i.e. the amount of oil and gas resources per evaluation area or scale area) is to evaluate suitability of offshore oil and gas development considering geological resources.

Table 5 Grading system of oil and gas resource abundance.

Level	Oil resource abundance per area （10^4t/km^2）	Gas resource abundance per area （10^8m^3/km^2）
Very High	> 30	>3
High	20 ~ 30	2 ~ 3
Medium	10 ~ 20	1 ~ 2
Low	5 ~ 10	0.5 ~ 1
Very Low	< 5	< 0.5

Step 2: Integrated evaluation

(1) Initial evaluation of the suitability for offshore oil and gas development is categorized into very high, high, medium, low, very low in accordance with area resource abundance index.

Table 6 Threshold of patch configuration.

Patch configuration	Very Low	Low	Average	High	Very High
Oil patch（km^2）	<3.0	3.0-4.5	4.5-9.0	9.0-18.0	≥18.0
Gas patch（km^2）	<1.0	1.0-2.0	2.0-4.0	4.0-8.0	≥8.0

Adjustment is made by integrating patch configuration with reference to Discriminant matrix for modifying offshore oil and gas development suitability. In areas with suitability graded as “low” or “very low”, no adjustment is needed.

Table 7 Discriminant matrix for modifying offshore oil and gas development suitability.

Grades of offshore oil and gas development suitability	Patch configuration				
	Very high	High	Medium	Low	Very low
Very high	Very high	High	High	High	High
High	High	High	Medium	Medium	Medium
Medium	Medium	Medium	Medium	Medium	Medium

4.4 Environmental analysis of resource endowment

Advantages and constraints of the resource environment is summarized by combining analysis of marine environment, biodiversity, ecology, mineral resource (e.g. quantify, quality, structure, distribution and trend), climate, disaster, etc.

4.5 Risk identification

Environmental problems caused by overexploitation of resources are identified by comprehensively analysing the status of development and utilization of marine resources (e.g. scale, structure, layout, quality, efficiency, benefits and changes). Therefore, future trends can be predicted and risks can be assessed based on the identified environmental problems.

4.6 Evaluation of carrying capacity

Ecological carrying capacity is estimated as the maximum capacity of development and utilization of marine resources to ensure sustainable development of coastal area. The maximum carrying capacity is estimated by excluding areas of ecological importance with level “high importance” and areas not suitable for marine development and utilization activities.

4.7 Potential analysis

With reference to the evaluation results of suitability and ecological carrying capacity, the following situations can be assessed:

- Zonation of suitability classification
- Status of marine resource exploitation
- Identity activities carried out in areas not suitable for development
- Potential risks

In the meantime, potential analysis provides scientific support to optimize marine spatial planning and resource utilization by analysing the status of current planning/strategy and future needs for marine development.

SM2: Technical guidance on evaluation of Marine Resource-Environment Carrying Capacity and Spatial Development Suitability (EMODPACE adapted version)

1. Scope

This technical guideline specifies the objectives, technical processes, indicator systems, and assessment methods in evaluating Marine Resource-Environment Carrying Capacity and Spatial Development Suitability. It is applicable to the preparatory research work for marine spatial planning (MSP). This standard is region specific, meaning that different regions can refine, add relevant requirements and contents given specific local conditions to make evaluation targeted and practical.

2. Terms and definitions

2.1. Marine Resource-Environment Carrying Capacity

"Environment Carrying Capacity" (ECC) refers to the maximum and feasible volume of marine human activities[1] which can be supported by marine resources and environment in a given sea area, which is associated with (based on) levels of development, economy and technology, production and lifestyle and goals for ecological protection[2].

2.2. Suitability for maritime activities[3]

Suitability for maritime activities refers to the level of human activities at sea (e.g. marine aquaculture, port construction, offshore wind power development, offshore oil and gas development), in a given ocean space, with the premise of national security and maintaining marine ecosystem health[4].

3. Evaluation aims

The evaluation aims are to:

- Analyse regional conditions of marine resources[5] and environment.
- Identify and investigate problems and risks in development[6] and utilization of marine space.
- Identify key features and areas for protection (including ecosystem service provisioning areas and vulnerable areas).
- Clarify resource and environmental carrying capacity and suitable space for maritime activities development.
- identify and define environmental limits for sustainable development.
- Establish basic rules for MSP implementation by optimizing the marine sectors objectives (both considering their performance and development, together with ecological protection and conservation) and regional positioning of main functions,

[1] In the official document referred to as 'exploitation activities', adapted to the European terminology, such as that in the Marine Strategy Framework Directive (MSFD).
[2] Hence, in European terminology, the amount of activities that can be undertaken in an area, in a sustainable way, without compromising to achieve Good Environmental Status (GES), after the MSFD.
[3] In the official document referred to as 'Marine Spatial Development', adapted to the European terminology, such as that in the MSFD or the Maritime Spatial Planning Directive (MSPD), as well as in the Blue Growth Strategy.
[4] In European terminology, to achieve or maintain GES, after the MSFD.
[5] Either biotic (i.e. fish, crustaceans, etc.) or abiotic (i.e. wind energy, wave energy, etc.).
[6] Equivalent to the ecological risk assessment, in Europe.

and delineation of areas of ecological importance red line areas, etc.[7]

4. Methods to implement the MRECC

4.1. Data collection

It is important to collect accurate, complete, relevant, and timely data. With regard to marine resources and spatial planning, essential data includes marine environmental data (i.e. geography, marine space distribution of the resources, marine environment, marine ecology, marine disasters, climate and meteorology), as well as status of marine development and utilization, coastal socioeconomics, marine spatial planning and zoning, etc.[8]

4.2. Evaluation of areas of ecological importance

The evaluation of areas of ecological importance includes the assessment to ecosystem services and the ecological sensitivity of marine ecosystem. Ecosystem services are assessed by levels of marine biodiversity and coastal protection[9]. The sensitivity of marine ecosystem is evaluated based on vulnerability to coastal erosion and sand loss[10]. As a first step, the above factors will be evaluated individually, amongst which the highest level of importance is identified as the regional ecological importance level; secondly, important/highly relevant ecological functional areas are identified.

4.2.1 Marine biodiversity importance areas

The importance of marine biodiversity is evaluated at three levels: species, habitat[11], and genes[12]. The evaluation is carried out following three steps (Table 1):

(4) Identify the spatial distribution of habitats[13] through field surveys, remote sensing, and topographical and oceanographic features;

(5) Determine the specific evaluation indicators and identify the importance of each habitat considering the main ecological functions;

(6) The highest grade of each habitat area is the evaluation result of the importance for marine biodiversity.

Table 1. Classification system of importance for marine biodiversity

Level	Area	Identification and delineation method	Specific indicators	Areas of high importance	Areas of importance
Species Level	Species[14] distribution area	Field survey or relevant protected areas to identify targeted areas of species distribution, breeding, migratory, living	Population size	Endangered / critical	Vulnerable
			Importance of distribution area	Centralized distribution area / breeding area	Migratory area
Habitat	Seagrass bed	Remote sensing and field investigation	Habitat area and coverage	Identify as high-importance	

[7] In European terminology, this means to achieve or maintain GES (after the MSFD) while at the same time allowing sustainable maritime activities (MSPD). This is, making compatible MSFD and MSPD.

[8] In European terminology, this should include biotic (habitats, species, etc.) and abiotic (hydrography, climate, etc.) information, as well as uses, planning (including marine protected areas), environmental status (from MSFD or Regional Seas Conventions), ecosystem services mapping and assessment, etc.

[9] In addition to those proposed in this official method, all ecosystem services types should be considered (provisioning, regulating and cultural). They must be spatially explicit and at the highest spatial resolution.

[10] But we will need to also add vulnerability to biological (including habitats, biodiversity) loss.

[11] In the official version 'habitats' are 'ecosystems', but in European terminology, they refer to habitats. Changed throughout the text.

[12] In the official version is 'genetics', I think that 'genes' is more correct.

[13] In the official version is 'regional patches', but it should be considered as 'habitat distribution areas'

[14] Here, those threatened species which are vulnerable, endangered, or critically endangered according to IUCN red list are considered. However, we can consider those species under Descriptor 1 (biodiversity) within the MSFD.

Level	Area	Identification and delineation method	Specific indicators	Areas of high importance	Areas of importance
Level[15]	Seaweed habitat	Field investigation	Habitat area	$<50^{th}$ percentile[16]	$>50^{th}$ percentile
			Primary productivity or chlorophyll	High	Medium and low
			Biodiversity (fish, mammals, etc.)	High	Medium and low
	Coastal marsh	Remote sensing and field investigation	Habitat area	$<50^{th}$ percentile	$>50^{th}$ percentile
			Life history (i.e. migration and habitat of birds)	Importance	Average
			Vegetation coverage	High	Medium and low
	Tidal flats and shallow waters[17]	Tidal flat refers to the area that is above water level at low tide and underwater at high tide; shallow water refers to areas from high tide to -6 m isobath	Habitat area	$<50^{th}$ percentile	$>50^{th}$ percentile
			Diversity of benthos	High	Medium and low
			Life history (i.e. migration and habitat of birds)	Important	Average
	Estuary	Remote sensing, landscape, water depth	Primary productivity or Chlorophyll	High	Medium and low
			Diversity (swimming species)	High	Medium and low
			Life history (mainly migration and inhabitation for birds, spawning and migration for fish)	High importance	Average
	Island	Remote sensing to identify islands, based on which the area is extended along 6m water depth; islands distributed in a concentrated manner can be grouped	Life history (mainly for the migration and habitat of birds)	High importance	Average
			Diversity (mainly for species only occur on the island and fishery resources in adjacent area)	High	Medium and low
			Vegetation coverage	>75%	<75%
			Importance of rights	Islands within the territorial sea	
	Fish spawning area	Field survey or relevant protected areas	Importance of life history (fishery resources)	Spawning ground	Important fishing ground, wintering field, migratory channels, etc.
			Population importance	Key species	Common species
	Other unique habitats	Other areas with unique and rare populations, topography, landforms or oceanographic characteristics, are decided onsite or by physical geographic boundaries, oceanographic characteristics (such as upwelling)	Unique	High	Medium and low
			Diversity	High	Medium and low
Genes level	Aquatic genetic resources	Field survey or determination with reference to aquatic germplasm resource protection areas.	Importance of area	Important (such as nature reserve, core area)	Average

4.2.2. Importance of coastal protection function

The relative importance of the coastal protection function is assessed by identifying biological protection areas (i.e. coastal forests, salt marshes), and physical protection areas (i.e. bedrock coast, sandy shores) (Table 2).

[15] Here, we can consider some criteria in D1 and D6 (seafloor integrity), from the MSFD

[16] Areas with the habitat extent of top 50% in China are determined to be of high importance.

[17] In China this includes both tidal flats and shallow waters, which are no deeper than 6 m, based on the definition in Ramsar Wetland.

Table 2. Classification system of coastal protection function.[18]

Area		Identification and delineation method	Specific indicators	Areas of high-importance	Areas of importance
Biological protection area	Salt marshes, coastal forests, etc. (shelterbelts)	Remote sensing and field survey to identify distribution areas of mangroves, salt marshes and coastal forests	Habitat area, vegetation coverage, belt width of coastal forests	Concentrated patch, high vegetation coverage, large width	Others
Physical protection area	Bedrock coast	The distance from coastline to the land ranges up to 100 meters	Shore length	Large scale and complete; >1 km	Other
	Sandy shore	The distance from coastline to land and delineated towards sea by geographical boundaries [19]	Shore length, width, slope	Gently sloping, large scale, complete and quite flat	Other

4.2.3. Assessment of coastal vulnerability: coastal erosion and sand loss

Coastal erosion and sand loss are assessed via parameters such as coastal sediment types, storm surge and erosion rate, as well as identification of vulnerable natural coast and restored sandy/silty/muddy coasts. Area is defined by geographic boundary from shoreline to land.

Coastal erosion vulnerability is calculated[20] as:

$$\mathbf{(N+M)/2}$$

in which **N** is Natural factors of coastal erosion and **M** is the dynamic factor of coastal erosion, being:

$$\mathbf{N = (g \times a1 + h \times a2 + Hw \times a3)/3}$$

in which **g** is Coastal sediment type, **h** is water-level rise caused by storm surge, **Hw** is average wave height, **M** is Coastal erosion rate and **a** is weighting factor (refer to Table 3, a1, a2, and a3 are valued at 0.5, 0.4 and 0.1, respectively).

Final vulnerability is:

- Scores 3.5-5: very vulnerable
- Scores 1.5-3.5: vulnerable
- Scores <1.5: less vulnerable

Table 3. Parameters for assessment of classification and evaluation of coastal erosion vulnerability (values as annual averages)[21]

Parameters	Scores for different types		
	5	3	1
Types	Sandy/silty/muddy coasts	Natural shorelines with ecological functions	Artificial shorelines/bedrock shores
Water-level increase by storm surge (m)	≥3.0	1.5~3.0	<1.5
Average wave height (m)	≥1.0	0.4~1.0	<0.4

[18] They should be considered as ecosystem services protection. This paper can serve as guide and we can use the results from there: Liquete, C., G. Zulian, I. Delgado, A. Stips, J. Maes, 2013. Assessment of coastal protection as an ecosystem service in Europe. Ecological Indicators, 30: 205-217.

[19] This is to set a physical buffer in rocky and sandy shores, generally 100 metres.

[20] All data are into raster layers with the same resolution (e.g. 20 m) and do calculations between different layers.

[21] We need to discuss these values, to adapt them to the Bay of Biscay/Europe.

Erosion rate (m yr^{-1})	Silty/muddy coast	≥10	1-10	<1
	Sandy coast	≥2.0	0.5-2	<0.5

4.3. Suitable marine development and utilization

Suitability of marine development and utilization is assessed via maritime spatial planning[22], considering the potential of marine resources and the status of development and utilization[23]. Individual elements (e.g. sea resources, environment, ecology, location, etc.) are evaluated as a first step. Secondly, the individual elements are integrated. Suitability of marine development and utilization is classified into five levels: Highly suitable, Suitable, Moderately suitable, Less suitable and Unsuitable[24].

4.3.1 Suitability for marine aquaculture[25]

Step 1: An individual evaluation index is selected, based on factors such as regional topographical features[26], hydrodynamic conditions, environmental conditions, biological resources, and natural disaster risk, specific breeding varieties and breeding methods.

(1) Marine environment

Seawater quality reflects the limiting effect of seawater environment on aquaculture. It is classified into 5 levels[27] according to the Water Framework Directive (physico-chemical factors and chemical status) and the MSFD (Descriptors 5 -eutrophication-, 8 -contaminants in the environment- and 9 -contaminants in seafood-). Indicators analysed for the assessment include regional seawater quality monitoring data, regional pollution problems, pH, dissolved oxygen, and contaminants (except for inorganic nitrogen, phosphate, silicate and other nutrients).

The suitability for marine aquaculture is classified into five levels, as in the WFD: high, good, moderate, poor, and bad[28].

(2) Marine disasters

Impact of marine disasters on marine aquaculture activities is evaluated by indexing risks of sea wave, and red tides. Assessments to wave disaster risk is performed by referring to "Sea Wave Disaster Risk Assessment and Zoning Technical Guidelines" and historical wave data. It is quantified as wave disaster risk index based on the effective wave height during the typical recurrence period and classified into very low, low, medium, high and very high.

(3) Marine resources and physical/chemical conditions

The conditions are classified into three grades (i.e. high, medium and low) based on specific breeding species and breeding methods, water depth, bottom sediment types (i.e. bedrock,

[22] In the original document this term was ‘marine development and utilization functions’, which has been adapted to MSP.
[23] In the original document four activities are included: aquaculture, port development, wind farms and oil & gas exploitation. We should consider all activities, not only those.
[24] In the original document the levels were: suitable, more suitable, generally suitable, less suitable and unsuitable. They have been adapted.
[25] In the original document, they are trying to build a general framework to assess the suitability for spatial use of maritime aquaculture. More factors based on the physiological features of specific species can be considered.
[26] Some automated classification techniques, based on the gridded bathymetry (focus on the depth for specific species or sheltering conditions such as bay), can be considered.
[27] In the original document the assessment was done following "Seawater Quality Standards" (GB3097-1997), "Technical Regulations for Evaluation of Seawater Quality" (Trial) (Haihuanzi [2015] No. 25): 1st, 2nd, 3rd, 4th class and worse than 4th class”. These have been adapted to the European legislation.
[28] In the original document they were, good, better, fair, poor, and poor (something was wrong), and they have been adapted to those in the WFD.

gravel, sand, mud, etc.), flow velocity, water temperature, salinity and biological resource conditions of marine aquaculture.

Step 2: Integrated evaluation

Integration of individual evaluation to develop a comprehensive marine aquaculture suitability grading system.

(1) Integrated evaluation of marine disasters

The highest grade evaluated from wave disaster and red tides is identified as the integrated index of marine disasters. The risks are classified into five grades: very low, low, medium, high and very high.

(2) Integrated evaluation of marine resources and physical/chemical conditions

The various marine resources and physical and chemical conditions are integrated by discriminant matrix method according to the requirements of marine aquaculture. The conditions are divided into three levels: high, medium and low.

(3) Comprehensive evaluation of suitability

The suitability level for marine aquaculture is finally decided based on the results of integrated evaluation of marine disasters and integrated evaluation of marine resources and physical/chemical conditions:

The suitability level is reduced to a lower grade in an area with high/very high risk of marine disasters, and the suitability level is identified as low in an area with seawater environmental conditions worse than 2nd class.

4.3.2. Suitability for port construction[29]

Step 1: Individual evaluation

Evaluation of the suitability for port construction activities is based on appropriate individual evaluation index. These indexes are decided by factors such as regional spatial resources, hydrodynamic conditions and natural disaster risks.

(1) Evaluation of onshore area

Onshore area moves towards land (~2 km) from the shoreline, conditions of which are characterized by slope and relief height. Slope is calculated from digital elevation models and a slope map is created by categorizing slopes into ≤3°, 3~8°, 8~15°, 15~25° and >25°.

Revision of the categorization according to relief height: in an area with relief height >200 m, the grade decreases two levels; in an area with relief height between 100 m and 200 m, the grade decreases one level.

The averaged value is calculated within 2 km region applying neighbourhood tool and categorised into five grades: very high (≥ 5), high (4 ~ 5), medium (3 ~ 4), low (2 ~ 3), and very low (< 2).

(2) Evaluation of bottom conditions

The impact of port construction is categorized into three levels based on sediment types: bedrock (no impact), silty/muddy shoreline (medium impact) and sandy shoreline (high

[29] Maybe some parts can be taken from the ETC-ICM work done for the EEA on sustainable ports and shipping.

impact)[30].

(3) Evaluation of water depth

According to the standards for the deep-water coastline[31] of a port. The conditions of water depth are divided into 5 levels depending on the distances from 10 m isobaths: ≤1.5 km (Good), 1.5~3 km (above average), 3~4.5 km (average), 4.5~6 km (below average), >6 km (bad)[32].

(4) Assessment to risks of marine disasters

The risks of marine disasters are categorized into four levels (i.e. very low, low, high, very high) with reference to Guideline for risk assessment and zoning of storm surge disaster. Annual average risk index of storm surge disasters at each tide (water) station is determined by factors such as water level increase caused by storm surge and storm alert.

(5) Water width

Water width is considered in the areas with narrow waterways and islands dependent on the distance to shoreline >600 m (good), 300-600 m (medium), <300 m (bad).

(6) Evaluation of transportation infrastructure

The condition for port construction is characterized by public transport accessibility from main roads and transportation hubs. Public transport accessibility from the main roads is analysed by distances between grid cells and roads/railways and categorized into five levels: very good, good, average, bad, very bad. Public transport accessibility from transportation hubs is dependent on the travel time from grid cells to transportation hubs and categorized into five levels: very good, good, average, bad, very bad.

Step 2: Integrated valuation

(1) Integration of shoreline bottom type and water depth is used to evaluate conditions of shoreline resource utilization with reference to the discriminant matrix (Table 4). The conditions are classified into 5 levels: very high, high, medium, low and very low.

Table 4. Discriminant matrix.

Conditions of water depth	Conditions of sediment types		
	Good	**Medium**	**Bad**
Good	Very High	High	Medium
Above average	High	Medium	Low
Average	Medium	Low	Very Low
Below average	Low	Very Low	Very Low
Bad	Very Low	Very Low	Very Low

The evaluation result is adjusted based on onshore area and water width. For areas with onshore area grades “very low” and “low”, the final grades are reduced two levels and one level as the final results, respectively. For areas with water width grade “very low”, the final grade is reduced one level.

(2) Suitability for port construction

Initial evaluation is performed based on grade results of shoreline resource utilization and

[30] In the original document the levels were good, medium and bad.

[31] The coastline is defined as the intersection of the topography and the lowest astronomical tide

[32] In China, the slope of the bathymetry is not taken into account, because nearly almost territorial waters are on the continental shelf, which has gentle slope. Hence, they consider the factor of distance from the coast and do not consider the slope. This can be modified.

risk of marine disasters. It is further adjusted to grade “medium” for areas with shoreline resource utilization evaluated as “high” and “very high”. For areas where shoreline resource utilization was evaluated as “very high” and risk of marine disaster was evaluated as “high”, the final grade is adjusted to “high”.

Final evaluation is done by integrating transportation infrastructure grade, i.e. port construction suitability grade is adjusted to “very low” and reduced one level in areas with transportation infrastructure evaluated as “very bad” and “bad” respectively.

4.3.3. Suitability for Development and Construction of Offshore Wind Power[33]

Step 1: Individual evaluation

(1) Evaluation of wind energy potential

Wind energy potential is evaluated by wind power density at 100 m height and classified into five grades i.e. very high, high, medium, low, very low correspondent to ≥450 W/m^2,400-450 W/m^2, 350-400 W/m^2,300-350 W/m^2, and <300 W/m^2.

Step 2: Integrated evaluation on suitability for development and construction of offshore wind power

(1) Suitability is categorized into 5 levels in accordance with evaluation of wind energy potential, i.e. very high, high, medium, low, very low.

(2) Adjustment made to the integrated evaluation based on offshore distance and water depth. With reference to Measures for the Administration of the Development and Construction of Offshore Wind Power (No. 394 [2016] of the National Energy Administration), suitability is adjusted to “very low” for areas with offshore distance <10 km and reduced one level in areas with water depth >50 m where offshore wind power is difficult to be developed and constructed.

4.3.4. Offshore oil and gas development suitability

Step 1: Individual evaluation

(1) Evaluation of oil and gas resources

Area resource abundance index (i.e. the amount of oil and gas resources per evaluation area or scale area) is to evaluate suitability of offshore oil and gas development considering geological resources (Table 5).

Table 5. Grading system of oil and gas resource abundance

Level	Oil resource abundance per area (10^4t/km^2)	Gas resource abundance per area (10^8m^3/km^2)
Very High	> 30	>3
High	20 ~ 30	2 ~ 3
Medium	10 ~ 20	1 ~ 2
Low	5 ~ 10	0.5 ~ 1
Very Low	< 5	< 0.5

[33] We should consider using the European approach.

Step 2: Integrated evaluation[34]

(1) Initial evaluation of the suitability for offshore oil and gas development is categorized into very high, high, medium, low, very low in accordance with area resource abundance index (Table 6).

Table 6 Threshold of patch configuration.

Patch configuration	Very Low	Low	Medium	High	Very High
Oil patch (km^2)	<3.0	3.0-4.5	4.5-9.0	9.0-18.0	≥18.0
Gas patch (km^2)	<1.0	1.0-2.0	2.0-4.0	4.0-8.0	≥8.0

Adjustment is made by integrating patch configuration with reference to Discriminant matrix for modifying offshore oil and gas development suitability (Table 7). In areas with suitability graded as "low" or "very low", no adjustment is needed.

Table 7 Discriminant matrix for modifying offshore oil and gas development suitability.

Grades of offshore oil and gas development suitability	Patch configuration				
	Very high	High	Medium	Low	Very low
Very high	Very high	High	High	High	High
High	High	High	Medium	Medium	Medium
Medium	Medium	Medium	Medium	Medium	Medium

4.4. Environmental analysis of resource endowment

Advantages and constraints of the resource environment is summarized by combining analysis of marine environment, biodiversity, ecology, mineral resource (e.g. quantity, quality, structure, distribution and trend), climate, disaster, etc.

4.5. Risk identification[35]

Environmental problems caused by overexploitation of resources are identified by comprehensively analysing the status of development and utilization of marine resources (e.g. scale, structure, layout, quality, efficiency, benefits and changes). Therefore, future trends can be predicted, and risks can be assessed based on the identified environmental problems.

4.6. Evaluation of carrying capacity[36]

Ecological carrying capacity is estimated as the maximum capacity of development and utilization of marine resources to ensure sustainable development of a coastal area. The maximum carrying capacity is estimated by excluding areas of ecological importance with level "high importance" and areas not suitable for marine development and utilization activities.

[34] For the integration, all data are included into raster layers with same resolution, and do calculations.

[35] This is undertaken by overlapping the assessment result and existing/potential maritime activities, to identify problems and risks. We could derive those areas that might be suitable for developing more than one maritime activity. Such information, plus the information regarding to environmental status and ecologically significant areas, would inform about the risks.

[36] The ECC method is designed for spatial planning, so the maximum spatial capacity of each maritime activities is determined by deducting the ecological protection areas with high importance and areas not suitable for specific activities. However, we need to modulate this, since this means that all the ocean (excepting unsuitable and protected areas) is suitable for any human activity, irrespective of the environmental impact.

4.7. Potential analysis[37]

With reference to the evaluation results of suitability and ecological carrying capacity, the following situations can be assessed:

- Zonation of suitability classification.
- Status of marine resource exploitation.
- Identity activities carried out in areas not suitable for development.
- Potential risks.

In the meantime, potential analysis provides scientific support to optimize MSP and resource utilization by analysing the status of current planning/strategy and future needs for marine development.

[37] This is a qualitative analysis, synthesizing the assessment, current maritime activities and other analysis, to put forward the integrated layout for spatial utilization, and to provide suggestions to spatial planning.

Figures

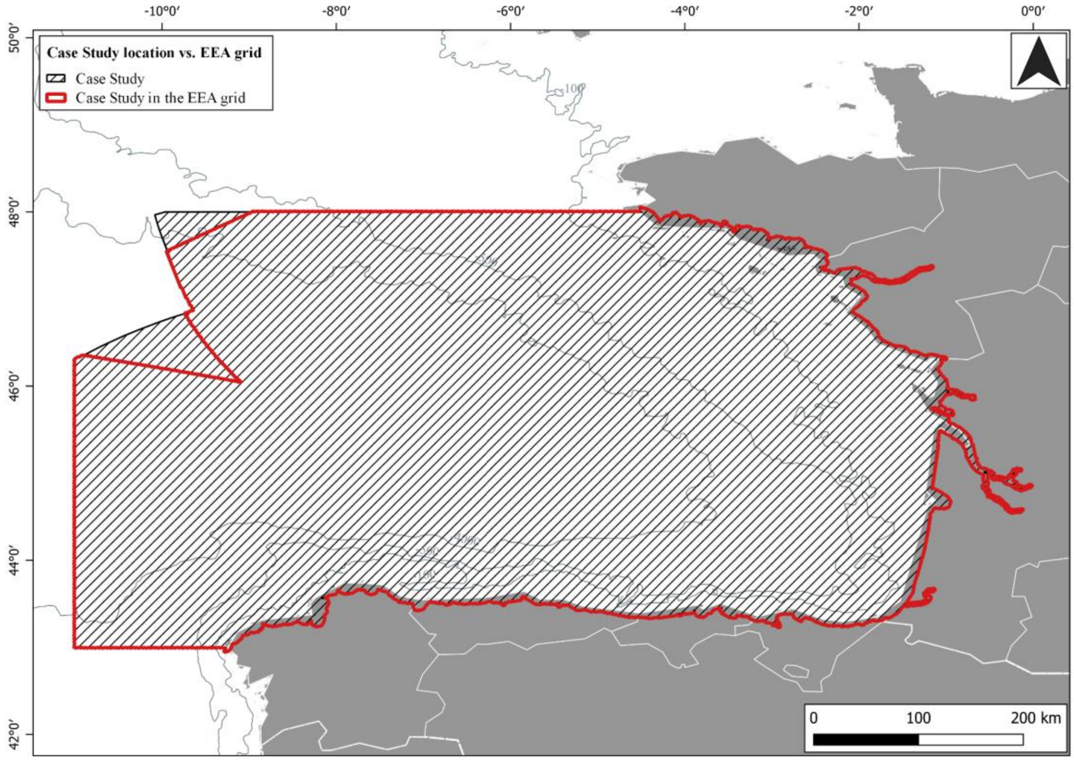

Figure SM1. Original boundaries of the Bay of Biscay case study area, and adapted boundaries to fit with the European Environment Agency (EEA) 1x1 km reference grid.

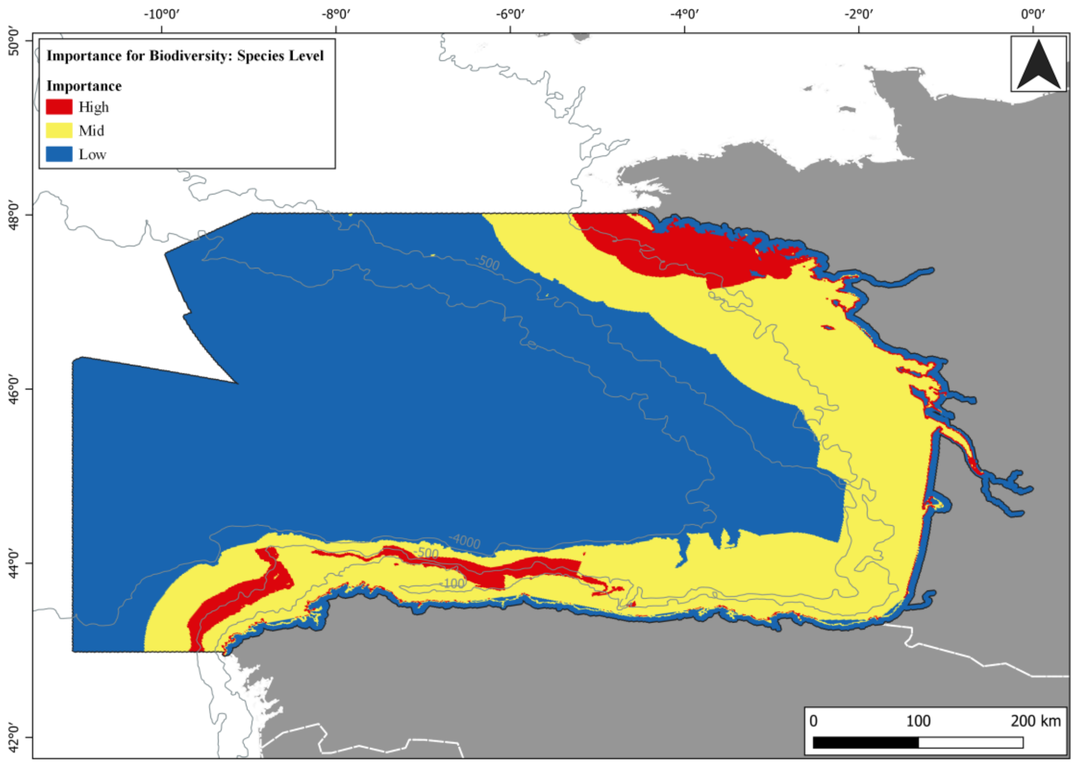

Figure SM2. Importance for marine biodiversity: Species of interest level.

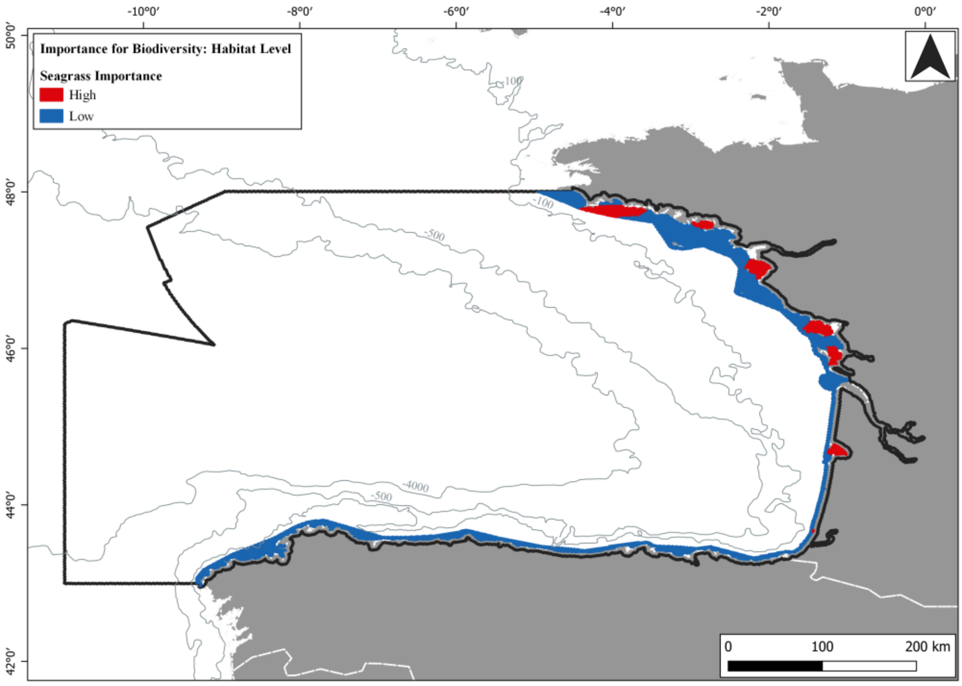

Figure SM3. Importance for marine biodiversity: Seagrass habitat in the Bay of Biscay.

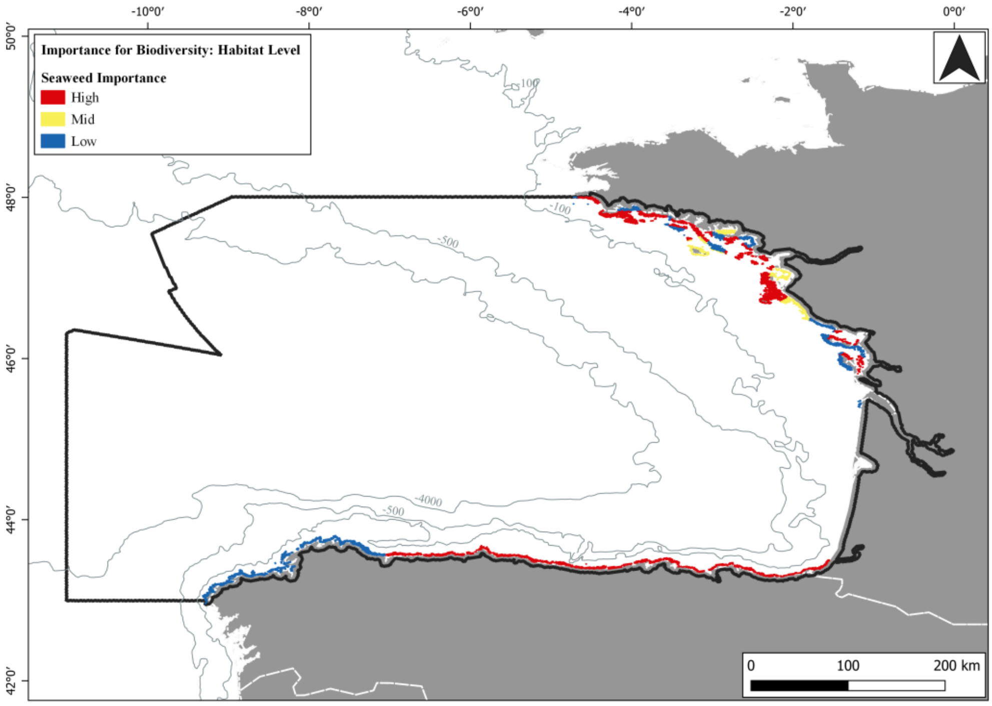

Figure SM4. Importance for marine biodiversity: Seaweed habitats in the Bay of Biscay.

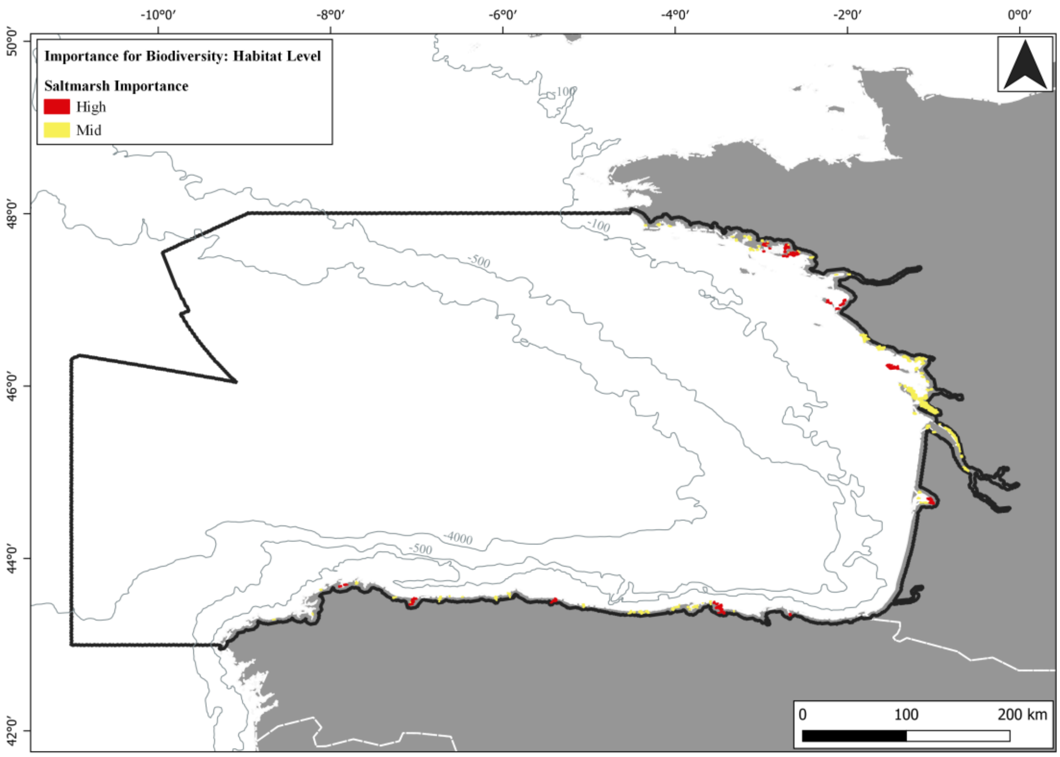

Figure SM5. Importance for marine biodiversity: Coastal marsh habitats in the Bay of Biscay.

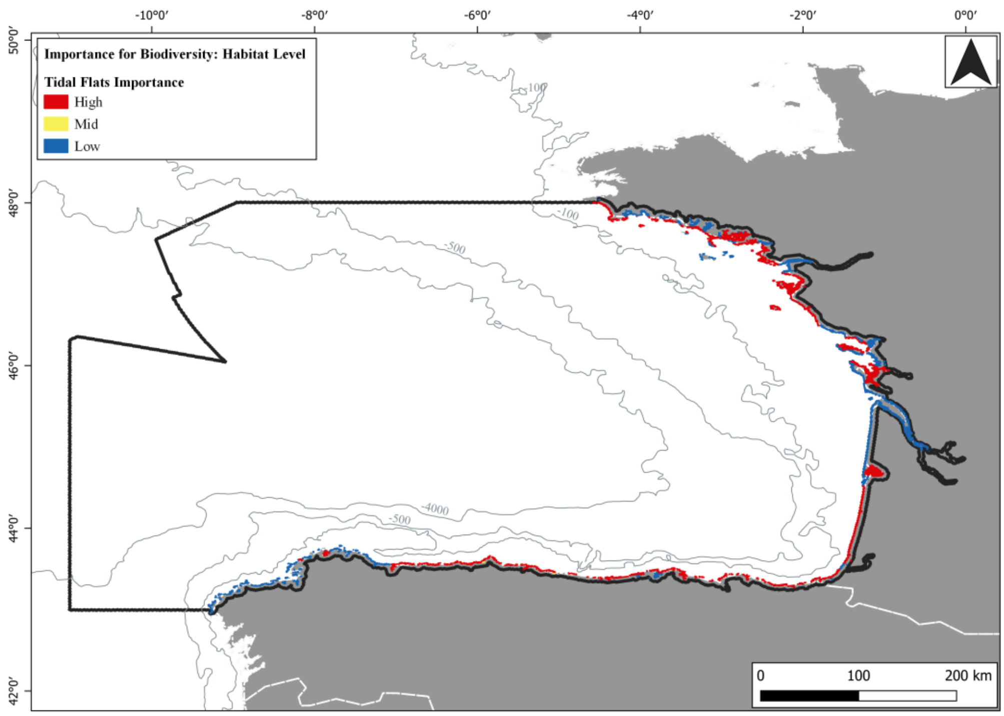

Figure SM6. Importance for marine biodiversity: Tidal flats and shallow waters habitats in the Bay of Biscay.

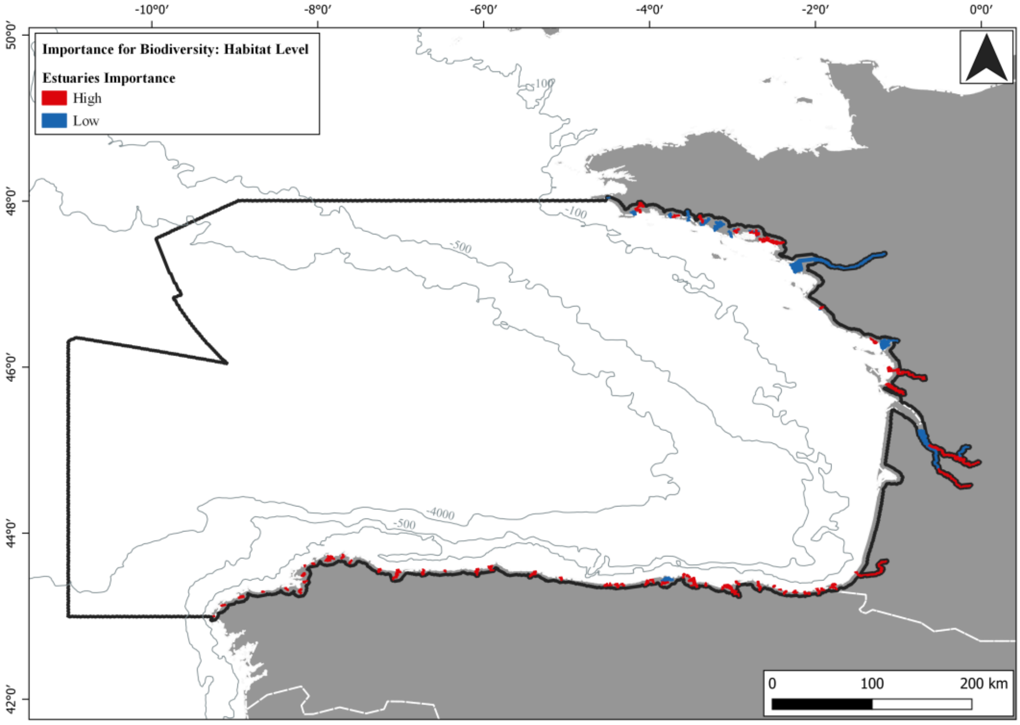

Figure SM7. Importance for marine biodiversity: Estuarine habitats in the Bay of Biscay.

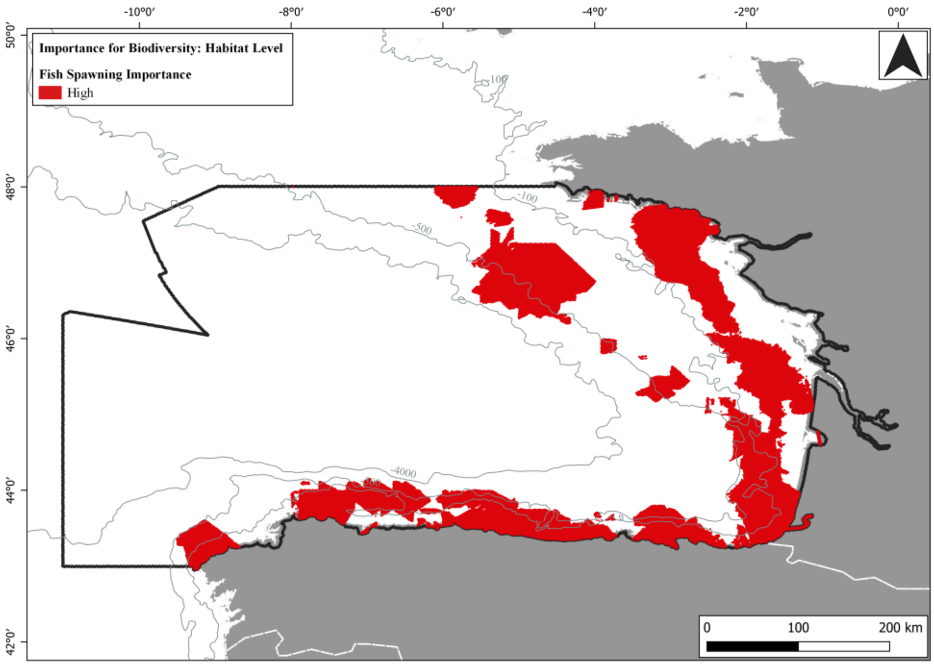

Figure SM8. Importance for marine biodiversity: Spawning areas for commercial fish species in the Bay of Biscay.

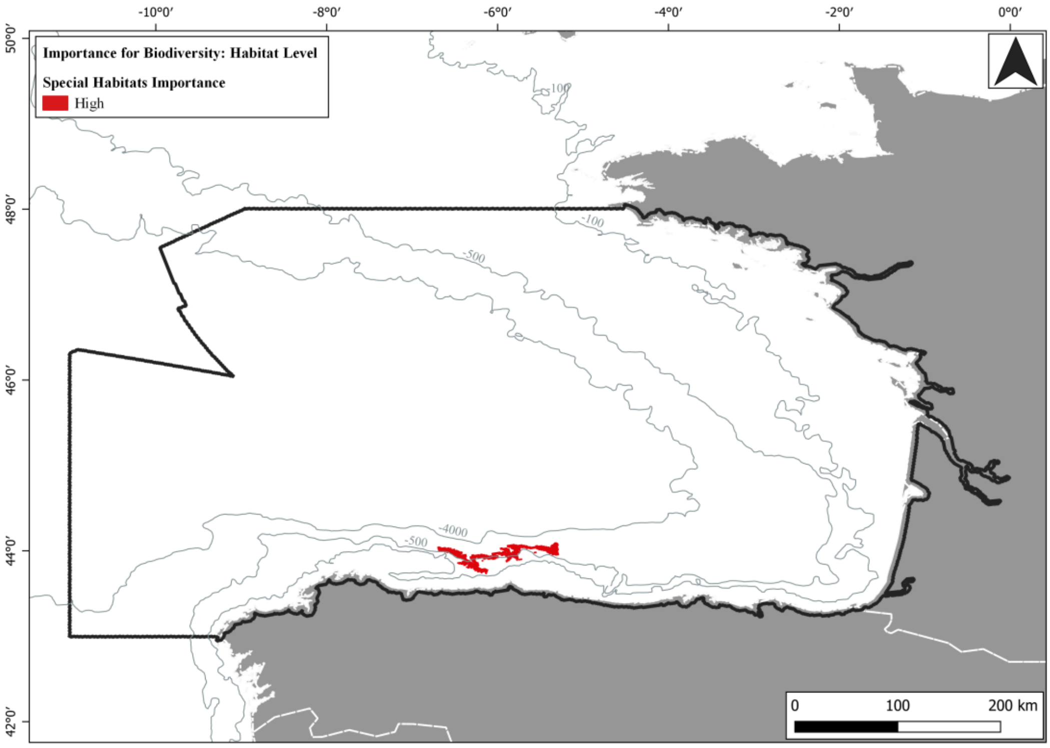

Figure SM9. Importance for marine biodiversity: Other unique habitats in the Bay of Biscay.

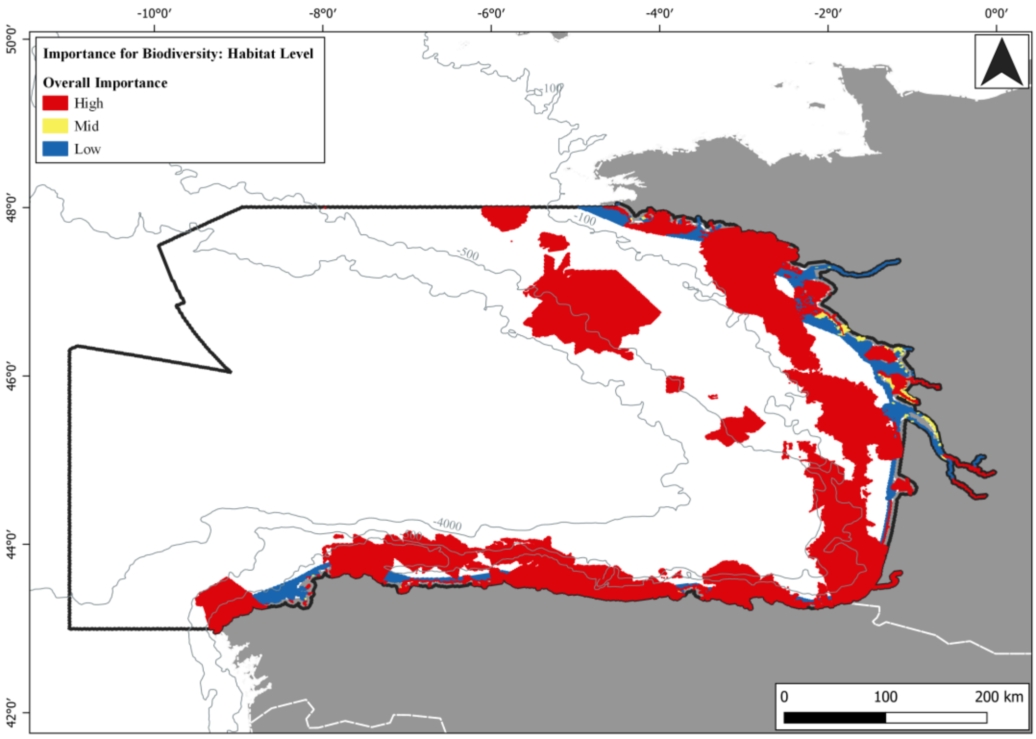

Figure SM10. Importance for marine biodiversity, at habitat level, in the Bay of Biscay.

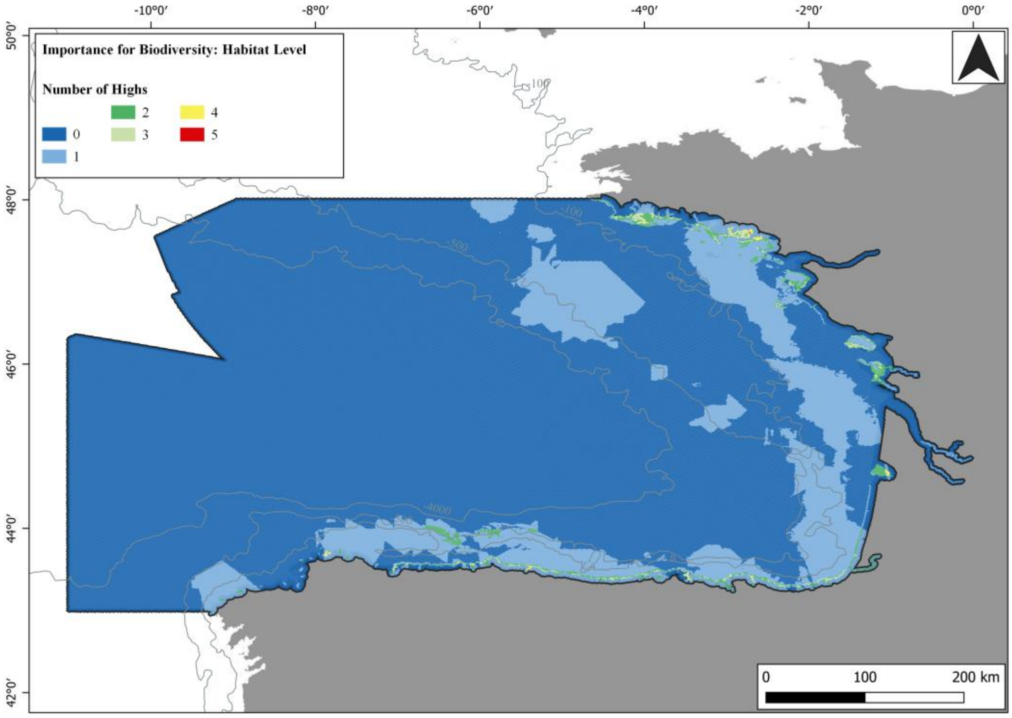

Figure SM11. Importance for marine biodiversity, at habitat level, in the Bay of Biscay, showing the number of habitats of high importance per square kilometre.

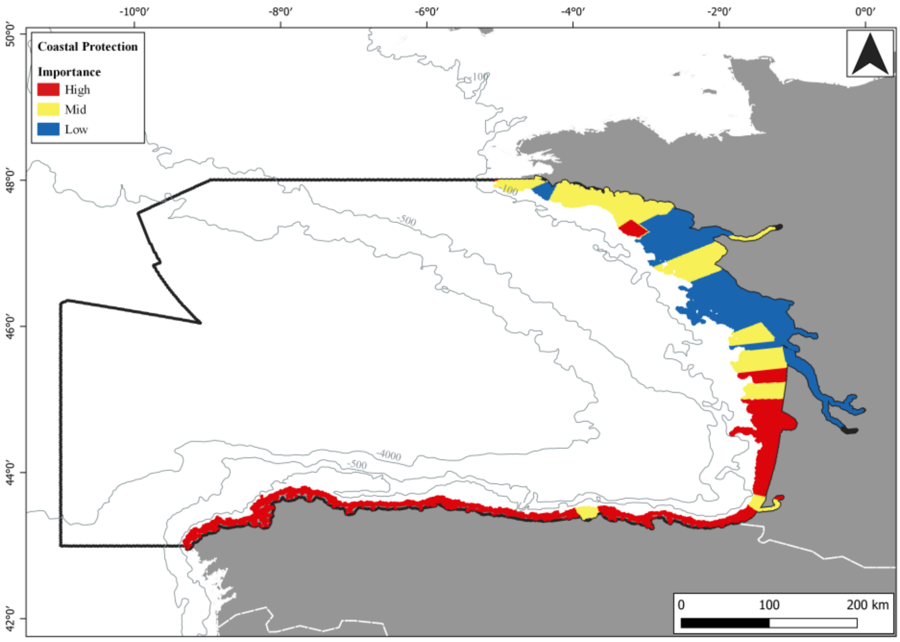

Figure SM12. Assessment of the coastal protection function in the Bay of Biscay.

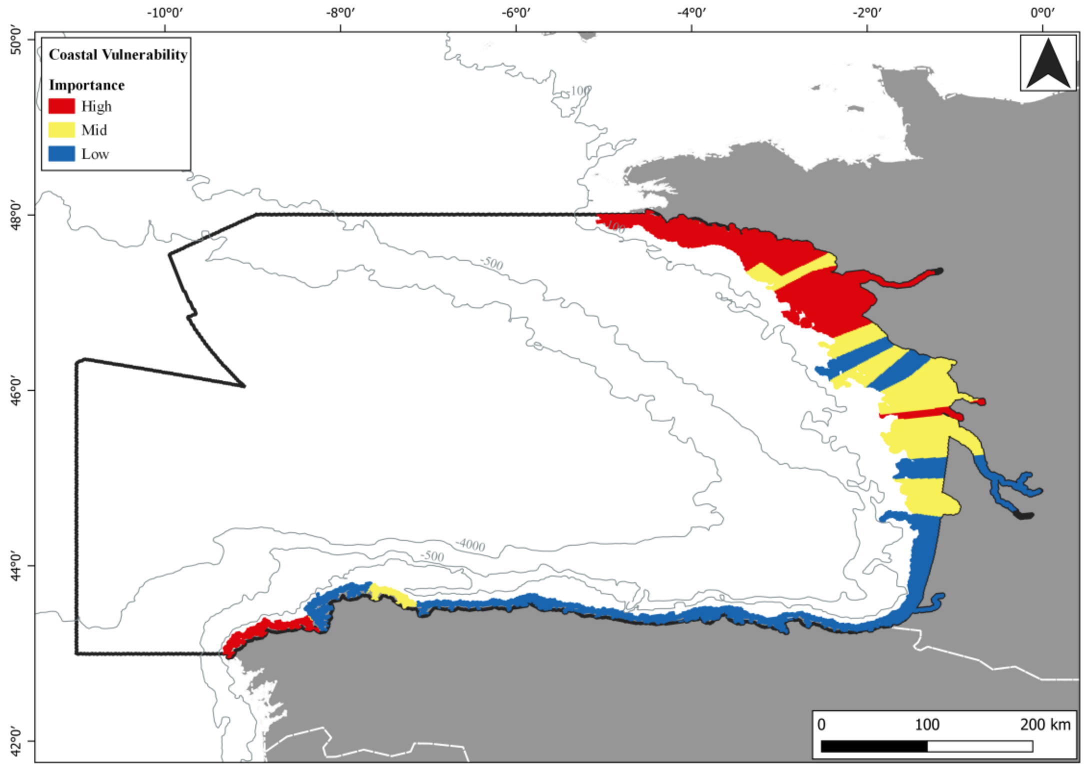

Figure SM13. Coastal vulnerability in the Bay of Biscay.

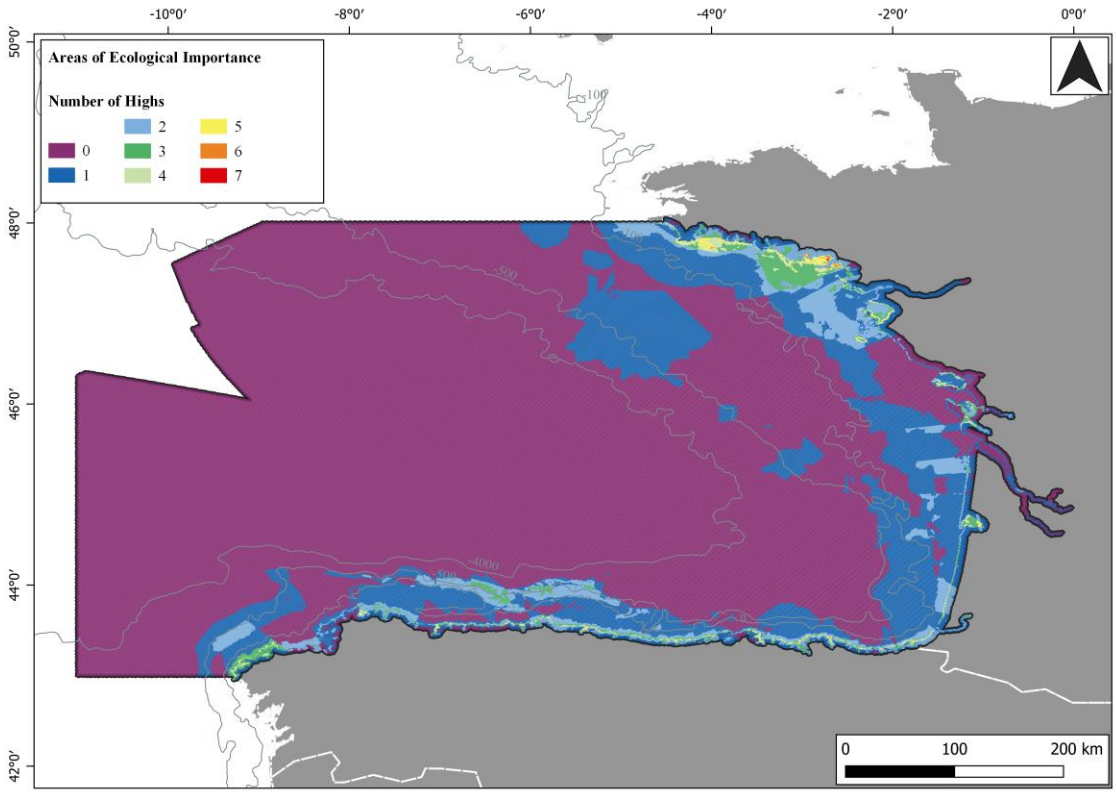

Figure SM14. Areas of high ecological importance in the Bay of Biscay. Cells ranked according to the number of components for which the cell ranked as "High".

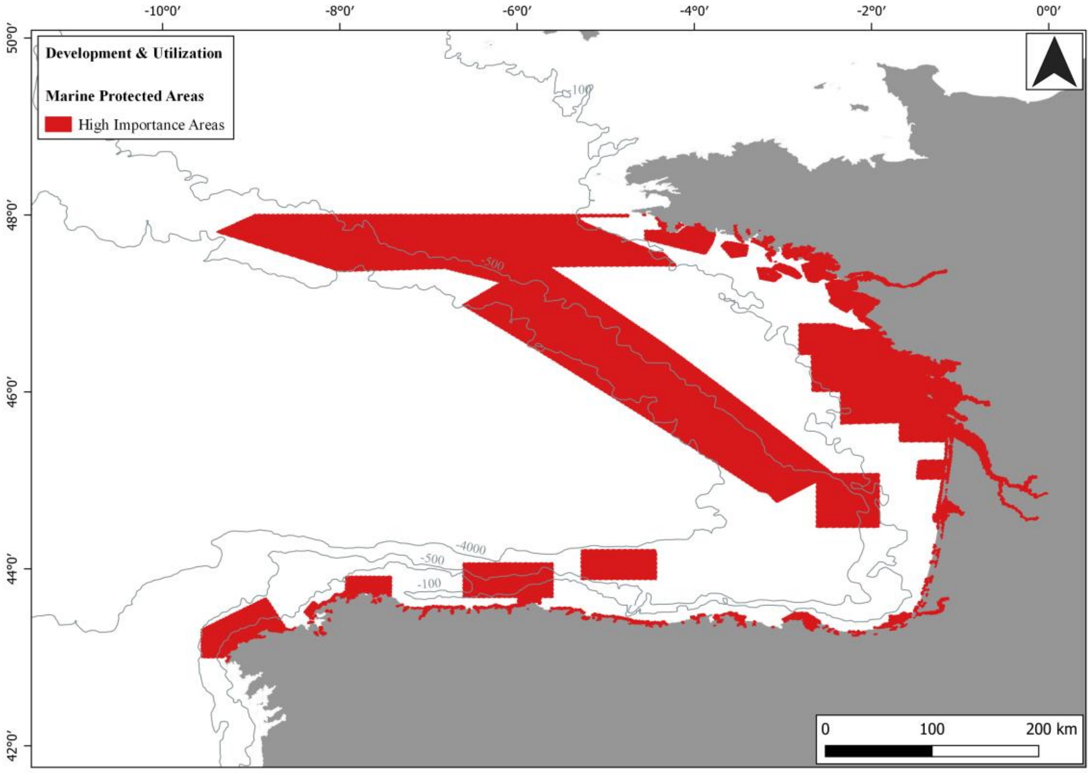

Figure SM15. Marine Protected Areas in the Bay of Biscay, including Natura2000 sites, OSPAR Marine Protected Areas and Nationally Designated Areas.

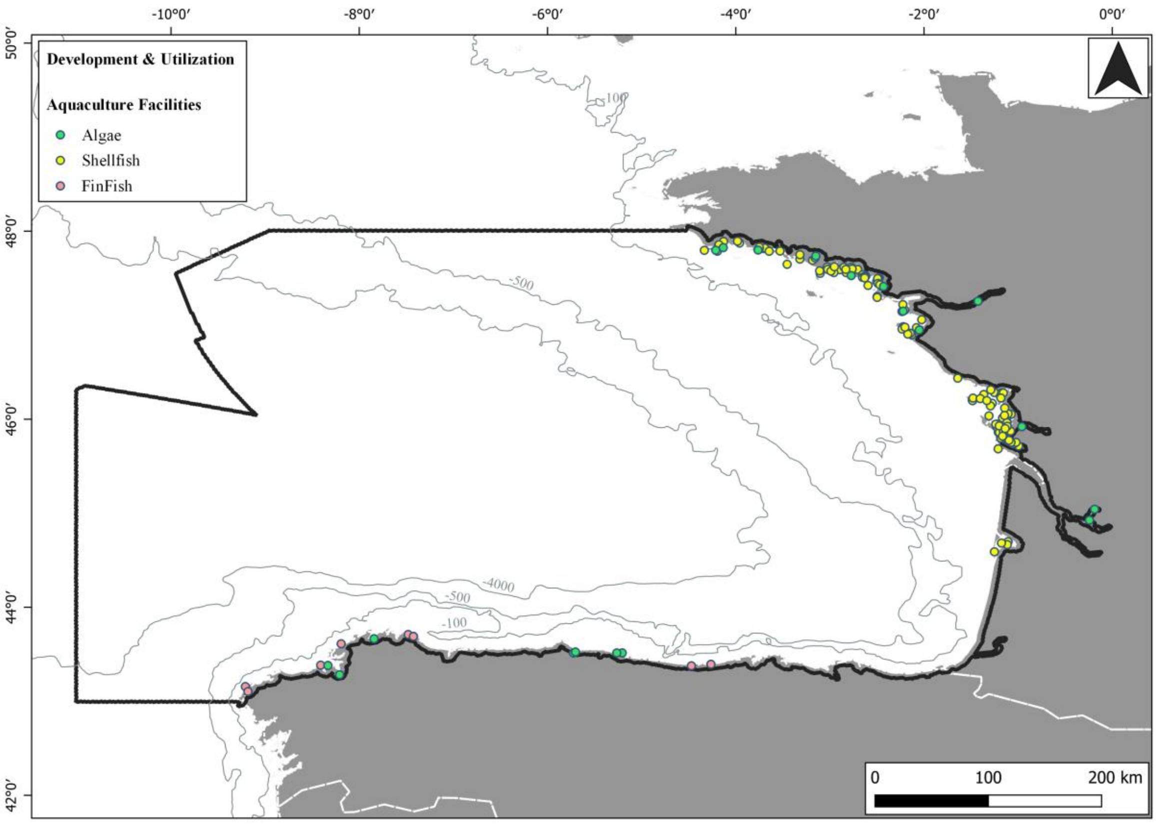

Figure SM16. Location of aquaculture facilities in the Bay of Biscay.

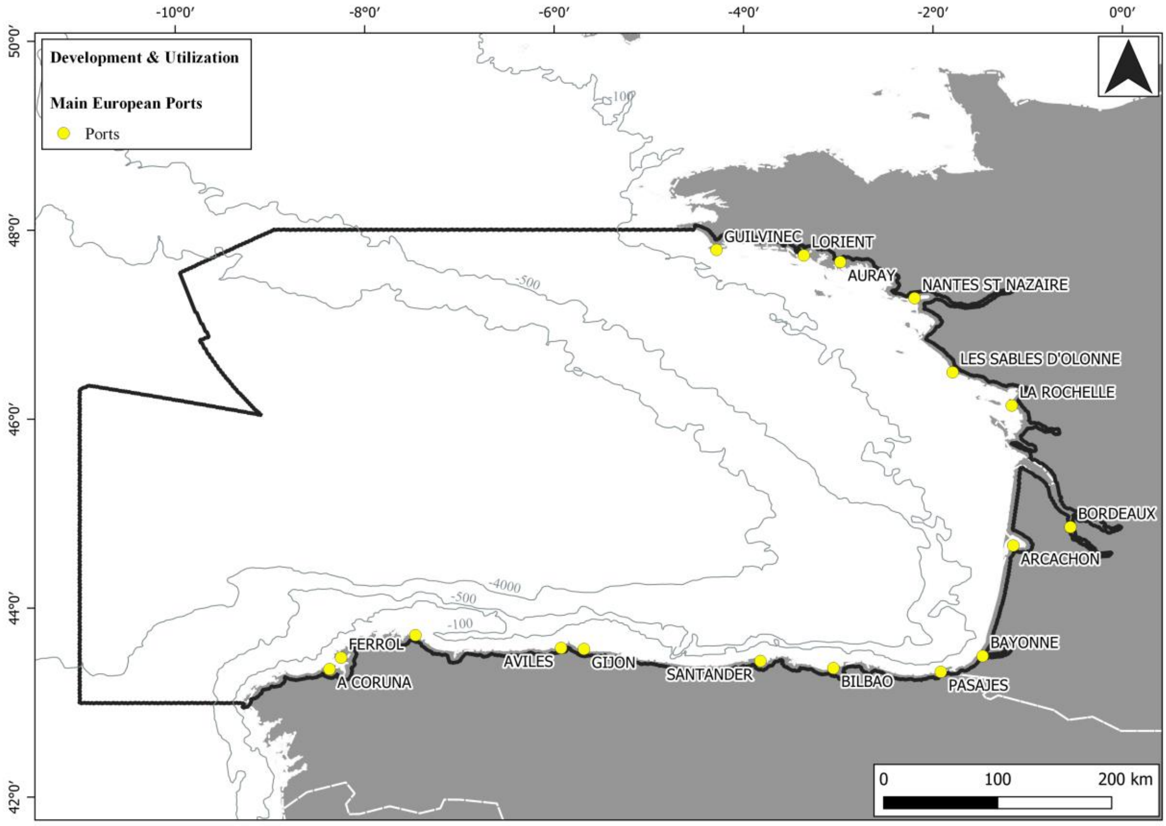

Figure SM17. Main commercial ports in the Bay of Biscay.

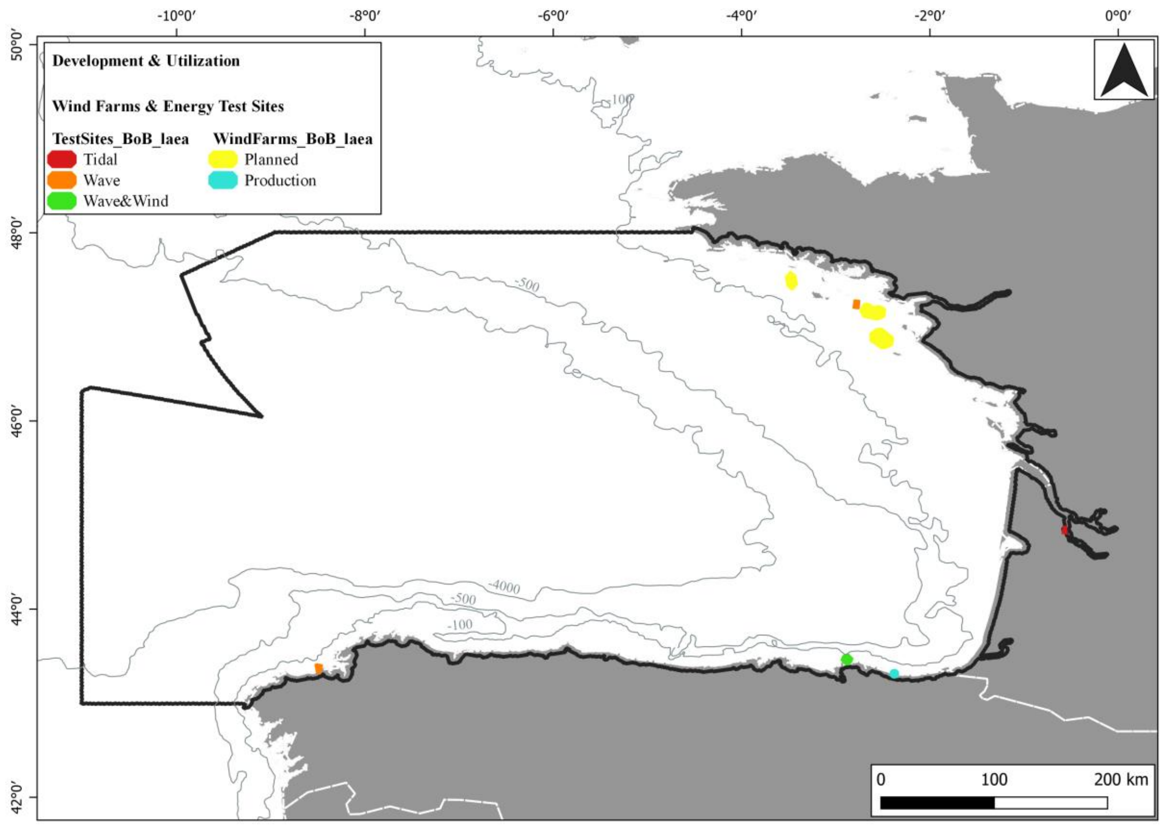

Figure SM18. Location of offshore wind farms and ocean energy test sites in the Bay of Biscay.

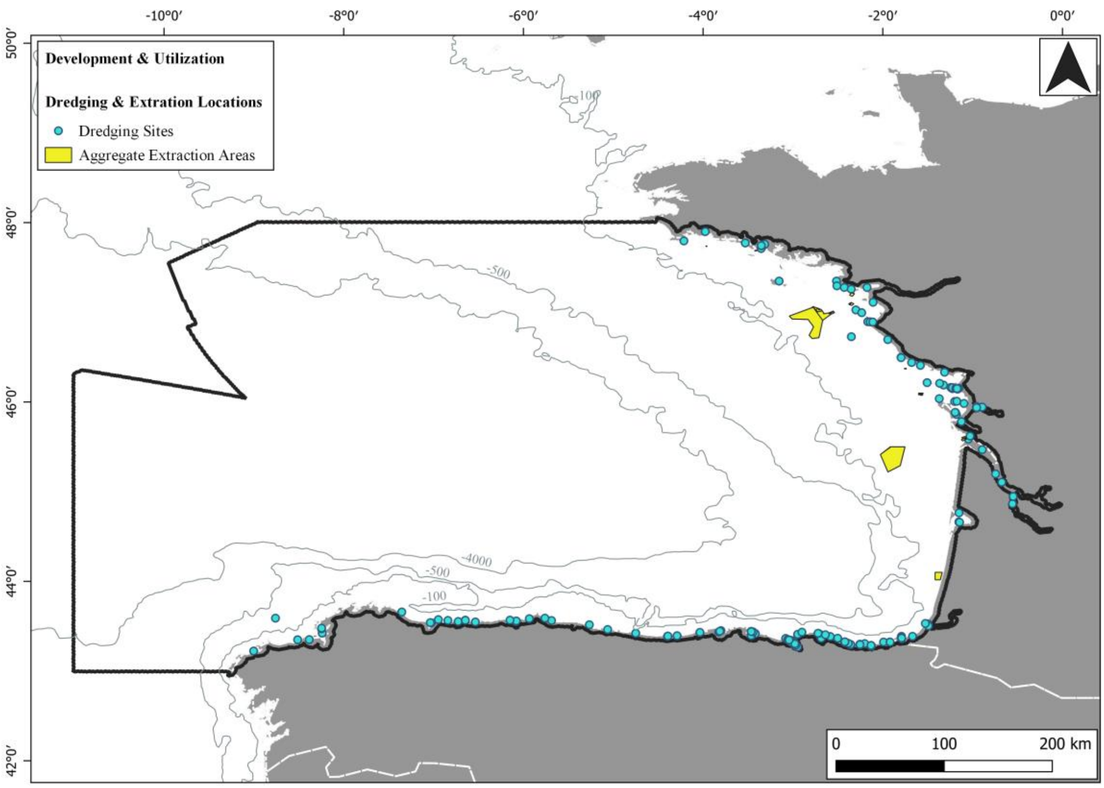

Figure SM19. Location of dredging and disposal sites and aggregate extraction areas in the Bay of Biscay.

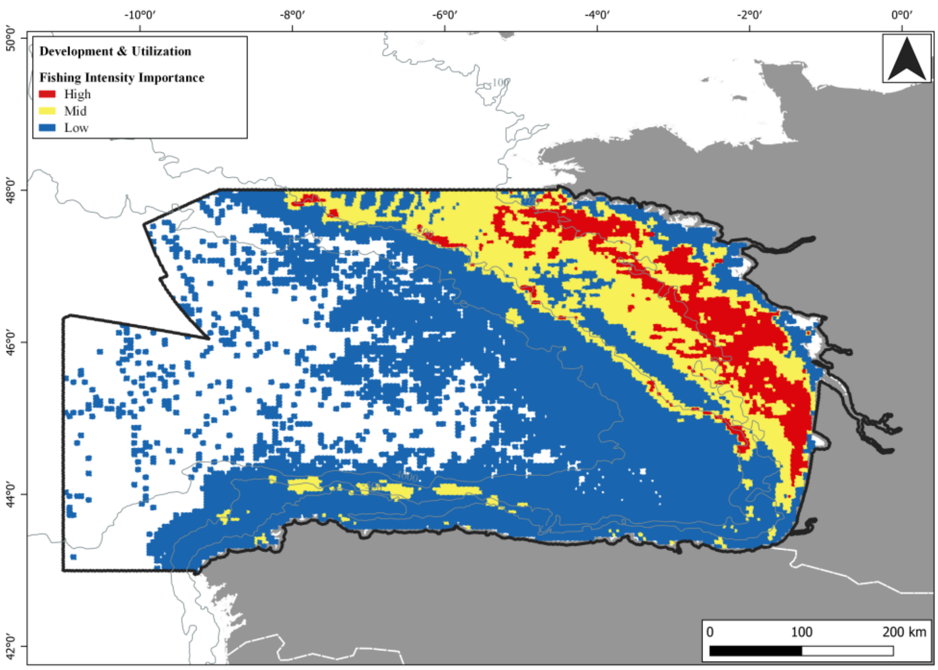

Figure SM20. Fishing importance, estimated with fishing activity intensity (averaged number of fishing hours) in the Bay of Biscay.

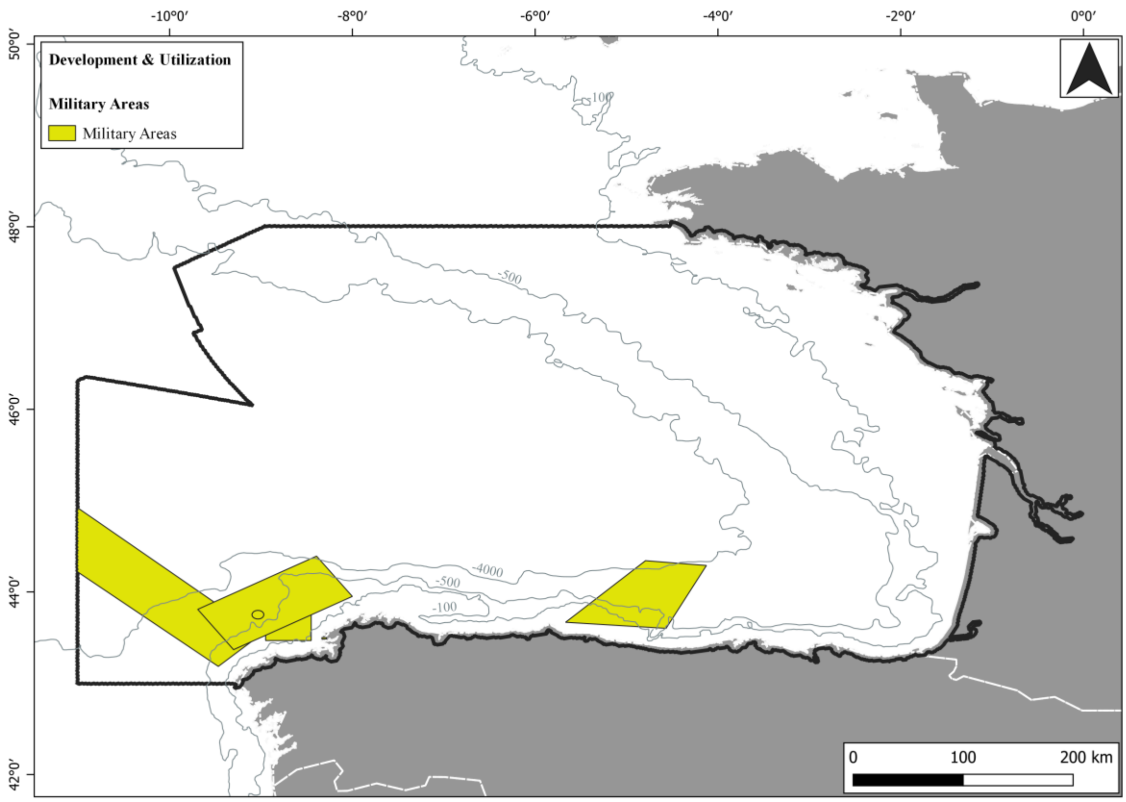

Figure SM21. Location of military areas in the Bay of Biscay.

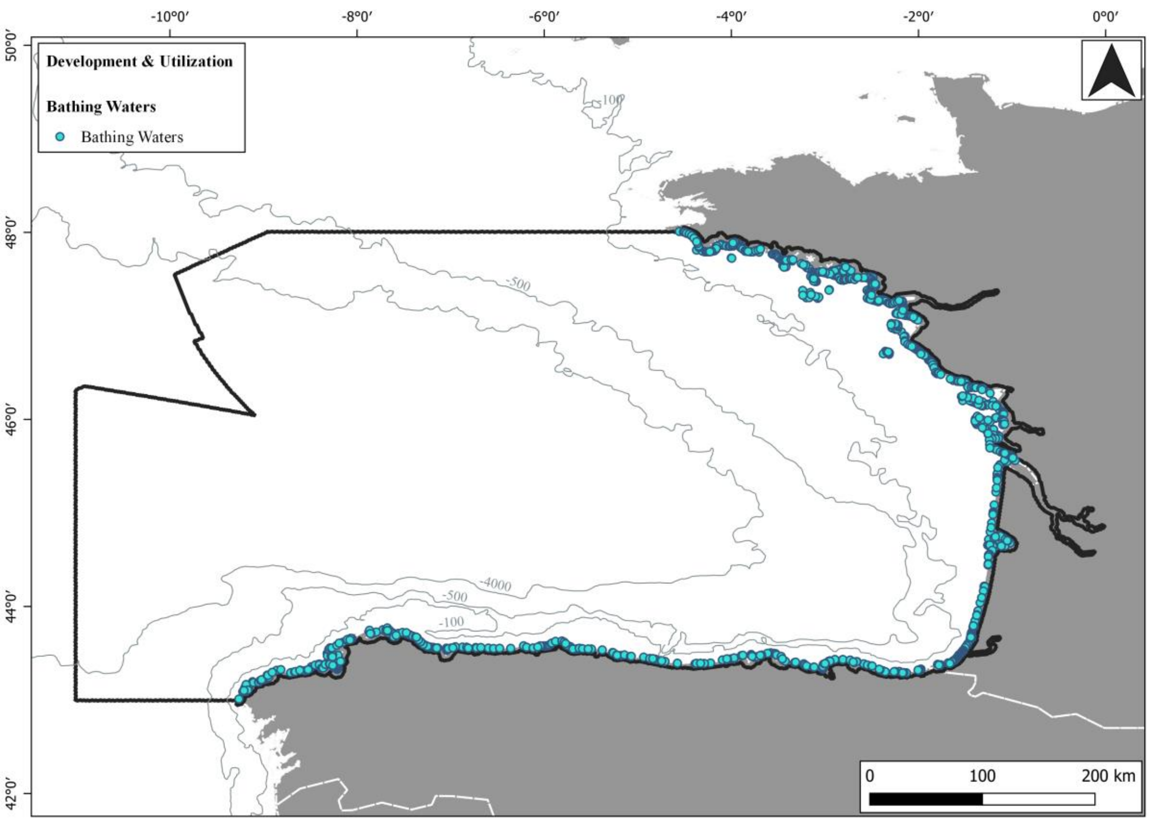

Figure SM22. Location of bathing waters within the Bay of Biscay.

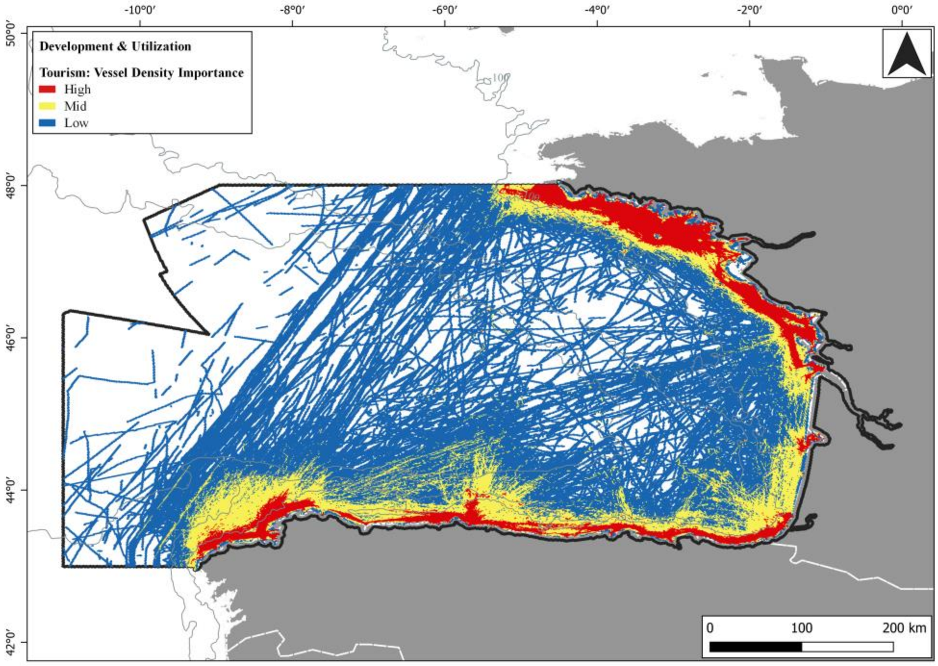

Figure SM23. Importance for recreational navigation within the Bay of Biscay.

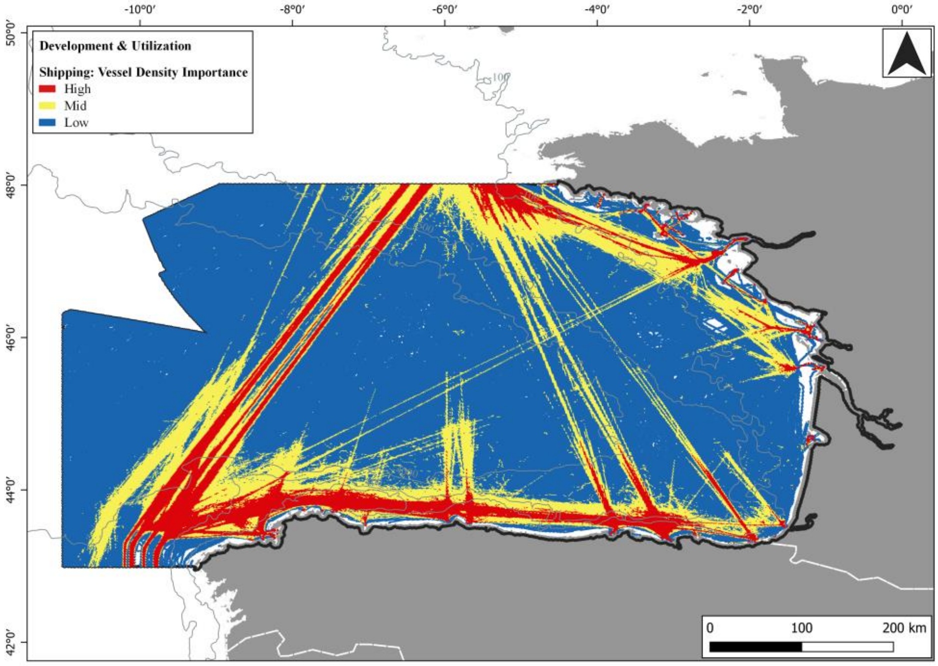

Figure SM24. Shipping traffic density within the Bay of Biscay.

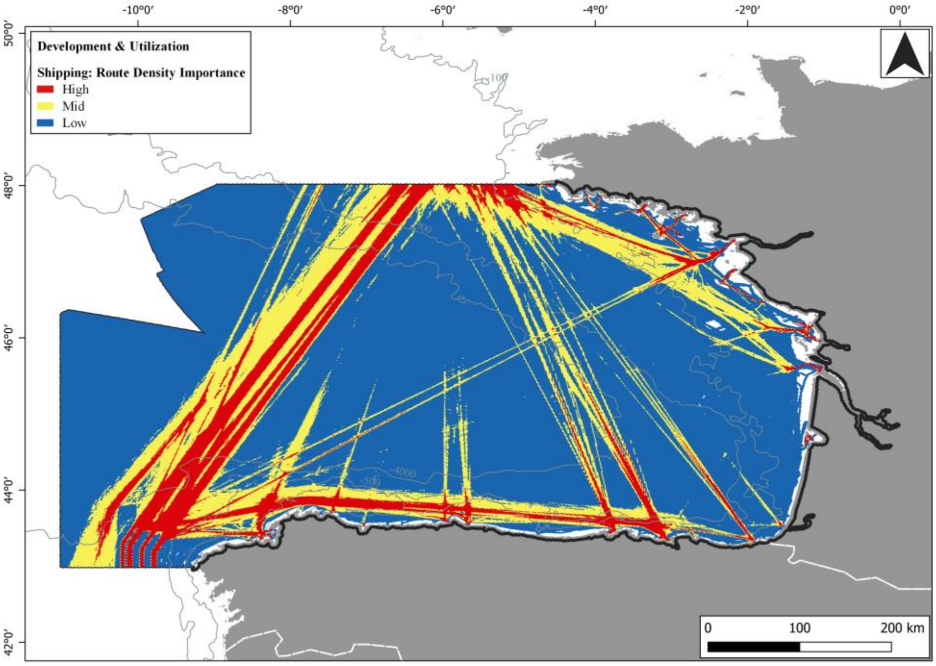

Figure SM25. Shipping vessel route density within the Bay of Biscay.

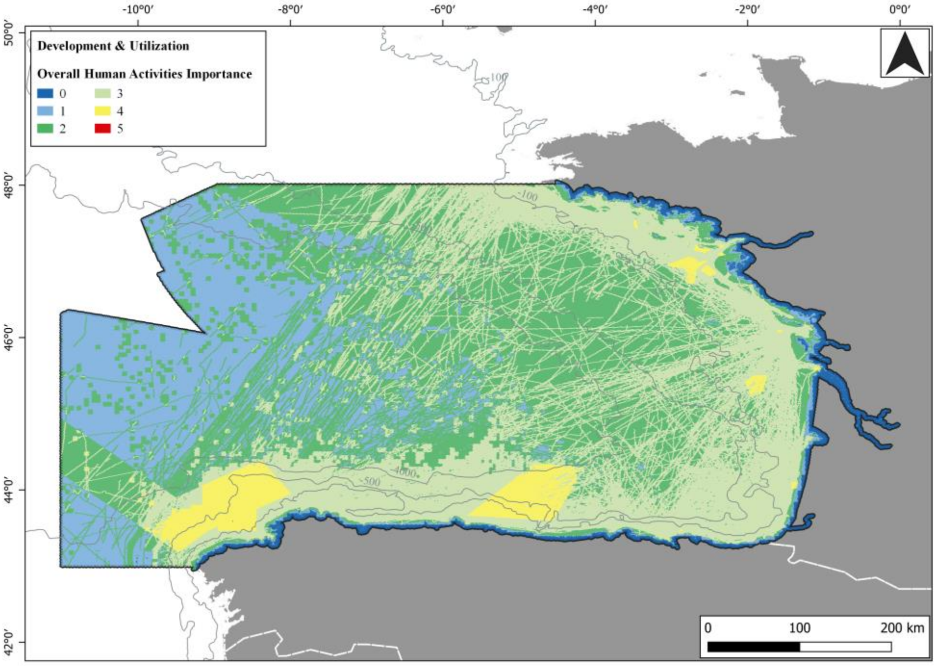

Figure SM26. Importance of human activities within the Bay of Biscay based on the number of activities per km^2. The total number of human activities included is eight: aquaculture, ports, ocean energy, aggregate extraction and dredging, fishing, military areas, tourism and shipping. Only marine protected areas are excluded.

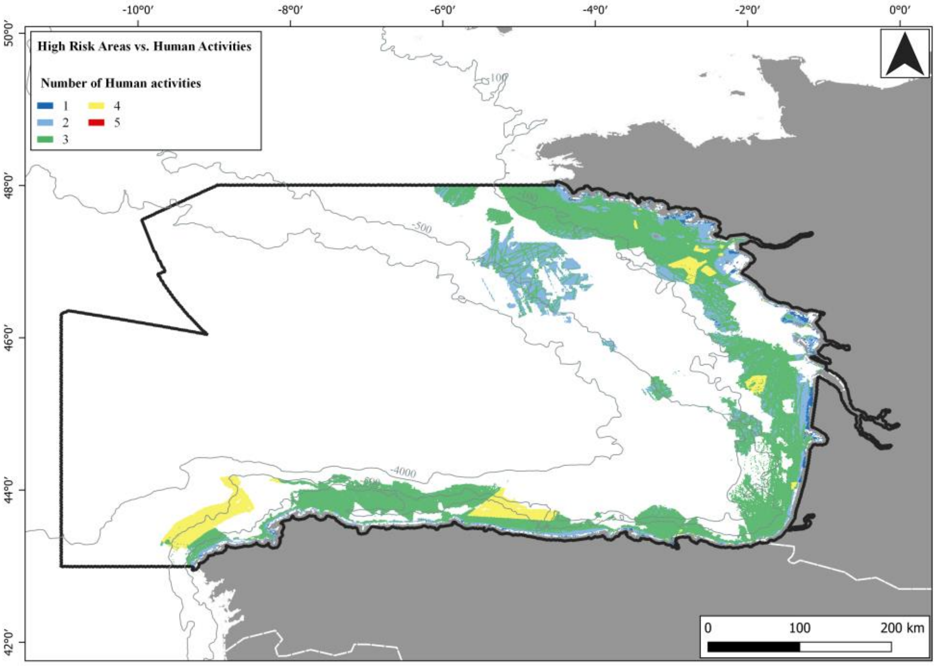

Figure SM27. Number of Human activities performed within 'High' risk areas in the Bay of Biscay.

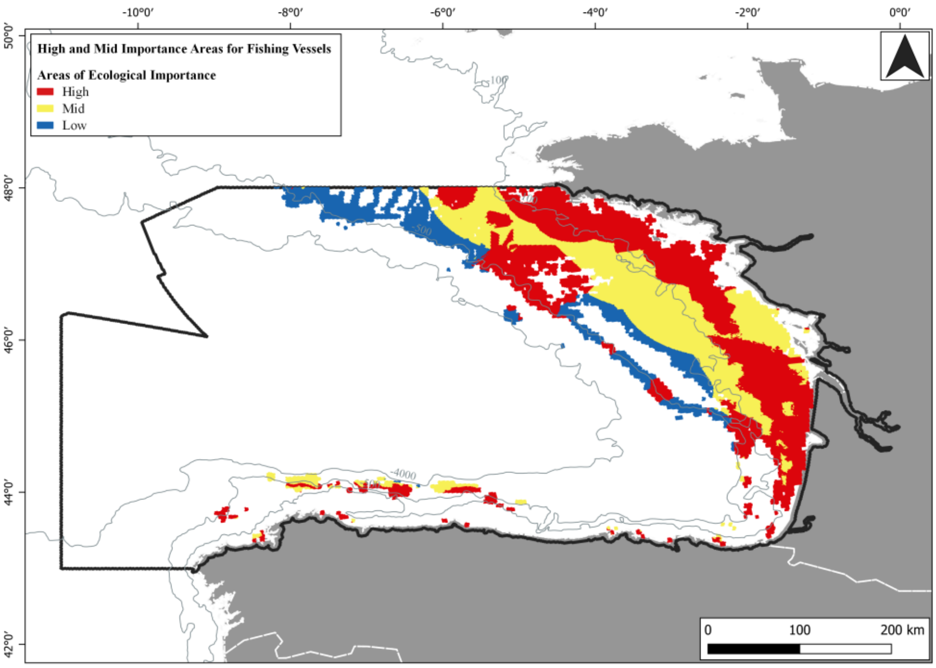

Figure SM28. Areas of ecological importance in the Bay of Biscay within areas with High or Mid fishing activity importance, aggregating the two indicators used.

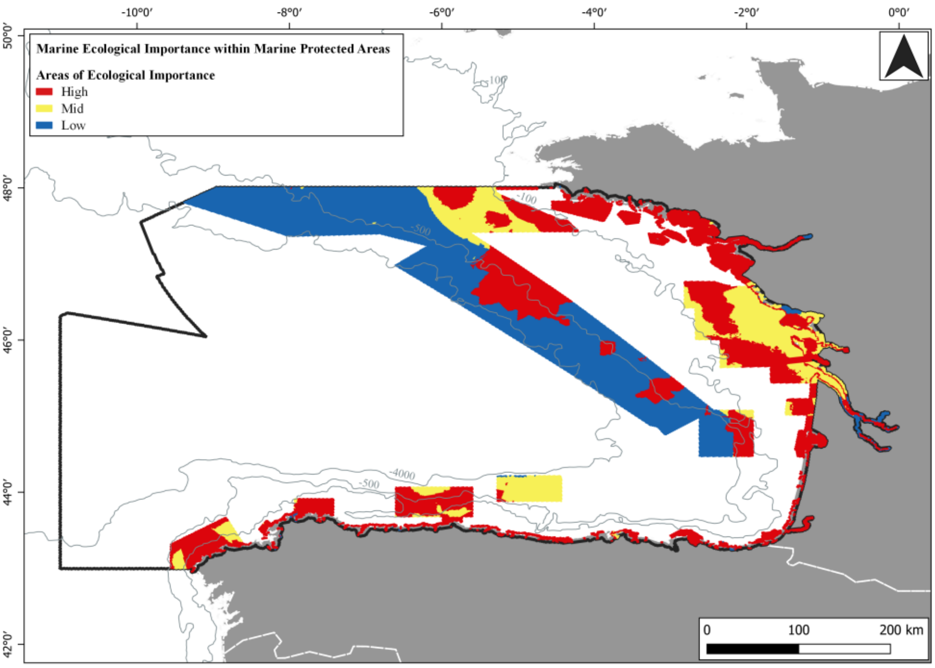

Figure SM29. Areas of ecological importance within Marine Protected Areas in the Bay of Biscay.

Tables

Table SM1. Spatial data availability and source of species of interest for conservation. The species list was defined according to the ‘OSPAR list of Threatened and/or Declining species’ and the ‘Reference List for the Marine Atlantic Region’ of the Habitats Directive.

Species of interest	Spatial data availability (Source)
INVERTEBRATES	
Nucella lapillus	*Not available*
FISH	
Acipenser sturio	Available (IUCN Red List)
Alosa alosa	Available (IUCN Red List)
Alosa fallax	Available (IUCN Red List)
Anguilla anguilla	Available (IUCN Red List)
Centroscymnus coelolepis	Available (IUCN Red List)
Centrophorus granulosus	Available (IUCN Red List)
Centrophorus squamosus	Available (IUCN Red List)
Cetorhinus maximus	Available (IUCN Red List)
Dipturus batis OR Raja batis	Available (IUCN Red List)
***Raja montagui* OR Dipturus montagui**	Available (IUCN Red List)
Hippocampus guttulatus OR Hippocampus ramulosus	Available (IUCN Red List)
Hippocampus hippocampus	Available (IUCN Red List)
Lamna nasus	Available (IUCN Red List)
Lampreta fluviatilis	Available (IUCN Red List)
Petromyzon marinus	Available (IUCN Red List)
Raja clavata	Available (IUCN Red List)
Rostroraja alba	Available (IUCN Red List)
Salmo salar	*Not available*
Squalus acanthias	Available (IUCN Red List)
Squatina squatina	Available (IUCN Red List)
REPTILES	
Caretta caretta	Available (IUCN Red List)
Dermochelys coriacea	Available (IUCN Red List)
MAMMALS	
Balaenoptera musculus	Available (IUCN Red List)
Eubalaena glacialis	Available (IUCN Red List)
Tursiops truncatus	Available (IUCN Red List)
Phocoena phocoena	Available (IUCN Red List)
Halichoerus grypus	Available (IUCN Red List)
Phoca vitulina	Available (IUCN Red List)
BIRDS	
Puffinus mauretanicus	Available (Birdlife)
Sterna dougallii	Available (Birdlife)
Uria aalge	Available (Birdlife)
Hydrobates pelagicus	Available (Birdlife)

Table SM2. Adaptation and integration of the specific indicators for species of interest and habitats, to determine the levels of importance in the Marine Resource-Environment Carrying Capacity (MRECC) calculation. WFD: Water Framework Directive.

Specific indicators		MRECC Method: integrated indicator				
		High		Mid	Low	Not applicable
Species of interest	Number per cell	>21		19-21	<19	
Seagrass bed	Angiosperm status (WFD)	High or Good		Moderate	Bad, poor, Unknown, unpopulated, no data	
Seaweed habitat	Infralittoral rocks	Presence		Presence	Presence	Absence
	Macroalgae status (WFD)	High or Good		Moderate	Bad, poor, Unknown, unpopulated, no data	Any
Saltmarshes	Global distribution	Presence		Presence		Absence
	Ramsar sites	Yes		No		Any
Tidal flats	Global distribution	Presence		Presence	Presence	Absence
	Ramsar sites	Yes	No	No	No	Any
	Macroinvertebrates status (WFD)	Any	High or Good	Moderate	Bad, poor, Unknown, unpopulated, no data	Any
Estuaries	Transitional water bodies (WFD)	Presence		Presence	Presence	Absence
	Phytoplankton status (WFD)	Any	High or Good	Moderate	Bad, poor, Unknown, unpopulated, no data	Any
	Fish status (WFD)	Any	High or Good	Moderate	Bad, poor, Unknown, unpopulated, no data	Any
	Ramsar site	Yes	No	No	No	Any

Table SM3. Relative importance and area of each habitat type.

Habitat type	Characterized areas (km^2) High Importance	Mid Importance	Low Importance	Areas not characterized or not relevant for the habitat (km^2)
Seagrass beds	2,159	0	12,603	349,876
Seaweed habitats	2,594	431	1,508	360,105
Coastal marshes	341	761	0	365,536
Tidal flats and shallow waters	2,432	10	1,767	360,429
Estuaries	1,437	0	884	362,317
Fish spawning areas:	58,335	0	0	306,303
Engraulis encrasicolus	13,808	0	0	350,830
Sardina pilchardus	12,447	0	0	352,191
Merluccius merluccius	9,964	0	0	354,674
Trachurus trachurus	13,780	0	0	350,858
Scomber scombrus	17,892	0	0	346,746
Other habitats	886	0	0	363,752
Aggregated Habitats Value	62,449	479	6,123	295,587

Table SM4. Area distribution according to importance for each of the nine human activities studied. *Aggregated values for human activities include all human activities except protected areas.

Human activity Type	Importance	Total km²	%	Total (H, M, L) km²	%
Protected areas	High	88,698	24.3		
	Not present	275,940	75.7		
Aquaculture	High	146	0		
	Not present	364,492	99.9		
Ports	High	17	0		
	Not present	364,621	100		
Energy facilities	High	307	0.1		
	Not present	364,331	99.9		
Aggregate extraction and dredging	High	1,433	0.4		
	Not present	363,205	99.6		
Fishing	High	24,219	6.6	222,209	66.4
	Mid	48,436	13.3		
	Low	169,554	46.5		
	Not present	31,036	8.5		
Military area	High	23,890	6.5		
	Not present	340,748	93.4		
Tourism	High	19,407	5.3	189,385	51.8
	Mid	37,714	10.3		
	Low	132,264	36.2		
	Not present	175,253	48.1		
Shipping	High	42,835	11.7	344,916	94.5
	Mid	79,299	21.7		
	Low	222,782	61.1		
	Not present	19,722	5.4		
Human Activities - Aggregated*	High	93,844	25.7	355,120	97.4
	Mid	97,285	26.7		
	Low	163,991	45.0		
	Not present	9,518	2.6		

Table SM5. Ecological risk level within areas of ecological importance, at three levels of importance, in the Bay of Biscay.

	Areas of ecological importance					
Risk	High		Mid		Low	
	km²	%	km²	%	km²	%
High	64,859	17.8	0	0.0	0	0.0
Mid	9,998	2.7	51,605	14.2	0	0.0
Low	6,902	1.9	10,233	2.8	221,041	60.6

Table SM6. Area occupied according to the number of different human activities held within the three risk categories of areas of ecological importance in the Bay of Biscay.

	Number of different human activities and km^2 occupied					
Areas of ecological importance Risk	**0**	**1**	**2**	**3**	**4**	**5**
High	0	1,064	11,663	45,321	6,807	4
Mid	0	2,795	15,485	35,215	8,107	0
Low	9,518	71,031	101,595	55,490	542	0