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Annex 2 to Initial Assessment: Pressures/Impacts

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1 Introduction

This Initial Assessment of anthropogenic pressures and impacts on ecosystems in OSPAR Region IV provides information on different types of pressures that are assessed under the Marine Strategy Framework Directive (MSFD). The main goal of the MSFD is to achieve Good Environmental Status (GES) of EU waters by 2020. GES is defined as “The environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive”. GES is described by eleven Descriptors, including nine Descriptors that are related to anthropogenic pressures, belonging to “biological”, “physical” or “substances, litter and energy” categories.

For each type of pressure, this document mentions activities driving this pressure, potentially impacted areas (areas subject to high levels of pressures), and if available also information on actual impacts of the pressure on ecosystems.

This document did not assess ‘input of microbial pathogens’, ‘input of genetically modified species and translocation of native species’, ‘loss of, or change to, natural biological communities due to cultivation of animal and plant species’.

As the knowledge on cumulative impacts is currently limited, this report is restricted to potential and actual impacts of each pressure on the ecosystem.

2 Biological pressures

2.1 Input or spread of non-indigenous species introduced by human activities (Descriptor 2)

A non-indigenous species is a species introduced by humans outside of its natural past or present distribution. Non-indigenous species can be introduced intentionally, or imported intentionally but not deliberately spread, or not intentionally imported.

2.1.1 Activities driving input or spread of non-indigenous species

According to the French MSFD Initial Assessment of the Bay of Biscay, 40% of vectors for introduction of the 129 non-indigenous referenced species in the Bay of Biscay are unknown or doubtful.

However, it is commonly accepted that the principal activities causing introduction of alien species are mariculture and maritime transport.

Table 1 below lists activities that are likely to introduce species, from the MarLIN matrix of activities/pressures (Annex I. Maritime and coastal activities to environmental factor matrix.):

Environmental factor (from MarLIN)	Activities (from MarLIN)
Introduction of non-native species	→ **Aquaculture(fin-fish, macro-algae, shellfisheries) (R)** → **Development (dock/port facilities, marinas) (R)** → **Recreation (boating/yachting) (R)** → **Uses** (animal sanctuaries, mooring/beaching/launching, research (P) and **shipping (R)**) → **Wastes** (**shipping wastes (R),** thermal discharges (P)) → **Climate change (current change, temperature change, weather pattern change) (R)**

Table 1 : activities driving introduction of non-indigenous species (probable effect (R) or possible (P)) adapted from MarLIN 'Maritime and coastal activities to environmental factors matrix'

2.1.1.1 Additional information on mariculture and alien species

Mariculture is the principal activity causing introduction of non-indigenous species. A significant portion of mariculture in the OSPAR area is reliant on non-native species (for example, Pacific oyster *Crassostrea gigas*).

Concern is increasing about the impacts of introduced species on marine ecosystems. If allowed to escape, these species may establish breeding populations and dislodge native species from established niches. Non-reproducing alien species may also interact with native species and affect predation and competition for food. Mixing of exotic genes through hybridisation, habitat modification and the introduction of diseases and parasites are other areas of concern. There has been little research to date on the ability of natural populations to recover from introgression of farmed genes.

It is likely that new alien species will continue to be introduced to supply the needs of the growing aquatic food market. It is therefore important to have procedures in place to assess the risks and benefits associated with the introduction of alien species into an ecosystem and, if appropriate, to develop and implement a plan for their introduction and responsible use. Several programs have recently been introduced to manage the threat of invasive species, including the European Strategy on Invasive Alien Species as established under the Berne Convention (2003) in accordance with the Guiding Principles for Invasive Alien Species under the Convention on Biological Diversity.

Several non-native marine organisms have become established after being accidentally introduced with imports of bivalve mussel seed. These include the American slipper limpet (*Crepidula* *fornicata*) which competes with native bivalves, and diseases such as Bonamia which infect oysters and was introduced from the USA. The introduction of some non-native bivalve species for cultivation in some OSPAR regions was carried out in the belief that the temperature would be too low for larval production and recruitment to occur. Species such as the Pacific oyster (*Crassostrea gigas*) and the Manila clam (*Ruditapes philippinarum*) are important mariculture species which have become established in the wild.

(OSPAR Commission, 2009)

2.1.1.2 Additional information on maritime transport and alien species

Maritime transport is a major cause of introduction of non-indigenous species in the area. OSPAR Region IV has the two major shipping routes in the EU. Large ports with international traffic are found in France, Spain and Portugal.

Source	Vector	Target taxa
Commercial shipping	Ballast water	Plankton, nekton, benthos in sediment
	Hull fouling	Encrusting, nestling, and some mobile species
	Solid ballast (rocks, sand, etc.)	Encrusting, benthos, meiofauna and flora

Table 2 : Vectors for marine introduction related to commercial shipping. Adapted from (Bax et al. 2003)

2.1.2 Impacts of introduction of non-indigenous species

2.1.2.1 Introduction of non-indigenous species: Impact analyses of invasive species

A detailed bibliographic assessment has been carried out to obtain precise quantitative information about the distribution, abundance, and interactions with other elements of the ecosystem of the invasive species. In the North-Atlantic region a minimum of 33 invasive species or potentially invasive has been detected. The gathered information has been included in a table by considering several criteria, and the assessments have been categorised into five levels (own development) depending on the impact of the invasive species caused in the recipient ecosystem (presence and distribution, biology and autoecology of the species, etc.) (Table 3). Assessments with no rigorous scientific criteria have been excluded from this review. The most studied species in the region is *Sargassum muticum* (24 assessments) which induces changes in the associated algal and invertebrate communities. Two other species should be mentioned as habitat modifiers, these are: *Ficopotamus enigmaticus* and *Crassostrea gigas*.

Typology and impact levels for invasive species of the North-Atlantic region:

1. Spatial and temporal assessments
2. Assessments at species level
   - 2.1. Fisiological chages
   - 2.2. Change in growth
   - 2.3. Fecundity assessments
   - 2.4. Toxicity
   - 2.5. Genetic alterations
   - 2.6. Transmission of pathogens
3. Alterations or changes in the structure of the community and habitat. Abundance modifications, species composition, species richness
4. Alterations in processes (Ecosystems)
   - 4.1. Recruitment modification
   - 4.2. Trophic modifications
   - 4.3. Energy flow modifications

4.4. Chemical physical modifications of the medium
4.5. Modifications of interspecific relationships (competition for space, ecological niche,...)
5. Impacts on uses and services

In general terms, there exists a lack of information regarding impacts on the North-Atlantic region as per establishing a monitoring programme. Nevertheless, several indexes have been proposed for monitoring of invasive species, like: Hurlbert's expected species richness or Taxonomic distinctness, amongst others. Either way, it is difficult to establish the impacts of invasive species amongst ecosystems, as these have to include an evaluation and quantification of processes as well as biological parameters; integrating the resilience of the ecosystem. In the future, local and global assessments will be necessary, as well as a quantification of the impacts of invasive species amongst the habitat.

Typology and levels of impact of invasive species in the Noratlantic

	1	2						3	4					5	
Species	**1**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**3**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**5**	**Reference**
Algae															
Asparagopsis armata	x														Martínez & Adarraga, 2006
esporofito de *A. armata (Falkenbergia rufolanosa)*	x														Martínez & Adarraga, 2005,2006
Centroceras clavulatum	x														Martínez & Adarraga, 2005,2006
	x														Gorostiaga et al., 2004
Codium fragile subsp. *tomentosoides*	x														Martínez & Adarraga, 2005,2006
Grateloupia turuturu															Arrontes et al., 2007
Hypnea musciformis	x														Martínez & Adarraga, 2005,2006
	x														Casares, 1987
Sargassum muticum								x							Gorostiaga et al., 1988
															Andrew & Viejo, 1998
								x							Viejo et al., 1995
								x							Viejo, 1999
								x							Sánchez et al., 2005
								x							Olabarría et al., 2009
	x														Martínez & Adarraga, 2005, 2006
	x														Casares et al., 1987
	x														Arenas et al., 1995
	x														Arenas & Fernández, 1998
	x														Salinas et al., 1988
	x														Arenas & Fernández,2000
	x														Arenas et al., 2002
	x														Sánchez & Fernández., 2005
	x														Fernández et al., 1990
	x														Rossi et al., 2010
	x														Pérez-Cirera et al.,1989
	x														Incera et al., 2009
	x														Cacabelos et al., 2010
	x														Sánchez & Fernández., 2006
	x														Olabarria et al., 2006
	x														Salinas et al., 1988
	x														Arronte et al., 2006
Polysiphonia morrowii	x														Bárbara et al., 2011
Undaria pinnatifida	x														Cremades Ugarte et al., 2006;
	x												x		Freire-Gago et al., 2006
	x														BD.Cabal
	x														Arronte et al., 2007

	x														Cremades Ugarte et al., 2006
	x														Báez et al., 2010
	x														Peteiro, 2003 (Pers.comm)
	x														Nieto, 2001
	x														Santiago Camaño et al., 1990
	x														Pérez- Ruzafa et al., 2002
	x														Freire-Gago et al., 2006
	x														Salinas et al., 1996
	x														Llera (Pers.comm)
	x														Peteriro, 2008
Amphipoda															
Hyale spinidactyla	x														Martínez & Adarraga, 2005, 2006
Ascidiacea															
Corella eumyota	x														Soto et al. 2006
Styela clava	x														Davis et al., 2007
Microcosmus squamiger	x														Turón et al., 2007
	x														Rius 2008
Bivalvia															
Crassostrea gigas	x														Martínez & Adarraga, 2005,2006
	x														Hidalgo, 1917
	x														Arronte et al., 2006
Corbicula fluminea	x														Rolán & Otero-Schmitt, 1996
	x														Pérez Quintero, 2008
Venerupis philippinarum	x														Martínez & Adarraga, 2005,2006
	x														Arronte et al., 2007
	x														Rolán & Horro, 2005
Xenostrobus securis	x														Garci et al., 2007
	x														Rolán (Pers.comm)
	x														BD.Cabal
	x														Arronte et al., 2007
Cirripeda															
Balanus improvisus															Arronte et al., 2007
Decapoda															
Eriocheir sinensis														x	Martínez & Adarraga, 2005
Hemigrapsus takanoi	x														Martínez & Adarraga, 2005,2006
Gastropoda															
Crepidula fornicata	x														Rolán, 1983
	x														Otero-Schmitt (Pers.comm)
	x														Rolán et al., 1985
	x														Mosquera, 1984
	x														Anadón,R. (Pers.comm)
	x														BD.Cabal
	x														Anadón,N. (BD.Cabal)
	x														Arronte et al., 2007
Tanaidacea															
Hexapleomera robusta	x														Martínez & Adarraga, 2005, 2006
Polychaeta															
Boccardia semibranchiata	x														Martínez & Adarraga, 2005,2006
Desdemona ornata	x														Martínez & Adarraga,2006
	x														Martínez & Adarraga, 2005
	x														Martínez & Adarraga, 2006
	x														Ceberio et al., 1998
	x														Sola et al.,
Ficopomatus enigmaticus	x													x	Martínez & Adarraga, 2006, 2005
	x													x	Martínez & Adarraga, 2006
	x														Fischer & Piette, 1951
Pseudopolydora paucibranchiata	x														Martínez & Adarraga,2005, 2006
Phytoplancton															
Gymnodinium catenatum	x														BD.Cabal
	x														Estrada et al., 1984
	x														Bravo et al., 1990

	x														Gestal et al., 1978
	x														Campos et al., 1982
	x														Wyatt, 1992
Karenia mikomotoi	x														El Haddad et al., 2006a
Parasites															
Perkinsus olseni	x														Riera et al., 1995
	x														Santmartí et al., 1995
	x														Arronte et al., 2007
Marteilia refringens	x														Arronte et al., 2007

Table 3 : Typology and levels of impact of invasive species in the Noratlantic

2.1.2.2 Types of impacts on ecosystem components

Non-indigenous species can cause various types of impacts, among them:

- → **Dislodge the native species**. While many of the alien species become part of the background flora and fauna, others become invasive, reaching densities of 1000 s.m^{-2}. The numerical dominance of invasive alien marine species swamps native species and alters ecosystem services. (Bax et al. 2003)
- → **Impact on foodwebs**. Non-reproducing alien species may also interact with native species and affect predation and competition for food. (OSPAR Commission 2010)
- → **Mixing of exotic genes through hybridization**. There has been little research to date on the ability of natural populations to recover from introgression of farmed genes from mariculture. (OSPAR Commission 2010)
- → **Pathogens**. Ballast water is also capable of transporting viral and bacterial pathogens, including the bacteria that cause cholera and the resistant cysts of toxic dinoflagellates that can lead to harmful algal blooms and shellfish poisoning. (Bax et al. 2003)
- → **Hosts for parasites affecting humans**. Ballast water and other vectors can carry invasive alien marine species that are intermediate hosts for parasites affecting humans—e.g. the Chinese mitten crab that has invaded Europe and the US West coast is an intermediate host of the human liver fluke. (Bax et al. 2003)

2.1.2.3 Impacted or potentially impacted components and/or areas in French waters (Bay of Biscay)

2.1.2.3.1 Location of main pressure sources

In order to define Environmental Targets in the first MSFD implementation (Agence des Aires Marines Protégées et Ifremer 2011) France has identified 'ecological' challenges and/or challenge areas for which an action is required to reach GES, based on a qualitative analysis or on expert opinion.

For Descriptor 2 'Introduction of non-indigenous species', areas subject to high levels of pressure were drawn from the spatial distribution of activities likely to introduce species.

In French waters of the Bay of Biscay, major areas for introduction of non-indigenous species were identified as:

- → Shellfish aquaculture areas
- → Port areas

Shellfish aquaculture areas are mainly located in south Finistère, Morbihan, Loire Atlantique and Charente-Maritime. Ports that were identified as major introduction areas are those were a lot of ballast water is discharged: Lorient, Saint Nazaire, La Rochelle, Bordeaux and Bayonne.

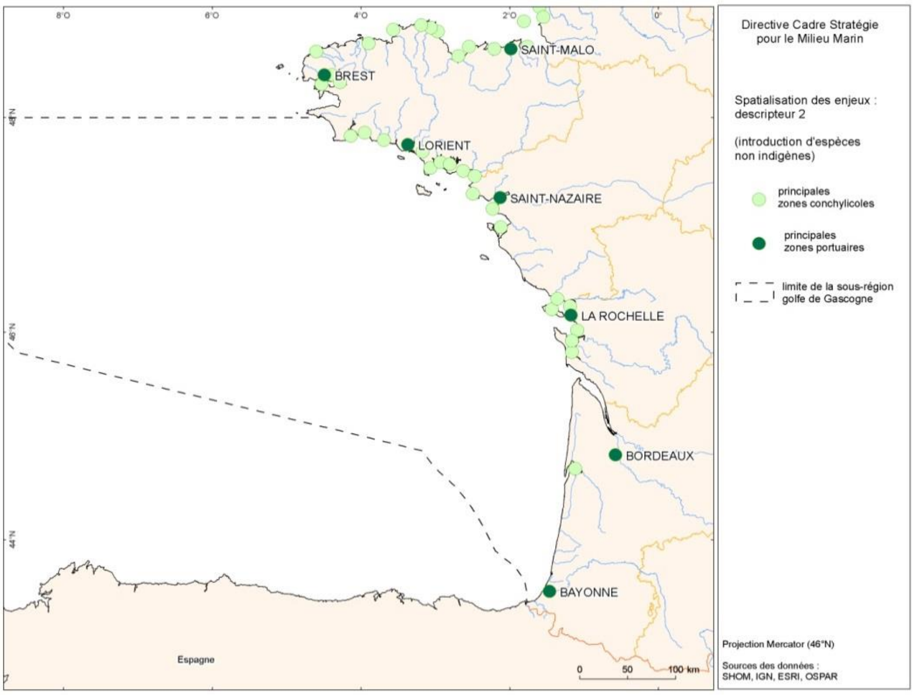


Figure 1: Challenge areas for introduction of non-indigenous species (major introduction vectors: Shellfish aquaculture areas (light green) and Port areas (dark green).(Agence des Aires Marines Protégées et Ifremer 2011)

2.1.2.3.2 Potentially impacted ecosystem components and areas

In the MSFD framework, France has summarized impacts from non-indigenous pressures for each marine environment feature in the context of the Bay of Biscay (Agence des Aires Marines Protégées et Ifremer 2011). This impact assessment was contextualized in the Bay of Biscay (taking into account if there is an existing interaction, resulting in actual impacts). A confidence index is also provided for each impact diagnostic (low, medium, high).

Impacted components in the Bay of Biscay Pressure : *Input or spread of non-indigenous species introduced by human activities*	
HIGH IMPACT	Littoral rock communities
SIGNIFICANT IMPACT	→ Phytobenthos → Infralittoral and circalittoral with hard substrate communities; Infralittoral with soft substrate communities → Commercially exploited shells (including mariculture)
LOW IMPACT	→ Marine birds → Demersal fish and cephalopods → Zooplankton; phytoplankton → Littoral with soft substrate communities; Circalittoral with soft substrate communities → Commercially exploited fish, cephalopods, crustaceans → Food webs

Table 4 : High, significant and low impacts of the pressure ‘Input or spread of non-indigenous species’ on

ecosystem components in the Bay of Biscay.

In the Bay of Biscay, introduction of non-indigenous species was assessed to have a 'high impact' on communities of mediolittoral hard substrate: For example : Pacific oyster *Cassostrea gigas*, mollusk *Ocinebrellus inornatus* introduced in France in the 90s, parasite *Bonamia ostreae* of the oyster Ostrea edulis.

In the MSFD Initial Assessment in 2011, France suggested that 'potentially impacted areas' includes **areas of distribution of non-indigenous invasive engineer species**. Invasive engineer species that were introduced in the Bay of Biscay include, among others: Pacific oyster (*Crassostrea gigas*), American slipper limpet (*Crepidula fornicata*), Atlantic cordgrass (*Spartina alterniflora*) and English cordgrass (*Spartina anglica*).

These areas of distribution of these species were not provided in the report(Agence des Aires Marines Protégées et Ifremer 2011).

2.1.2.4 Impacted or potentially impacted components and/or areas in Spanish waters (Cantabrian sea and Galicia)

2.1.2.4.1 Location of main pressure sources

The MSFD Initial assessment of pressures and impacts in Spain (Instituto Espanol de Oceanografia et Asistencia Tecnica TRAGSATEC SA 2012a) provides information on the pressure of introduction of alien species.

To determine the areas where the introduction or spreading of non-indigenous species is more probable the following activities or facilities were considered: fish or mussel farms, structures related to commercial and recreational navigation like harbours, marinas, single-buoy moorings, anchorage areas, and also authorised areas for the disposal of dredged material. Due to the difficulty of knowing the area of influence of these activities, the index is built based on the intersection of the activities with the grid cells, no buffer areas are defined. A value of 1 is assigned to the cell containing each facility, except for the ports of general interest, which have a value of 2 if the mean annual traffic of loaded bulk goods is lower than 6 million tonnes and a value of 4 if this indicator is greater than this quantity. The criteria are as follows:

Very high: 5-7 / High: 4 / Medium: 3 / Low: 2 / Very Low: 0-1

The cells classified as "Very high" are assumed to have a great potential of input or spread of non-indigenous species (4 areas: Rías Bajas, Golfo Ártabro, Gijón y San Sebastián-Pasajes) while those classified in the range "High" are assumed to have a moderate potential (3 areas: San Cibrao, Avilés y Bilbao).

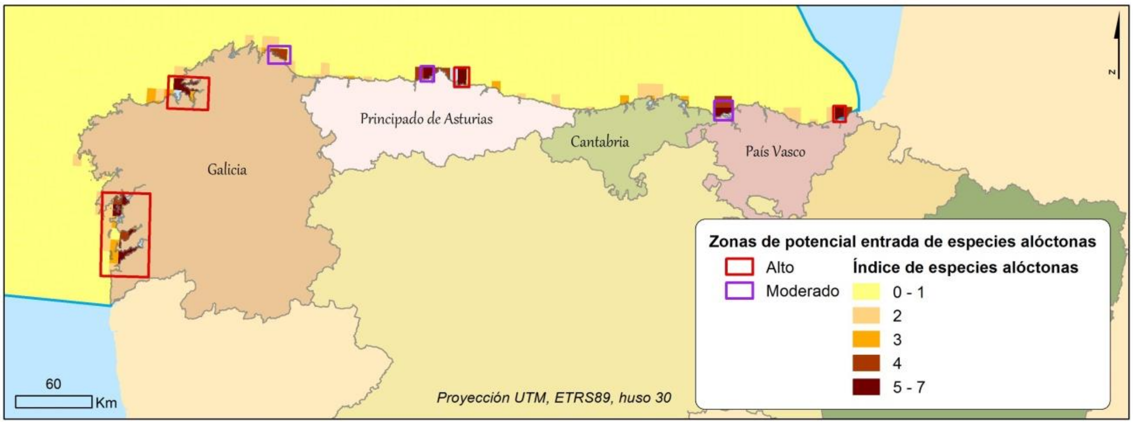


Figure 2: Zones of accumulation of pressures of input of non-indigenous species in North Atlantic Spanish waters (Instituto Espanol de Oceanografia et Asistencia Tecnica TRAGSATEC SA 2012a)

2.1.2.4.2 Potentially impacted areas

Potentially impacted areas can also be drawn from areas of distribution of non-indigenous species. For example,

species. For example,

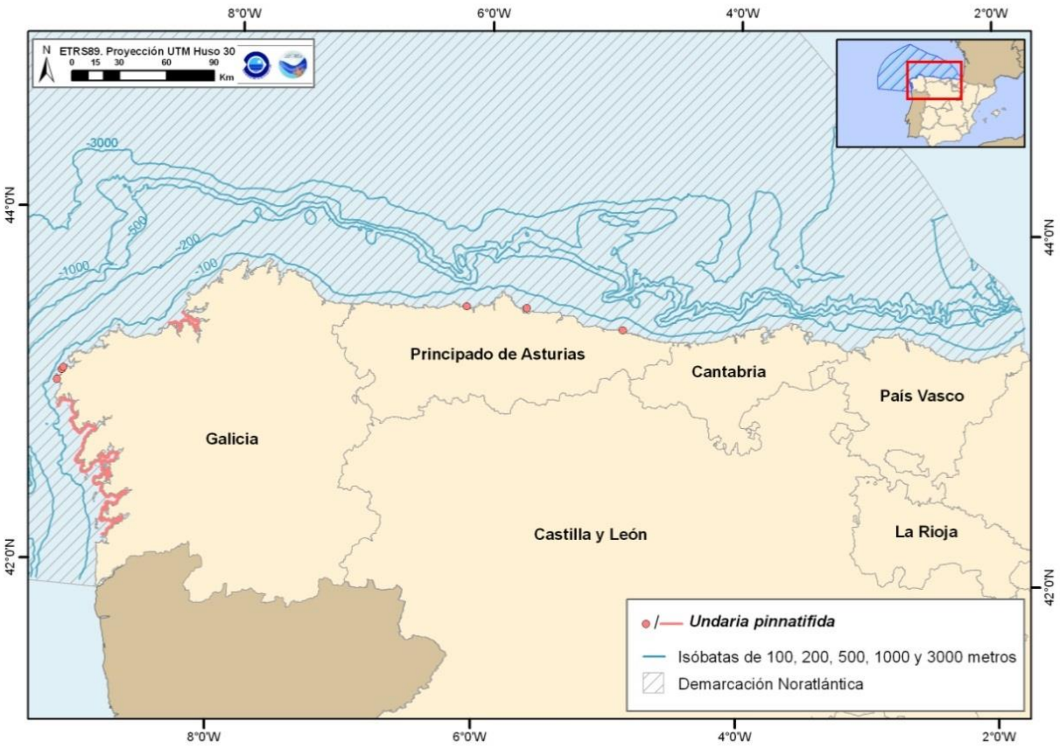


Figure 3 shows the area of distribution of Undaria pinnatifida. It's distribution broadly corresponds to the location of sources of pressure as shown in

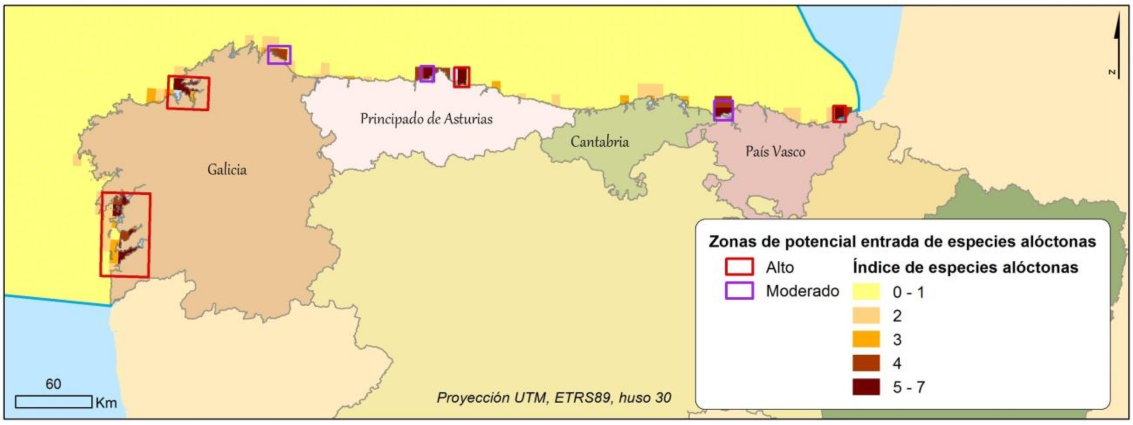


Figure 2 above.

An example (Undaria pinnatifida) is presented in the

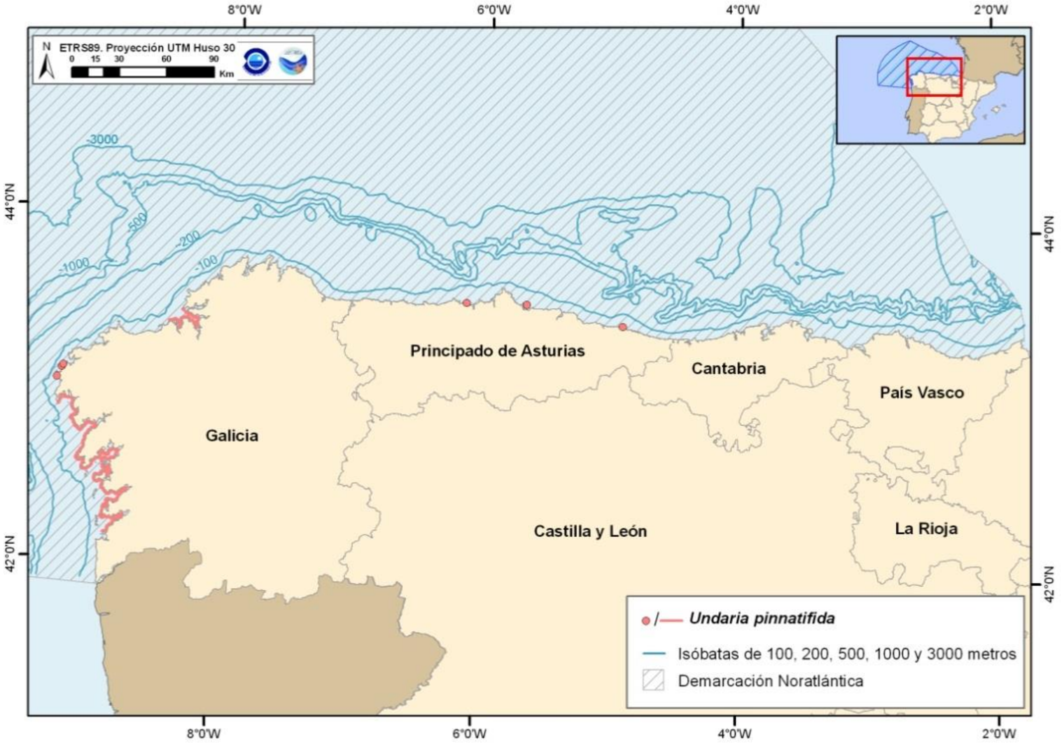


Figure 3.

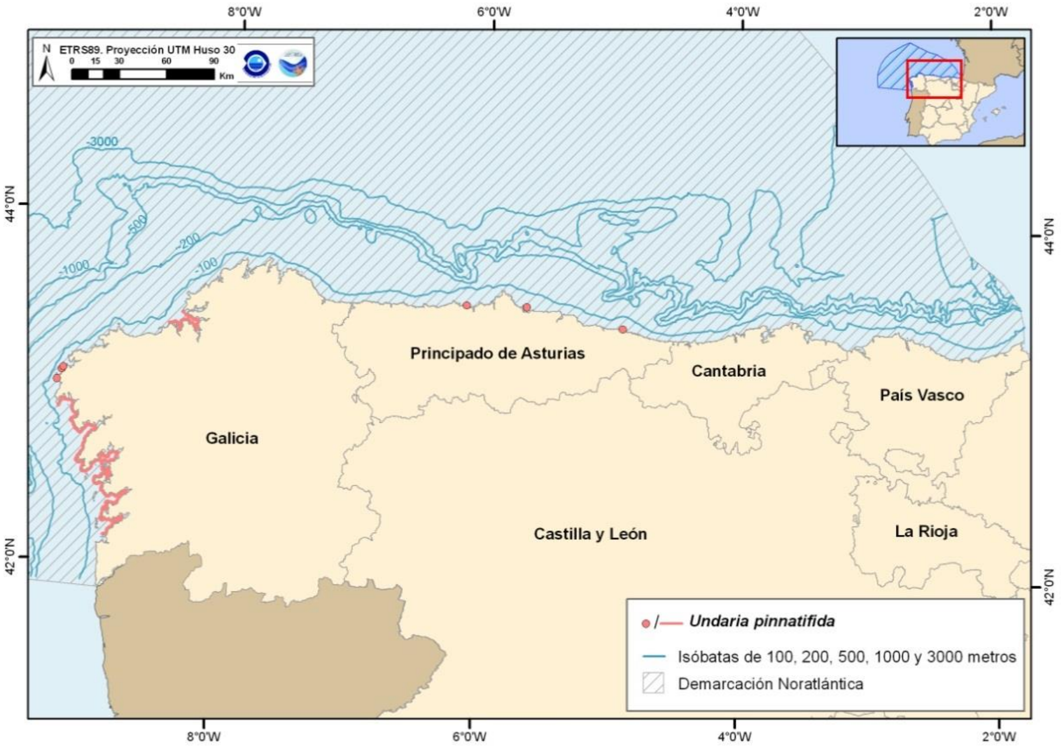


Figure 3: Distribution of Undaria pinnatifida along the Spanish Coasts. Source: IEO

2.1.2.5 Impacted or potentially impacted components and/or areas in Portuguese waters

According to the Portuguese mainland subdivision MSFD (2012) Report the main activities responsible for the Input or spread of non-indigenous species introduced by human activities (D2) are Navigation and Aquaculture (Table 5).

Identified activities	Pressures	Impact assessment
Navigation; Aquaculture	Input or spread of non-indigenous species introduced by human activities (D2)	It was evaluated the nº of species, the ratio between non-indigenous and native species, and species abundance and distribution. Due the limited abundance of non-indigenous species, information was crucial the analysis of the available data combined with several years of research in marine environment of the involved institutions. Due to the lack of information it was not possible to establish a direct relationship between activities and the presence of non-indigenous species

Table 5 : : Identification of the activities, pressures and impact assessment of the Input or spread of non-indigenous species introduced by human activities (D2). (Ministério da Agricultura, do Mar, do Ambiente e do Ordenamento do Território 2012).

The evaluation area considered was the entire geological continental platform of the subdivision of Portuguese mainland, from the infralitoral superior limit to the isobaths 200m (Figure 5). In Face of the obtained results for the indicators analysed, was considered that does not exist, presently, evidences of negative changes due to non-indigenous species, at species, communities, habitats or ecosystems level (Table 6).

Criteria	Used indicators	Present state characterization	Environmental status evaluation	Degree of trust
2.1 Abundance and	a) Magnitude of spatial	The percentage of the	Good	Low

characterization of the non-indigenous species state, specially the invasive	distribution b) Number of occurrences through time	occupied evaluation area is small; The number of species non-indigenous is small	environmental status achieved	
2.2Environmental Impact of invasive non-indigenous species	2.2.1. Ratio between non-indigenous species in some taxonomic groups aimed by solid studies	Ratio between non-indigenous species and indigenous species is small	Good environmental status achieved	Low
	2.2.2. Impacts of non-indigenous species at species, habitats and ecosystems	Inexistent or unknown impacts	Good environmental status achieved	Low

Table 6 : Summary of the evaluation of Descriptor 2 to the Portuguese mainland subdivision (Ministério da Agricultura, do Mar, do Ambiente e do Ordenamento do Território 2012).

Regarding the present knowledge is considered that the Good Environmental Status in the evaluation area was achieved. However, the evaluation degree of trust is low, since the coverage of the evaluation area is not exhaustive. The information regarding the abundance of species is insufficient, the information regarding the magnitude of species distribution have several gaps, has it does not cover, neither the total evaluation area, neither cover the total adequate substrata and several temporal discontinuities in the available data where identified, namely regarding the recently introduced species *Ocenebra inornata*, *Corella eumyota* and *Ostreopsis ovata*.

2.1.2.5.1 Number of non-indigenous species in the evaluation area

- → Microalgae: 4
- → Macroalgae: 22
- → Cnidarian: 1
- → Arthropods: 6
- → Chordata: 4

The number of species recorded has been suffering a significate increase through time (Fig.xxx). This phenomena is certainly related to the increase focus on the problem, but also related with the increase intensity of maritime traffic, once one of the two major routes of maritime traffic of the EU is located in OSPAR area IV (OSPAR Commission 2010)

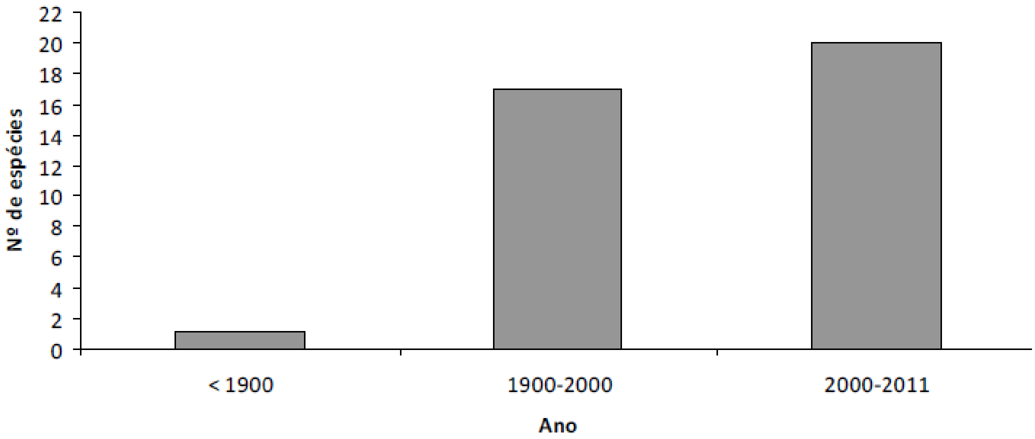


Figure 4 : Evolution of the non-indigenous species records (Ministério da Agricultura, do Mar, do Ambiente e do Ordenamento do Território 2012).

2.1.2.5.2 Characterization of non-indigenous marine species introduced by human activities

The majority of the marine species non-indigenous are coastal benthonic organisms (3 species of microalgae, 2 species of macroalgae, cirripeds, molluscs and ascidian) from hard substrata habitats. Only one species from mobile habitats was recorded (amphipod). One microalgae and one Cnidarian where recorded for the pelagic habitat. Some invasive species or groups deserve a special reference:

- → Microalgae: Include 3 species that form blooms with adverse effects in other marine species and human health (*Gymnodinium catenatum* and benthonic species *Ostreopsis*
- → *siamensis* and *Ostreopsis ovata*);
- → Macroalgae: They seem to prefer artificial substrates (marinas and recreational harbours) for their installation. The invasive red algae *Asparagopsis armata* its presente in the marine environment of the Portuguese mainland subdivision for a long time (Ardré 1969) and no adverse effects are known. The invasive brown algae *Sargassum muticum* occurs in the totality of the littoral mainly in ifra-littoral enclaves of intertidal areas (Engelen et al. 2008). Despite the invasive behaviour of this species, its expansion seems to be decreasing.
- → Cirripeds: *Elminius modestus*, invasive species, installed in the Portuguese mainland subdivision for a long time; recorded for the first time in 1956 by Fischer-Piette (ICES Advisory Committee 2011), for which it is considered installed/neutralized.
- → Ascidians: They seem to find the preferential way of installation and dissemination in marinas. The study undertake by (El Nagar, Huys, et Bishop 2010) about *Corella eumyota* in marinas from north to south of Portugal mainland, showed that the specie the installation and the numbers of individuals increased rapidly in recent structures (2 years before the study), suggesting a rapid growing and colonization capability of populations. *C. eumyota* became invasive in Europe and can affect negatively, in the future, bivalves aquaculture (El Nagar, Huys, et Bishop 2010).
- → Molluscs: the oyster *Crassostrea gigas*, is installed for a long time in the Portuguese mainland subdivision, being cultivated in aquaculture and, therefore, its dissemination is controlled. The carnivorous gastropod *Ocenebra inornata* was recentlly recorded, in the coast of Sagres, near oyster installations of aquaculture, and its abundance has significativlly increased since 1999 to 2008 (Afonso 2011). Its most feared impacts are related to the reduction of biodiversity and socioeconomics (Afonso 2011).

2.1.2.5.3 Non-indigenouse species abundance in the evaluation area

The available information regarding the abundance of non-indigenous species is relevant for four species, the toxic micro algae *Gymnodinium catenatum* and *Ostreopsis ovata, the* gastropod mollusc *Ocenebra inornata* and the ascidian *Corella eumyota*, and is presented in Table 7. *Gymnodinium catenatum* occurs with high abundance (>1000 cél.L-1) in the blooms periods, and is subject to a monitorization program by the Instituto Português Mar e Atmosfera (IPMA). The *Ostreopsis ovata* was only record once, with high number of cells and it is expectable the increase of the number of occurrences. *Ampelisca heterodactyla* occurs with low abundance.

Species	Month/year of currence	Ocurrence locations	Abundance
Gymnodinium catenatum	Since 1981	**N-S Portugal**	<1000 cél.L-1 e >1000 cél.L-1 when booms occur
Ostreopsis ovata	09/ 2011	**S Portugal**: Praia de D. Ana Praia deFerragudo Meia Praia Praia do Zavial	5420 cel.L-1 320 cel.L-1 80 cel.L-1 40 cel.L-1

Ampelisca heterodactyla	07/1998; 08/1998; 10/1998; 05/2000	Plataforma adjacente ao Tejo	10-20 ind./m2
Ocenebra inornata	01/1999 11/2005 02/2007 10/2008	**S Portugal**: Sagres Sagres Sagres Sagres	1 individual 12 individuals > 100 individuals > 100 individuals
Corella eumyota	09/2008 09/2008; 07/2009 10/2008; 07/2009 07/2009 07/2009 07/2009 07/2009 07/2009	**N Portugal**: Póvoa do Varzim Vila Praia de Âncora Matosinhos Peniche Nazaré **SW Portugal**: Oeiras Sines **S Portugal**: Albufeira	>60 ind./m2 >60 ind./m2 1-30 ind./m2 31-60 ind./m2 1-30 ind./m2 31-60 ind./m2 Absent Absent

Table 7 : Abundance of some non-indigenous species and their location in the evaluation area (Ministério da Agricultura, do Mar, do Ambiente e do Ordenamento do Território 2012).

Regarding the distribution of the recently introduced species, in the case of *Corella eumyota*, it occurs in the adjacent areas of the main ports such as Viana do Castelo, Leixões, Peniche and Lisbon. For *Ocenebra inornata* and *Ostreopsis ovata*, the evaluation only shows evidences of occurrence in the southwest point of Portugal mainland in the area of high concentration of aquaculture facilities (Figure 5).

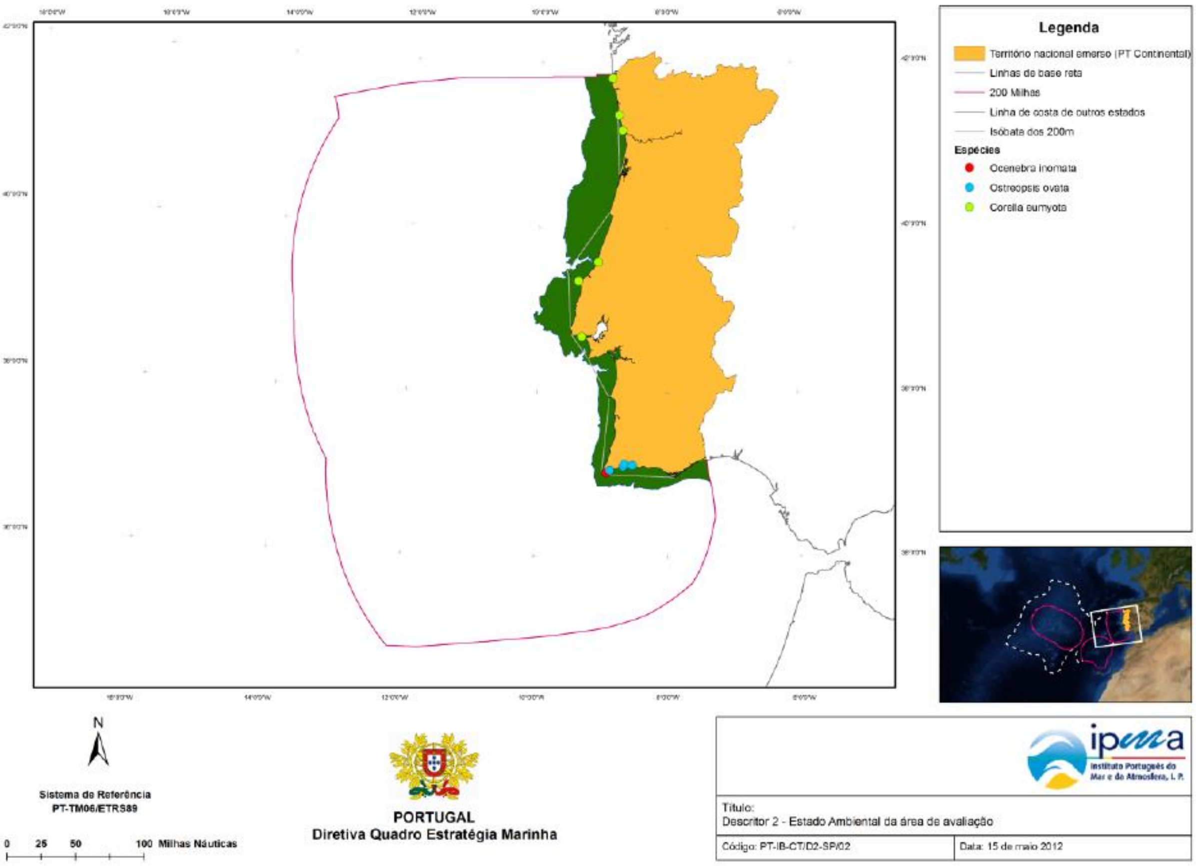


Figure 5 : Map of the Descriptor 2 evaluation, representing the environmental status (good) of the evaluation area (isobaths 200m) and location of the species recently introduced with evident dispersal potential. (Ministério

da Agricultura, do Mar, do Ambiente e do Ordenamento do Território 2012)

2.2 Disturbance of species (e.g. where they breed, rest and feed) due to human presence

This pressure was mentioned in the Commission Directive (EU) 2017/845 that provides indicative lists of elements to be taken into account for the preparation of marine strategies.

Disturbance can be defined as any event caused by an activity that provokes a defensive reaction or fleeing by an animal, or that directly or indirectly causes higher mortality risk, or decrease in reproductive success during the breeding period (Agence des Aires Marines Protégées et Ifremer 2012)

There are three types of disturbance (Agence des Aires Marines Protégées et Ifremer 2012) :

- → visual disturbance (movement of objects, visual barrier)
- → light disturbance (night lightning)
- → sound disturbance.

An extreme form of disturbance is collision.

2.2.1 Activities driving disturbance of species

Human frequentation related to tourism and nautical activities are the main cause of disturbance to wild species. Navigation and constructions can also result in collisions, which is an "extreme" kind of disturbance.

- → Activities causing introduction of sound in the sea are described in part III 'Substances, litter and energy'
- → Light disturbance is mainly caused by night lighting is coastal areas
- → Activities causing visual <u>presence</u> are drawn from the MarLIN matrix of activities to pressure, in Table 8 below.

Environmental factor (from MarLIN)	**Activities (from MarLIN)**
Visual presence	**Mainly maritime** → **Aquaculture** (fin-fish, macro-algae (P), **predator control, shellfisheries (R))** → **Coastal defence (barrage, beach replenishment, groynes, sea walls/breakwaters) (R)** → **Development (construction phase, communication cables, dock/port facilities, marinas, oil&gas platform, urban) (R)** **Mainly coastal** → **Collecting (bait digging, bird eggs,** curios (P), **higher plants, kelp&wrack harvesting, macro-algae, peelers, shellfish) (R)** → **Dredging (capital dredging, maintenance dredging (R)** → **Energy generation (nuclear power generation, power stations, renewable** (tide/wave) (P), **wind farms) (R)** → **Extraction (maerl, rock/minerals, oil&gas, sand/gravel) (R)** → **Recreation (angling, boating/yachting, diving/dive site, public beach, tourist resort, water sports) (R)** → **Uses** (animal sanctuaries (P), **archaeology, coastal farming, coastal forestry, education/interpretation, military, mooring/beaching/launching, research (P) and shipping) (R)** → **Others (removal of substratum) (P)**

Table 8 : activities driving introduction of non-indigenous species (probable effect (R) or possible (P)) adapted from MarLIN 'Maritime and coastal activities to environmental factors matrix'

2.2.2 Impacts of disturbance

2.2.2.1 Nature of impacts of disturbance

2.2.2.1.1 Impacts on marine birds

Impacts of disturbance are verified on some marine bird species. In the breeding period, it can cause a decrease in reproductive success (e.g. panic movement of adults resulting in eggs falling). In wintering or migration period, disturbance might cause a decrease in energetic resources or limited access to feeding areas (Agence des Aires Marines Protégées et Ifremer 2012)

Human frequentation on the littoral as well as leisure navigation (jet skis, small boats, kayaks…) can cause reproductive failure and might eventually result in the relocation of colonies.

Marine birds can also be impacted by collisions with fast boats or wind farms (Agence des Aires Marines Protégées et Ifremer 2012).

2.2.2.1.2 Impacts on cetaceans and turtles

Collision with ships of constructions is an extreme form of disturbance, and has an impact on marine mammals and turtles (Agence des Aires Marines Protégées et Ifremer 2012).

2.2.2.2 Impacted components and/or areas in French waters

2.2.2.2.1 Impacted components

In the MSFD framework, France has summarized impacts from disturbance for each marine environment feature in the context of the Bay of Biscay (Agence des Aires Marines Protégées, Ifremer, 2011). For each type of pressure and each ecosystem component, the level of impact was assessed by experts. A confidence index is also provided for each impact diagnostic (low, medium, high). This impact assessment is contextualized in the Bay of Biscay (taking into account if there is an existing interaction, resulting in actual impacts).

No 'high' impact was assessed from the pressure 'Disturbance of species' in the Bay of Biscay.

Impacted components in the Bay of Biscay Pressure : *Disturbance of species (e.g. where they breed, rest and feed) due to human presence*	
SIGNIFICANT IMPACT	→ Marine birds
LOW IMPACT	→ Marine mammals → Marine turtles → Demersal and pelagic fish and cephalopods → Littoral with soft and rock substrate communities → Infralittoral and circalittoral with hard substrate communities

Table 9 : High, significant and low impacts of the pressure 'Disturbance of species' on ecosystem components in the Bay of Biscay. The full table is provided in Annex II. Non-indigenous species in the OSPAR area that have been identified as problematic

Disturbance of marine bird species. The littoral of the Bay of Biscay is a major migration path, especially for marine and coastal birds. Many protection areas were created after their identification as wintering or migratory stop areas. Some Natura 2000 sites were designated mostly because of their importance for birds species.

2.2.2.2.2 Impacted areas

In the Bay of Biscay, the Sandwich tern (*Thalasseus sandvicensis*) nests south of Finistère, Vendée (Noirmoutier island) and Arguin bank. It is impacted by tourism on littoral (disturbance on roosting sites) and by leisure navigation that can disturb reproduction. The Roseate tern (*Sterna dougallii*) occasionally nests in Brittany islands. The development of leisure nautical activities highly contributed to colonies shifting in the 1970s. The little tern *(Sternula albifrons)* and the Common tern (*Sterna hirundo*) nest along the Loire river and in a few coastal sites of the Bay of Biscay. They are also subject to disturbance (Agence des Aires Marines Protégées et Ifremer 2012).

The North West part of the continental slope in the Bay of Biscay has both high cetaceans density and high maritime traffic, and could be considered as a potentially impacted area considering collisions (Agence des Aires Marines Protégées et Ifremer 2012).

2.2.2.3 Impacted components and/or areas in Spanish waters

2.2.2.3.1 Impacted components

2.2.2.3.2 Impacted areas

2.2.2.4 Impacted components and/or areas in Portuguese waters

Portuguese MSFD does not adress this issue.

2.3 Extraction of, or mortality/injury to, wild species, including target and non-target species (D3)

2.3.1 Activities driving extraction of, or mortality to wild species

Fishing is the main activity contributing to this pressure in the Bay of Biscay and the Iberian Coast. Fishing continues to have a considerable impact on marine ecosystems and many problems remain despite efforts to improve management. Exploitation of many stocks continues to be beyond the levels they can sustain, while the status of a large number of stocks cannot be fully assessed due to poor data. Fisheries affect target species (landings + discards) as well as non-target species (by-catch). Recreational fishery is becoming a relatively important activity and is in some cases taken into consideration for the management of marine fisheries. Tourism is also linked to aquatic and marine activities that contribute to the increase of this pressure in coastal areas. Other activities causing mortality/injury to wild species are dredging, maritime works, extraction of material, littoral tourism (Ministério da Agricultura, do Mar, do Ambiente e do Ordenamento do Território 2012).

2.3.2 Impacts of extraction of or mortality to wild species

2.3.2.1 Nature of impacts

The pressures of extraction or mortality/injury to wild species have both direct and indirect impacts. Fishing causes the death of many species including those being targeted and a range of other species such as non-targeted invertebrates and fish (including sharks), seabirds, turtles and marine mammals (seals and small cetaceans). Excessive fishing pressure on targeted species may lead to impaired reproductive capacity and a risk of stock collapse (OSPAR Commission 2010).

Impacts of bottom fishing on the sediments are considered in the 'physical pressures' section.

2.3.2.2 Impacted components

In the Bay of Biscay and Iberian Coasts Ecoregion, selective extraction of species impacts the following ecosystem components (ICES 2016) :

- → Commercial stocks
- → Threatened and declining fish species
- → Foodwebs

→ Seabird and marine mammals

In the MSFD framework, France has summarized impacts from 'extraction of, or mortality/injury to wild' species for each marine environment feature in the context of the Bay of Biscay (Agence des Aires Marines Protégées et Ifremer 2011). This impact assessment was contextualized in the Bay of Biscay (taking into account if there is an existing interaction, resulting in actual impacts).For each type of pressure and each ecosystem component, the level of impact was assessed by experts. A confidence index is also provided for each impact diagnostic (low, medium, high).

Impacted components in the Bay of Biscay **Pressure** ***: Extraction of, or mortality/injury to, wild species, including target and non-target species***	
HIGH IMPACT	→ Commercially exploited fish and cephalopods
SIGNIFICANT IMPACT	→ Marine mammals → Marine turtles → Demersal and pelagic fish and cephalopods → Phytobenthos → Littoral with soft substrate communities → Infralittoral and circalittoral with hard substrate communities → Circalittoral with soft substrate communities → Bathyal and abyssal communities → Commercially-exploited crustaceans → Food webs
LOW IMPACT	→ Littoral with rock substrate communities → Infralittoral with soft substrate communities → Commercially-exploited shells (including mariculture)

Table 10 : High, significant and low impacts of the pressure 'Extraction of, or mortality/injury to, wild species, including target and non-target species' on ecosystem components in the Bay of Biscay.

Impacts of the pressure 'extraction of, or mortality to wild species' on target and non-target fish species are assessed in the 'Marine Environment' section.

2.3.2.2.1 Impact on threatened and declining fish species

Stocks of several fish species have been adversely affected by fishing and are now on the OSPAR list of threatened and declining species. These include the sturgeon *Acipenser sturio*, European eel *Anguilla Anguilla*, gulper shark *Centrophorus granulosus*, skates and rays like *Dipturus batis*, *Raja montagui*, and *Rostroraja alba*, spurdog *Squalus acanthias*, and salmon *Salmo salar*. Although there are no TACs for these species and some are prohibited to be landed under EU law, several species are vulnerable to existing fisheries. Common skates, and less often spurdogs, are caught as bycatch in demersal trawl fisheries while deepwater sharks are caught in the mixed deep-water trawl fishery (ICES 2016).

2.3.2.2.2 Impact of fishing on food webs

Fishing can disturb the foodweb. Predator–prey relationships can change, depending on the species and on the amount of food (prey) that is available for a given predator. Poor management of fishing for one species could have an adverse effect on the whole foodweb. Multispecies assessment methods can account for some of these interactions and guide appropriate management measures.

Indicators like the large fish indicator (LFI) index (describing the proportion –by weight– of the demersal fish community on survey catch larger than regional length thresholds) can be used to monitor changes in the fish populations. In the Bay of Biscay, the LFI index has shown a positive temporal trend since the year 2000. There is no trend in the LFI in Portuguese waters, the index shows high interannual variability (ICES 2016).

2.3.2.2.3 Impact of by-catch on marine mammals, an "unacceptable interaction"

The catch of non-target or non-commercial species in fishing gear, or bycatch, is considered the most serious threat to cetacean populations in the area. It is qualified of 'unacceptable interaction' by ASCOBANS. However, the magnitude of this threat is not well known. Bycatch can be defined as ‘the portion of the capture that is discarded at sea dead (or injured to an extent that death is the most likely outcome) because it has little or no economic value or because its retention is prohibited by law (Hall 1996). Bycatch is a threat for long-lived species with slow population growth rates, low fecundity or low survival to adulthood. Fishing gear causing bycatch are: Pelagic trawls, bottom-set gillnets or entangling nets, driftnets, high-opening trawls.

Uncertainties on this threat. Uncertainties about the true magnitude of bycatch delay management decision-making. Although it is probably one of the most important man-induced threats to marine mega-vertebrates, it still remains largely unresolved. Recent studies on the effects of interactions between fisheries and mega-vertebrate demography or population genetics revealed pessimistic conservation scenarios (Mannocci et al. 2012; Mendez et al. 2010). Bycatch issues have long been ignored or under-documented, mostly because the process remains barely visible as it takes place far from ports and fish markets.

Situation in OSPAR Region IV. Stranding records are an important source of information on marine mega-vertebrates, and can provide critical information to estimate a minimum level of bycatch across fisheries. Through the understanding of the small cetacean carcass drifting and stranding processes, relationships between stranding records and relative abundance and mortality can be elucidated.

Observation of marine mammal bycatch has occurred in certain fisheries off France and in a few off Galicia. Harbour porpoises Phocoena phocoena are being caught as bycatch off Iberia in set nets to the extent that the local population of the species may become extinct. Set net fisheries and pelagic trawls, particularly those for seabass *Dicentrarchus labrax*, have caught common dolphins *Delphis delphinus* and striped dolphins *Stenella coeruleoalba* (ICES 2016).

A focus on by-catch of Harbour porpoise and Common dolphins in French waters is provided in the next section.

What has been done. The European Union has acknowledged bycatch as the most serious threat and adopted regulations introducing mitigation measures with the aim of reducing byctach, such as phase out of driftnets in the Baltic Sea, introduction of the widespread use of pingers and others. In particular, regulation EC 812/2004 sets down measures concerning incidental catches of cetaceans in European fisheries (On-board observer monitoring programs).

2.3.2.2.4 Impacts of fishing on seabirds

In the Bay of Biscay and Iberian Coasts Ecoregion, seabird bycatch seems likely to be part of the reason for the loss of the Iberian form of the common guillemot *Uria aalge* and some other seabird species (ICES 2016).

2.3.2.3 Impacted areas and ecosystem components in French waters

2.3.2.3.1 By-catch of Common dolphin and Harbour porpoise

Death in fishing gear of non-target species (called by-catch) is a major concern for marine wildlife, and mostly worrying for long-lived species like cetaceans considering their demographic characteristics (slow population growth rates and low fecundity).

‘Challenge areas’ for by-catch of Common dolphin (*Delphinus delphinus*) and Harbour porpoise (*Phocoena phocoena*) in the Bay of Biscay were identified in the MSFD Initial Assessment process in France (Agence des Aires Marines Protégées, Ifremer, 2011). The central and southern part of the continental slope were identified as challenge areas for by-catch of common dolphin and harbour propoise.

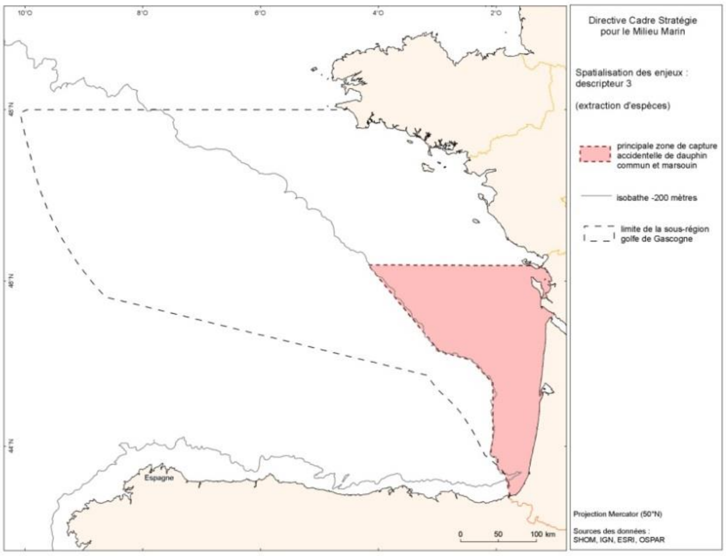


Figure 6: Challenge areas for by-catch of Common dolphin and Harbour porpoise in the Bay of Biscay. From (Agence des Aires Marines Protégées et Ifremer 2011)

A recent study on common dolphin supports the identification of the continental shelf in the Bay of Biscay as an important area of by-catch. In this study, cartographic parameters inferred from strandings were adapted to highlight the areas at sea with high vulnerability of common dolphins to fisheries. The highest densities of by-caught common dolphins at sea were predicted on the continental shelf to the slope of the Bay of Biscay. Estimates based on stranding records were about 10 times higher than estimates produced by observer programs conducted under regulation 812/2004. This suggested potentially unsustainable level of by-catch for Common dophin in the NE Atlantic. (Peltier et al. 2016)

The Bay of Biscay (part of ICES Assessment Unit 'Celtic and Irish sea') has the highest by-catch of harbour porpoise, among assessed areas (ICES 2017)**.** ICES estimated the number of harbour porpoise caught in commercial nets (mainly set gillnets). The by-catch estimates are derived from estimates of annual fishing effort and counts of by-caught harbour porpoises made by observers or remote electronic monitoring on commercial fishing vessels. In the 'Celtic and Irish sea' Assessment Unit – that includes the continental slope of the Bay of Biscay-, the annual by-catch as a percentage of the best abundance estimate is 1.06-1.37%.

2.3.2.4 Impacted components and/or areas in Spanish waters

In the Cantabrian Sea, the fisheries have a major effect on the structure and dynamics of the ecosystem. In recent decades, the mean trophic level of the demersal and benthic fisheries has declined (ICES 2008).

The North Iberian Peninsula is a fisheries region with fleets targeting different resources. Bycatch is the part of the catch that is unintentionally captured during a fishing operation, in addition to target species (FAO, 2016). Marine turtles are important part of fisheries bycatch in certain areas worldwide and represent a big challenge for fisheries managers. Incertitude on the figures of turtles captured in the region is related to the active fleets. Main gears involved in marine turtle's bycatch include surface longline, bottom trawlers and artisanal fleets. Gillnets and trawl fisheries are equally high or higher than longline bycatch with far higher mortality rates (Lewison et Crowder 2007).

The distribution of the Spanish fishing effort of surface longline fleets targeting tuna and swordfish is represented in Figure 7. Surface longline fishing effort from the Spanish fleet is obtained by IEO from official logbooks (provided by Secretaria de Pesca) and scientists on board observers.

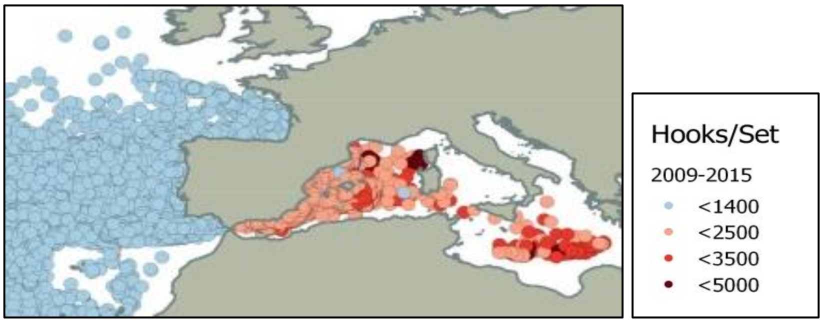


Figure 7: Distribution of Spanish surface longline effort (hooks/set) around Iberian Peninsula. Merged data from 2009-2015 (García-Barcelona et al. 2016)

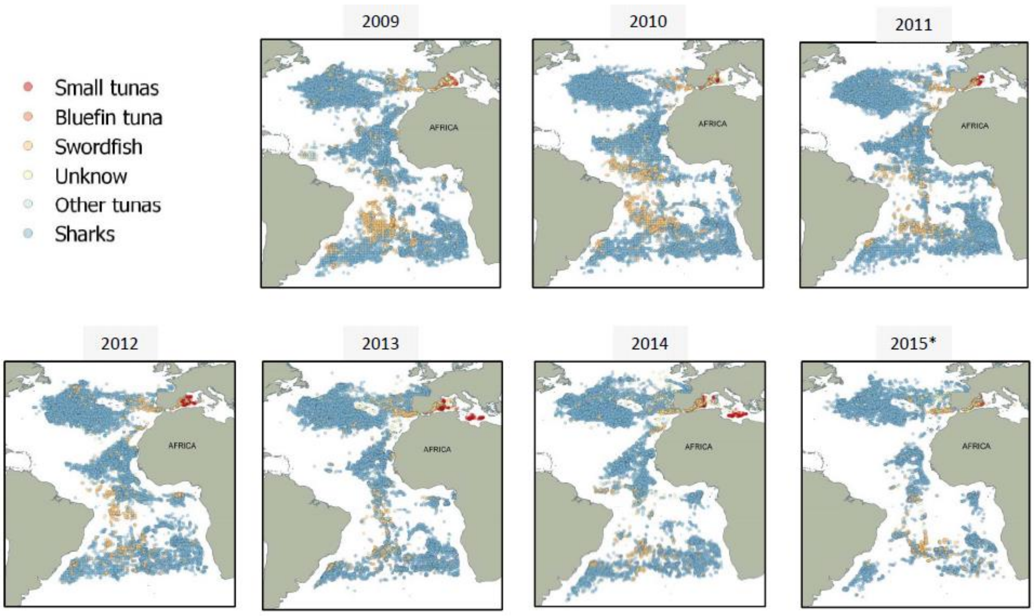


Figure 8: Distribution of sets in function of fisheries categories. Period 2009-2015 (García-Barcelona et al. 2016)

Fishing effort by surface longline in Gulf of Biscay increase from 2009. Figure 8 represent the distribution of sets in function of fisheries categories identified or target species. The fishing effort of this group of gears (surface longline) increases in the Gulf of Biscay from near cero in 2009 until maximum in 2013 and 2014, although the values are not comparable with other regions with high turtle's bycatch, as the Mediterranean Sea (see Figure 7).

Within the Spanish jurisdiction, Act 3/2001 on National Maritime Fishing establishes the creation of structured censuses by fishing grounds and modality for the management and distribution of fishing possibilities at the national level. "Fishing ground" means a geographical area subject to management or conservation measures that are unique according to biological criteria, while the type of use of a specific gear is called "modality". Each modality has its corresponding regulations in which the technical characteristics of the vessels and gears are determined, as well as the conditions in which they can be used. The procedure for the inclusion and registration of vessels in the Census of the Operational Fishing Fleet (COFF) (Order APA / 320/2008, of 6 February) establishes the structure between fishing grounds and modalities. In addition, for the purpose of scientific sampling, under the Pan-European Biological-Fishing Data Collection Plan (DCF), it has been determined, as sampling strata, the homogeneous tides group, that is, the same group of ecologic species using the same gear and period, which is called “metier”.

The waters of the Bay of Biscay are divided between the jurisdictions of Spain and France. In Spanish waters, the fishery ground is “Cantabrian-Northwest”, which is distributed from the border with France, at the mouth of the Bidasoa River, to the border with Portugal on the River Miño. Six types of fishing modalities are permitted in this fishing ground: Bottom trawling, Purse seine, Bottom longline, “Volanta”, “Rasco” and minor arts. On the other hand, the fishing grounds of communitarian waters to which the Spanish fleet has access were determined in the "Act of Adhesion of Spain and Portugal to the European Community". Leaving apart other areas, within the French waters of the Bay of Biscay, the modalities of bottom trawling and fixed arts are authorized throughout the year. In addition, temporary access is permitted to certain modalities of Cantabrian-northwest national fishing such as that of purse seine, as well as to vessels of other modalities that adapt their gear for the seasonal capture of albacore tuna.

Registration in the COFF is the first essential step to allow the activity of any Spanish vessel, although an authorization or "fishing license" issued by the Ministry of the Environment, Rural and Marine Affairs (MARM) is required, which is the document that specifies and determines the nature of the activity. This license, which is mandatory to have always on board, includes the identification of the ship-owner and the vessel, its technical characteristics, fishing zone or fishing ground, fishing method and period of validity of the license. In addition, this license may be accompanied by specific complementary permits, such as the "Special Fishing Permit" (SFP) and the "Temporary Fishing Permit" (TFP). The SFP is required in cases in which the specific characteristics of a fishery advise additional conservation measures or limitation on effort, and it contains the precise conditions for the development of the fishing activity. The TFP is used when it becomes necessary to limit the fishing effort in a fishery during specific time periods.

2.3.2.4.1 Spanish fishing activity in Spanish jurisdictional waters of the Bay of Biscay (Cantabrian-northwest national fishing ground).

The Cantabrian-Northwest national fishing ground includes Division VIIIc and north of Division IXa of ICES, as well as a small band of Division VIIIb. Currently, the Spanish Administration distinguishes six modalities within this fishing ground: bottom trawling, purse seine, bottom longline, “volanta”, “rasco” and minor gear. The fishing capacity and technical characteristics of the Cantabrian-Northwest national fishing fleet by modality are shown in Table 11:

Characteristics	Trawling	Purse seine	Longline	Volanta	Rasco	Minor arts
Nº of vessels	92	267	71	50	24	4085
Seniority	1999	1995	1997	1997	2000	1983
Overall length (m)	28.5	22.2	16.4	18.1	16.8	6.7
Tonnage (GT)	229.0	80.4	41.6	59.6	44.0	2.8
Power (Kw)	325.4	236.2	125.9	136.2	125.9	24.0

Table 11 : Capacidad pesquera y las características técnicas de la flota matriculada en caladero nacional Cantábrico-noroeste.

It is known that the bottom trawling fleet has evolved over the past decades abandoning or adopting various technological changes. However, since the prohibition of pelagic trawling (Royal Decree 1441/1999, BOE No. 251) and the drag with spinnakers and bowling gear (Order of 1 February 2001, BOE No. 29, Order APA / 16/2002, BOE No. 4, Order APA / 910/2006, BOE No. 76), this fleet basically uses two types of gear: bottom trawling with doors and bottom pair trawling. With regard to mesh size, a minimum size of 70 mm is currently in force (Royal Decree 1441/1999), which can be reduced to 55 mm in trawls directed to pelagic species (Order APA / 16/2002). Regarding the fishing activity, the bottom trawling method exercises three different metiers (Figure 9):

→ Trawling with doors targeting demersal species with 70 mm mesh (OTB_DEF> = 55_0_0_0).

→ Trawling with doors targeting pelagic and demersal species (OTB_MPD> = 55_0_0_0).

→ Trawling in pair targeting demersal species with mesh of 55-70 mm (PTB_DEF> = 55_0_0_0).

Purse seine in the Cantabrian-Northwest fishing ground is defined in its regulations as a net of rectangular shape, with a length of less than 600 m, a height of less than 130 meters and a minimum mesh of 14 mm (Order APA / 676/2004, BOE No. 65). This fleet has authorization to carry out its fishing activity both in national waters and in non-Iberian community waters of the Bay of Biscay (divisions VIIIabd) (Reg. EC nº 2371/2002), as well as in Portuguese waters (division ICES IXa) through "transboundary agreements "with this country. The fishing activity of the purse seine modality can be observed in Figure 10.

Bottom longline consists of a main line with a number of branches or "streamer lines" from which the hook hangs with the bait, and is fixed on the bottom or close to it by weights and buoys. The technical measures of application on the Cantabrian-Northwest bottom longline collect a maximum number of 4000 hooks and a maximum length of 15 km of its main line (Royal Decree 410/2001, BOE nº 96). The fishing activity of the bottom longline modality can be seen in Figure 11.

The bottom gillnet set consists of a single net panel constituted by several rectangular pieces joined to each other and maintained vertically by a waterline and a lower headband provided with ballasts. The variations in its design originate the modalities of "volanta" and "rasco", targeting hake and monkfish, respectively (Royal Decree 410/2001). This regulation defines the “volanta” as a gillnet with a minimum mesh size of 90 mm consisting of panels 10 m high and 50 m long, the length of which should not exceed 7 km. The “rasco” modality is delimited by a minimum mesh of 280 mm and is made up of panels 3.5 m high and 50 m long, whose total length should not exceed 11 km, being prohibited its use on sea bottom shorter than 50 m depth. Official fishing journals do not always properly capture the type of gill art used; however, the list of vessels authorized in independent modalities of the COFF allows their disaggregation. The fishing activity of the “volanta” and “rasco” modalities can be observed in Figure 12 and Figure 13.

The modality of minor arts is composed of three categories (Royal Decree 410/2001): gill net, hooks and pots. In addition to these three categories, the Autonomous Regions of Galicia allows the use of beam trawling and the Danish net in waters of its competence. This modality has a great social importance in the Cantabrian-Northwest fishing ground, affecting a high number of boats, generally of small size. Figure 14 shows the geographical distribution of the activity of its main metiers:

→ Pods targeting crustaceans (FPO_CRU_0_0_0).
→ Pods targeting molluscs, mainly octopus (FPO_MOL_0_0_0)
→ "Beta" type gill targeting demersal fish with a mesh size between 60 and <80 mm (GNS_DEF_60-79_0_0).
→ Trawling targeting demersal fish with mesh between 60 and <80 mm (GTR_DEF_60-79_0_0).
→ Hand line aimed at small pelagic fish (LHM_SPF_0_0_0).

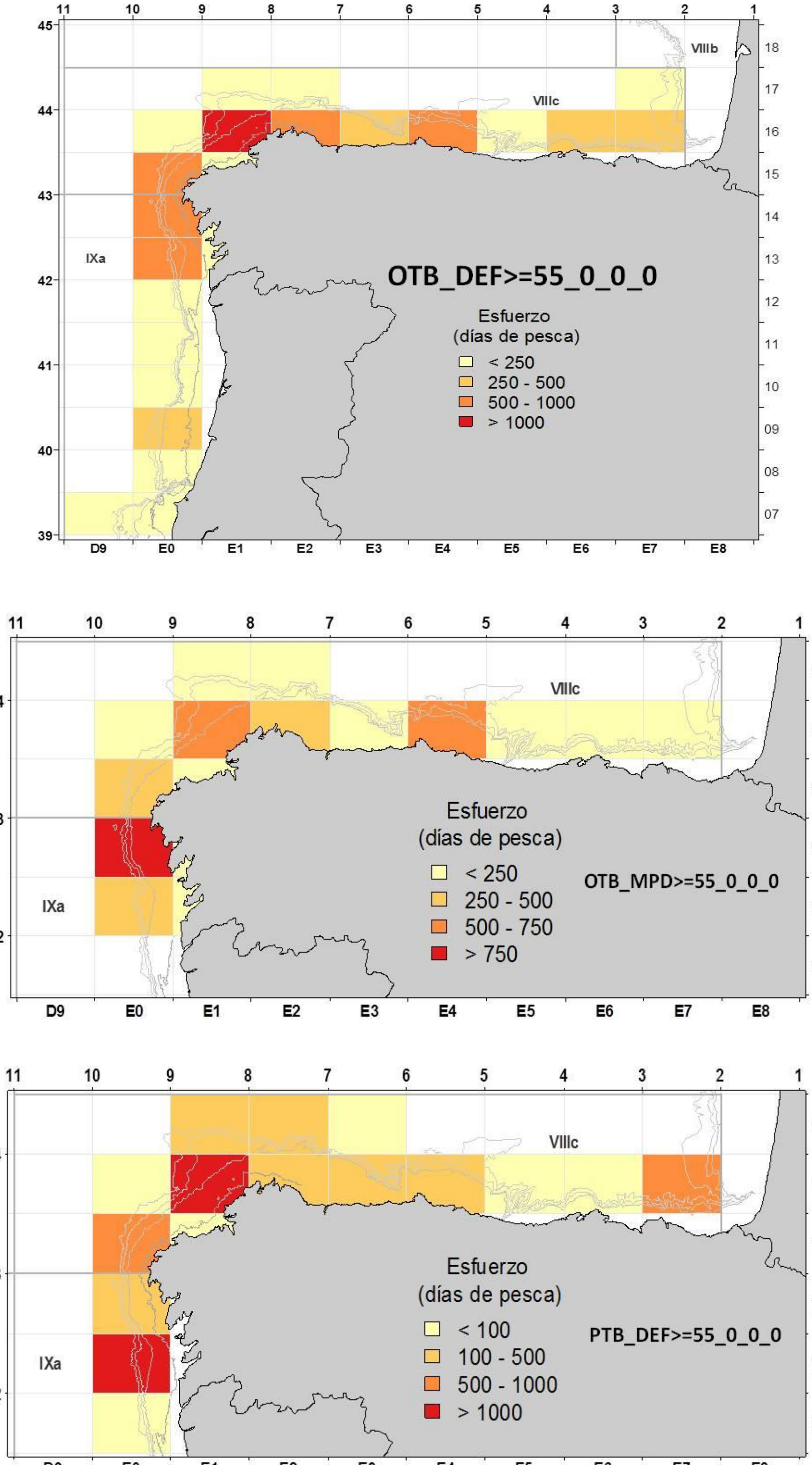


Figure 9 : Spatial distribution of the effort of the three métiers of the Cantabrico-Northwest national fishing trawl fleet: trawl with doors for demersal species (OTB_DEF> = 55_0_0_0), for pelagic species (OTB_MPD> = 55_0_0_0) and pair trawling (PTB_DEF> = 55_0

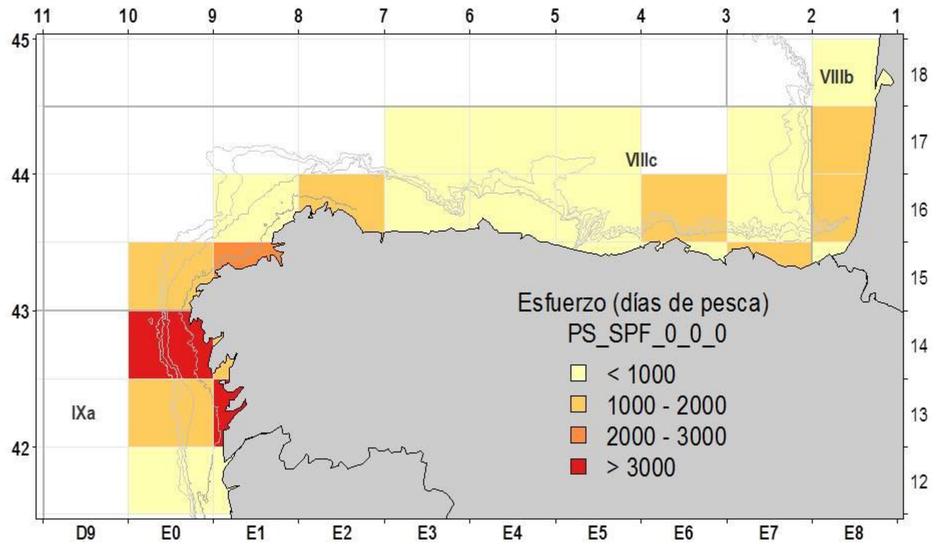


Figure 10 : Spatial distribution of the effort in the Cantabrian-Northwest national purse seine fleet (PS_SPF_0_0_0).

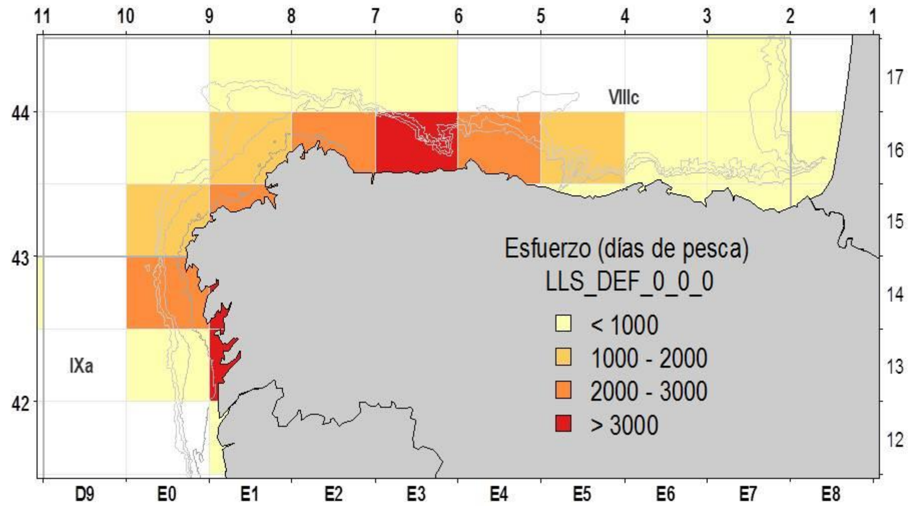


Figure 11 : Spatial distribution of the effort of the bottom longline fleet of the Cantabrian-Northwest national fishing ground (LLS_DEF_0_0_0).

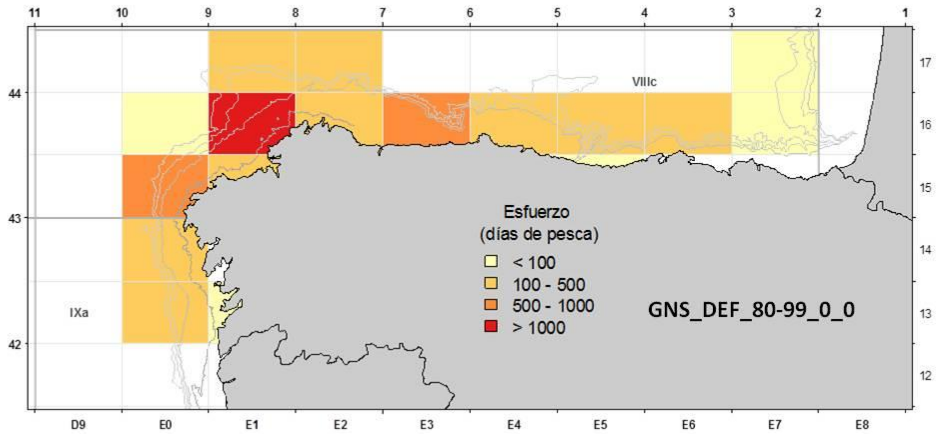


Figure 12 : Spatial distribution of the effort of "volanta" fleet in the Cantabrico-Northwest national fishing ground (GNS_DEF_80-99_0_0).

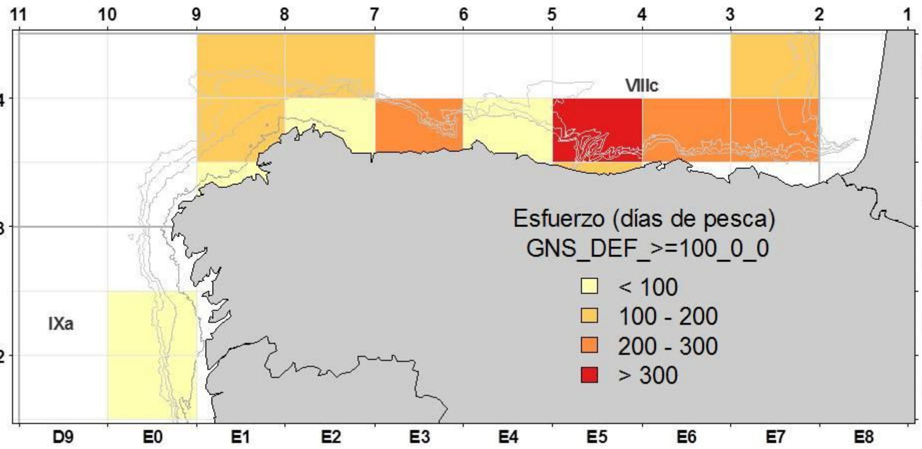


Figure 13 : Spatial distribution of the effort of "rasco" fleet in the Cantabrian-northwest national fishing ground (GNS_DEF _> = 100_0_0).

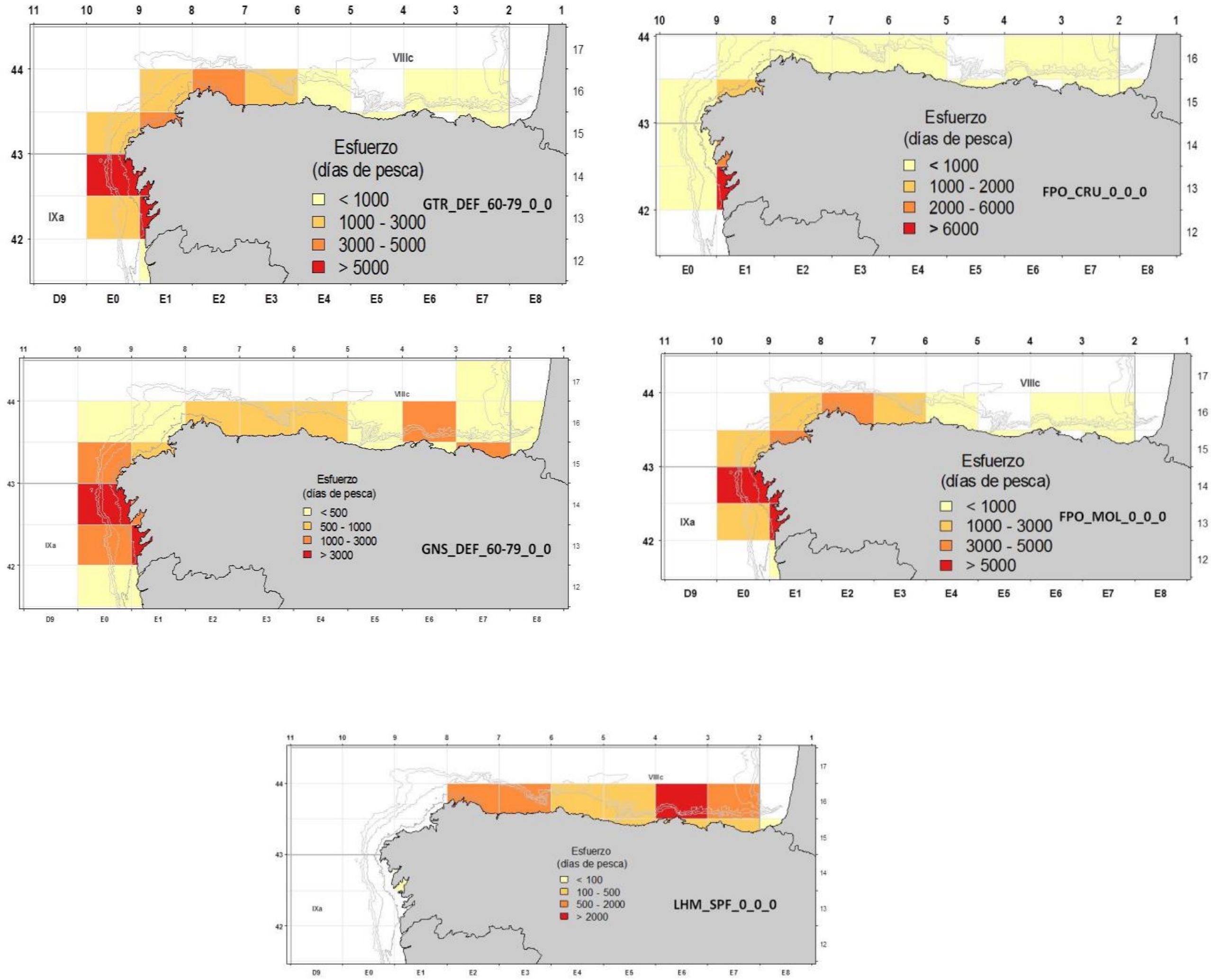


*Figure 14 : Spatial distribution of the effort of the main métiers of the minor arts modality of the Cantabrian-Northwest national fishing ground: pods targeting crustaceans (FPO_CRU_0_0_0), pods targeting octopus (FPO_MOL_0_0_0), gill of "beta" (GNS_DEF_60-79_0_*

2.3.2.4.2 *Spanish fishing activity in French jurisdictional waters of the Bay of Biscay.*

The Spanish vessels that can currently exercise their fishing rights in European Community waters were determined in the "Act of Accession of Spain and Portugal to the European Community", in 1986. The regulation of their fishing activity is dealt with in Part 4 of the Marine Environment report, specifically in its Titles II and III where the "Transitory Measures" of the accession of Spain and Portugal, respectively, are determined. Chapter IV of Title II, in its articles 158 and 160, establishes the limitations of access of the Spanish fleet to non-Iberian community waters. In addition to other activities allowed temporarily, there are two modalities specifically registered for their permanent activity in non-Iberian Atlantic European waters (from Scottish waters, at the north, to French waters, at the south): trawling and fixed gears. The fishing capacity and the technical characteristics of both modalities are shown in Table 12

Characteristics	Trawling	Fixed gears
Nº of vessels	37	61
Seniority	2002	1999
Overall length (m)	35.8	30.1
Tonnage (GT)	354.3	256.0
Power (Kw)	483.8	384.7

Table 12 : Fishing capacity and technical characteristics of the Spanish fleet of Atlantic non-Iberian European waters.

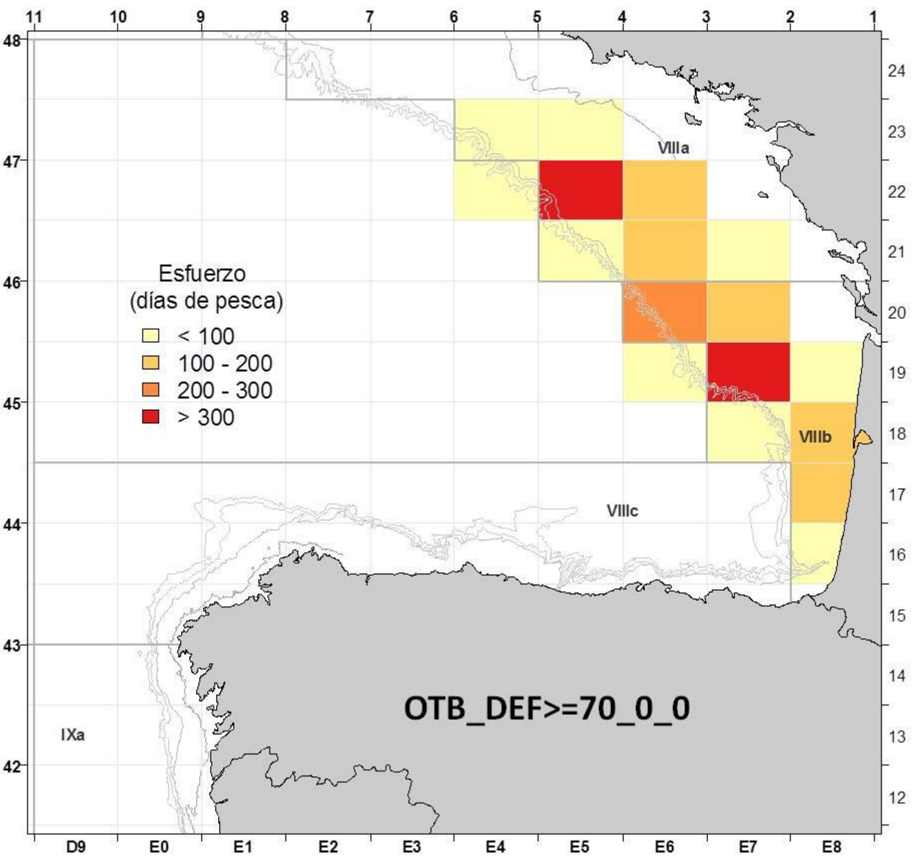
The deep-sea fleet licensed to fish in Atlantic non-Iberian community waters under the trawl mode has employed different types of art over time. Currently, the activity of this fleet has been restricted to the use of bottom trawling with doors and pair trawls. The first uses the art called "baca", while the second has almost completely replaced the traditional art used by another more recent called "naberán". Regardless of the art used, the trawl mode is regulated by European regulations that have been determining different technical measures over the past years. At the end of the 90s, the minimum mesh for trawls allowed in European waters from Norway to the Bay of Biscay was limited to 80 mm for boats targeting hake or roosters, and could be lowered to 70 mm in the case of those targeting Norway lobster (EC Reg. No. 850/98). Shortly thereafter, the implementation of the "Emergency plan for the recovery of the northern stock of hake" increased the minimum mesh allowed to 100 mm for all those trawlers whose catches contained more than 20% of hake (EC Reg. No. 1162/2001) . In addition, two areas were defined, one in zone VII (southwest of Ireland) and another in zone VIII (gulf of Vizcaya), where the minimum mesh of 100 mm was required of all trawlers regardless of the amount of hake conserved on board. In 2006, the use of 70 mm mesh was approved for those trawlers operating in zone VIII using square mesh panels, maintaining the mandatory 100 mm mesh for all other trawlers (Reg. EC No. 51/2006). In terms of fishing activity, the bottom trawling method exercises two different metiers (Figure 15).

- → Trawling with doors targeting demersal fish with a minimum mesh of 70 mm (OTB_DEF _> = 70_0_0).
- → Pair trawling targeting demersal fish with a minimum mesh of 70 mm (PTB_DEF _> = 70_0_0).

The use of both gears has continued uninterruptedly since then, except in 2006, when the activity of the gillnet fleet was affected by a new European regulation that prohibited its use in a generalized way at depths greater than 200 m in ICES zones VI and VII (Reg. EC No. 51/2006). However, a repeal of this regulation, introduced in June of the same year, exempted from this prohibition the gill in sea bottoms of less than 600 m provided it is targeting hake or monkfish (Reg. EC No. 941/2006).

Regarding the regulation of technical measures, the bottom gillnet of community waters is governed by the minimum mesh thresholds established in the "Emergency plan for the recovery of the northern stock of hake": 120 mm in Irish waters (zone VII) and 100 mm in French waters (divisions VIIIabd) (Reg. CE No. 1162/2001), differentiation that was already included in the EC Regulation No. 850/1998. In another vein, the Commission published the regulation for the identification and marking of fixed gears, with the intention of avoiding the ecological damage that their loss may cause in the seabed (Reg. EC nº 356/2005).

On the longline side, vessels under 100 GRT are subject to specific regulations. The Order of June 12, 1992 (BOE nº 150) specified three types of fishery: hake, demersal species not subject to TAC and deep species. A few years later, European regulations establish specific measures applicable to deep-sea fishing because of their vulnerability to exploitation, extending this category with a greater number of species (EC Reg. No. 2347/2002) and setting quotas for some of them (Reg. CE nº 2270/2004). These community regulations forced the adaptation of the national regulations, which had to update the lists and categories of the species without TAC, as well as those considered depth species (Resolution MAPA of November 30, 2005, BOE No. 300).



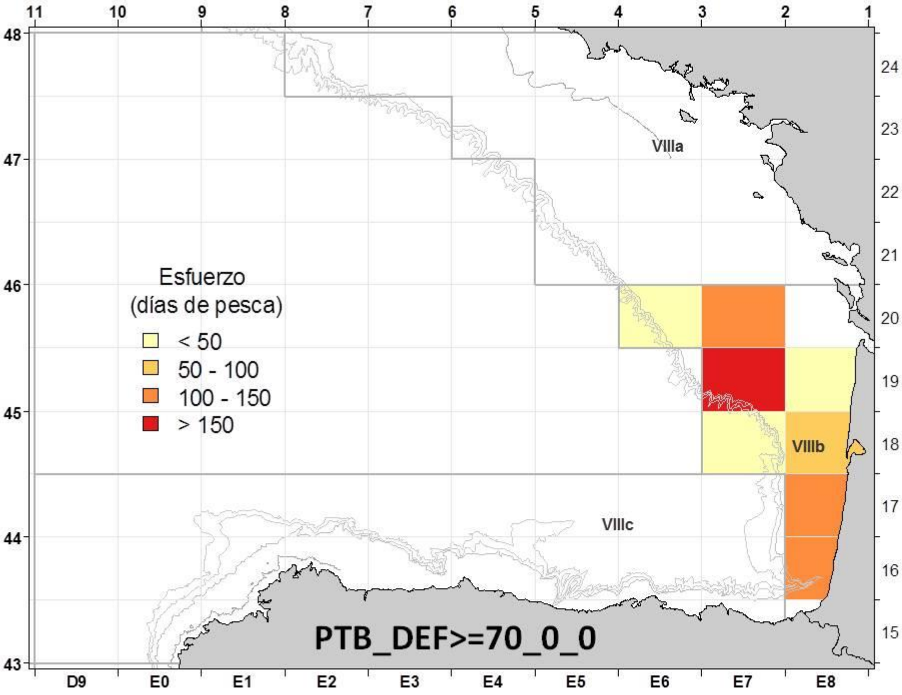
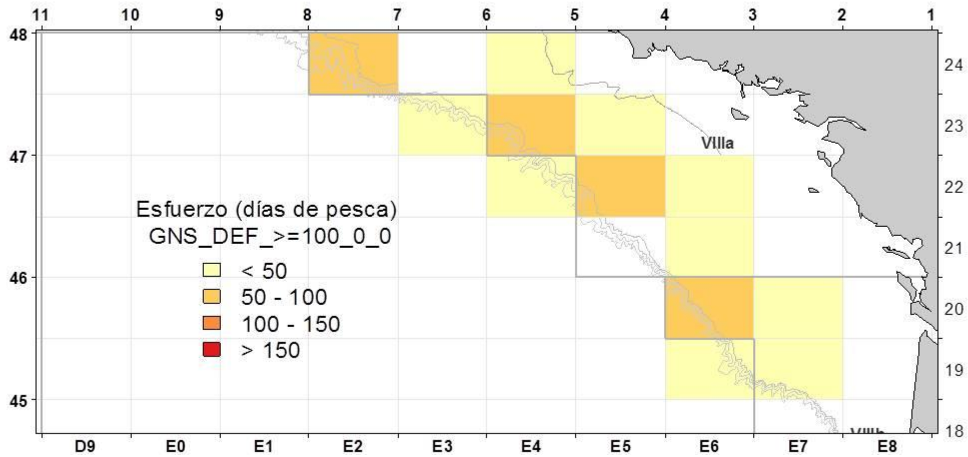


Figure 15 : Spatial distribution of the effort of the two métiers of the Community water trawling fleet on the French coast: trawling with doors targeting demersal species (OTB_DEF> = 70_0_0) and pair trawling (PTB_DEF> = 70_0_0).



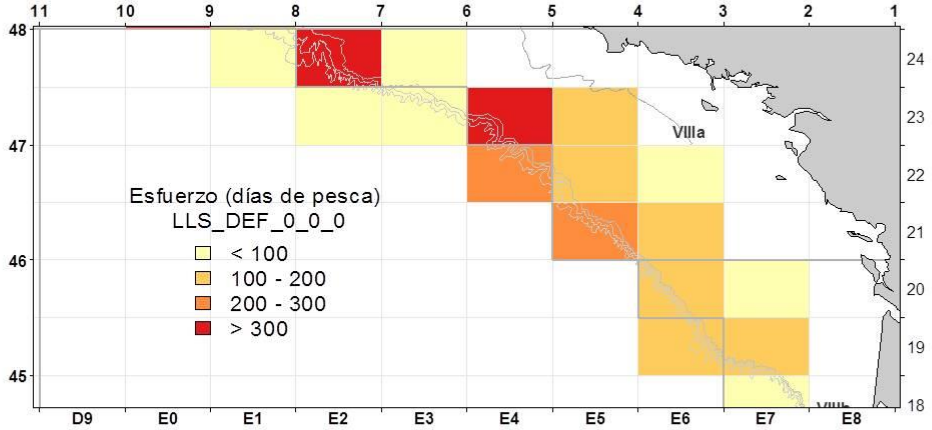


Figure 16 : Spatial distribution of the effort of the two métiers of the fixed-gear fleet of Community waters on the French coast: bottom gillnet targeting demersal species (GNS_DEF> = 100_0_0_0) and bottom longline (LLS_DEF_0_0_0).

2.3.2.5 Impacted components and/or areas in Portuguese waters

In the scope of Descriptor 3 (Selective extraction of species), used, to establish the evaluation of the God Environmental Status, the Decision COM 2010/477/UE. This decision stablishes the use of 3 criteria: 3.1 Level of pressure of Fishery; 3.2 Reproductive capacity of the stock; 3.3 Structure of the population by age and size, presenting the indicators by criteria, to operationalize the quantification of the Good Environmental Status (Table 13).

Criteria	Indicator
3.1 **Level of pressure of Fishery**	3.1.1 Mortality by fishery (primary)
	3.1.2 Ratio Capture/Biomass (secondary)
3.2 **Reproductive capacity of the stock**	3.2.1 Reproductive biomass (SSB) (primary)
	3.2.2 reproductive biomass index (secondary)
3.3 **Structure of the population by age and size**	3.3.1 Proportion of fishes with lenght above average lenght of 1st maturation (primary)
	3.3.2 Average maximum lenght of all captured species in research campaigns (primary)
	3.3.3 Percentil 95 of the distribution by observed lenght in research campaigns (primary)

Table 13 : Criteria and Indicators (synthese) to Descriptor 3 of Portuguese mainland MSFD (Ministério da Agricultura, do Mar, do Ambiente e do Ordenamento do Território 2012).

In Figure 17, is presented a map of the evaluation areas to support the description of pressures and impacts of selective extraction of species.

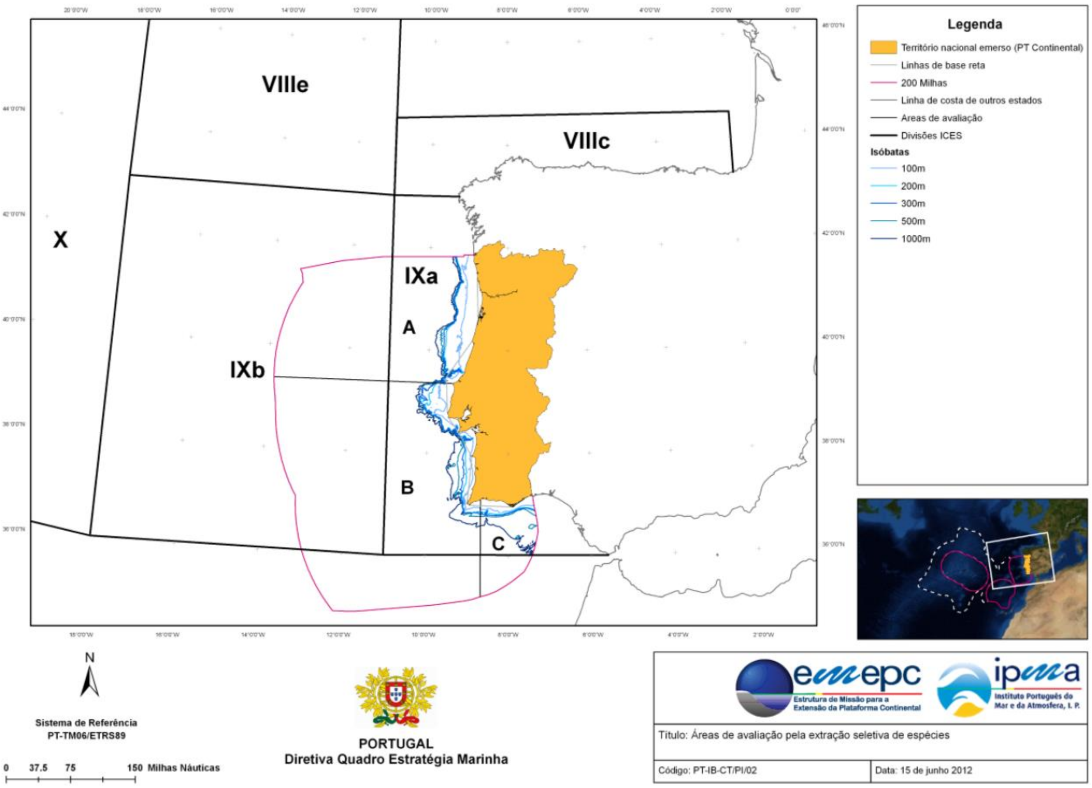


Figure 17 : Areas of evaluation to support the description of pressures and impacts of selective extraction of species (Ministério da Agricultura, do Mar, do Ambiente e do Ordenamento do Território 2012).

In Table 14, is presented a synthesis of the classification of Good Environmental Status by species, criteria and evaluation area. The species considered have at least one classification in one of the descriptors. Most of the commercially explored species is in a presently Good Environmental Status (Table 15).

The analysis of the environmental status by criteria (Table 14, Table 15) shows that for the level of pressure by fisheries was evaluated as not good for 5% of the species (Merluccius merlucius, Lepidorhombus longirostris), both in VII AND XIa areas of ICES.

Scientific name	Area of Evaluation	Criteria 3.1	Criteria 3.2	Criteria 3.3
Fishes				
Sardina pilchardus	VIIIc and XIa (ICES)	H	H	H
Trachurus trachurus	XIa (ICES)	H	H	H
Aphanopus carbo	VIII e IX (ICES)	M		
Merluccius merluccius	VIIIc e XIa (ICES)	H	H	H
Trisopterus luscus	mainland subdivision	H	M	H
Scomber colias	mainland subdivision	L		M
Pagellus acarne	mainland subdivision	H	M	H
Conger conger	mainland subdivision	M	L	H
Zeus faber	mainland subdivision	M		H
Mullus surmuletus	mainland subdivision	L	H	H
Micromesistius poutassou	mainland subdivision	L	H	H
Lophius piscatorius	VIIIc and XIa (ICES)	H	H	
Lophius budegassa	VIIIc and XIa (ICES)	H	H	
Scomber scombrus	mainland subdivision	M	M	H
Xiphias gladius	North Atlantic (ICCAT)	H	H	H
Argyrosomus regius	B	M		
Engraulius encrasicolis	XIa (ICES)	M	M	M
Trachurus picturatus	mainland subdivision	M	H	H
Lepidorhombus whiffiagonis	VIIIc e XIa (ICES)	H	H	
Lepidorhombus boscii	VIIIc e XIa (ICES)	H	H	
Crustacea				
Parapeneus longirostris	B and C	H	H	H
Nephrops norvegicus	B and C	H	H	H
Aristeus antennatus	B and C	L	L	
Molluscs				
Octopus vulgaris	A	M		M
	B	M		
	C	M		M
Sepia officinalis	A	M		M
	B	M		
	C	M		M
Loligo vulgaris	mainland subdivision	H	H	H
Spisula solida	A	M	H	H
	B	M	H	H
	C	M	H	H
Donax trunculus; D. vittatus	B	M	H	H
	C	M	H	H
Elasmobranchii				
Isurus oxyrinchus	North Atlantic (ICCAT)	L	L	L
Raja clavata	mainland subdivision	H		H
Raja brachyura	mainland subdivision	H		
Raja montagui	mainland subdivision	M		M
Leucoraja naevus	mainland subdivision	M		
Prionace glauca	North Atlantic (ICCAT)	M	M	M

Table 14 : Classification of the Good Environmental Status by specie and criteria. For each evaluated criteria, the respective evaluation degree of trust is presented (H-HIGH; M-MEDIUM; L-LOW) (Ministério da Agricultura, do Mar, do Ambiente e do Ordenamento do Território 2012).

3.1 Pressure of fishery	3.2 Reproductive capacity	3.3 Structure of the population
95%	61%	74%
5%	5%	3%
0%	34%	23%

Table 15 : Summary of the actual status the commercially exploited species in the mainland subdivision. For some species, it was not possible to determine the state to all descriptors (grey) (Ministério da Agricultura, do Mar, do Ambiente e do Ordenamento do Território 2012)

3 Physical pressures

3.1 Pressures on sea-floor integrity: Physical loss and Physical Disturbance to the seabed (Descriptor 6 and Descriptor 1)

The MSFD Good Environmental Status Descriptor n° 6 (Sea-floor integrity) assesses two pressures: **physical loss** (due to permanent change of seabed substrate or morphology and to extraction of seabed substrate) and **physical disturbance** to seabed (temporary or reversible). According to Commission Decision (EU) 2017/848, physical loss shall be understood as a 'permanent change to the seabed which has lasted or is expected to last for a period of two reporting cycles (12 years) or more.

3.1.1 Physical loss or physical disturbance?

Whether an activity causes physical loss or physical disturbance might differ according to sources. For example:

→ **Extraction selective of materials** is considered as a *physical loss* in the French MSFD, Portuguese MSFD, MarLIN matrix, and recent Decision 2017/848 but is considered as a *physical disturbance* in Spanish MSFD (Annex III. Physical pressures categories and activities (Spanish MSFD assessment)) as well as in (La Riviere et al. 2017) (Annex IV. Physical pressures categories and definitions (La Riviere et al. 2017))

→ **Dumping of dredge spoil** is considered as a *physical disturbance* in the Spanish MSFD assessment, but as a physical loss in(La Riviere et al. 2017); it is not qualified as either *loss* or *disturbance* by French and Portuguese MSFD assessments.

→ **Abrasion** is considered as a *physical disturbance* in the French, Spanish and Portuguese MSFD assessments, in the recent MSFD Decision 2017/848 as well as in MarLIN matrix. However, the former version of the Directive considered that abrasion could also be a *physical loss* when applied to biogenic habitats, but this is not taken into account in the new Decision 2017/848.

Definition as a physical loss or disturbance might also differ according to specific and local variations. For example, based on the MSFD definition, aquaculture installations could cause either physical disturbance or physical loss depending on their lifespan (more or less than 12 years).

Annex III. Physical pressures categories and activities (Spanish MSFD assessment) provides two matrixes: the first shows the classification as 'loss' or 'disturbance' of pressures considered by Spain, as well as corresponding activities. Annex IV. Physical pressures categories and definitions (La Riviere et al. 2017)shows the classification as 'loss' or 'disturbance' of pressures considered in (La Riviere et al. 2017), as well as pressures definitions.

3.1.2 Activities driving physical loss or disturbance to the seabed

Activities causing sealing and/or smothering (that can be considered as physical loss) are: all permanent man-made structures (harbours, seawalls, defense infrastructure, hydrocarbon platforms, polders etc.), shellfish culture infrastructure, dumping of dredge spoil. To a lesser spatial extent, other activities are drivers of this pressure: submarine cables, artificial reefs, and wrecks (Agence des Aires Marines Protégées et Ifremer 2012; Ministério da Agricultura, do Mar, do Ambiente e do Ordenamento do Território 2012).

Extraction of sand, maerl or coarse sediments can also be considered as causing physical loss (MSFD Decision 2017/848).

Abrasion pressure (physical disturbance) is generated by the following activities: commercial fishing (trawl nets, purse seines, dragging, trolling), boating, anchoring; abrasion in the surroundings exploitation of subsoil resources and installation of cables. The major cause for surface abrasion in OSPAR Region IV is bottom-fishing activity (OSPAR Commission 2017). Bottom fishing activities induce abrasion pressure on a very large spatial extent; other sources of abrasion are very local. Moreover, although depending on how the pressure varies over time, impacts due to bottom fishing abrasion are considered high (OSPAR Commission 2017).

Other physical disturbance pressures could be considered apart from abrasion, such as trampling or reworking of the sediment (Annex III. Physical pressures categories and activities (Spanish MSFD assessment), Annex IV. Physical pressures categories and definitions (La Riviere et al. 2017)), but they are not assessed in this document.

The former evaluation of activities in the context of project MARLIN is shown in Table 16

MSFD name of pressure	Sub-category (from MarLIN)	Activities(from MarLIN)
Physical loss (permanent change)	Substratum loss (physical removal	→ Coastal defence (**barrage (R)**, beach replenishment, groynes, sea walls/breakwaters)(P) → **Collecting (bait digging, higher plants, kelp & wrack harvesting, macro-algae, shellfish) (R)** → **Development (Construction phase, land claim) (R)** → **Dredging(Captial dredging, maintenance dredging) (R)** → **Energy generation (wind farms) (R)** → **Extraction (maerl, rock/minerals, sand/gravel) (R)** → **Fisheries/ shellfisheries (benthic trawls, suction dredging) (R)** → Uses (**archaeology (R),** research (P)) → **Other (removal of substratum) (R)**
	Smothering (including sealing)*	→ **Aquaculture(fin-fish,** macro-algae**, shellfisheries) (R)** → **Coastal defence (barrage, beach replenishment (R)**, groynes, sea walls/breakwaters (P)) → **Collecting (bait digging, peelers, shellfish) (R)** → **Development (Construction phase (R),** artificial reefs, communication cables (P)**, dock/port facilities, land claim, marinas, oil&gas platforms (R))** → **Dredging (Captial dredging, maintenance dredging) (R)** → Energy generation (nuclear power generation, power stations, renewable (P) → **Extraction (Maerl, rock/minerals, oil&gas, sand/gravel) (R)** → **Fisheries/shellfisheries (benthic trawls, potting/creeling, suction dredging) (R)** → **Uses (Archaeology, coastal farming, coastal forestry, mooring/beaching/launching (R),** shipping (P)) → **Wastes (Fisheries & agricultural wastes, industrial effluent discharge, inorganic mines and particulate wastes, land/waterfront runoff, litter and debris, sewage discharge (R),** shipping wastes (P), **spoil dumping (R))** → **Other (Removal of substratum) (R)**
Physical disturbance (theoretically non-permanent)	Abrasion / physical disturbance	→ **Aquaculture (fin-fish, shellfisheries) (R)** → **Coastal defence (barrage, beach replenishment) (R)** → **Collecting (bait digging, bird eggs, curios, higher plants, kelp& wrack harvesting, macro-algae, peelers, shellfish) (R)** → **Development (construction phase, dock/port facilities, marinas, oil& gas platforms, urban)** → **Dredging (capital dredging, maintenance dredging) (R)** → **Energy extraction (wind farms) (R)** → **Fisheries/shellfisheries (benthic trawls, netting, potting/creeling, suction dredging) (R)** → **Uses (**Animal sanctuaries (P)**, archaeology, coastal farming,**

		coastal forestry, education/interpretation, military, mooring/beaching/launching, research shipping (R)) → **Wastes (inorganic mines and particulate wastes, litter and debris (R),** spoil dumping**)**

Table 16 : Activities driving physical loss and physical damage (probable effect (R) or possible (P)) adapted from MarLIN 'Maritime and coastal activities to environmental factors matrix'

Due to the nature of some activities, and a lack of knowledge concerning some habitats recovery time, an uncertainty exist on this activities and their spatial distribution (namely bottom fishing).

A distinction has to be done between occurrence and intensity. Occurrence is the number of time an action occurs, and intensity adds a gradient in the impact of activities (strong impact or low impact).

3.1.3 Nature of impacts of physical loss or physical disturbance to the seabed

Physical disturbance and physical loss directly impact benthic habitat and communities, as well as food webs. Moreover, ecosystems are often subject to many different pressures, which can have cumulative impacts.

Physical disturbance can adversely affect habitats, through change in their biotic and abiotic structure and their functions, for example through changes in species composition and their relative abundance, absence of particularly sensitive or fragile species or species providing a key function, changes in size structure of species (Commission Decision 2017/848, definition of criteria D6C3).

Remark: Impacts of abrasion pressure (physical disturbance) depend on its **frequency**. How pressure varies over time is an important factor for subsequent analysis of disturbance impacts. It affects the ability of habitats to recover. Impacts of abrasion also depend on the sensitivity of the exposed habitats (Table 17, Table 21)**.** Further information regarding sensitivity of seabed habitats is provided in Annex V. Benthic habitats sensitivity to physical pressures.

Type of impacts on habitats and benthic communities	
Physical disturbance: ABRASION	Impacts of abrasion depends on the following factors: → existence of the pressure, → **frequency** (fishing effort per time unit) of fishing activity on seabed, habitat type (sediment type, tide exposure…), → sensitivity and resilience of species . (Agence des Aires Marines Protégées et Ifremer 2012) Abrasion due to bottom-trawling fisheries has impacts on: → species composition, → diversity, → production. (Agence des Aires Marines Protégées et Ifremer 2012)
Physical loss : EXTRACTION	Impacts vary according to sites and extraction techniques. (Agence des Aires Marines Protégées et Ifremer 2012) Extraction of sands and gravel can cause local significant decrease in biomass, abundance and species richness. Living organisms can be sucked with extracted material or damaged. Substrate extraction can cause quick changes to benthic communities due to re-sedimentation of suspended sediments, changes in grain size and topography, creation of an area to be colonized. (Agence des Aires Marines Protégées et Ifremer 2012)
Physical loss : SEALING AND	Construction works (polders, seawalls, etc.) cause local destruction of benthic communities. Dumping of dredge spoil might have different impacts according to

SMOTHERING	the site, method, type of sediments, currents, and types of benthic communities. (Agence des Aires Marines Protégées et Ifremer 2012) Activities causing sealing or smothering can also cause changes to hydrographical conditions (cf Part on Changes to Hydrographical conditions), that can themselves impact benthic communities.

Table 17 : Nature of impacts of physical loss and physical damage pressures

3.1.4 Impacts of physical pressures in OSPAR Region IV

This section is structured into three parts. Firstly, the types of possible impacts of physical pressures (loss and disturbance) to the seabed are mentioned (section 1.2.1). Then, an assessment of exposure and intensity (if information is available) of physical pressures in OSPAR Region IV is provided (section 1.2.2). Finally, an overlap is made between physical pressures (loss and disturbance) exposure and intensity, and habitat type and sensitivity (in information is available).

A similar approach is used in the MSFD framework, with on one hand criteria D6C1 and D6C2 focusing on spatial extent of physical pressures, and on the other hand criteria D6C3 to D6C5 focusing on the impacts on benthic habitats.

MSFD	Criteria elements	Criteria
Descriptor 6: 'Sea-floor integrity'	Physical loss of the seabed (including intertidal areas)	D6C1: Spatial extend and distribution of physical loss (permanent change) of the natural seabed
	Physical disturbance to the seabed (including intertidal areas)	D6C2: Spatial extend and distribution of physical disturbance on the natural seabed
	Benthic broad habitat types or other habitat types	D6C3: Spatial extent of each habitat type which is adversely affected (…) by physical disturbance
Descriptor 1: 'Biodiversity'	Benthic broad habitat types	D6C4: Extent of loss of the habitat resulting from anthropogenic pressures
	Benthic broad habitat types	D6C5: Extent of adverse effects from anthropogenic pressures on the condition of the habitat type

Table 18 : Criteria used to assess benthic habitats under MSFD Descriptor 1 and Descriptor 6 (Decision 2017/848)

3.1.4.1 Spatial extent (and intensity) of physical disturbance

This part focuses on the spatial extent and distribution of physical disturbance (MSFD criteria D6C2), as well as its intensity when the information is available. Therefore, this section provides information on potentially impacted areas, taking into account exposure to and intensity of the pressure (when the information is available). The only physical pressure considered for this assessment of physical disturbance is abrasion.

3.1.4.1.1 Physical disturbance (spatial extent) in French waters

Those disturbances have been evaluated in the north French part of Bay of Biscay in the MFSD context. Those results presented in Table 19 but are still under the validation process so could be slightly different than the official report coming in 2018.

	Activities considered	Area with pressures data(km²)	% of the total marine area	Reliability of results
D6C2		**97 169,3**	**102,88**	**Low**
	Extent of the potential physical disturbance due to coastal constructs	8,3	<0,02	(very) Low
	Extent of the potential physical disturbance due to extraction	24,8	0,03	Low
	Extent of the potential physical disturbance due to dredging	3,3	<0,02	Low
	Extent of the potential physical disturbance due to immersion of dredging materials	66,1	0,07	Low
	Extent of the potential physical disturbance due to bottom fishing	97 024,3	102,73	Low
	Extent of the potential physical disturbance due to mooring	39	0,04	Low
	Extent of the potential physical disturbance due to aquaculture	128,4	0,14	Low

Table 19 : Results of the French MFSD Evaluation for potential physical disturbances

The reliability on those results is considered low because of huge uncertainty concerning those evaluations. Regarding the data used, the hypothesis and the necessary interpretations, quantified results must be discussed separately for each activities considered. However, despite those uncertainties, it appears that a majority of the marine are is affected by potential physical disturbance due to bottom fishing. (Brivois et al. 2018)

3.1.4.1.2 Physical disturbance (spatial extent, intensity) in Cantabrian sea and Galicia

For the Spanish MSFD assessment of abrasion pressure in the Cantabrian sea and Galicia, the following activities were taken into account: bottom trawling, anchoring and dredging. The spatial extent of the last two stressors is very small in comparison to the abrasion due to bottom trawling. For this reason, and due to the harmful effects of the use of this gear on the sea floor, it was decided to evaluate them separately. No information about the distribution of scuba diving is available, and therefore, this activity was not included in the analysis. (Instituto Espanol de Oceanografia et Asistencia Tecnica TRAGSATEC SA 2012a)

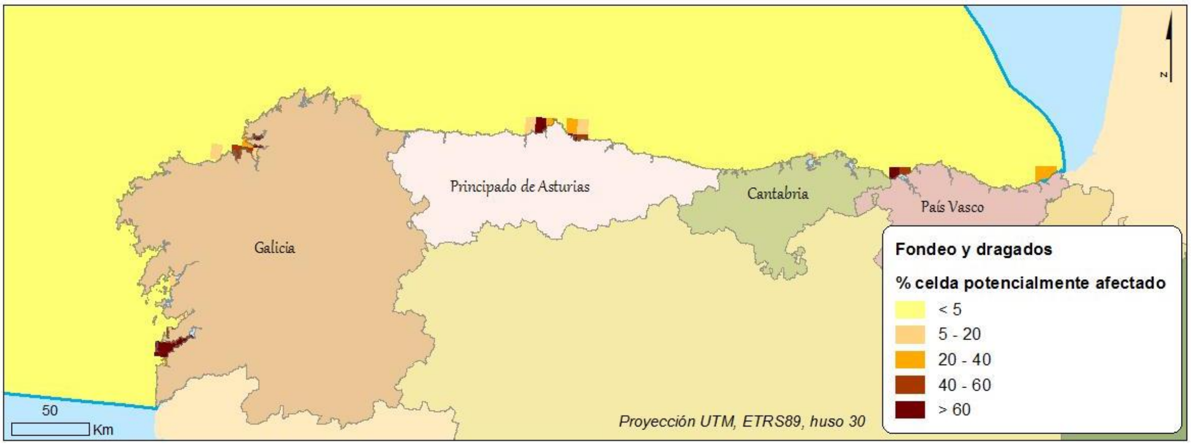
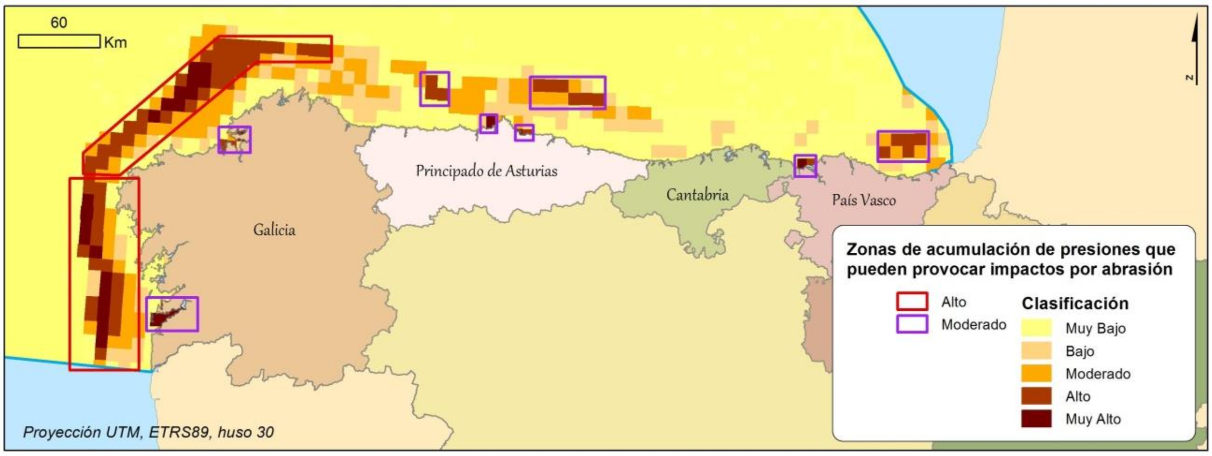


Figure 18: Zones of accumulation of 'abrasion' pressure due to anchoring and port dredging (Instituto Espanol de Oceanografia et Asistencia Tecnica TRAGSATEC SA 2012a). For anchoring and port dredging the area percentage potentially occupied by both types of pressure has been calculated per cell, classified by potential levels of affection according to the following range of values: Very High: > 60% / High: 40 - 60% / Medium: 20

- 40% / Low: 5 - 20% / Very Low: <5%

In the case of bottom trawling, the range of values is established taking into account the hours of trawling per year. The sum of the hours fishing with bottom otter trawl and bottom pair trawl per cell is made, punctuating double the pair trawl, since this technique is considered more abrasive.



The overlapping of both grids gives place to a new, qualitative one.

Figure 19: Zones of accumulation of 'abrasion' pressure due to bottom trawling, anchoring and port dredging (Instituto Espanol de Oceanografia et Asistencia Tecnica TRAGSATEC SA 2012a). The resulting range of values is as follows: Very High: > 8000 / High: 4001-8000 / Medium: 2001-4000 / Low: 1001-2000 / Very Low: <1000.

Although the classification reflects very high values for some ports, since anchoring and dredging are activities supervised by the port and maritime authorities, they haven't been considered in areas with potential high abrasion. Thus, two areas with a high potential impact due to abrasion (Costa de las Rías Bajas and Costa da Morte-Costa de Lugo) and 8 with moderate potential are identified (those corresponding to the ports of Vigo, Coruña -Ferrol, Avilés, Gijón and Bilbao, as well as fishing areas in western Asturias, eastern Asturias and the Basque Country).

3.1.4.1.3 Physical disturbance (spatial extent) in Portuguese waters

Spatial distribution physical disturbance (abrasion caused by bottom fishing activity, and extraction of material sites) in Portuguese waters is found in Impacts of physical pressures in Portuguese waters, with an overlap with broad habitat types.

3.1.4.2 Spatial extent of physical loss

This part focuses on the spatial extent and distribution of physical loss (MSFD criteria D6C1). Therefore, this section provides information on potentially impacted areas, taking into account exposure to the pressure.

3.1.4.2.1 Physical loss (spatial extent) in French waters

Those disturbances have been evaluated in the north French part of Bay of Biscay in the MFSD context. Those results presented in Table 19 but are still under the validation process so could be slightly different than the official report coming in 2018.

	Activities considered	Area with pressures data(km²)	% of the total marine area	Reliability of results
D6C1		146	0,16	**Faible**
	Extent of the potential physical disturbance due to coastal constructs	26,1	0,02	(très) Faible
	Extent of the potential physical disturbance due to extraction	30,1	0,03	Faible
	Extent of the potential physical disturbance due to dredging	3,3	< 0,02	Faible
	Extent of the potential physical disturbance due to immersion of dredging materials	87,6	0,09	Faible

Table 20 : Results of the French MFSD Evaluation for potential physical loss

Despite uncertainties, again important, potential physical losses in this marine area are mostly due to coastal constructs, extraction and immersion of dredging materials

Moreover, physical disturbance (bottom fishing, mooring, aquaculture) could induce physical loss. Using the precaution principles, those data should be considered as potential losses. Those activities have not been evaluated because of missing data on specific habitats and missing time. (Brivois et al. 2018)

3.1.4.2.2 Physical loss (spatial extent) in the Cantabrian sea and Galicia

The MSFD Initial assessment of pressures and impacts in Spain (Instituto Espanol de Oceanografia et Asistencia Tecnica TRAGSATEC SA 2012a) provides the distribution of areas subject to high levels of pressure of ‘smothering and changes in the seabed profile’ and ‘sealing’.

Pressure: Smothering and changes in the seabed profile

In order to identify the areas possibly affected by smothering or changes in the seabed profile, several activities are taken into account: dredging, sand extraction, dumping of dredged material, beach nourishment, cables and pipelines, artificial reefs and controlled sinking of ships.

When the information is not represented as polygons but as points or lines with no available surface, a buffer area around the pressure is considered:

- → Sunken ships: 75 m
- → Cables and pipelines: 5 m
- → Nourished beach: 200 m

The next step is to compute, by cell, the area percentage occupied by all cited pressures.

Groups of cells classified as very high are considered to have a high potential risk of smothering or changes in the seabed profile (3 areas: Puerto de Vigo, Golfo Ártabro y Gijón), while those classified as high are designed as with a moderate potential risk (2 areas: Vilagarcía y Ensenada de Calderón).

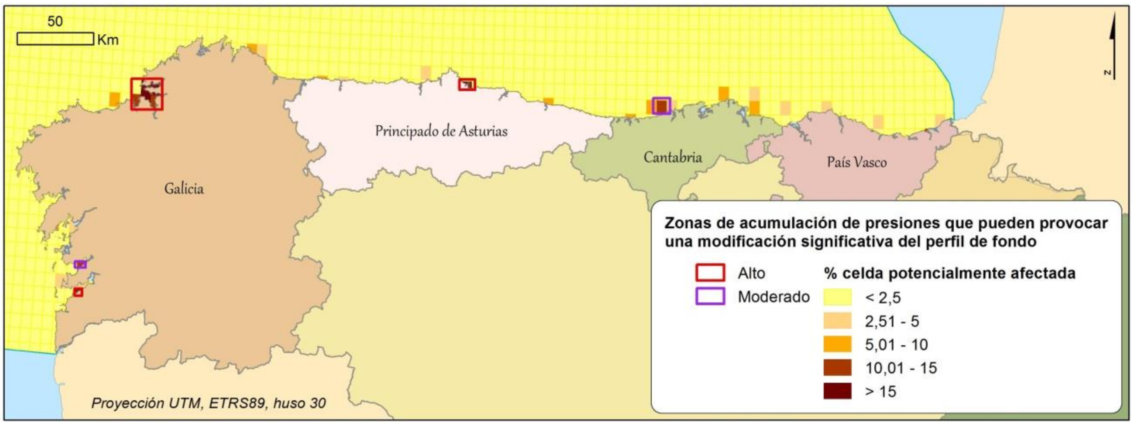


Figure 20: Zones of accumulation of pressure 'smothering and changes in the seabed profile (Instituto Espanol de Oceanografia et Asistencia Tecnica TRAGSATEC SA 2012a). Cells are classified as follows: Very high: > 15 % / High: 10 – 15 % / Medium 5 – 10 % / Low: 2,5 – 5 % / Very low: < 2,5 %

Pressure: Sealing

Similar to smothering, the percentage of the cell surface occupied by structures that permanently seal the seabed is estimated. Pressures considered are:

→ artificial coast: buffer distance of 100 m
→ artificial reefs: no buffer distance applied
→ off-shore platforms: buffer distance of 50 m
→ sunken ships: buffer distance of 75 m

Areas with a potentially high impact due to sealing are selected from cells classified as "Very High" and areas with a moderate potential impact from cells classified as "High". It should be noted that "Very High" cells due to the presence of ports are only classified as areas with high potential impact in the case of Ports of General Interest.

3 areas with high sealing potential (Puerto de Vigo, Puerto de Ferrol and Gijón) and 1 with moderate potential (Ensenada de Calderón) are identified.

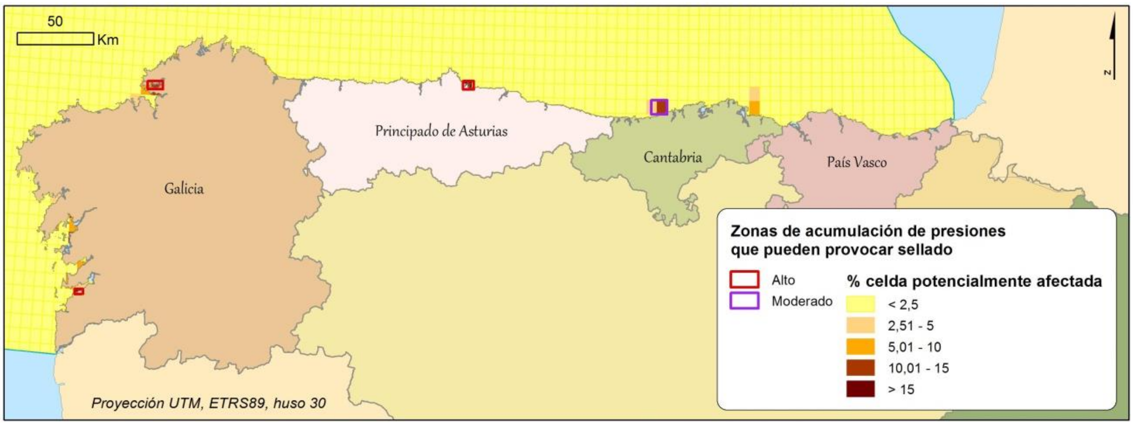


Figure 21 : Zones of accumulation of pressure 'sealing' (Instituto Espanol de Oceanografia et Asistencia Tecnica TRAGSATEC SA 2012a). The ranges are: Very high: > 15 % / High: 10 – 15 % / Medium 5 – 10 % / Low: 2,5 – 5 % / Very low: < 2,5 %

Pressure: Selective extraction of materials

Areas that can be potentially impacted by selective extraction activities are identified taking into account the spatial distribution of the areas designated for sand extraction, the port areas that can be potentially dredged and the permits for the exploitation of fossil fuel. As in previous pressures, the percentage of area affected by any of the activities mentioned is calculated for each grid cell.

Since most of these activities are subject to Environmental Impact Assessment, the impacts will generally be anticipated and minimized, corrected and/or compensated. For this reason, only 3 zones of moderate potential of being impacted are considered (Costa Ártabra, Gijón and Gaviota platform). The ranges of values established in the grid are:

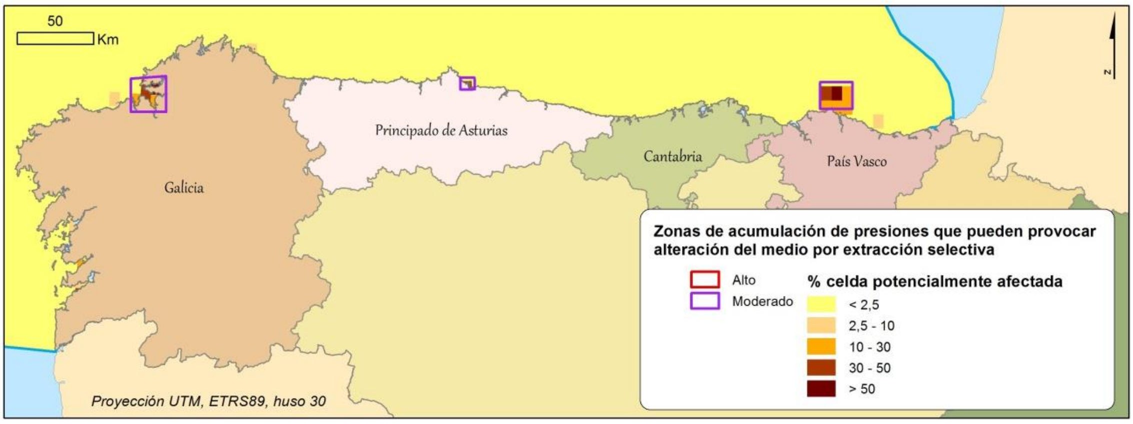


Figure 22: Zones of accumulation of pressure 'extraction of material' (Instituto Espanol de Oceanografia et Asistencia Tecnica TRAGSATEC SA 2012a). Very High: > 50% / High: 30 - 50% / Medium: 10 - 30% / Low: 2.5 - 10%

3.1.4.2.3 Physical loss (spatial extent) in Portuguese waters

Spatial distribution of activities causing physical loss in Portuguese waters is found Impacts of physical pressures in Portuguese waters, with an overlap with broad habitat types.

3.1.4.3 Areas impacted by physical disturbance and physical loss

The previous section identifies areas subject to physical pressures (exposure, or spatial extent) as well as their magnitude, frequency and duration when available (intensity). However, this approach does not allows to estimate impacts: to do so, the nature and sensitivity of seabed habitats and communities have to be taken into account.

3.1.4.4 Sensitivity of benthic habitats to physical pressures

According to (La Riviere et al. 2017), many considered habitats have a 'High' sensitivity to substrate extraction (e.g 1110 Sandbanks which are slightly covered by sea water all the time – **Coarse sand or gravel;** 1130 Estuaries, 1140 Mudflats and sandflats not covered by the sea at low tide etc.). It takes time for substrate to reform and to be colonized by benthic communities. Many considered habitats have a 'Very High' or 'High' sensitivity to abrasion. Sensitivity depends on the depth of abrasion (superficial, shallow or deep).Finally, many habitats have a 'High' sensitivity to dumping of material, the sensitivity level depending on the amount of material.

The most sensitive features are those that are easily damaged and slow to recover. Some never recover. Reefs of the cold-water coral *Lophelia pertusa* are slow-growing and delicate can be severely damaged by bottom trawl fisheries (OSPAR Commission 2010).

3.1.4.5 OSPAR assessment of Extent of Physical Damage indicator

OSPAR produced an assessment[1] of current distribution and extent of habitat sensitivity; the overlapping fishing pressure causing surface and subsurface abrasion; and the resulting habitat disturbance. These results allow the distinction to be made between seafloor habitats of varying sensitivity that are under pressure from these types of fishing activities.

The 'Extent of Physical Damage' indicator uses two types of information: the distribution and sensitivity of habitats (resilience and resistance); and the distribution and intensity of human activities and pressures that cause physical damage (e.g. mobile bottom gear fisheries, sediment extraction and offshore constructions) although only fisheries are covered in this assessment. These two sources of information (i.e. sensitivity and pressure) are combined to calculate the potential damage to a given seafloor habitat, and the trends across a six-year period (2010-2015)

This is the first OSPAR-wide assessment of physical damage to benthic habitats. As such, confidence in the methodology is low / moderate. Confidence in the data availability is low (but moderate to high in well surveyed areas).

Figure 23 shows that the highest disturbance categories are found on the French continental shelf, as well as in the southern Portuguese continental shelf.

[1] https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/biodiversity-status/habitats/extent-physical-damage-predominant-and-special-habitats/

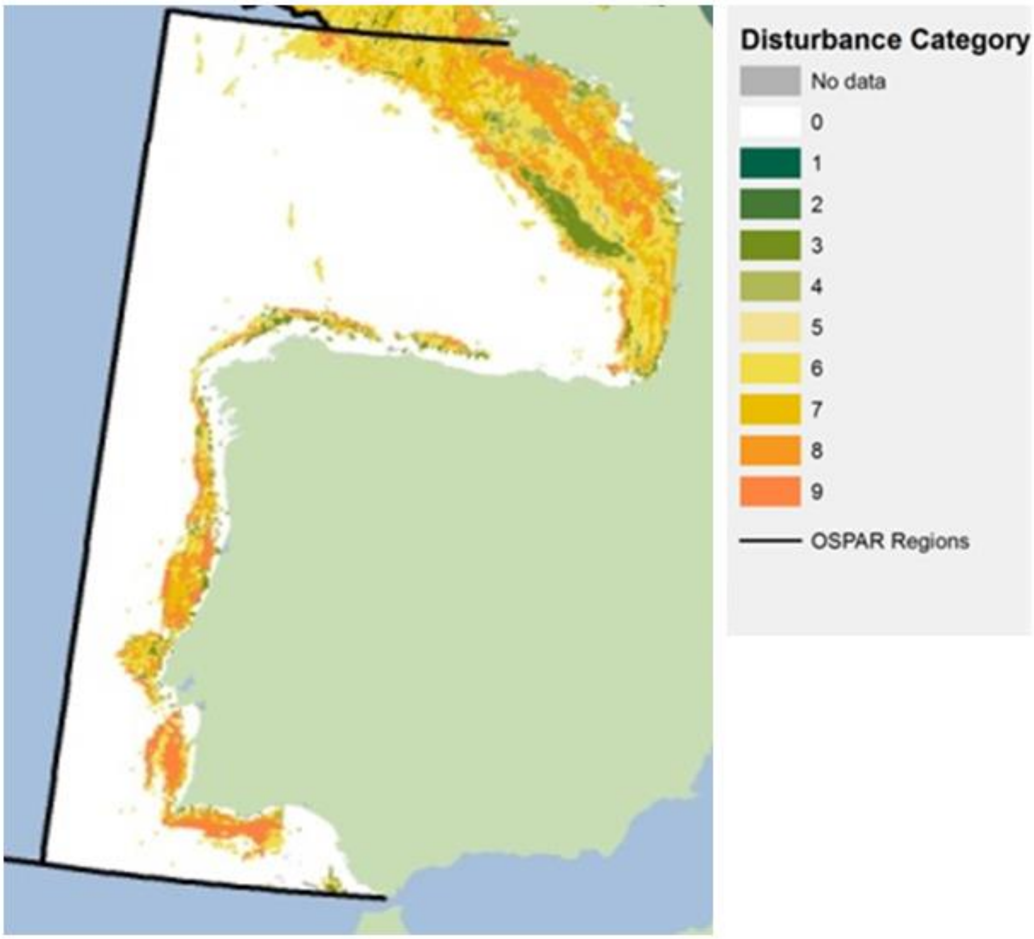


Figure 23: Spatial distribution of aggregated disturbance using the 2010–2015 data series across OSPAR sub-regions (OSPAR Commission 2017)

Disturbance categories 0–9, with 0= no disturbance and 9= highest disturbance. Plots show percentage area of OSPAR sub-regions in disturbance categories 0–4 (none or low disturbance) and 5–9 (high disturbance) across reporting cycle (2010–2015). The percentage was not included for the Bay of Biscay and Iberian Coast due to the lack of complete data.

Remarks: Some areas under high levels of surface and especially sub-surface abrasion, show low habitat disturbance. This could be caused by sensitive features being replaced by opportunistic and less sensitive species. At present, there are limitations due to data availability and accessibility for assessing habitat extent and distribution and associated habitat sensitivity. Some areas have already lost sensitive species and biotopes due to past human activities, such occurrences cannot be assessed by this Indicator and this will result in a lower disturbance score in such areas(OSPAR Commission 2017).

3.1.4.6 Impacts of physical loss and abrasion in the Bay of Biscay (French MSFD assessment)

In the MSFD framework, France has summarized impacts from physical pressures for each marine environment feature in the context of the Bay of Biscay (Agence des Aires Marines Protégées et Ifremer 2011). This impact assessment was contextualized in the Bay of Biscay (taking into account if there is an existing interaction, resulting in actual impacts). A confidence index is also provided for each impact diagnostic (low, medium, high).

Impacted components in the Bay of Biscay Pressure : *Physical loss (due to permanent change of seabed substrate or morphology and to extraction of seabed substrate)*	
SIGNIFICANT IMPACT	→ Demersal fish and cephalopod species → Littoral with hard or soft substrate communities → Exploited fish and cephalopods
LOW IMPACT	→ Marine mammals → Marine birds → Pelagic fish and cephalopods → Phytobenthos → Infralittoral and circalittoral hard substrate communities → Infralittoral soft substrate communities → Commercially-exploited crustaceans and shellfish → Food webs
Impacted components in the Bay of Biscay Pressure : *Physical disturbance to the seabed*	
HIGH IMPACT	→ Infralittoral and circalittoral soft substrate communities
SIGNIFICANT IMPACT	→ Bathyal and abyssal communities → Commercially-exploited crustaceans
LOW IMPACT	→ Demersal and pelagic fish and cephalopods → Phytobenthos → Littoral hard and soft substrate communities → Infralittoral and circalittoral hard substrate communities → Commercially-exploited fish, cephalopods and shellfish → Food webs

Table 21: High, significant and low impacts of the pressure 'Physical loss (due to permanent change of seabed substrate or morphology and to extraction of seabed substrate) and physical disturbance to the seabed (temporary of reversible)' on ecosystem components in the Bay of Biscay.

In order to define Environmental Targets in the first round of MSFD (Agence des Aires Marines Protégées et Ifremer 2011), France has identified 'ecological' challenges and/or challenge areas for which an action is required to reach Good Environmental Status, based on a qualitative analysis or on expert opinion.

Challenge areas for sea-floor integrity are represented in Figure 24and correspond to areas both exposed to intense pressures and with sensitive ecosystems, which are impacted by these pressures. Both Descriptor 6 'seabed integrity' and 7 'changes to hydrographical conditions' were assessed simultaneously.

Moreover, coastal areas that were transformed into polders a long time ago were not considered in this assessment (Agence des Aires Marines Protégées et Ifremer 2011).

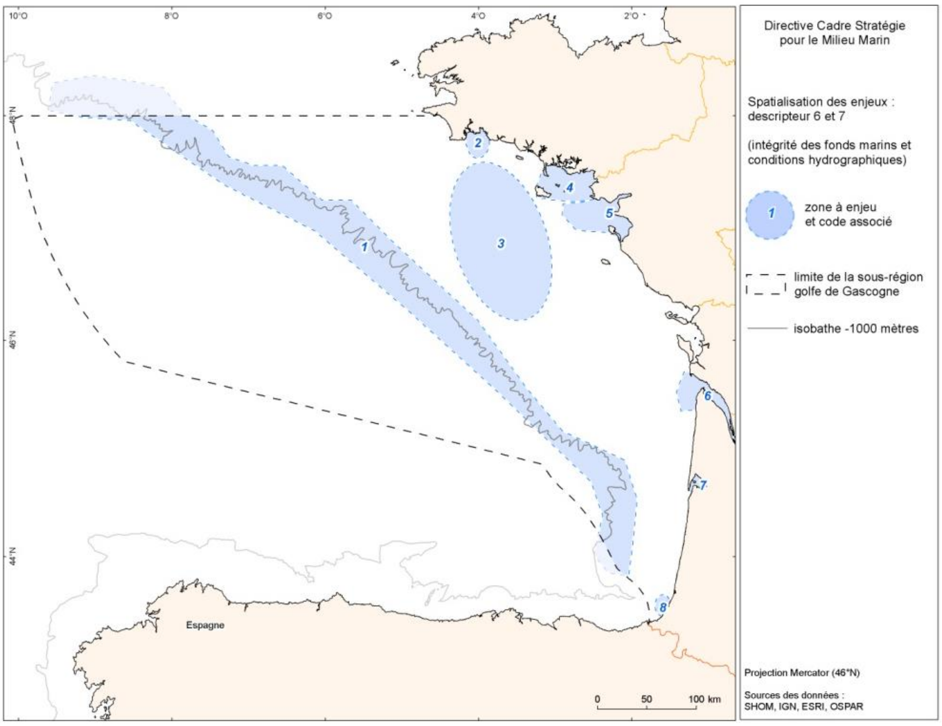


Figure 24: Challenge areas for sea-floor integrity and changes to hydrographical conditions in the Bay of Biscay (Agence des Aires Marines Protégées et Ifremer 2011)

In the Bay of Biscay, challenge areas are:

1) **Continental slope**, between 150 and 1000 meters. Benthic communities, including deep-sea corals are very sensitive to abrasion pressure due to bottom fishing.
2) **Glénan archipelagos**, presence of maerl beds and zostera beds that are sensitive to extraction (for maerl beds) and abrasion due to recreational fishing, shellfish dredging, beach fisheries (for zostera beds)
3) **(*) Offshore, south Brittany: large mud area "Grande Vasière**", with benthic communities that are sensitive to abrasion due to bottom fishing (this area is highly subject to bottom fishing)
4) **Mor Braz sector**, from Belle-Île/ Quiberon to Vilaine estuary. This area is highly subject to physical pressures on the seabed and water column. It includes sensitive habitats such as maerl beds, zostera beds and *Laminaria* fields.
5) **Sector from Loire estuary to Bourgneuf bay until Noirmoutier island**. This area is highly subject to pressures on the seabed and water column, such as abrasion, smothering, changes in turbidity, changes in sediments types. Estuary habitats that have a high ecological significance (spawning areas and nurseries for fish species), as well as *Laminaria* fields, are sensitive to these pressures.
6) **Downstream part of Gironde estuary**: a lot of activites of maintenance of navigation paths (dredging and dumping) create abrasion, smothering, changes of turbidity and sediment nature. Estuary habitats are sensitive to these pressures. Moreover, it's the last known area for sturgeon reproduction in Europe.
7) **Arcachon basin**: activities of beach fishing and mooring cause abrasion on seabeds, as well as dredging of navigation paths. Seagrass beds, spawning areas and nurseries can be highly impacted. The Arcachon basin has partially submerged seagrass beds on which some birds species feed.
8) **Adour estuary**, where dredging and dumping is very developed, with an impact on spawning areas and nurseries.

(*) Remark for the large mud area ‘Grande Vasière’: The impacts of physical loss and physical damage are high when the upper layer sediment morphology and grain size are intensively and regularly modified. Dredging or intense bottom-trawling areas have strongly modified sediments because repetitively re-suspend fine sediments. In France, the large mud area ‘Grande Vasière’ south of Brittany has been very impacted by intense bottom-trawling mainly targeting lobster. In 35 years, grain size has changed, sediments have become more homogeneous, and mud particles fraction has dramatically decreased. These changes alter structure of habitats and biological communities become more homogeneous (Agence des Aires Marines Protégées et Ifremer 2012).

3.1.4.7 Impacts of physical pressures in Spanish waters

The spatial extent of each habitat type significantly affected by anthropogenic activities was assessed in North Atlantic subdivision of Spanish waters in the MSFD framework (Instituto Espanol de Oceanografia et Asistencia Tecnica TRAGSATEC SA 2012b).

Actually, this assessment assessed *potential risk* rather than real impact. Indeed, it provided a superposition of pressures on habitats with a 5x5 miles mesh for pressure distribution, therefore the real impact could not be assessed because it would require knowing the exact area where the pressure occurs and the habitat sensitivity to this pressure. The assessment was made on several infralittoral habitats as well as deep, circalittoral and infralittoral rock substrate.

3.1.4.7.1 Activities other than fishing

Only pressures on the seabed that are caused by other activities than fishing are considered in Table 22. A description of the considered pressures is found in the Spanish MSFD document on analysis of pressures and impacts (Instituto Espanol de Oceanografia et Asistencia Tecnica TRAGSATEC SA 2012a).

Indicator: % of area affected among area of distribution of this habitat in North Atlantic subdivision				
Habitat	Changes of sedimentation process (trhough changes of hydrodynamic conditions)	Extraction of material	Changes in bathymetry and/or sediment type	Sealing
Reefs (Habitats Directive) – Laminaria forest	**15,71**	**2,64**	**4,03**	0,03
Reefs (Habitats Directive) – dominated by Gelidium spp. communities	**9,57**	0,00	0,58	0,02
Reefs(Habitats Directive) – Deep rocks	0,00	0,82	0,00	0,00
Reefs(Habitats Directive) – Infralittoral rock	**14,89**	**1,63**	**3,25**	**1,09**
Reefs(Habitats Directive) – Circalittoral rock	**3,82**	0,28	0,47	0,31
Maerl beds (OSPAR, Habitats Directive)	**47,75**	0,80	**4,34**	0,00
Reefs(Habitats Directive) – dominated by Paracentrotus lividus	**8,35**	0,69	1,30	0,22

Table 22 : spatial extent of each habitat type significantly affected by anthropogenic activities other than fishing (% of area affected among area of distribution of this habitat in North Atlantic subdivision). From (Instituto Espanol de Oceanografia et Asistencia Tecnica TRAGSATEC SA 2012b)

Table 22 shows that ‘changes of sedimentation process’ is the pressure that accounts for the highest percentage of potentially impacted area for infralittoral habitats. Almost 50% of maerl beds area is affected by this pressure, therefore 50% is potentially impacted. Selective extraction is the only pressure affecting Deep rocks (Reefs).

3.1.4.7.2 Fishing activities

Pressures on the seabed that are caused by fishing activities were separately assessed in the Spanish MSFD Initial Assessment of Descriptor 6 ‘seabed integrity’. The highest interaction area between fishing and studied infralittoral habitats were found for purse-seine gear (55,53% of maerl beds area and 39,21% of Reefs with *Laminaria* area)(Instituto Espanol de Oceanografia et Asistencia Tecnica TRAGSATEC SA 2012b).

As previously mentioned, purse-seiners have the highest interaction surface with infralittoral habitats such as maerl beds or reefs.

3.1.4.8 Impacts of physical pressures in Portuguese waters

The impact of physical pressures on the seabed was not assessed in the first MSFD Initial Assessment of Portugal, because the extent of affected seabed as well as the intensity of pressures was unknown. Therefore, the ‘Environmental Status’ was not assessed with respects to the MSFD criteria on spatial extent of affected seabed.

Figure 25 shows the spatial representation of activities responsible pressures and impacts identified in the Portuguese mainland subdivision MSFD. They include bottom trawling fishing activity (considered to be the main source of abrasion), as well as the localization of other activities (submarine cables, artificial reefs, sand extraction sites, dumping sites for dredge spoil and ports and marinas). Figure 25 clearly shows that the majority of the activities are spread from the coastline to the limit of the Contiguous Zone (24 nautical miles).

Figure 25 also shows the overlap of predominant habitats with activities causing physical pressures. The Portuguese MSFD assessment in 2012 shows that all the substrata between the six nautical miles and 500m depth is trawled. About 46 % of the substrate typologies is trawled in more than 75% of the occurrence area (Ministério da Agricultura, do Mar, do Ambiente e do Ordenamento do Território 2012).

Remark: This assessment does not provide information on real impacts caused by physical pressures to the seabed, it only gives an overlap between broad habitat types and activities driving physical pressures.

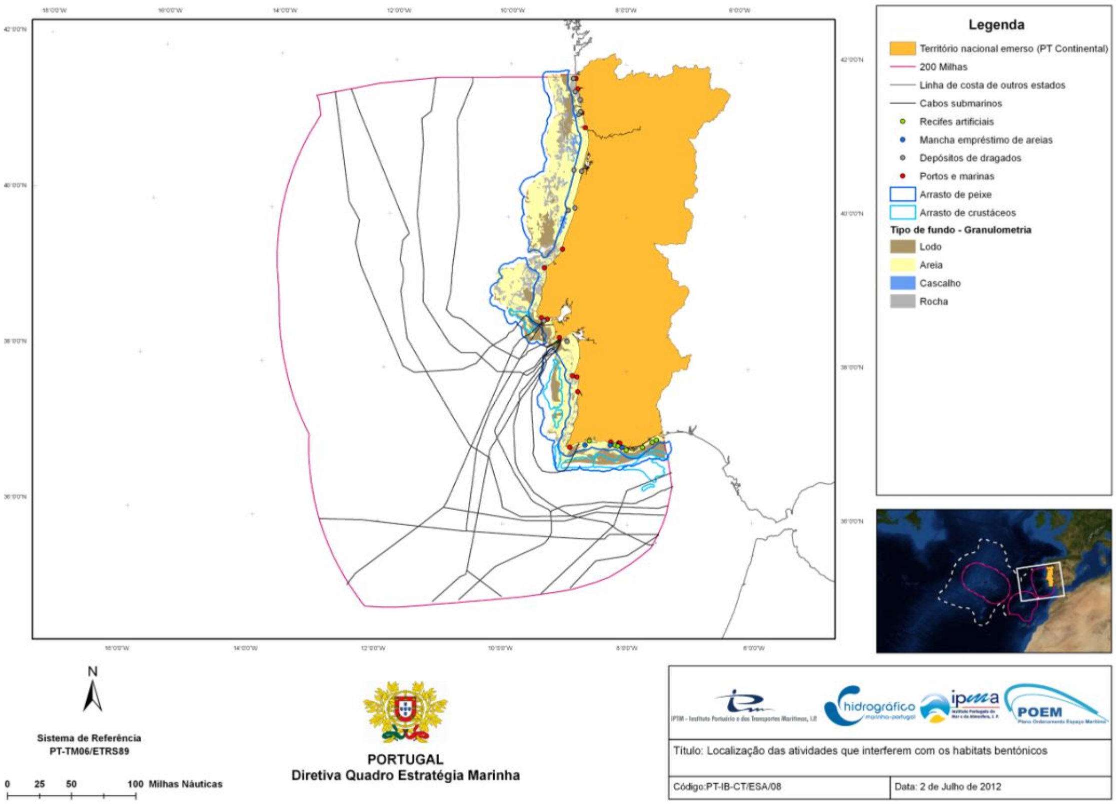


Figure 25 : Overlap of the predominant substrata and the occurrence of the activities that interfere with benthic habitats (Ministério da Agricultura, do Mar, do Ambiente e do Ordenamento do Território 2012)

Indicators of condition and function of benthic communities (such as species richness, proportion of opportunistic species as compared to sensitive species) as well as measure of near bottom oxygen, show a good ecological quality of benthic communities, compatible with a good status of seabed integrity (Ministério da Agricultura, do Mar, do Ambiente e do Ordenamento do Território 2012).

3.2 Changes in hydrographical conditions: current and wave regime, suspended sediments, turbidity, and hydrological changes

3.2.1 Hydrological changes (salinity, temperature and currents)

3.2.1.1 Modification of the temperature regime

The input of water used for power plants cooling is the major sources for this pressure, apart from climate change.

French waters. There are no littoral power plants in France in the Bay of Biscay, the closest are in the estuaries of the Loire and the Gironde. However, the residual heating due to these power plants in marine waters is not significant (from MSFD Initial Assessment (Agence des Aires Marines Protégées et Ifremer 2012)).

Cantabrian sea and Galicia. The cumulative analysis performed in the Spanish MSFD Initial Assessment (Instituto Espanol de Oceanografia et Asistencia Tecnica TRAGSATEC SA 2012a) considered thermal discharges from power plants or regasification plants. Grid cells located within a distance of 5 km from them have been selected. This distance, which a priori may seem very high, is taken applying the precautionary principle, since the location of the facilities is known but the exact location of the thermal discharge is unknown. The presence of a plant is rated a 1. The final values range between 0-2.

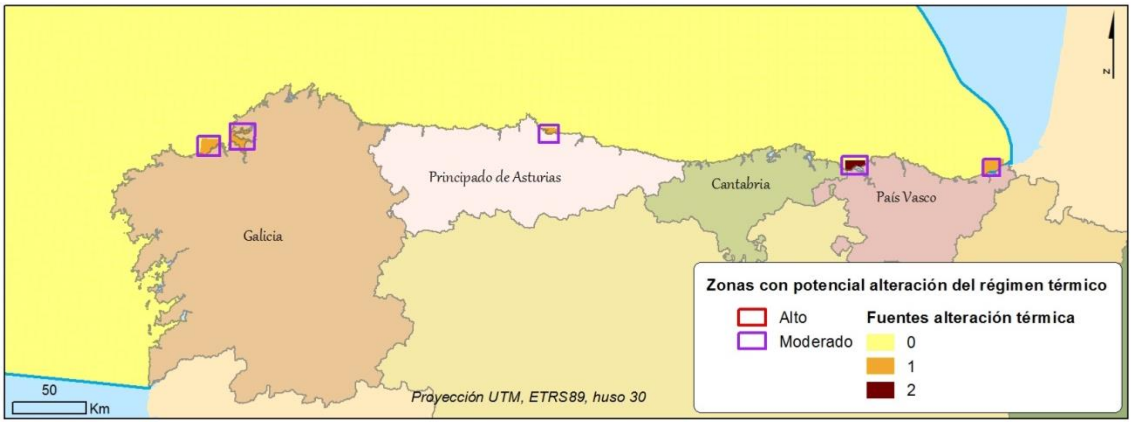


Figure 26 : Zones of accumulation of changes to temperature regime (Instituto Espanol de Oceanografia et Asistencia Tecnica TRAGSATEC SA 2012a).

All areas where there is a power plant or a regasification plant (Arteixo, Mugardos, Aboño, Bahía de Vizcaya and Pasajes) are selected as areas with a moderate potential for alteration of the thermal regime. Since these are projects subject to Environmental Impact Assessment, it is assumed that there is no high risk of alteration of the thermal regime in any case, or that, if it happens, it is properly corrected and controlled through environmental monitoring programmes.

Portuguese waters. Two centrals of desalinization were identified with a maximum volume of 50000 m^3/year and 10 water extraction sites from which only are 3 for refrigeration circuits. These are considered without relevance given their local dimension (from MSFD Initial Assessment (Ministério da Agricultura, do Mar, do Ambiente e do Ordenamento do Território 2012)).

3.2.1.2 Changes to salinity regime

Salinity changes can occur with changes in the flow of streams, which have a natural seasonal and inter-annual variability, but can also be consecutive to agricultural irrigation, river channeling or construction of dams.

French waters. The activity of industrial desalination is minor in France. In a general way, it is not possible to reveal on the scale of the Bay of Biscay a modification of the salinity due to an anthropological effect (from MSFD Initial Assessment (Agence des Aires Marines Protégées et Ifremer 2012)).

Cantabrian sea and Galicia. The pressures that give rise to changes in salinity are mostly associated with land-based activities in this area. Even the regulation of river flows causes changes in temperature and salinity near the river mouth, regulation is not that important in this region since rainfall is high compared to the rest of Spain. For this reason, neither desalinization plants are needed (from MSFD Initial Assessment (Instituto Espanol de Oceanografia et Asistencia Tecnica TRAGSATEC SA 2012a)). No cumulative analysis is performed for changes in salinity since the stressor are the wastewater treatment plants. No information on discharge points or flow rates is available (Instituto Espanol de Oceanografia et Asistencia Tecnica TRAGSATEC SA 2012a).

3.2.1.3 Changes in current regime

According to the French MSFD Initial Assessment in 2012, no significant change in current was proved in the Bay of Biscay. The impact of anthropogenic activities on current has a very local impact. However, the future development of wind farms might have a broader impact on current regime.

Changes to hydrodynamic conditions in Spanish waters are assessed simultaneously to the pressure 'changes in suspended sediments' (section 2.2).

3.2.2 Changes in suspended sediments and turbidity

Sedimentary processes (erosion, transport and deposition) affect the sea floor composition and the water clarity (turbidity) and thus partly determine the distribution and status of benthic and pelagic types. In addition to seabed dynamics driven by natural hydrodynamic and meteorological processes, present and foreseen human activities in coastal seas (bottom trawling, wind farms and tidal turbines, dredging activities, etc.) concern significant proportion of our shelves and significantly impact the sediment mobility and pathways.

It is important to remember that 'hydrodynamic changes' directly affect sedimentary processes, and therefore directly affect 'changes in suspended sediments'.

The following section focuses on 'changes in suspended sediments', bearing in mind that this pressure is affected by 'hydrodynamic changes'.

3.2.2.1 Activities causing changes in suspended sediments

Human influence on sedimentary processes is caused by on-land and at sea activities. They include: river management and damming, dredging, marine aggregate extraction, aquaculture, fishing, offshore renewable energy farms. All these activities may change sediment inputs from the continent and the conditions of sediment remobilization and transport.

3.2.2.1.1 Bottom-trawling, an important driver of seascape evolution (increased turbidity, sedimentation, changes in bathymetry)

Bottom trawling is a non-selective commercial fishing technique whereby heavy nets and gear are pulled along the sea floor. The direct impact of this technique on fish populations and benthic communities has received much attention, but trawling can also modify the physical properties of seafloor sediments, water–sediment chemical exchanges and sediment fluxes.

A study analyzed the effects of bottom-trawling on upper continental slopes (Puig et al. 2012). On upper continental slopes, the reworking of the deep sea floor by trawling gradually modifies the shape of the submarine landscape over large spatial scales. Trawling-induced sediment displacement and removal from fishing grounds causes the morphology of the deep sea floor to become smoother over time, reducing its original complexity as shown by high-resolution seafloor relief maps. The study results suggest that in recent decades, following the industrialization of fishing fleets, bottom trawling has become an important driver of deep seascape evolution.

Given the global dimension of this type of fishery, the study anticipates that the morphology of the upper continental slope in many parts of the world's oceans could be altered by intensive bottom trawling, producing comparable effects on the deep sea floor to those generated by agricultural ploughing on land.

3.2.2.1.2 Dredging affects sedimentary processes (increased turbidity, sedimentation, changes in bathymetry)

Coastal construction, land reclamation, beach nourishment and port construction all involve dredging. The excavation, transportation and disposal of soft-bottom material may lead to various adverse impacts on the marine environment, especially when carried out near sensitive habitats such as coral reefs or seagrass beds. Direct effects are physical removal of substratum and associated biota from the seabed, and burial due to subsequent deposition of material. (cf Part on Physical Loss and Physical Disturbance to the Seabed)

However, dredging activities potentially affect not only the site itself, but also surrounding areas, through a large number of impact vectors (e.g. turbid plumes, sedimentation, resuspension, release of contaminants and bathymetric changes). Elevated turbidity and sedimentation can cause the loss of coral reef habitats, as a consequence of lethal or sublethal stress to corals (Erftemeijer et al. 2012).

3.2.2.2 Impacts of changes in suspended sediments

Although the effects of human activities are sometimes known at the local scale, their cumulated impacts and footprints on the ecosystem upscaled from the local to the regional scale and the seabed and benthic communities' resilience capacity are highly unknown. Local changes in the seafloor morphodiversity may induce changes of sediment pathways that are not only affecting the marine ecosystem, but that may also have an impact on coastal erosion and impair coastal management practices, particularly under increased rates of sea level rise.

→ Fine sediments resuspension (due to bottom-trawling or dredging) causes increase in turbidity, therefore might alter the primary production of phytoplankton in coastal areas, or loss of coral habitats

Impacts of increased turbidity and sedimentation on coral reefs (Erftemeijer et al. 2012)

Dredging activities often disturb sediments, reducing visibility on surrounding areas. Elevated turbidity and sedimentation can cause the loss of coral reef habitats, as a consequence of lethal or sublethal stress to corals. The risks and severity of impact from dredging (and other sediment disturbances) on corals are primarily related to the **intensity, duration** and **frequency of exposure to increased turbidity and sedimentation**. The sensitivity of a coral reef to dredging impacts and its ability to recover depend on the antecedent ecological conditions of the reef, its resilience and the ambient conditions normally experienced.

3.2.2.2.1 Potentially impacted areas in French waters

This indicator can be rely on the results presented in part Physical disturbance (spatial extent) in French waters and Physical loss (spatial extent) in French waters

3.2.2.2.2 Potentially impacted areas in Cantabrian sea and Galicia (Spanish MSFD)

Both pressures 'changes in hydrodynamic conditions' and 'changes in suspended sediments' were considered in the MSFD assessment, since the first one directly affects the second.

It was considered that the activities/pressures that produce changes in siltation or modification of the hydrodynamic conditions are: port and coastal defence infrastructure, regulation of river flows, sand/gravel extraction, dredging and dumping of dredged material, artificial reefs, sunken ships, beach nourishment and mussel farms.

The analysis of accumulation of pressures is carried out through a semi-quantitative index, which takes into account the presence or proximity of elements that can cause this type of disturbances. The possible affected cells are selected according to the following criteria:

→ Those containing any areas authorized for the disposal of dredged material
→ Those containing any areas of sand extraction
→ Those that are within 500 m from any artificial or nourished beach
→ Those that are within 100 m from any stretch of artificial coast
→ Those that are within 500 far from any port

→ Those containing sunken ships
→ Those containing artificial reefs
→ Those containing mussel farms
→ Those that are within 2 km from the mouth of a river suffering from hydrological regulation
→ Those containing a highly modified water body declared under the Water Framework Directive
→ Those that are within 100 m from any stretch of eroded coast

Areas with a high potential for hydrodynamic modification and/or changes in siltation have been selected for cells classified as "Very High" (4 zones: Ría de Arousa, Ártabro Gulf, Gijón and San Sebastián-Pasajes) and zones with moderate potential for cells classified as "High" (6 zones: Ría de Vigo, San Cibrao, Navia, Avilés, Santander and Bilbao)

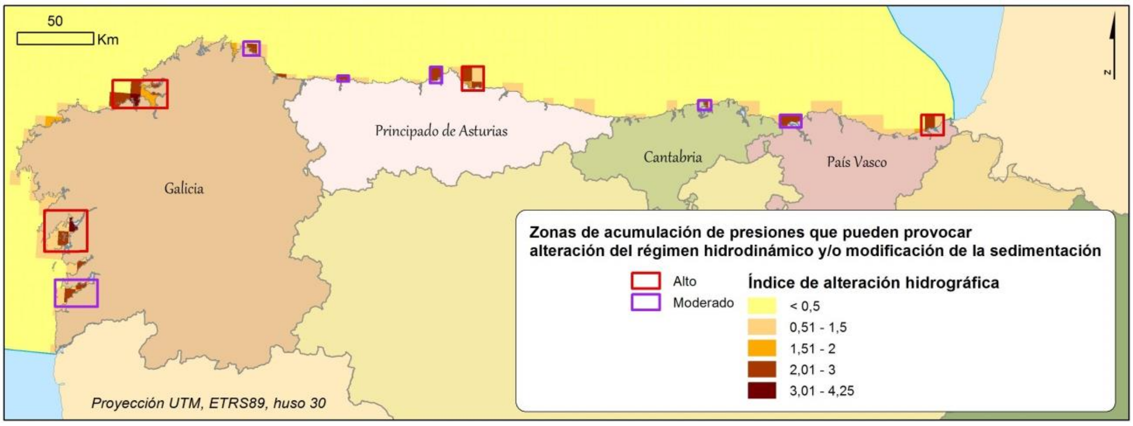


*Figure 27 : Zones of accumulation of pressures 'changes in hydrodynamic conditions' and 'changes in suspended sediments (Instituto Espanol de Oceanografia et Asistencia Tecnica TRAGSATEC SA 2012a). To calculate the index, the following formula is applied: Changes in siltation = 0.1 * [sunken ships + artificial reefs] + 0.25 * [dredged material + sand extraction + nourished beaches + mussel farms] + 0.5 * [artificial coast + ports + rivers with regulation] + 1 * [heavily modified water body in application of DMA + eroded coast]. The selected ranges are: Very High: 3 - 4 / High: 2.2 - 3 / Medium: 1.5 - 2.2 / Low: 0.5 - 1.5 / Very Low: <0.5*

3.2.2.2.3 ***Potentially impacted areas in Iberian coasts (Portuguese MSFD)***

Portuguese mainland subdivision MSFD considers that the main activities/uses that directly produce changes in the suspended sediments are:

Deposition and extraction of dredge material

Areas of dredge material deposition are identified and indispensable as they are a need for navigation (Figure 28).

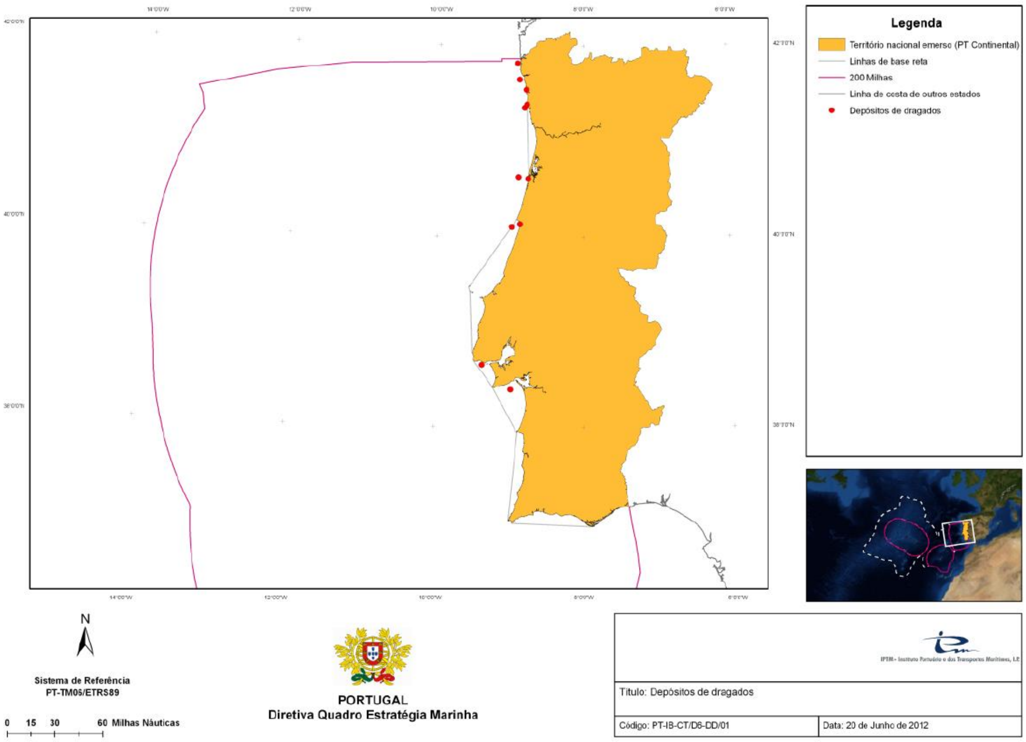


Figure 28 : Location of the dredge material deposition areas (Ministério da Agricultura, do Mar, do Ambiente e do Ordenamento do Território 2012).

The distance from the deposition area to the coast is determined according to the class of contamination of the sediments:

- → **Class 1:** Clean dredge material – deposited in marine environment or repositioned in places of identified erosion or used to beach nourishment without restrictive norms;
- → **Class 2**: Dredge material with vestigial contamination – can be deposited in the marine environment according to the characteristics of the location and use;
- → **Class 3**: Dredge material with slighted contaminated – can be used to hard standing operations or in case of immersion a deep study is needed in the deposition area posterior monitoring;
- → **Class 4**: Contaminated Dredge material – Deposition in land, in sealed bottom location, with recommendation of posterior coverage of waterproof soils;
- → **Class 5**: Very contaminated Dredge material – ideally should not be dredge, and, when imperative, the dredge material should be directed to a previous treatment and/or deposited in an authorized dump its immersion forbidden.

Extraction areas in are indispensable for beach nourishment, from which an important economic activity depends such as coastal tourism. The sand and gravel resources are dredge, in most cases, in the internal geologic platform, in depths no more than 30m. The sand is extracted and used to the nourishment of the closest beaches and, as such is maintained in the littoral system.

Beach nourishment is done mainly in Algarve (south coast), however, some nourishment operations have been made in other places of the coast, namely Costa da Caparica, near Lisbon.

In Algarve, authorities have designated specific areas of sand resources to be used in the artificial nourishment of beaches located in Lagos, Albufeira and Quarteira (Figure 29).

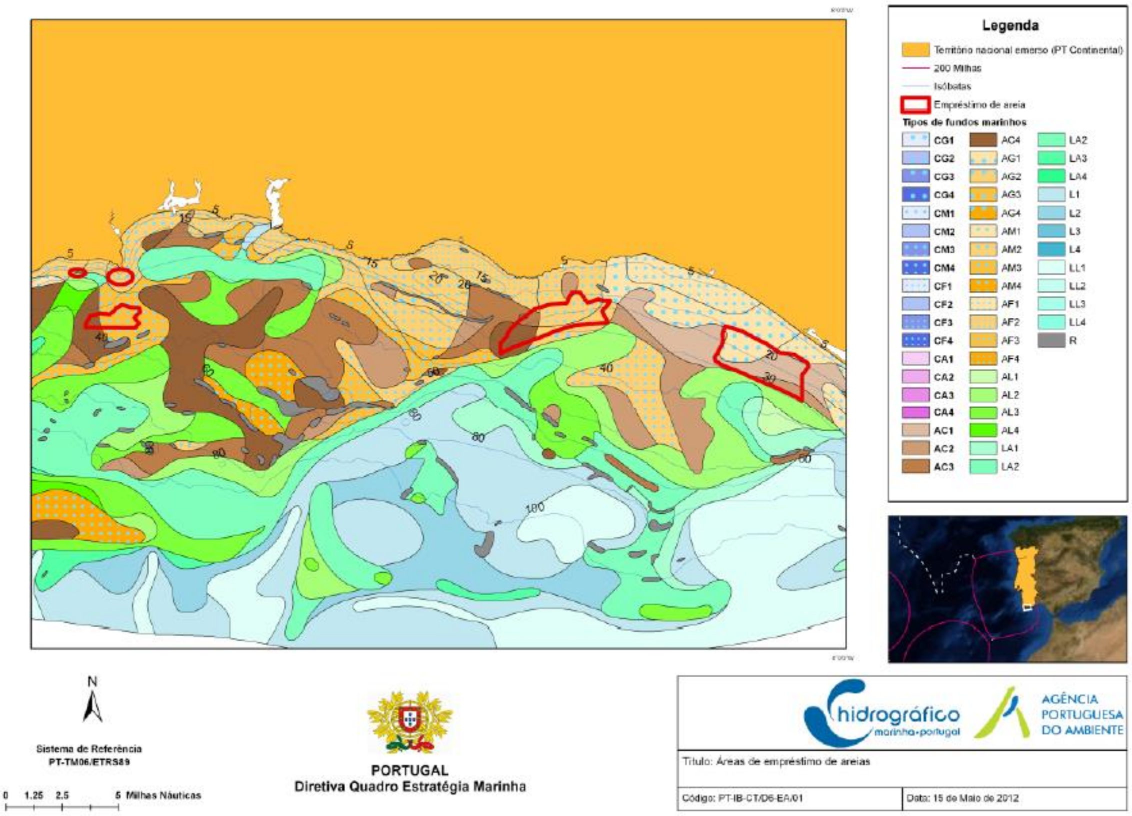


Figure 29 : Location of the sand extraction areas identified by the authorities in the south coast of Algarve (Ministério da Agricultura, do Mar, do Ambiente e do Ordenamento do Território 2012).

Trawling fisheries

This typology of fisheries is considered have a considerable impact on suspended sediments as their activity implies sand turn over causing sediments re-suspension, damaging on sessile organisms and significate impacts on benthonic communities, contributing to habitat damaging.

In Figure 30, Figure 31, Figure 32, is showed that the areas where this fisheries occur in the Portuguese mainland seas are exclusively in the continental platform within the territorial waters (12nm).

The Portuguese mainland MSFD highlight the impact of the trawling bivalve fisheries with “ganchorra” on sediments (Figure 33). This fishery takes place exclusively on mobile sediments such as sand, mud and gravel.

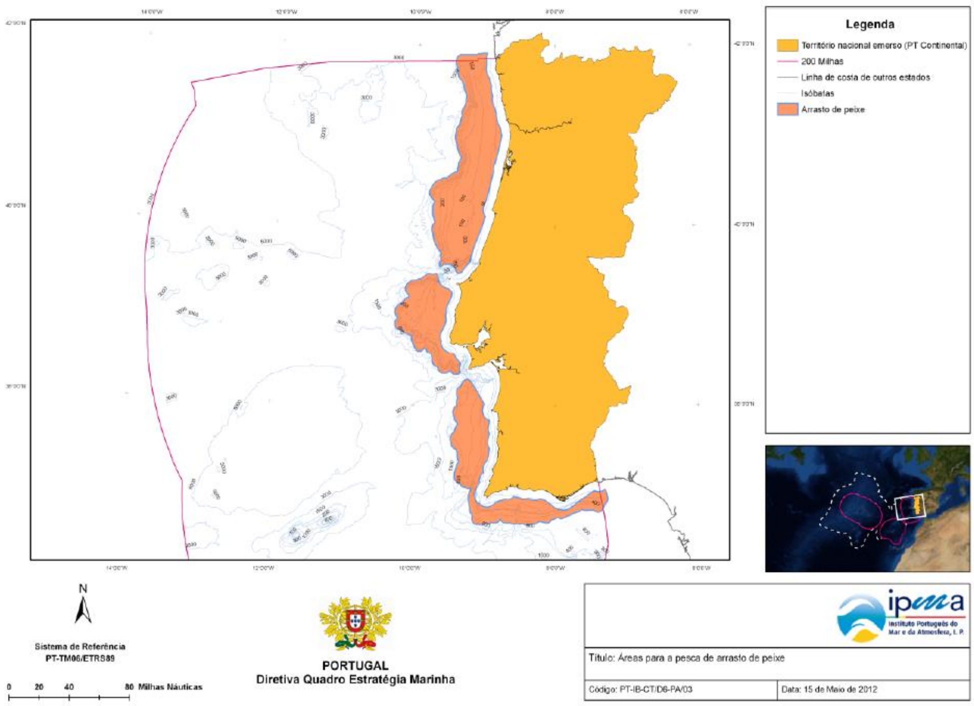


Figure 30 : Fish trawling areas. Mapping obtained through VMS data processing (2005 data) (Ministério da Agricultura, do Mar, do Ambiente e do Ordenamento do Território 2012).

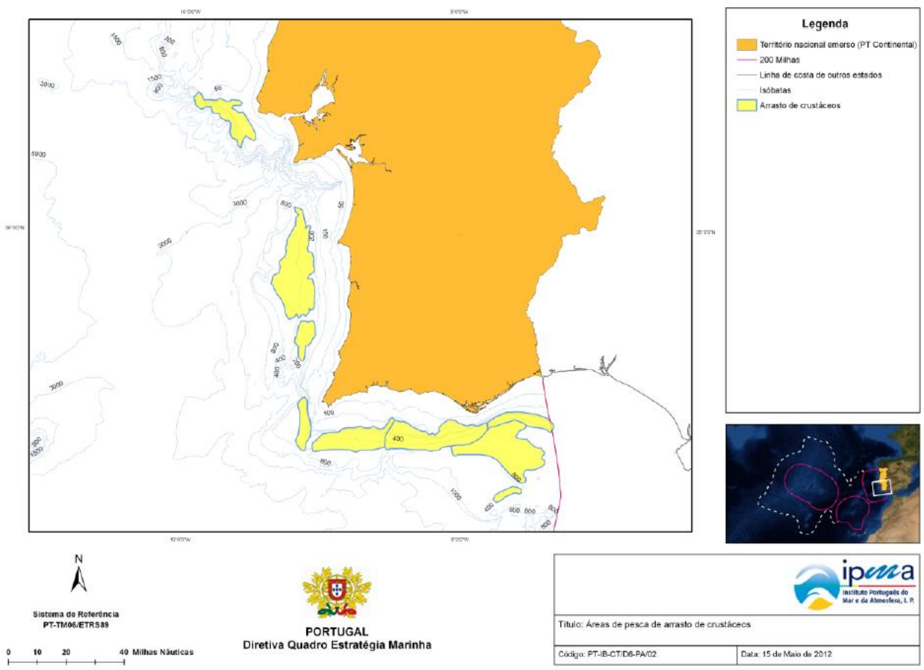


Figure 31 : Crustacea trawling areas. Mapping obtained through VMS data processing. Adapted from Simões et al. (2003) (Ministério da Agricultura, do Mar, do Ambiente e do Ordenamento do Território 2012)

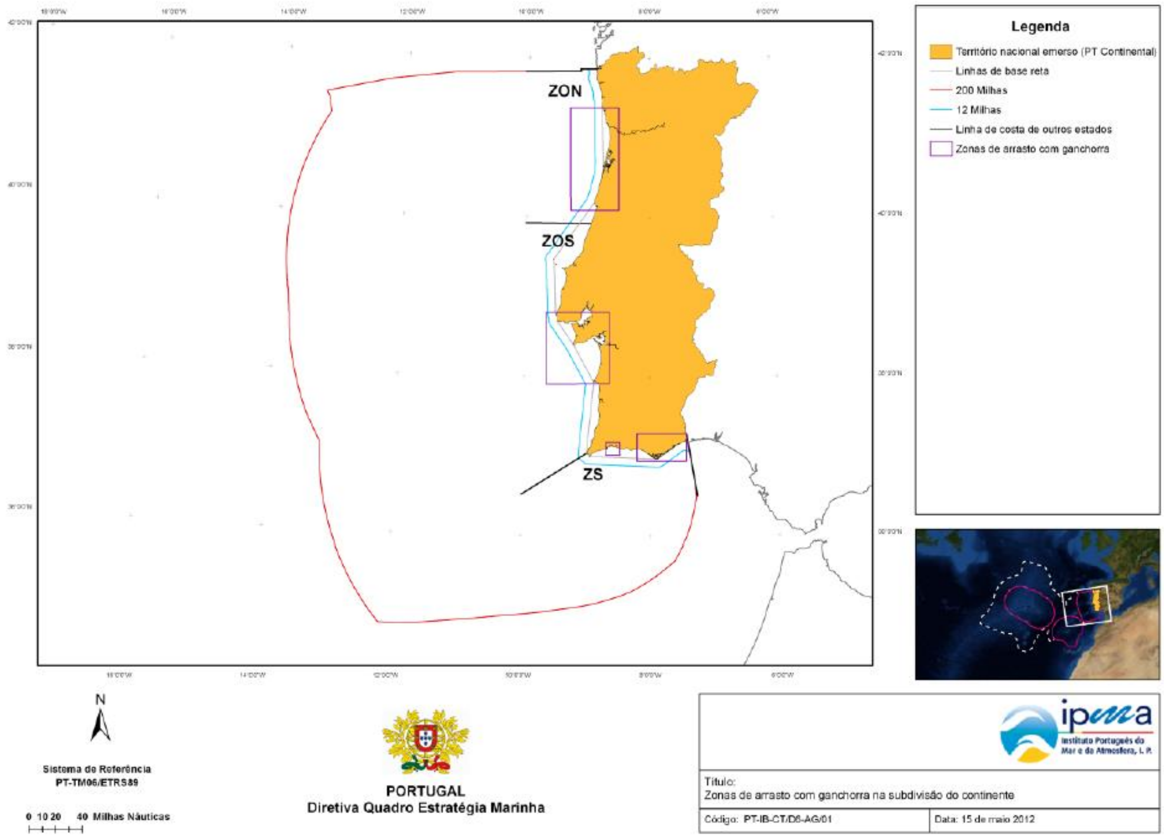


Figure 32 : The areas of trawling bivalve fisheries with "ganchorra" *(Ministério da Agricultura, do Mar, do Ambiente e do Ordenamento do Território 2012).*

Figure 33 : work mode of the "ganchorra" (a and b) and its respective trail (c) (Photography by Miguel Gaspar) (Ministério da Agricultura, do Mar, do Ambiente e do Ordenamento do Território 2012).

4 Substances, litter and energy

4.1 Pressure: Input of nutrients, inputs of organic matter, leading to human-induced eutrophication (Descriptor 5)

4.1.1 Definition of eutrophication

OSPAR defines 'human-induced eutrophication' (eutrophication hereafter) as the 'enrichment of water by nutrients causing an accelerated growth of algae and higher forms of plant life to produce an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned, and therefore refers to the undesirable effects resulting from anthropogenic enrichment by nutrients (OSPAR Commission 2009a).

The MSFD guidance for eutrophication (Ferreira et al. 2010) agreed on the following definition as a basis for the Descriptor 5: Eutrophication is a process driven by enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus, leading to: increased growth, primary production and biomass of algae; changes in the balance of organisms; and water quality degradation. The consequences of eutrophication are undesirable if they appreciably degrade ecosystem health and/or the sustainable provision of goods and services.

There are numerous models of the eutrophication process: both in the scientific literature and in policy implementation documentation. These link the cause (i.e nutrients enrichment altering the natural ratios of nutrients concentrations in water) and effects (e.g. excessive algal growth) of the eutrophication process. It is now well known that the manifestations of eutrophication may be much more complex, subtle and involve non-linear responses impacted ecosystems. A proportional link between nutrients and biomass for example may not be applicable in all aquatic environments. In this perspective a more comprehensive approach to classification is required, in order to account for the different non-linear relationships and the different intrinsic manifestations of eutrophication.

4.1.1.1 An example of eutrophication model

The development of the OSPAR Common Procedure[2].was developed based on a common conceptual framework of eutrophication. The Guidance Document on Eutrophication Assessment (European Commission 2009) provides a conceptual framework of eutrophication, derived from previous developments made in the frame of the OSPAR Common Procedure. (Figure 34). This diagram describes the ecological mechanism linking the different elements and partial processes involved in the eutrophication process, as well as the associated undesirable side effects. Three categories of assessment parameters that are considered in the OSPAR Common Procedure appear in the diagram:

1) Cat. I: Degree of nutrient enrichment
2) Cat. II: Direct effects of nutrient enrichment
3) Cat. III: Indirect effects of nutrient enrichment

[2] Common Procedure for the Identification of the Eutrophication Status of the OSPAR Maritime Area

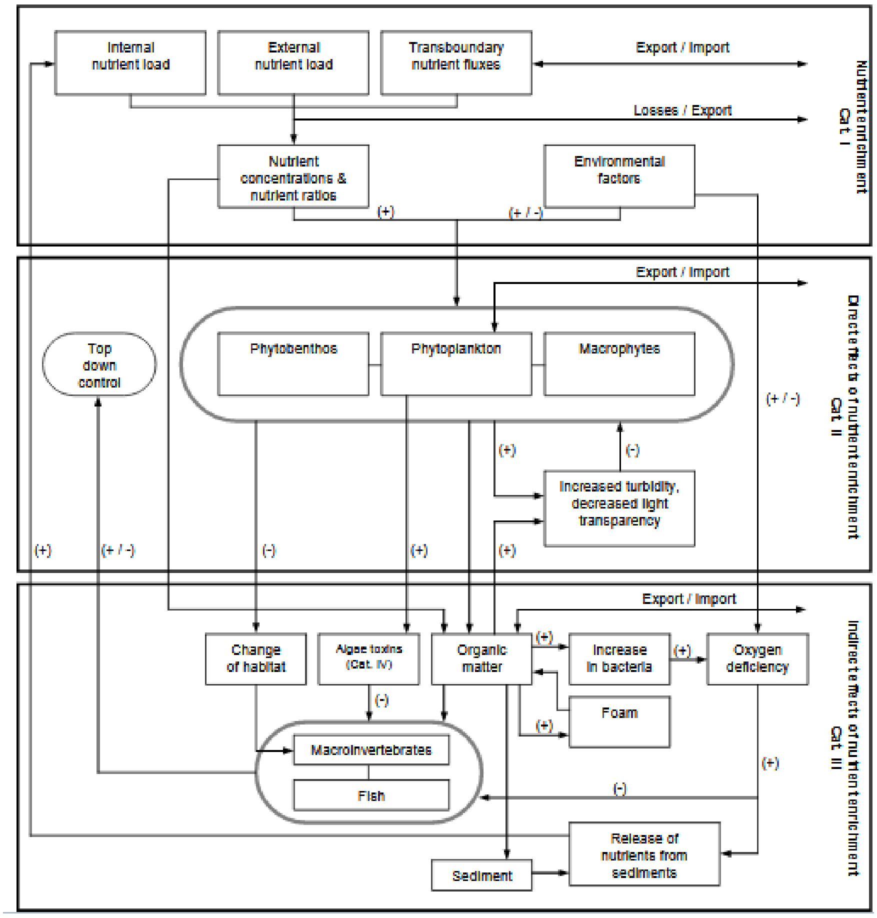


Figure 34: General conceptual framework to assess eutrophication in all categories of surface waters. (+) indicates increase; (-) indicates decrease; round boxes indicate biological quality elements of WFD (European Commission 2009)

The effects of hydrological and morphological changes and their potential influence on eutrophication, which play an important role in WFD Ecological Status (see 4.1.4.2) assessment and can be an important factor for eutrophication are not detailed in the diagram, but summarized under 'environmental factors'.

Other conceptual models exist, such as the one provided in the report of the Task Group for MSFD Descriptor 5 'Eutrophication' that was adapted from HELCOM (Ferreira et al. 2010).

4.1.2 Direct and indirect effects of nutrient enrichment

Links between cause (here, nutrients enrichment) and effects are not always linear. A conceptual framework of eutrophication process that includes hydrological and morphological elements ('environmental factors'), is presented in Figure 35. This diagram distinguishes direct and indirect effects of nutrient enrichment:

- → **Direct effects of nutrient enrichment (Cat. II)**: Phytobenthos, phytoplankton, macrophytes, increase turbidity and decreased light transparency
- → **Indirect effects of nutrient enrichment (Cat. III)**: Change of habitat, excessive amount of decaying organic matter, oxygen deficiency, etc.

These effects can be inserted in the DPSIR approach, which distinguishes driving forces (D), pressures (P), state (S), impact (I) and responses (R). Here, Category II and III (direct and indirect effects) correspond to impacts, while Category I (Nutrients enrichment) corresponds to pressures and state.

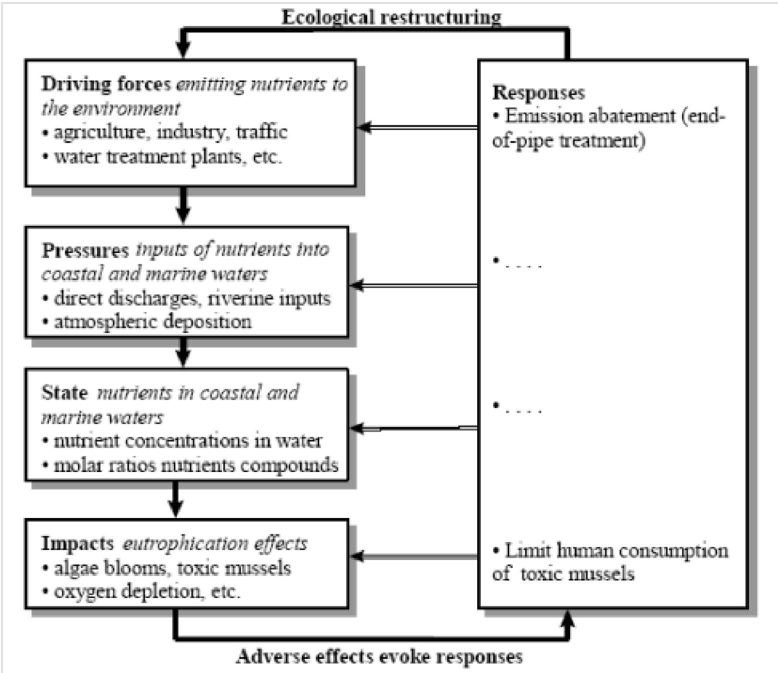


Figure 35: DPSIR assessment framework in the context of eutrophication (European Commission 2009)

4.1.3 Activities leading to nutrients enrichment causing eutrophication

Nutrient concentrations in transitional, coastal and marine waters are caused by inputs mainly from land and atmospheric sources (European Environment Agency 2012).

Rivers are the main pathway for excess nutrients in Region IV, collecting direct discharges from point sources, such as sewage treatment plants and industry, and inputs from land run-off and leaching, mainly as a result of agriculture (OSPAR Commission 2010). Modern-day agricultural practices often entail the intense use of fertilisers and manure, leading to high nutrient surpluses that are transferred to water bodies. Agriculture is the largest contributor of nitrogen pollution (European Environment Agency 2012). Measures to reduce agricultural inputs of nitrate at European level exist, such as EU Nitrates Directive 91/676/EEC.

Atmospheric deposition is an important pathway for nitrogen to the sea and is usually greatest close to the source. Nitrogen isemitted to the atmosphere from agriculture and from combustion processes associated with industry and transport, including maritime shipping, and can be carried by winds to places far from the emission sources, where it is deposited (OSPAR Commission 2010).

Annex VIII. International and EU instruments and respective tools and objectives related to eutrophication to this report gives International and EU instruments and respective tools and objectives related to eutrophication.

4.1.4 Eutrophication pressure: status of marine waters in the OSPAR region IV

Regarding eutrophication, marine waters are assessed under three main frameworks : OSPAR Convention, EU Marine Strategy Framework Directive and EU Water Framework Directive. The jurisdictional zones of these frameworks are presented in Figure 36. The following sections (1.4.1, 1.4.2, 1.4.3) present assessment results as conducted by different frameworks in the Region IV.

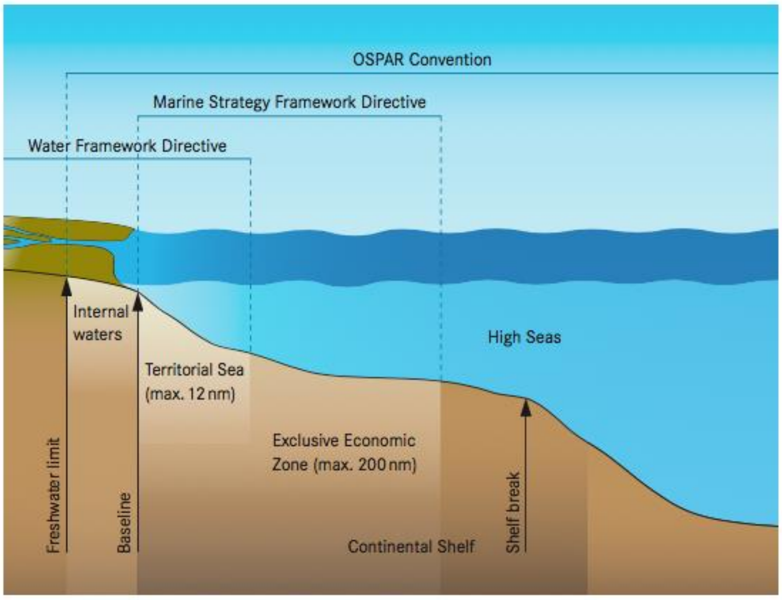


Figure 36 : Jurisdictional zones of the United Nations Convention on the Law of the Sea, the OSPAR Convention, the EU Water Framework Directive and the EU Marine Strategy Framework Directive. The jurisdictional rights of coastal states over the water column extend up to 200 nautical miles (nm) from the baseline. Their jurisdictional rights over the Continental Shelf, relating to the seabed and subsoil, can extend beyond 200 nm (OSPAR Commission 2010).

4.1.4.1 Eutrophication Status (OSPAR Common or Comprehensive Procedure)

Eutrophication status was assessed by the Second OSPAR Common Procedure in 2007 (OSPAR Commission 2009a) and by the Third Application of the Comprehensive Procedure (COMP3) for the period 2006-2014 in France only (Devreker et Lefebvre 2016).

OSPAR Common Procedure for the Identification of the Eutrophication Status ('Common Procedure')

The Common Procedure consists of an initial screening procedure (a "one-off broad-brush approach") to identify obvious non-problem areas. Areas in the OSPAR area which cannot be set aside as obvious non-problem areas (NPA) require a comprehensive assessment of their eutrophication status (Comprehensive Procedure). Other areas are assessed given 'OSPAR harmonized assessment parameters and associated elevated levels'. They are then qualified of Potential Problem Areas (PPA) or Problem Areas (PA) with respect to eutrophication. There are considerable synergies in the biological parameters used by the WFD and the assessment parameters of the Common Procedure. Distinction between NPA or PA under Common Procedure is based on nutrient enrichment and eutrophication effect. Assessment of ecological status under WFD takes into account all human pressures.

The 2007 report concluded that the Bay of Biscay and the Iberian coast are not considered very sensitive eutrophication because of the hydrographic conditions at the edge of the open ocean (high water mixing) inhibiting the conversion of riverine nutrient discharges to extended phytoplankton blooms.

Along the French coast, the identified Problem Areas or Potential Problem Areas (Table 23) are, notably affected by the coastal current (OSPAR Commission 2009a). The situation in the Bay of Biscay was re-assessed in the Third Integrated Report (cf Figure 37 below).

The Iberian coast is characterized by steep slopes on a narrow shelf (about 12 km long) and frequent upwelling processes, which occasionally lift nutrient rich water to the surface. Therefore, detection of anthropogenic eutrophication processes is restricted to estuaries and bays with low flushing. This further implies that only significant effects can be observed (OSPAR Commission 2009a).

Because not enough monitoring data were available, only a few parameters provided clear assessment results for Spanish waters, with 12 out of the 15 assessed areas classified as potential problem areas (Table 23). These assessments are in line with the application of the Urban Waste Water Treatment Directive (91/271/EEC).

Similarly, only the Mondego estuary was assessed and classified as potential problem area in Portugal. In the previous application of the Comprehensive Procedure the estuaries of Tejo and Sado rivers were classified as non-problem areas.

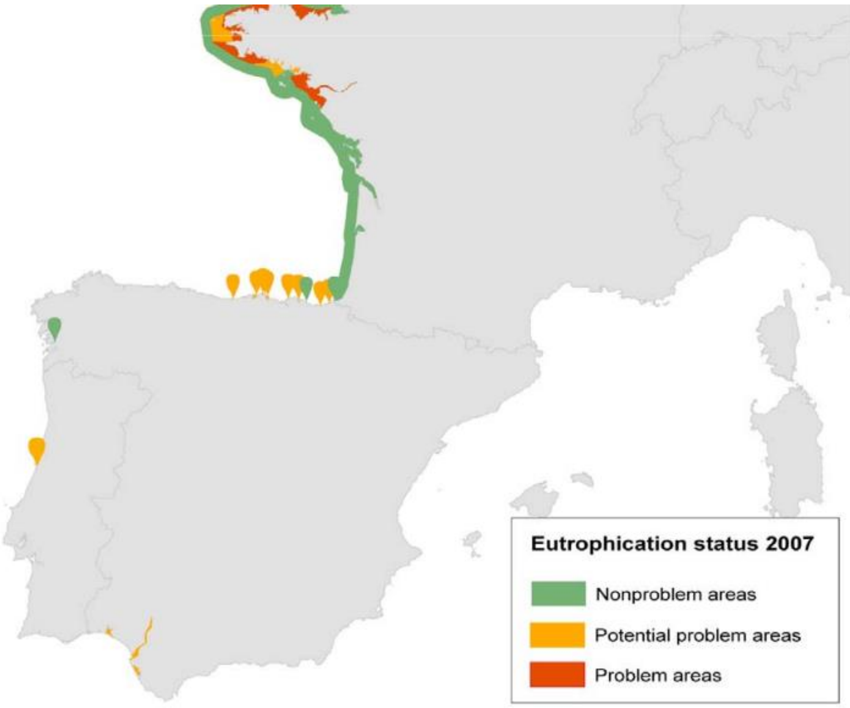


Figure 37: Eutrophication status of the Bay of Biscay and the Iberian Coast (region IV) identified in the second application of the Comprehensive Procedure (2007) in terms of problem areas, potential problem areas and non-problem areas (OSPAR Commission 2009a).

Water types (number of assessed areas	**French coast (11)**			**North Iberian Coast & Galicia (12)**			**Portugal (1)**			**Andalusia (3)**		
	PA	PPA	NPA	PA	PPA	NPA	PA	PPA	NPA	PA	PPA	NPA
Bays, estuaries	2	1	1	0	9	3	0	1	0	0	2	0
Coastal waters	3	1	3	0	0	0	0	0	0	0	1	0
Offshore waters	0	0	0	0	0	0	0	0	0	0	0	0
Total	5	2	4	0	9	3	0	1	0	0	3	0

Table 23: Number of assessed areas classified "problem area" (PA), "potential problem area" (PPA), "non-problem area" (NPA) in the Second Integrated Report (OSPAR Commission 2009a)

Remark: OSPAR Common Procedure of 2007 was executed while Water Framework Directive monitoring was not fully implemented. Expert's advice was used when data were lacking. The OSPAR assessment might be different than WFD assessment.

The Third Application of the Comprehensive Procedure (COMP3) to determine eutrophication status of OSPAR marine waters (Devreker et Lefebvre 2016) notably updates the status of French waters in the Bay of Biscay based on the national assessments using OSPAR Common Procedure. No results are available for Spain and Portugal.

In the Bay of Biscay two areas were classified as problem areas (approximately 800 km2) and half of the areas classified as potential problem areas (approximately 3 900 km2) with regard to eutrophication .

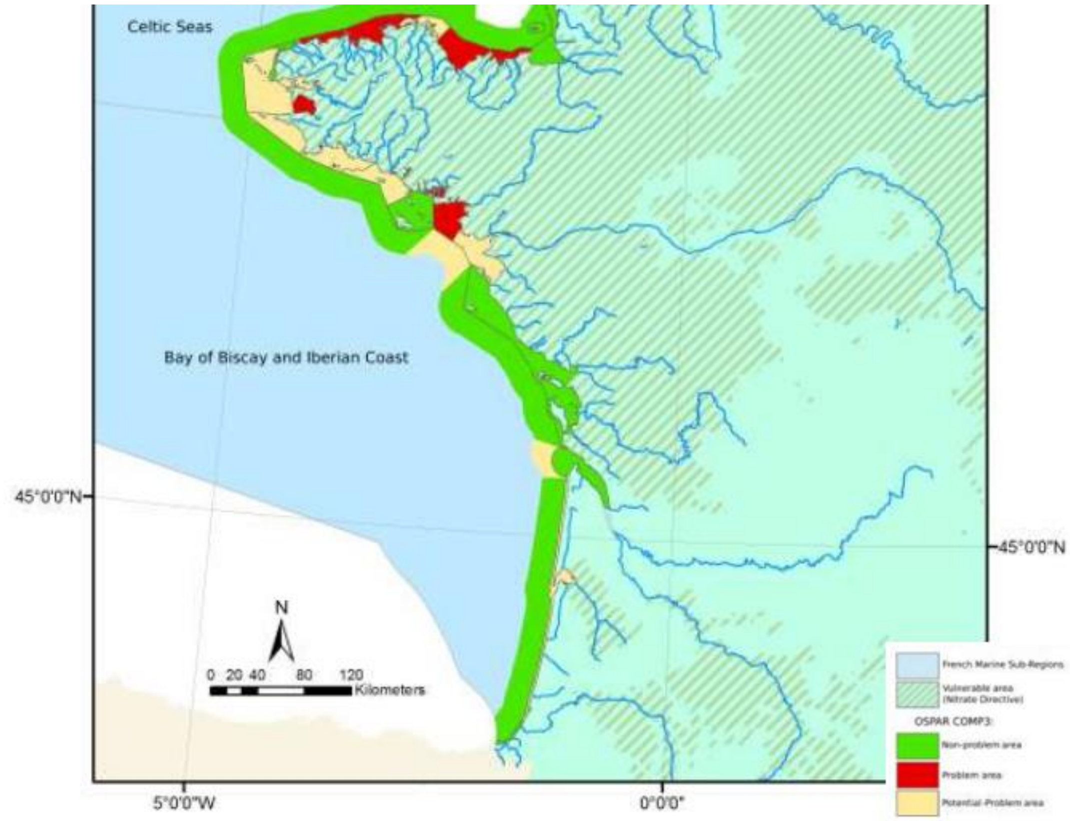


Figure 38 : Overall results from the third application of the OSPAR Common Procedure (COMP3) (2006-2014) for French national marine waters (Problem areas (red), potential problem areas (yellow) and non-problem areas (green)) and status of watersheds having regard to the Nitrate Directive (green shaded areas) (Devreker et Lefebvre 2016)

4.1.4.2 Ecological Status under Water Framework Directive

Regarding marine waters, WFD applies to transitional waters and to marine waters up to 1 nautical mile from the land (coastal waters).

4.1.4.2.1 WFD Ecological Status

Whilst the classification of Ecological Status is not centered on eutrophication assessment, it does incorporate the drivers and most manifestations of nutrient pollution, algal toxins not being considered. It includes the following ‘quality elements’:

- → Phytoplankton: ‘composition, abundance, biomass of phytoplankton’
- → Aquatic flora: ‘composition, abundance of other aquatic flora’ (angiosperms, fixed and opportunistic macroalgaes)
- → Benthic invertebrate fauna: ‘composition, abundance of benthic invertebrate fauna’
- → Fish: ‘composition, abundance and age structure of fish fauna’ (only in estuaries)
- → Other elements: hydromorphological and physico-chemical quality elements

Further information on Ecological status and quality elements is provided in Annex VII. Water Framework Directive Ecological Status

Assessment results in the framework of WFD (overall classification, as well as classification by parameters assessed) for French transitional and coastal waters can be found on the following websites:

- → **Adour-Garonne basin (south of the Bay of Biscay):** http://envlit.ifremer.fr/surveillance/directive_cadre_sur_l_eau_dce/la_dce_par_bassin/bassin_adour_garonne/fr/atlas_interactif (in French)
- → **Loire-Bretagne basin (north of the Bay of Biscay):** http://envlit.ifremer.fr/surveillance/directive_cadre_sur_l_eau_dce/la_dce_par_bassin/bassin_loire_bretagne/fr/atlas_interactif (in French)

The overall ecological status of the Spanish coastal waters can be found in the website: http://sig.mapama.es/redes-seguimiento/visor.html. No information on specific parameters is shown through visors during the elaboration of this report.

The ecological status of the Portuguese WFD results can be found REA (Portugal Environmental Report): https://rea.apambiente.pt/content/estado-das-massas-de-%C3%A1gua-superficiais-e-subterr%C3%A2neas

4.1.4.2.2 Comparison between OSPAR Common Procedure and WFD Ecological Status

OSPAR Common Procedure and WFD Ecological Status classifications are related as shown in Figure 39.

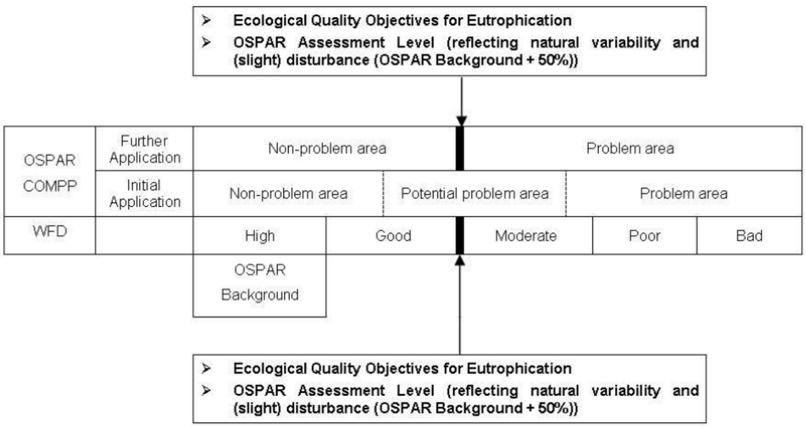


Figure 39 : relationship between the classification under OSPAR Comprehensive Procedure, the integrated set of OSPAR EcoQOS for eutrophication and the Water Framework Directive (European Commission 2009).

The last French WFD ecological assessment was made in 2015. Globally the assessment of coastal water quality made by France in regard of the OSPAR COMP3 for eutrophication do not differ so much from the WFD ecological evaluation in coastal waters. The OSPAR Problem Areas coincide with WFD water masses classified as moderate or poor status considering phytoplankton or macrophytes problems Some areas like OSPAR zone 'West Britanny' are downgraded considering OSPAR COMP3 as compared to WFD. This is mainly due to the 'algae toxins' parameter that is taken into account in the OSPAR COMP3 but in the WFD ecological assessment. On the contrary, WFD parameters 'fish' and 'subtidal macrophytes' downgrade some WFD water masses, but are not used for the French OSPAR COMP3 (Devreker et Lefebvre 2016).

A detailed comparison between assessment results of OSPAR COMP3, WFD Ecological quality status and MSFD Initial Status for French coastal waters in provided in (Devreker et Lefebvre 2016).

4.1.4.3 Eutrophication Status (Marine Strategy Framework Directive)

4.1.4.3.1 MSFD Good Environmental Status

For coastal waters (up to 1 nautical mile) the MSFD applies only if it adds new elements to the WFD. The MSFD does require a marine monitoring program to be established by 2014. Member States have to achieve "good *ecological* status" under WFD by 2017. They have to reach "good *environmental* status" under MSFD by 2020.

The MSFD assesses Descriptor 5 'Eutrophication' with the following criteria:

MSFD Descriptor	Criteria
Descriptor 5: Human-induced eutrophication	D5C1: nutrient concentrations
	D5C2: Chlorophyll a concentrations
	D5C3: number, spatial extent and duration of harmful algal bloom events
	D5C4: Photic limit (transparency) of the water column
	D5C5: concentration of dissolved oxygen
	D5C6: abundance of opportunistic macroalgae
	D5C7: Species composition and relative abundance or depth distribution of macrophyte communities
	D5C8: Species composition and relative abundance of macrofaunal communities

Table 24: criteria used to assess Descriptor 5 in MSFD framework, as in Decision (EU) 2017/848. In coastal waters, threshold values are set in accordance with WFD 2000/60/EC. Beyond coastal waters, should the criterion be relevant, Member States shall establish those values.

The assessment of each criterion for the three countries (France, Spain and Portugal) is not presented here.

4.1.4.3.2 MSFD 'ecological challenge areas' in French waters and comparison with OSPAR Common Procedure results

In France, the Initial Assessment made under the first phase of the MSFD in 2012 describes different coastal target areas where there is a potential problem of eutrophication (high phytoplankton biomass and macrophytes blooms) (Figure 40). Except for the coastal part southern to the Loire, the initial status reflects the same problems as the OSPAR COMP3 (Devreker et Lefebvre 2016).

A detailed comparison between assessment results of OSPAR COMP3, WFD Ecological quality status and MSFD Initial Status for French coastal waters in provided in (Devreker et Lefebvre 2016).

Figure 40 presents 'ecological' challenges and/or challenge areas identified by France in the MSFD implementation process for which actions are required to reach GES, based on a qualitative analysis or on expert opinion (Agence des Aires Marines Protégées et Ifremer 2011). Challenge areas relative to eutrophication were identified as either:

→ Areas of macrophytes proliferation (macrophytes blooms) and/or;
→ High productivity areas (high phytoplankton biomass)

Large rivers are the main contributors to nutrient inputs: Loire, Gironde and Adour rivers. Coastal waters from Brittany to Basque country correspond to the most productive area in the Bay of Biscay, because of high riverine nutrient inputs. For instance, the influence of the Loire river plum extends up to the English Channel (Agence des Aires Marines Protégées et Ifremer 2011).

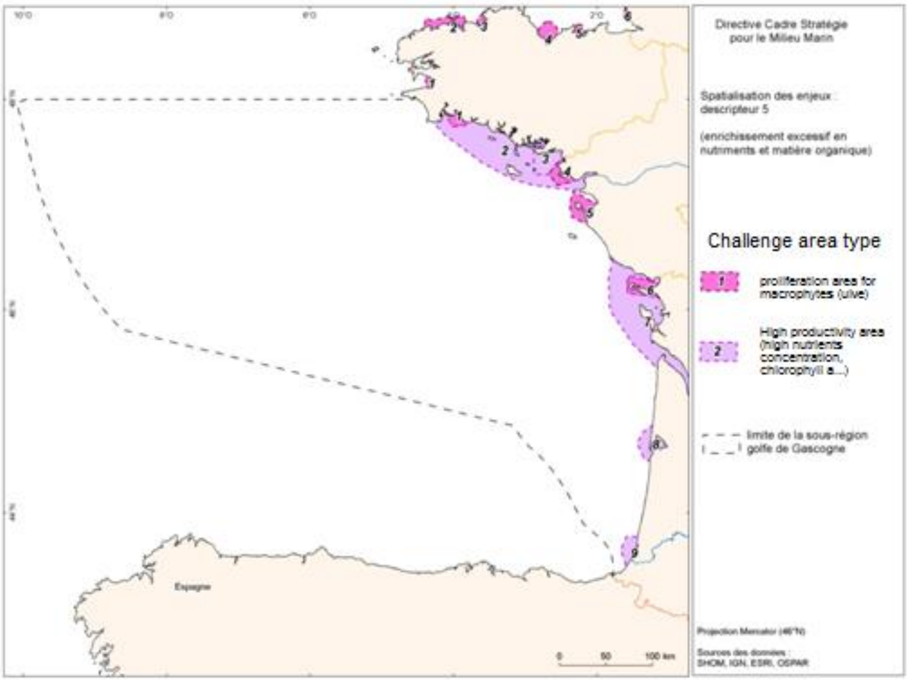


Figure 40: Challenge areas regarding eutrophication in the Bay of Biscay (Agence des Aires Marines Protégées et Ifremer 2011)

4.1.4.3.3 Areas with high potential input of nutrients identified in Spanish MSFD

In order to identify the areas with the highest contribution of nutrients to the sea, a spatial analysis of the following sources is carried out: direct discharges, riverine inputs, aquaculture, mussel farms, atmospheric deposition and disposal of dredged material. The following grid cells are selected:

- → Those that are within 500 m from any authorized area for disposal of dredged material
- → Those that coincide with EMEP cells with the highest nutrient loads (those that account for the 20% of the total pollution)
- → Presence of aquaculture facilities
- → Presence of mussel farms
- → Those that are at a distance of less than2 km from a river mouth
- → Those that are at a distance of less than 5 km from a river mouth whose loads are reported to the OSPAR convention (those that account for 85% of the total pollutant load for nitrogen and phosphorous)
- → Those that are at a distance of less than 5 km from a PRTR facility (wastewater treatment plants and industrial facilities) which is obliged to report total nitrogen and/or total phosphorus
- → Those that within 2 km from wastewater treatment plants that do not have the obligation to report the nutrient loads discharged according to the PRTR regulation
- → Those that overlap with any coastal water body that does not reach a good ecological status for phytoplankton in compliance with the Water Framework Directive
- → Those that are within 2 km from any river or transitional water body that does not reach a good ecological status for phytoplankton in compliance with the Water Framework Directive

The result is a grid showing probabilities of entrance of high nutrient loads. Areas of potential nutrient accumulation are selected from cells classified as "Very High" and "High". In addition, the above analysis has been completed with the work carried out under OSPAR and in compliance with other directives (Water Framework Directive, Wastewater Directive and Nitrate Directive), with the following criteria being applied:

→ Areas with high accumulation potential: the index reaches "Very High" values and, in addition, there is a sensitive area, vulnerable zone or potentially problematic zone under the OSPAR common procedure or there is a coastal water body that does not reach good phytoplankton status.

→ Areas with moderate accumulation potential: 2 options:
  1) the index reaches "Very High" values but there is neither a sensitive, vulnerable, potentially problematic zone under the common OSPAR procedure nor a coastal water body that does not reach good phytoplankton status.
  2) the index reaches “High” values, and there is a sensitive, vulnerable, potentially problematic zone in application of the OSPAR common procedure or there is a coastal water body that does not reach good phytoplankton status

3 areas of high nutrient accumulation potential are identified (Mouth of the Deba River, Bilbao-Butroe and Avilés) and 6 of moderate potential (Ría de Pontevedra, Golfo Ártabro, San Vicente de la Barquera, Suances, Santoña , San Sebastián-Pasajes)

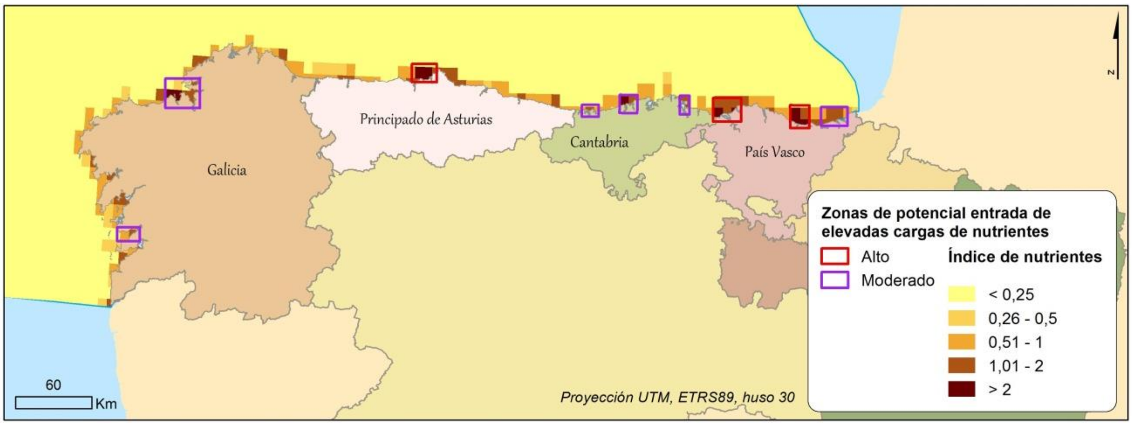


Figure 41 : Zones of potential high input of nutrients (Instituto Espanol de Oceanografia et Asistencia Tecnica TRAGSATEC SA 2012a).

*The following formula is used: NUTRIENT INDEX = 0.25 * [disposal of dredged material + atmospheric deposition with high nutrient concentrations + WWTPs not reporting to PRTR] + 0.5 * [river mouths + OSPAR rivers with high nutrient loads] + 0.75 * [rivers or transitional waters not in a status lower than good for phytoplankton + PRTR facilities that are obliged to report nutrients] + 1 * [Coastal waters in a status lower than good for phytoplankton]*

Very High: > 2 / High: 1 - 2 / Medium: 0.5 - 1 / Low: 0,25 - 0,5 / Very Low: <0,25

These areas are also pointed in as the 9 bays and estuaries identified as “Potential Problem Areas” identified by the OSPAR Common Procedure. It can be considered that these areas are also areas with potential inputs of organic matter, since the sources of nutrients are quite similar to those introducing organic matter.

4.1.4.3.4 Portuguese waters

The evaluation of Descriptor 5 in the Portuguese mainland MSFD was made in 6 different evaluation areas, A1, A2, B1, B2, C1, C2 (Figure 42), and based in the scientific knowledge related to the oceanographic and morphologic characteristics of the subdivision and on the delimitations already defined by the Water Framework Directive.

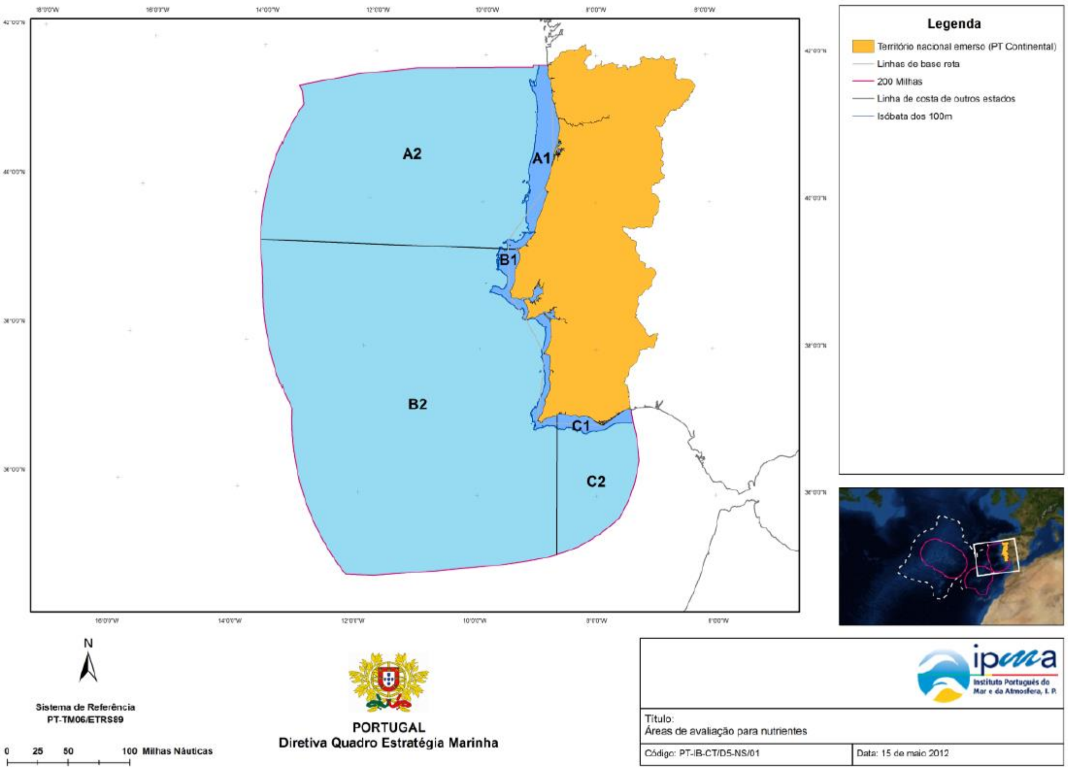
In the application of the criteria and methodologic norms defined by the Decision COM 2010/477/UE, it was assured the comparability of the several conventions, and the developed approaches developed to the eutrophication evaluation.

The criteria and indicators considered to the analysis of Descriptor 5 are the following:

→ **Criteria** 5.1 Level of nutrients.
  - **Indicator** 5.1.1 Concentration of nutrients in the water column.

→ **Criteria** 5.2 Direct effect on nutrient enrichment.
  - **Indicator** 5.2.1 Chlorophyll concentration in the water column;
  - **Indicator** 5.2.2 Water transparency related with the increase of suspended algae.

→ **Criteria** 5.3 Indirect effects of nutrient enrichment.



  - **Indicato**r 5.3.2 Dissolved Oxygen (changes due to the increase of organic matter and the area dimension

Figure 42 : Evaluation areas to Descriptor 5 in Portuguese mainland subdivision (Ministério da Agricultura, do Mar, do Ambiente e do Ordenamento do Território 2012).

The final classification to Descriptor 5 in Portugal mainland can be seen in Table 25.

Table 25 : Evaluation of the Environmental Status in Descriptor. (Portuguese mainland subdivision MSFD, 2012).

Evaluation Area	Environmental Status	Degree of Trust
A1	Good Environmental Status Achieved	High
A2	Good Environmental Status Achieved	Medium
B1	Good Environmental Status Achieved	High
B2	Good Environmental Status Achieved	Medium
C1	Good Environmental Status Achieved	High
C2	Good Environmental Status Achieved	Medium

The areas evaluated where considered as areas were does not exist evident changes in eutrophication as resulting from human activities. However strong evidences suggest that small areas, especially in the major river mouths, have high potential for eutrophication (Ministério da Agricultura, do Mar, do Ambiente e do Ordenamento do Território 2012).

4.1.5 Sensitive and impacted ecosystem components

4.1.5.1 *Impacted ecosystem components in the Bay of Biscay (French MSFD approach, 2011)*

In the MSFD framework, France has summarized impacts from eutrophication for each marine environment feature in the context of the Bay of Biscay (Agence des Aires Marines Protégées et Ifremer 2011). This impact assessment was contextualized in the Bay of Biscay (taking into account if there is an existing interaction, resulting in actual impacts). A confidence index is also provided for each impact diagnostic (low, medium, high).

Impacted components in the Bay of Biscay Pressure : *Input of nutrients, inputs of organic matter, leading to human-induced eutrophication*	
HIGH IMPACT	→ Phytobenthos
SIGNIFICANT IMPACT	→ Zooplankton, phytoplankton → Littoral soft and hard substrate communities → Infralittoral and circalittoral hard substrate communities → Commercially-exploited shellfish (including mariculture) → Food webs → Human health
LOW IMPACT	→ Marine mammals → Marine birds → Demersal and pelagic fish and cephalopods → Infralittoral soft substrate communities → Circalittoral soft substrate communities → Commercially-exploited fish, cephalopods and crustaceans

Table 26: High, significant and low impacts of the pressure 'Input of nutrients, inputs of organic matter, leading to human-induced eutrophication' on ecosystem components in the Bay of Biscay. The full table is provided in Annex VI. Summary of impacts by ecosystem components, for the marine region 'Bay of Biscay' according to French MSFD Initial Assessment in 2011

4.1.5.2 Condition of Benthic Habitat Communities: Assessment of Coastal Habitats in relation to Nutrient and/or Organic Enrichment

The OSPAR assessment of coastal habitats in relation to nutrient and/or organic enrichment shows that water bodies for which European Union WFD data were provided are mainly considered in 'good' status regarding nutrient and/or organic enrichment (OSPAR Commission 2017).

According to data provided, the WFD objectives of **good or high status are achieved for benthic invertebrates** in 95% of assessed water bodies of France, and 100% of Spain.

Figure 43 : Status (condition) of benthic invertebrates in intertidal and subtidal sediments, in response to the (direct or indirect) effects of nutrient and/or organic enrichment. The condition assessments are based on the European Union WFD data and classification (OSPAR Commission 2017).

According to data provided, water bodies are classified as **good or high status for macroalgae and angiosperms** up to 95% in Spain. Results for French water bodies exist and were provided, but not in the correct format.

Figure 44: Status (condition) of macroalgae on intertidal and subtidal rocks and angiosperms, in response to the (direct or indirect) effects of nutrient and/or organic enrichment. The condition assessments are based on the European Union WFD data and classification (OSPAR Commission 2017).

4.1.6 Conclusion: Eutrophication status in OSPAR Region IV

Eutrophication can be defined as 'enrichment of water by nutrients causing an accelerated growth of algae and higher forms of plant life to produce an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned, and therefore refers to the undesirable effects resulting from anthropogenic enrichment by nutrients (OSPAR Commission 2009a).

Eutrophication happens if many conditions are present: nutrient enrichment, as well as appropriate environmental factors. The link between the cause (i.e nutrients enrichment) and the effects (direct and indirect) are non-linear.

Eutrophication in OSPAR Region IV is assessed under Water Framework Directive (transitional and coastal waters), OSPAR Common Procedure and MSFD (both applying to marine waters including transitional and coastal waters). Even though criteria used to assess eutrophication slightly differ between the three frameworks, the identified “problem” areas are almost the same.

According to the second implementation of OSPAR Common Procedure (OSPAR Commission 2009a), the Bay of Biscay and the Iberian coast are mostly less affected by eutrophication processes because the hydrographic conditions at the edge of the open ocean (high water mixing) inhibit the conversion of riverine nutrient discharges to extended phytoplankton blooms.

Eutrophication is mainly a problem is coastal areas, such as enclosed estuaries and embayments. The Second Implementation of OSPAR Common Procedure in Spain and Portugal identified 9 estuaries in the North of Spain, 1 estuary in Portugal (Mondego estuary), 2 ‘bays or estuaries’ and 1 coastal area in Andalusia as ‘Potential Problem Areas’. No ‘Problem Areas’ were identified in both countries (OSPAR Commission 2009a). The OSPAR Common procedure was updated for France (Third Implementation, OSPAR COMP3), and allowed to identify two ‘Problem Areas’ as well as 5 ‘Potential Problem areas’ all corresponding to bays, estuaries or coastal waters.

Assessments within the Water Framework Directive (transitional and coastal waters) or the Marine Strategy Framework Directive show similar results regarding eutrophication status.

4.2 Pressure: Inputs of substances (synthetic substances, non-synthetic substances, radionucleides) (Descriptors 8 and 9)

MSFD Descriptor 8: Concentration of contaminants are at levels not giving rise to pollution effects

MSFD Descriptor 9: Contaminants in fish and other seafood for human consumption do not exceed levels established by Union legislation or other relevant standards

4.2.1 Type of polluting substances

Chemicals form an essential part of everyday life. They can be naturally occurring, like metals in the Earth’s crust, formed as unintended by-products of natural and human-induced chemical processes, or synthesized specifically for use in industrial processes and consumer products. There is a steadily increasing number of chemical substances on the market. About 100 000 substances are on the European market and around 30 000 of these have an annual production of more than 1 ton per year (OSPAR Commission 2010). Some of these substances are hazardous because they are persistent, liable to accumulate in living organisms and toxic.

4.2.1.1 List of Priority Substances in the Field of Water Policy (Annex X of the Water Framework Directive)

The first list of priority substances of the WFD (established by the Decision 2455/2001/EC) was replaced by Annex II of the Directive on Environmental Quality Standards ‘EQSD’ (Directive 2008/105/EC[3]). It identifies 33 priority substances. In 2013, another Directive amended the two

[3] **Directive 2008/105/EC** of the European Parliament and the Council on environmental quality standards in the field of water policy, amending and subsequently repealing Council Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC, 86/280/EEC and amending Directive 2000/60/EC, was published in the Official Journal on 24 December 2008. http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0105&from=EN

previously mentioned (Directive 2013/39/EU[4]). Therefore, Annex X of WFD (List of Priority Substances in the Field of Water Policy) is found in Annex I to Directive 2013/39/EU. It has 45 priority substances, among which 21 are qualified as 'priority hazardous substance'.

4.2.1.2 OSPAR List of Chemicals for Priority Action.

The OSPAR Convention considers than 300 substances are considered to be of possible concern for the marine environment. Forty substances and groups of substances have been identifies by OSPAR as chemicals for priority action, of which 26 pose a risk for the marine environment due to their use patterns. Chemicals for priority action are listed in the OSPAR List of Chemicals for Priority Action (revised 2013), in Annex X. OSPAR List of Chemicals for Priority Action (Revised 2013). This list does not include radioactive substances. Further information[5] on the 26 substances which pose a risk for marine environment is available in the OSPAR Quality Status Report (OSPAR Commission 2010).

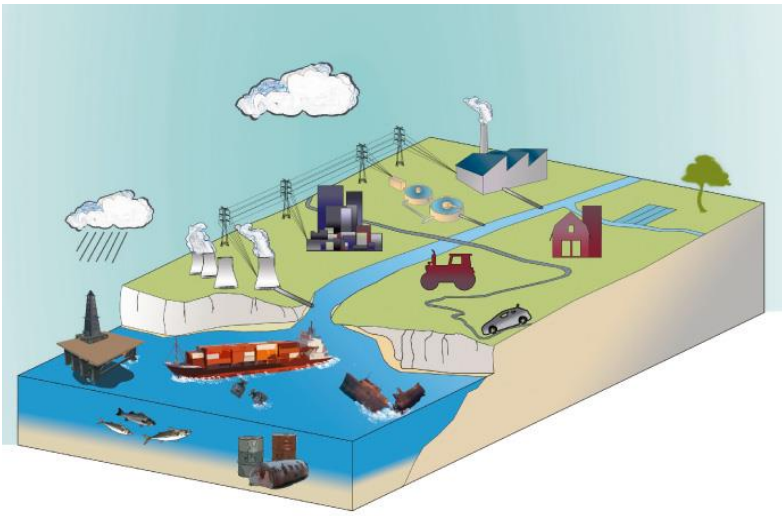
OSPAR and WFD lists are different (OSPAR list is bigger) and the evaluation thresholds are different: in the organism for OSPAR and in waters for WFD.

4.2.2 Activities and related released contaminants

Contaminants come from on-land or at-sea activities. They can come from diffuse sources (products, wastes), point sources (industry), atmospheric deposition and acute events.

Industrial and population centers produce most man-made and naturally occurring substances, some of which are hazardous to the marine environment, released either as emissions to air, discharge to water or as losses during the lifecycle of products. These substances are transferred to the North-East Atlantic along a range of environmental pathways. Historic pollution in riverine, estuarine and marine sediments acts as a continued source of release, especially when sediments are moved by currents or disturbed by human activities.

Figure 45 gives a view on sources of hazardous substances and pathways to the marine environment. Table 27 lists both on-land and at-sea activities as well as concerned released substances.



[4] Directive 2013/39/eu of the european parliament and of the council of 12 August 2013 amending Directives 2000/60/EC and 2008/105/EC as regards priority substances in the field of water policy http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013L0039&from=FR

[5] https://qsr2010.ospar.org/en/media/content_pdf/ch05/QSR_CH05_EN_Tab_5_1.pdf

Figure 45 : Schematic overview of the main sources of hazardous substances and pathways to the marine environment. (OSPAR Commission 2010)

Waterborne substances enter the sea directly, for example through sewage and industrial discharges, or from offshore activities such as oil and gas extraction, mariculture and shipping. They are also transported to the sea by rivers which collect inputs from inland sources such as industry and agriculture. Atmospheric transport is an important pathway for volatile substances that attach to particles (e.g. from combustion) which reach the sea mainly through deposition.

The main sources from which radioactive substances are discharged are the nuclear sector (associated with electricity generation (Table 27) and the non-nuclear sector, mainly the offshore oil and gas activities and medical uses. Other non-nuclear sources are minor.

Activities	
AT SEA Directly affecting coastal and non-coastal waters	→ Discharge of dredged material (activity)
	→ Oil and gas platforms (activity)
	→ Accidental pollution from boats (activity)
	→ Oceanic currents leading to transboundary circulation (pathway)
	→ Atmospheric deposition (pathway)
ON-LAND Directly influence coastal waters. Rivers are the main pathway.	→ Agriculture (activity)
	→ Collectivities (water treatment plants) (activity)
	→ Urban areas run-off (activity)
	→ Industrial discharges (activity)
	→ Mining (activity)
	→ Nuclear sector (activity)

Table 27: Activities and/or pathways and concerned contaminants. Adapted from (Agence des Aires Marines Protégées et Ifremer 2012)

Atmospheric deposition is a major pathway for heavy metals. By 2005, emissions from combustion in power plants and in industrial process were the main contributors to total atmospheric deposition of lead. Combustion processes leading to cadmium emissions in the air are also important, even though waterborne inputs may exceed those from atmospheric deposition. A main pathway of mercury to the sea is atmospheric deposition and it can be carried long distance from its source. Atmospheric deposition of Persistent Organic Pollutants (POP) is a global issue (Long-distance transportation) (OSPAR Commission 2009b).

Agriculture. In France, this sector releases: pesticides, impure substances in fertilizers (Cd, etc.), substances used for animal feed and care (Cu, Ni). Some pesticides are listed in WFD priority substances list (Agence des Aires Marines Protégées et Ifremer 2012).

Collectivities (water treatment plants). In France, treatment plants discharges release metals (Zn, Cu, Pb) (highest proportion), and other substances like DEHP, tributylphosphate, phenol, pesticides, etc (Agence des Aires Marines Protégées et Ifremer 2012).

Urban areas, run-off. In France, it is a source of PCBs, HAPs, metals, pesticides, DEHP, alkylphenols, DBT and MBT (Agence des Aires Marines Protégées et Ifremer 2012).

Industrial discharges. In France, it is a source of heavy metals (cadmium, mercury) from metallurgic industry, phthalates, CVOC (chlorinated volatile organic compounds), benzene, chlorobenzene ,HAP, alkylphenol, chlorinated paraffin (Agence des Aires Marines Protégées et Ifremer 2012).

4.2.2.1 Atmospheric deposition - Long-range transport of hazardous substances in air

Some of the OSPAR priority chemicals are volatile or semi-volatile making air the most important transport way. These include mercury and PAHs from combustion sources, pesticides (e.g.lindane) used in agriculture and other persistent organic pollutants (POPs) which hardly degrade in the environment, for example PCBs, brominated flame retardants and PFOS

The substances can be picked up in temperate regions as gases and are carried by air streams northwards. When temperatures drop they condense onto atmospheric particles and reach surface waters by precipitation (e.g. rain, snow) or dry deposition (OSPAR Commission 2010).

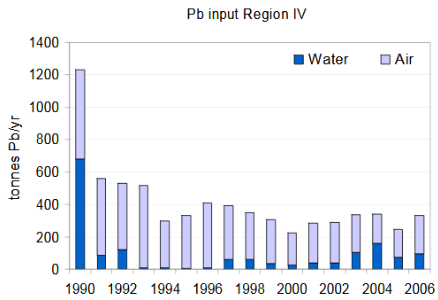


***Figure A10.14**: Total lead inputs to Region IV by direct discharges and riverine inputs (RID) and EMEP modelled atmospheric deposition (Note: RID data for Spain and Portugal only).*

Figure 46 : Total lead inputs to Region IV by direct discharges and riverine inputs (RID) and EMEP modeled atmospheric depositions (Note: RID data for Spain and Portugal only). (OSPAR Commission 2010) https://qsr2010.ospar.org/media/assessments/P00447_Trend_atmospheric_inputs.pdf

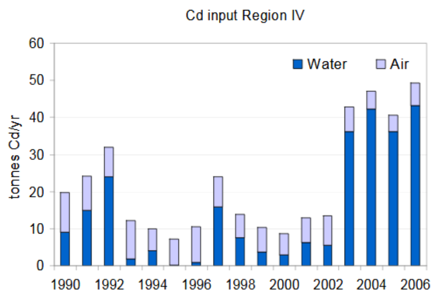


***Figure A10.15.** Total cadmium inputs to Region IV by direct discharges and riverine inputs (RID) and EMEP modelled atmospheric deposition (Note: RID data for Spain and Portugal only).*

Figure 47 : Total cadmium inputs to Region IV by direct discharges and riverine inputs (RID) and EMEP modeled atmospheric depositions (Note: RID data for Spain and Portugal only). (OSPAR Commission 2010) https://qsr2010.ospar.org/media/assessments/P00447_Trend_atmospheric_inputs.pdf

Annex IX. International and EU instruments and respective tools and objectives related to contaminants lists the main international and EU instruments and respective tools and objectives related to contaminants.

4.2.3 Concentration and impacts of contaminants

A distinction has to be made between concentration measures, and impact assessment of substances. This distinction appears in the MSFD criteria for Descriptors 8 and 9. Concentration of contaminants can be measures in three different matrix : water, sediment and biota.

	Concentration criteria (exposure)	Impact criteria
Descriptor 8 : Contaminants	D8C1 (8.1.1) Contaminants concentration (water, sediment, biota matrix)	D8C2 (8.2.1) Health of species and the condition of habitats affected by contaminants
	D8C3 Spatial extent and duration of significant acute pollution events	D8C4 (8.2.2) Adverse effects of significant acute pollution events on the health of species and on the condition of habitats
Descriptor 9: Contaminants in fish	D9C1: Level of contaminants in edible tissues (muscle, liver, roe, flesh or other soft parts, as appropriate) of seafood (including fish, crustaceans, mollusks, echinoderms, seaweed and other marine plants)	none

Table 28: MSFD criteria associated to Descriptor 8 and Descriptor 9 as in the Decision 2017/848

4.2.3.1 Nature of impacts caused by contaminants

Hazardous substances are found in seawater, sediments and marine organisms throughout the North-East Atlantic. The presence of hazardous substances leads to a range of responses within marine organisms, such as the induction of specific enzymes, changes in tissue pathology and death (OSPAR Commission 2010).

The effects of contamination can manifest at cellular or molecular levels. Effects can be assessed through the study of biomarkers: mixed-function oxygenases (MFO enzymes, such as EROD), glutatlon-S-transferase (GST), defensas antioxidates (Glutation peroxidasa GPx), acetilcholinesterase (AchE) (Instituto Espanol de Oceanografia et Asistencia Tecnica TRAGSATEC SA 2012c).

Nature of impacts of different substances		
Polycyclic aromatic hydrocarbons (PAHs)	PAHs are of concern due to their persistence, potential to bioaccumulate and toxicity. They are therefore included on the OSPAR List of Chemicals for Priority Action. The problems caused by PAHs in the marine environment vary considerably from tainting the taste of fish and shellfish to potential carcinogenic effects on humans and animals. (OSPAR Commission, 2017)	
Polychlorinated Biphenyls (PCB)	PCBs accumulate in marine animals, with greater concentrations found at higher trophic levels. PCB compounds are extremely toxic to animals and humans, causing reproductive and developmental problems, damage to the immune system, interference with hormones, and can also cause cancer. A sub-group of PCBs is 'dioxin-like', meaning they are more toxic than other PCB congeners. (OSPAR Commission, 2017)	
Polybrominated Diphenyl Ethers (PBDEs)	PBDEs are a group of 209 different congeners. PBDEs are toxic, they take a long time to degrade and have the potential to accumulate in fish or shellfish (taken in either directly from the surrounding water or indirectly via food). PBDE has been reported as neurotoxic, immunotoxic and to affect thyroid hormone receptors in sensitive human populations. Effects on behaviour and learning and hormonal function have been reported in mammals, while reduced reproductive success has been documented in birds. As a result, some PBDEs were banned or restricted within the European Union starting in 2004. Production of some groups of PBDEs was banned in 2009 by 180 countries that are signatories to the Stockholm Convention. (OSPAR Commission, 2017)	
TBT	In the 1980s, antifouling paint containing tributyltin (TBT) was used to prevent the attachment of algal slimes and other organisms. By the mid-1980s, the cause of poor growth in oyster stocks was identified as TBT in antifouling paints used on small craft operating in waters near the commercial shellfish beds. TBT is toxic to many	IMPACT INDICATOR : Imposex on *Nucella lapillus* *Ecological*

	marine organisms at very low concentrations and is unequivocally linked to reduced reproductive performance in several mollusc species. (OSPAR Commission, 2017)	*Quality Objective EcoQO for this indicator*
Heavy metals	The most toxic metals to fish and animals are mercury, cadmium and lead. Although other metals are also included in the OSPAR Coordinated Environmental Monitoring Programme, these are the three priority heavy metals. Mercury is highly toxic. Mercury and cadmium accumulate in the food chain. Lead is not accumulated via the food chain.	
Radioactive substances affect living organisms	Radioactivity is associated with energy released from radionuclides through radiation. Ionising radiation occurs as electromagnetic rays (γ-rays), particles (α and β). It can cause genetic, reproductive and cancerous effects in living organisms. Because of this, it has the potential to cause negative effects on marine organisms at the level of populations and to affect human health through seafood consumption. The potential for harm through radiation depends on the properties of the radionuclides, the amount of radiation energy absorbed by marine organisms (i.e the dose) and the pathway through which they are exposed: γ-rays and β-particles can penetrate the skin, while α-particles cannot, but are particularly dangerous if inhaled. (OSPAR Commission, 2010)	

Table 29 : Nature of impacts of different substances

4.2.3.2 Impacted components and spatial extent of the pressure in French waters

4.2.3.2.1 Impacted ecosystem components in French waters

In the MSFD framework, France has summarized impacts from substances for each marine environment feature in the context of the Bay of Biscay (Agence des Aires Marines Protégées et Ifremer 2011). This impact assessment was contextualized in the Bay of Biscay (taking into account if there is an existing interaction, resulting in actual impacts). A confidence index is also provided for each impact diagnostic (low, medium, high).

No 'high' impact was identified for this pressure. However, for many ecosystem component, the impact was qualified as 'Existing interaction but unknown impact'.

Impacted components in the Bay of Biscay Pressure : Inputs of substances (synthetic substances, non-synthetic substances, radionucleides)	
SIGNIFICANT IMPACT	→ Marine mammals → Marine birds → Demersal and pelagic fish and cephalopods → Phytoplankton → Commercially-exploited crustaceans and shellfish → Human health
LOW IMPACT	→ Commercially-exploited fish and cephalopods → Food webs

Table 30: High, significant and low impacts of the pressure 'Input of substances'. The full table is provided in Annex VI. Summary of impacts by ecosystem components, for the marine region 'Bay of Biscay' according to French MSFD Initial Assessment in 2011(Agence des Aires Marines Protégées et Ifremer 2011)

4.2.3.2.2 Potentially impacted areas (high exposure to contamination) in French waters

In order to define Environmental Targets in the first round of MSFD, France has identified 'ecological' challenges and/or challenge areas for which an action is required to reach GES, based on a qualitative analysis or on expert opinion.

Challenge areas for contaminants are presented in Figure 48. They correspond to areas of high pressure (high concentration of contaminants).

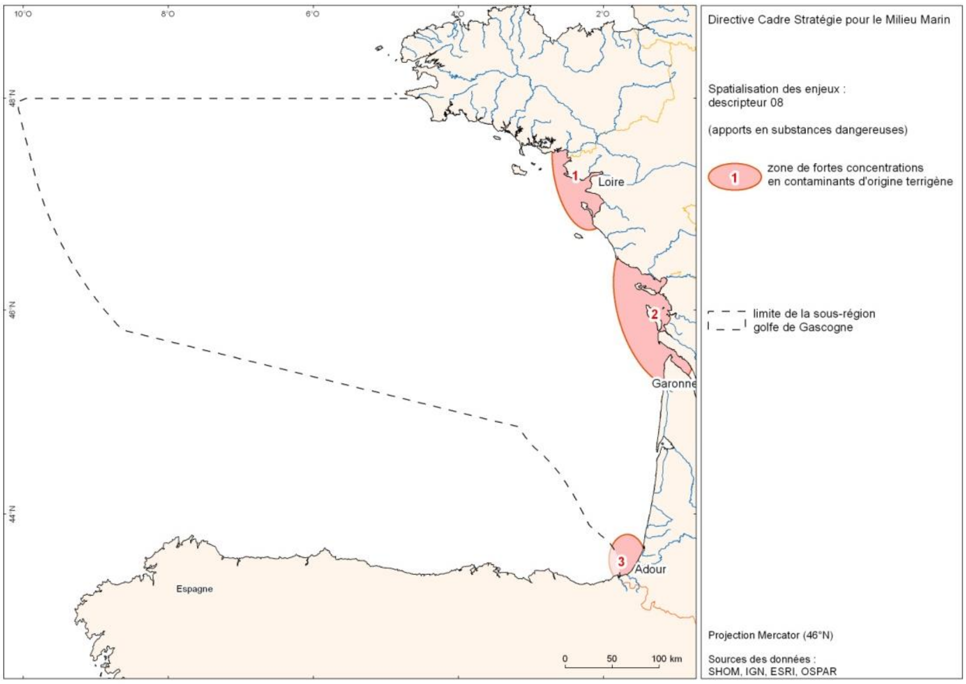


Figure 48: Challenge areas for contaminants in the Bay of Biscay as identified in the MSFD process in France (Agence des Aires Marines Protégées et Ifremer 2011)

In the context of WFD monitoring, the same water bodies show a 'bad' 'chemical status'[6].

4.2.3.3 Potentially impacted areas in Cantabrian sea and Galicia (Spanish MSFD)

4.2.3.3.1 MSFD identification of potentially impacted areas (high exposure) in Spain

The cumulative analysis of contaminants pressure conducted in Spanish MSFD Initial Assessment (Instituto Espanol de Oceanografia et Asistencia Tecnica TRAGSATEC SA 2012a) was made taking into account all the available sources of pollution. That is, neither an individual analysis by pollutant is carried out, nor the intentionality of the discharge is considered, but the zones with a higher probability of receiving polluting loads are identified. To accomplish this, a selection of grid cells is firstly made, according to the following criteria:

- → Those containing any single buoy mooring
- → Those containing any off-shore platform
- → Those that are within 500 m from any authorised area for disposal of dredged material
- → Those that coincide with the EMEP cells with the highest levels of dangerous substances (which account for 50% of the total dioxin pollution and 25% for heavy metals pollution, starting from the highest to the lowest concentrations)
- → Those that are within 5 km from any industrial complex included in the E-PRTR registry with no obligation of reporting to this registry.
- → Those that are within 2 km from wastewater treatment plants without obligation to report according to the PRTR regulation

[6] According to Annex V, point 1.4.3 of the WFD and Article 1 of the Environmental Quality Standards Directive (EQSD, 2008/105/EC), good chemical status is reached for a water body when it complies with the Environmental Quality Standards (EQS) for all the priority substances and other pollutants listed in Annex I of the EQSD. http://ec.europa.eu/environment/water/water-dangersub/pri_substances.htm#list

→ Those that are within 5 km of any facility with the obligation to report to the E-PRTR registry (including industrial facilities and wastewater treatment plants)
→ Those that are within 2 km from a river mouth
→ Those that are within 2 km from any municipal solid waste landfill
→ Those that are within 5 km from mining zones > 100 Ha
→ Those that are within 2 km from any port with no traffic of dangerous goods
→ Those that are within 5 km from any port with traffic of dangerous goods
→ Those that are within 2 km from rivers whose loads are reported to the OSPAR convention (those that add up to 85% of the total pollutant load for the Spanish OSPAR zone, beginning the sum from highest to lowest, for each of the contaminant, are selected)
→ Those that are within 2 km from some river or transitional water body that does not reach a good chemical status
→ Those that overlap with some coastal water body that does not reach a good chemical status

The result is a grid showing the probability of inputs of hazardous substances which, therefore, could indicate areas with potential risk of pollution.

6 areas of high potential for the accumulation of contaminants are identified (Rías de Vigo and Pontevedra, Ferrol-Coruña, San Cibrao, Avilés, Bilbao and San Sebastián-Pasajes) and 2 of moderate potential (Gijón and Suances).

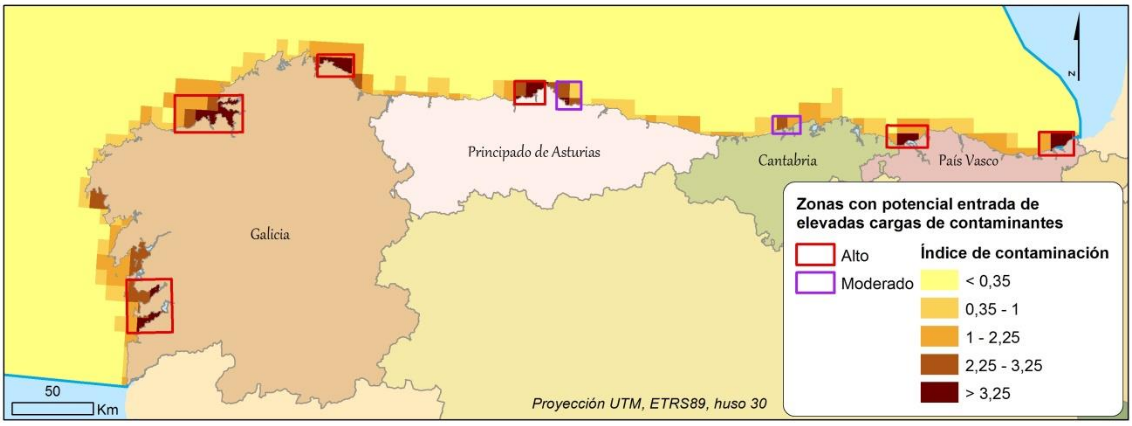


Figure 49 : Zones of potential accumulation of contaminants (Instituto Espanol de Oceanografia et Asistencia Tecnica TRAGSATEC SA 2012a)

4.2.3.3.2 MSFD assessment of exposure and impacts

The good environmental status (GES) proposed by Spain for MSFD Descriptor 8 (contaminants) is in accordance with the international environmental quality criteria derived from the law or proposed at regional level by international agreements.

Matrix	Below To	Basal level (To)	Between To and T1	Threshold value (T1)	Above T1
Water	Concentration is hazardous substance is close to zero or below basal level	Background Assessment Criteria (BAC) ICES/OSPAR	Low or no risk for environment and species	Environment Quality Standards (EQS) (2008/105/CE)	Risk for the environment and species
Sediment		Background Assessment Criteria (BAC) ICES/OSPAR		Environmental Assessment Criteria (EAC) (ICES/OSPAR) /Or Effects Range Low ERL	
Biota		Background Assessment Criteria (BAC) ICES/OSPAR		Environmental Assessment Criteria (EAC) (ICES/OSPAR)	

Table 31 : Reference values used for MSFD assessment.

Assessment results for North Atlantic subdivision (Demarcación Marina Noratlántica)

As shown in Figure 50, and according to the data available, none of the sampling points in this demarcation has levels of cadmium or lindane that constitute a risk to the ecosystem. For the remaining pollutants evaluated, to a different extent, the levels detected may produce adverse effects. Thus, levels exceed T1 values in 14% of cases for mercury (Hg), 11% for lead (Pb), 4% for PAHs, 26% for PCBs and 0.8% for DDE.

With respect to the indicators of biological effect, only T1 values were exceeded in the case of imposex (65%) and sea urchin larval growth (PNR) (2.4%). Subsequently, this assessment can be integrated into one more level, and can be presented in a graph with three columns in which are grouped, in the first column the pollutants, in the second column the exposure indicators and in the third those of effects, as shown in Figure 51.

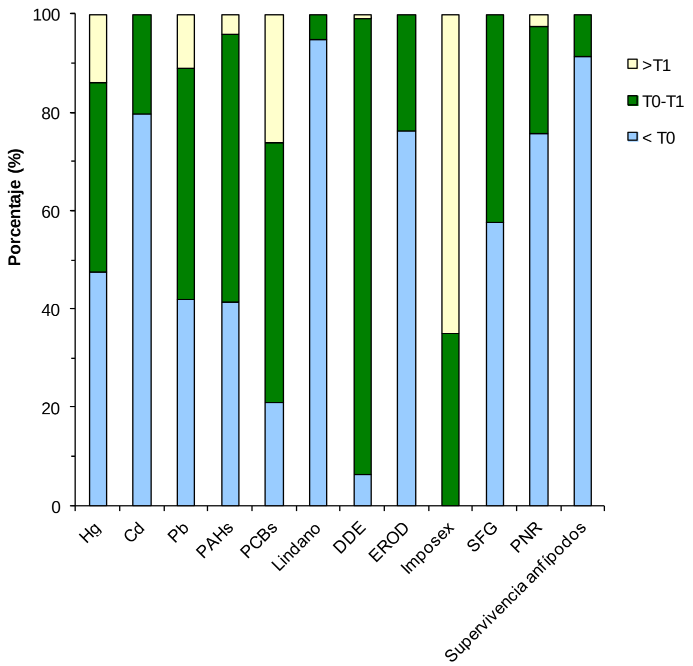


Figure 50 : Assessment of contaminant data (integrated values of biota and sediments) and available biological effects of the coastal zone of the Spanish North Atlantic demarcation according to the proposed assessment criteria.

As can be seen in Figure 51, a small proportion of the stations exceed the proposed criteria for pollutants (8.0%). In the case of the effects indicators, the T1 is not exceeded in any case and in the indicators of exposure the percentage is somewhat higher, 16.9%.

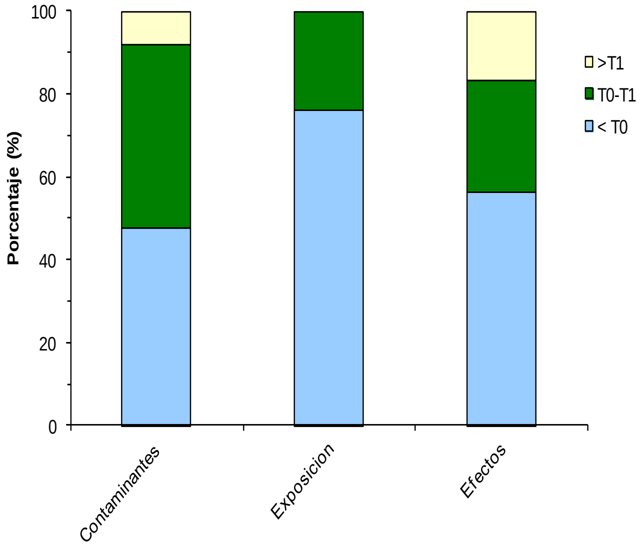


Figure 51: Integrated assessment of pollution indicators, indicators of exposure and indicators of effects of the North Atlantic demarcation according to the proposed assessment criteria. (Exposicion : EROD, Efectos : Imposex, SFG, PNR, Supervivencia anfipodos)

It should be recalled that all sampling points are located on the coastal strip, on the first miles from the coast. It is also important to remember that in 2003 much of the evaluated area of this demarcation was affected by the *Prestige* oil spill. This spill was reflected in the different hydrocarbon concentration studies in sediment and biota but, since the data presented here correspond to the year 2010, when the values had already recovered their normal levels, this effect is not evident. However, the effect might be more evident in the exposure indicators presenting the EROD data, since those samples were collected in the following months after the oil-spill.

In the case of the effect indicators, the values exceeding the T1 threshold correspond mainly to the Imposex measures, caused by the presence of TBT. It is expected that the levels of this pollutant will decrease due to the prohibition of its use and that this effect will become less frequent. It should be noted, however, that experts believe that despite presenting Imposex, none of the populations is estimated to be at risk of extinction.

4.2.3.3.3 WFD CHEMICAL STATUS & comparison with MSFD assessments

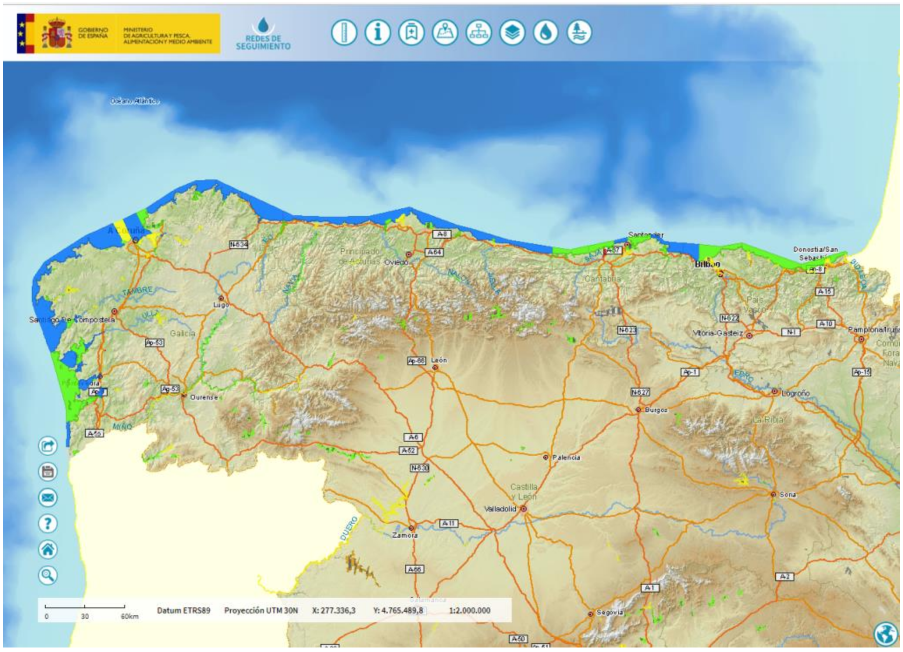


Figure 52 : Map of the chamical status of water bodies according WFD directive in Spain

WFD Results show that the majority of water bodies reach the good chemical status, and confirm the global good status shown in MSFD assessment.

4.2.3.4 Potentially impacted areas in Portuguese waters

4.2.3.4.1 Water Framework Directive 'Good Chemical Status' (coastal waters only)

According to Annex V, point 1.4.3 of the WFD and Article 1 of the Environmental Quality Standards Directive (EQSD, 2008/105/EC), good chemical status is reached for a water body when it complies with the Environmental Quality Standards (EQS) for all the priority substances and other pollutants listed in Annex I of the EQSD[7].

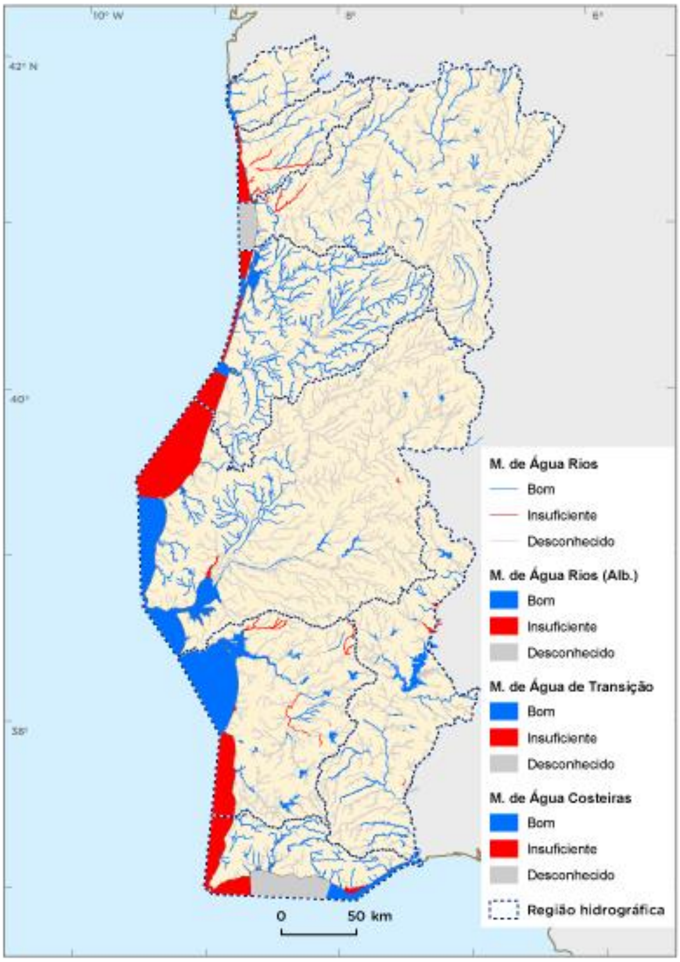


Figure 53: classification of chemical status of surface waters in Portugal mainland (2nd cycle). Source: Agencia Portuguesa do Ambiente, 2016. https://rea.apambiente.pt/node/72

[7] http://ec.europa.eu/environment/water/water-dangersub/pri_substances.htm#list

4.2.3.4.2 MSFD framework (coastal and offshore waters)

Areas A2, B2 and C2 (Figure 54) are not assessed under Water Framework Directive. In a first time, WFD results are used for MSFD classification. The MSFD Initial Assessment of 2012 concluded with a low confidence degree that these areas had a good environmental status.

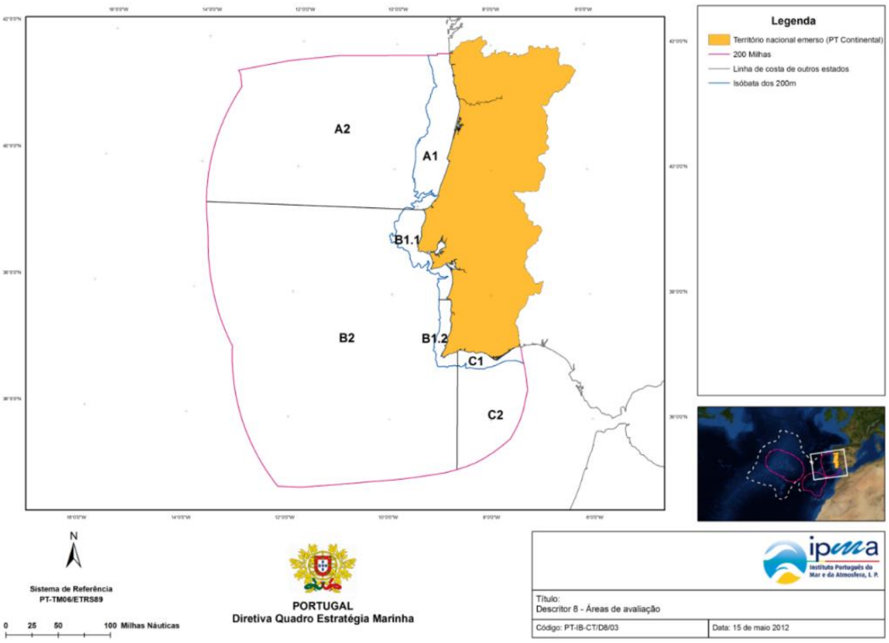


Figure 54: Areas of evaluation to the support the description of pressures and impacts of contamination by some priority substances (Ministério da Agricultura, do Mar, do Ambiente e do Ordenamento do Território 2012)

4.2.3.4.3 Box: climate change and substances

Remark : Depending on the physical and chemical properties of the hazardous substances, environmental changes resulting from global warming will alter the pathways of these substances. Warming of the atmosphere may lead to more evaporation and transport of contaminants by air, rainfall may increase and flooding may result in higher run-off from land and more river inputs. Increased storminess may result in additional remobilization of contaminants from marine sediments. Changes in food web structure may affect contaminant pathways. (*text from OSPAR QSR)*

4.3 Input of litter (D10)

4.3.1 Activities driving input of litter

Activities identified in the Portuguese MSFD Initial Assessment include: Fisheries, including aquaculture; Offshore vessel related kitchen litter; Sanitary litter associated with liquid effluent; Navigation, including offshore activities; Touristic and recreational activities.

4.3.2 Impacts of marine litter

4.3.2.1 Impacted components and potentially impacted areas in French waters

4.3.2.1.1 Impacted components

In the MSFD framework, France has summarized impacts from marine litter for each marine environment feature in the context of the Bay of Biscay (Agence des Aires Marines Protégées et Ifremer 2011). This impact assessment was contextualized in the Bay of Biscay (taking into account if there is an existing interaction, resulting in actual impacts). A confidence index is also provided for each impact diagnostic (low, medium, high).

Impacted components in the Bay of Biscay Pressure : Input of litter	
SIGNIFICANT IMPACT	→ Marine birds → Littoral soft substrate communities
LOW IMPACT	→ Marine mammals → Demersal and pelagic fish and cephalopods → Zooplankton → Phytobenthos → Littoral hard substrate communities → Infralittoral and circalittoral hard substrate communities → Infralittoral soft substrate communities → Circalittoral soft substrate communities → Bathyal and abyssal communities → Commercially-exploited fish, cephalopods and crustaceans → Human health

Table 32: High, significant and low impacts of the pressure 'Input litter' on ecosystem components in the Bay of Biscay. The full table is provided in Annex VI. Summary of impacts by ecosystem components, for the marine region 'Bay of Biscay' according to French MSFD Initial Assessment in 2011.

4.3.2.1.2 Input pathways and potentially impacted areas (high exposure) in French waters

In order to define Environmental Targets in the first round of MSFD (Agence des Aires Marines Protégées et Ifremer 2011), France has identified 'ecological' challenges and/or challenge areas for which an action is required to reach GES, based on a qualitative analysis or on expert opinion.

Challenge areas for marine litter correspond to high exposure areas, as well as source areas.

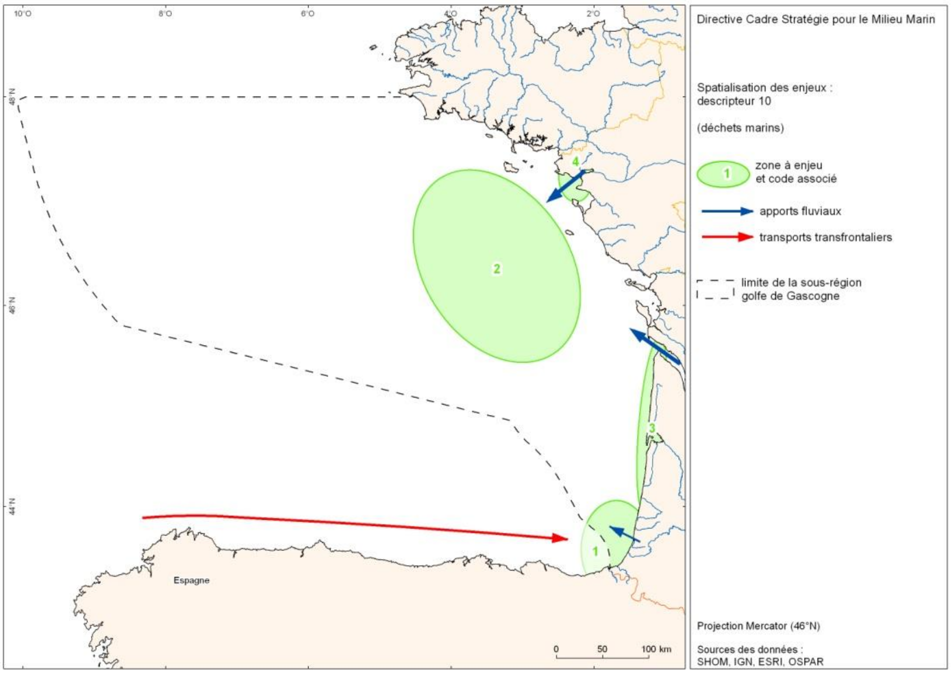


Figure 55 : Challenge areas (high exposure) and pathways for inputs and transport identified for marine litter in the Bay of Biscay, in the French MSFD process (Agence des Aires Marines Protégées et Ifremer 2011)

4.3.2.2 Input areas and potentially impacted areas in Cantabrian sea and Galicia (Spanish MSFD)

To characterize inputs of marine litter from terrestrial origin, the following sources are taken into account: coastal population, ports, bathing areas, urban solid waste landfills and rivers.

Areas with a high potential for littering are selected from the cells classified as "Very High" and zones of moderate potential from the cells classified as "High":

Very High: 8 - 10 / High: 6 - 8 / Medium: 4 - 6 / Low: 2 - 4 / Very Low: 0 - 2

3 areas with high risk of receiving litter from land sources (Rías Bajas, Ártabro Gulf and Costa de Santander) and 3 with moderate risk (Avilés-Gijón, Bilbao and San Sebastián-Pasajes) are identified.

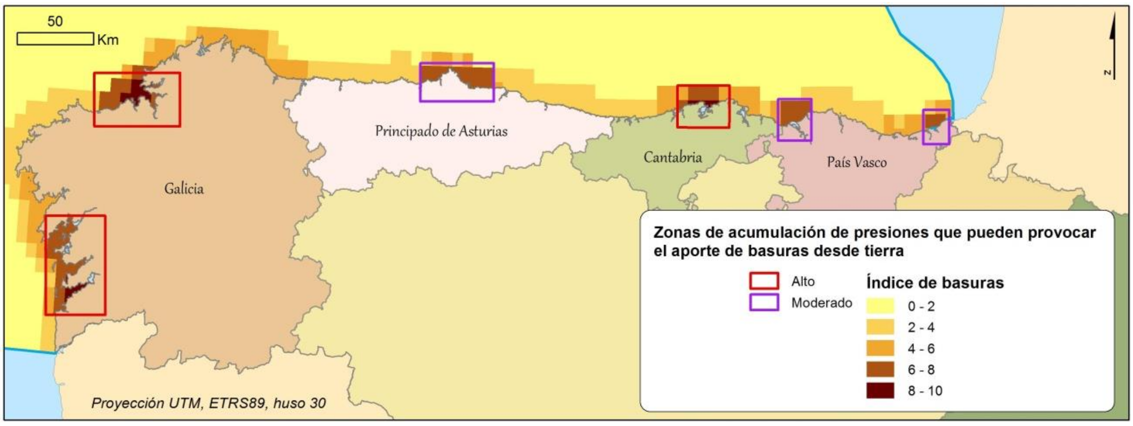


Figure 56: Zones of accumulation of pressures that contribute to the input of litter from land(Instituto Espanol de Oceanografia et Asistencia Tecnica TRAGSATEC SA 2012a). Very High: 8 - 10 / High: 6 - 8 / Medium: 4 - 6 / Low: 2 - 4 / Very Low: 0 - 2

Regarding marine litter, it should be noted that it comes mainly from fishing and navigation. In both activities, litter can be produced by the crew (lost, accidentally dumped or thrown overboard), and in the case of fishing, it may also come from abandoned or lost gear, causing what is known as "ghost fishing". Given the availability of information, in the first evaluation it is decided to identify only the areas with the highest density of fishing ships or merchant vessels (that is, the areas with the highest number of VMS and AIS signals). Both signals are added although some transformation is previously made to make them comparable.

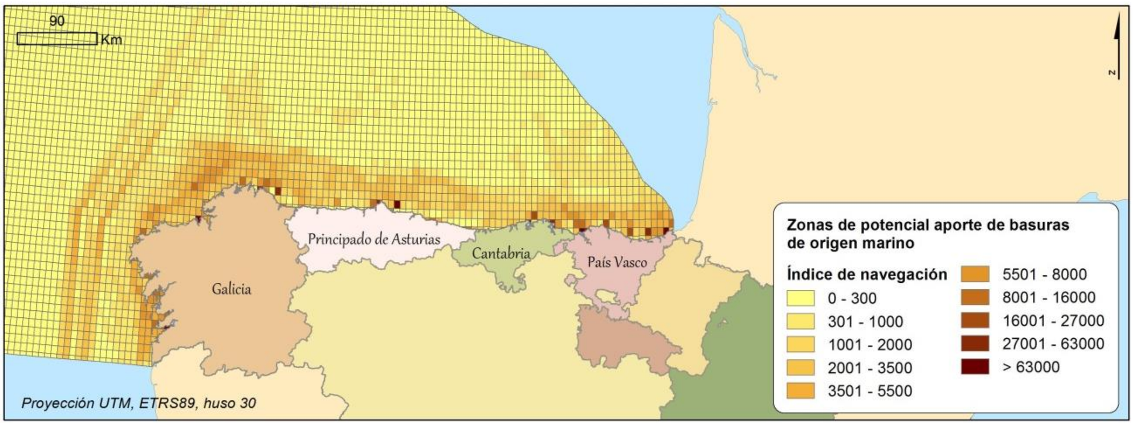


Figure 57: Accumulation of pressures that contribute to input of litter from the sea (sum of transformed VMS and AIS signals received in a month) (Instituto Espanol de Oceanografia et Asistencia Tecnica TRAGSATEC SA 2012a)

No specific areas are designed since navigation and fishing are well extended around the region.

4.3.2.3 Potentially impacted areas in Portuguese waters

The MSFD assessment of marine litter in Portugal found out that despite some data of monitoring efforts of beach litter there is a lack of methodologies and temporal standard data. There is no consistent data on bottom marine litter (Ministério da Agricultura, do Mar, do Ambiente e do Ordenamento do Território 2012).

However, some reports and scientific studies have been made to support marine litter knowledge, especially in what concerns the beach and floating components.

4.3.2.3.1 Beach Litter

OSPAR convention has undertake periodic monitoring and assessment studies in Portugal beaches (Figure 58 et Table 33).

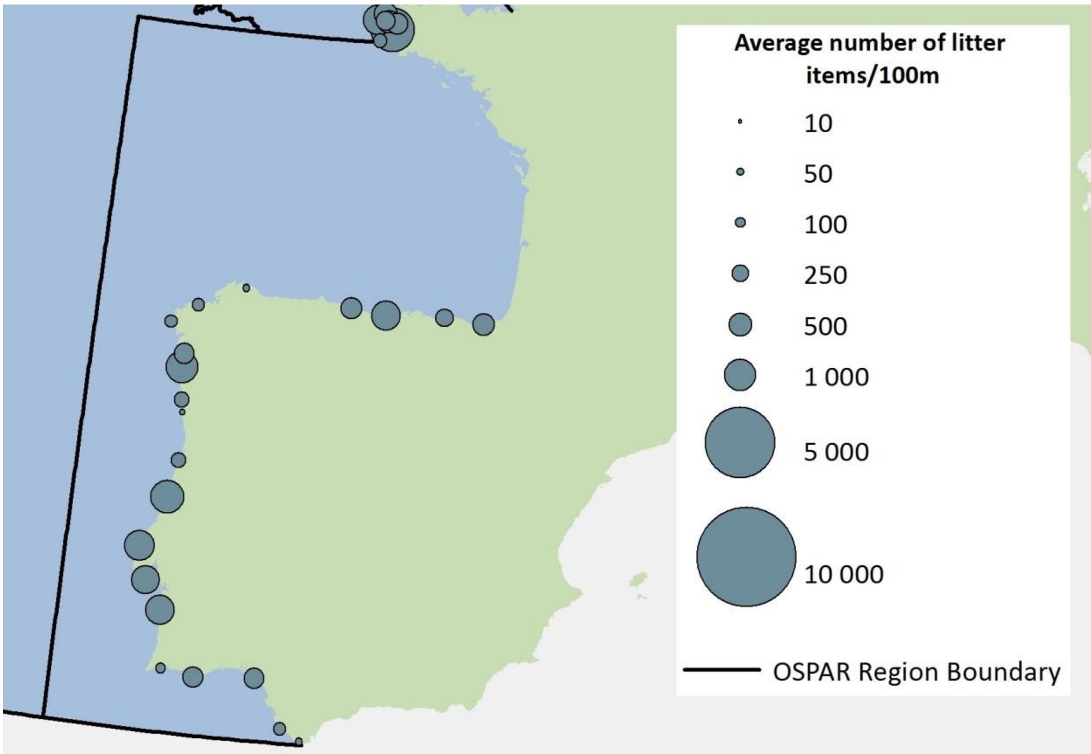


Figure 58 : Average number of litter items per 100m for the period 2014-2015 in OSPAR region IV. Source : OSPAR Commission. (2017).

Beaches	Average number of items/100m
Praia da Barra	247,375
Ilha de Faro	386,875
Batata	94,25
Cabedelo	231,5
Osso da Baleia	1105,25
Amoeiras	968,285714
Fonte da Telha	792,142857
Monte Velho	831,875
Barranha	31,625

Table 33 : Average number of litter items/100m by surveyed beach. Source : OSPAR Commission. (2017).

4.3.2.3.2 Floating litter

The study (Sá et al. 2016), addresses the occurrence of debris in the Portuguese mainland seas and identifies the areas were this occurrence is higher due to the presence of recurrent eddies activity (Figure 59). This study clearly shows that the concern to this problem should focus on the North sector of Portuguese waters.

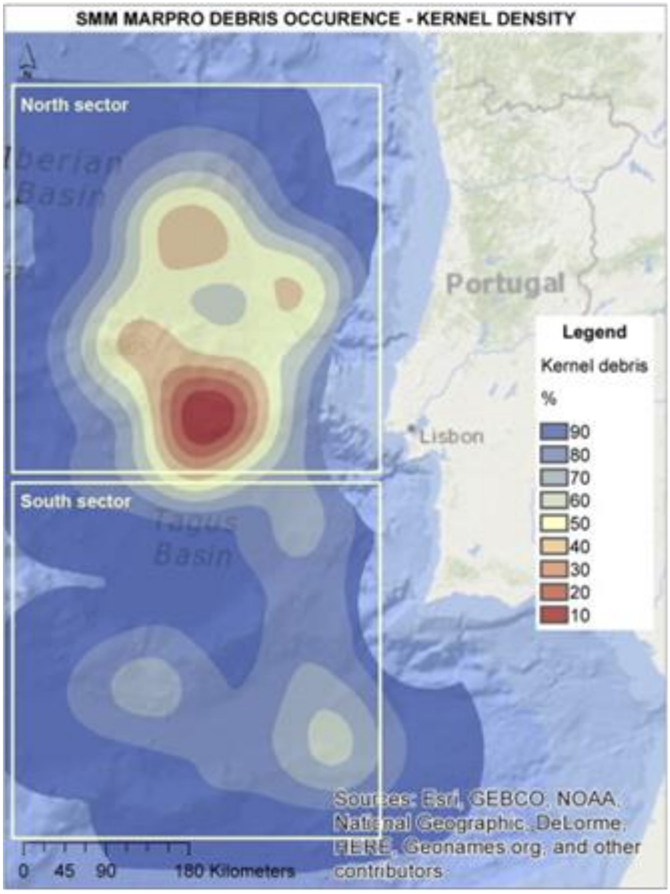


Figure 59 : Floating marine debris kernel density map (Sá et al. 2016)

4.4 Introduction of anthropogenic sound, input of other forms of energy (noise) (D11)

4.4.1 Activities driving introduction of sound

This pressure concerns impulsive and continuous anthropogenic sound, as well as other forms of energy (including electromagnetic fields, light and heat).

The main sources of noises are maritime traffic, sonar transmissions and constructions/labour in sea (Agence des Aires Marines Protégées et Ifremer 2012).

4.4.2 Impacts of noise

4.4.2.1 Nature of impacts

In the current state of knowledge, it is impossible to precisely evaluate the impact of noise on species. Even if there were no major incidents (like groundings) rely to the effect of noise, some species are known to be sensitive to this pressure (mostly marine mammals like Cuvier's beaked whale) and frequenting the marine area. Bay of Biscay could then be considered as a area with potential risk (Agence des Aires Marines Protégées et Ifremer 2012)

4.4.2.2 Impacted components and/or areas in French waters

4.4.2.2.1 *Impacted components*

In the MSFD framework, France has summarized impacts from marine litter for each marine environment feature in the context of the Bay of Biscay (Agence des Aires Marines Protégées et Ifremer 2011). This impact assessment was contextualized in the Bay of Biscay (taking into account if there is an existing interaction, resulting in actual impacts). A confidence index is also provided for each impact diagnostic (low, medium, high).

No 'high' or 'significant' impact was estimated for the pressure 'Introduction of anthropogenic sound, input of other forms of energy'. However, this pressure was assessed to have a 'low' impact on some biodiversity components.

Impacted components in the Bay of Biscay Pressure : Introduction of anthropogenic sound, input of other forms of energy	
LOW IMPACT	→ Marine mammals *(medium level of confidence)* → Demersal fish and cephalopods *(low level of confidence)* → Pelagic fish and cephalopods *(low level of confidence)* → Commercially exploited fish and cephalopods *(low level of confidence)*

Table 34 : Impacts of the pressure 'anthropogenic sound' on ecosystem components. The full table is provided in Annex VI. Summary of impacts by ecosystem components, for the marine region 'Bay of Biscay' according to French MSFD Initial Assessment in 2011. (Agence des Aires Marines Protégées et Ifremer 2011)

4.4.2.2.2 *Potentially impacted areas*

In order to define Environmental Targets in the first round of MSFD (Agence des Aires Marines Protégées et Ifremer 2011), France has identified 'ecological' challenges and/or challenge areas for which an action is required to reach Good Environmental Status, based on a qualitative analysis or on expert opinion.

Challenge areas for noise were obtained considering noise sources (maritime traffic, high intensity noise, construction works, and extraction) and marine mammals distributions, since they are the most sensitive ecosystem component.

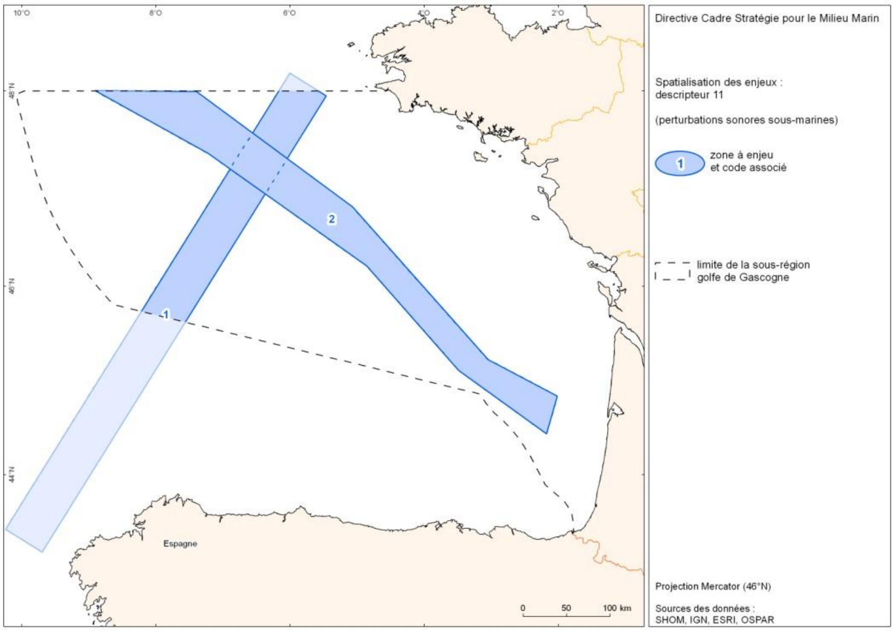


Figure 60: Challenge areas for introduction of sound energy in the Bay of Biscay (Agence des Aires Marines Protégées et Ifremer 2011)

Maritime traffic causes noise disturbance in the Bay of Biscay on an axis from Ouessant to La Corogne, as represented by zone 1 in Figure 60. The continental slope (zone 2 in Figure 60) is much visited by species like Ziphiidae, particularly sensitive to noise. This area is also a place of experiments (research, navy trainings), it is considered as a challenge area for noise.

These areas coincide with distribution areas of bottlenose dolphin, striped dolphins and deep diving species, which are at the intersection of the two zones. A better knowledge of distribution of bottlenose dolphins as well as stock structure and connectivity between stocks would allow better assessment of impacts of noise on marine mammals of the Bay of Biscay

4.4.2.3 Potentially impacted areas in Spanish waters (Spanish MSFD)

The approach to submarine noise in Spanish MSFD (Instituto Espanol de Oceanografia et Asistencia Tecnica TRAGSATEC SA 2012a) was to consider only the sources of continuous noise, that is, navigation. For this, a semi-quantitative index is developed, integrating AIS and VMS data.

2 areas with potentially high underwater noise levels (Ártabro Gulf and Vizcaya Gulf) and 5 areas with potentially moderate underwater noise levels (Santander-Bilbao, Gijón-Avilés, San Cibrao, Rías Baixas and the fishing area Costa de la Muerte-Costa de Ferrol) are identified.

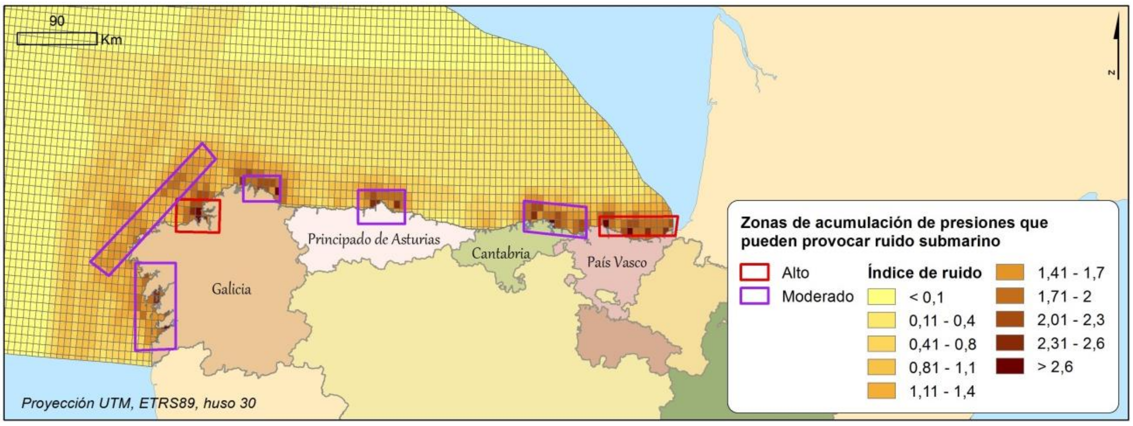


Figure 61: Zones of accumulation of pressures that may cause underwater noise (Instituto Espanol de Oceanografia et Asistencia Tecnica TRAGSATEC SA 2012a). Very High: > 2 / High: 1,71 - 2 / Medium: 0,41 - 1,7 / Low: 0,1 - 0,4 / Very Low: <0,1

4.4.2.4 Impacted components and/or areas in Portuguese waters

In the MSFD Initial Assessment of 2012, the activities responsible for the pressures on Descriptor 11 where identified: Acoustic modems, sonars, pingers and all the other acoustic equipment of data or positioning transmission, research and survey equipment; Underwater construction; All the underwater or surface vehicles. However, no environmental noise analyses been conducted. This topic needs additional information.

An example of modelling at national scale can be observed in Figure 62. This map shows the noise by the model of propagation distribution in all the coastal zone south of Roca Cape according the number and position of the ships sailing along Portuguese coast in real time in 10 minutes intervals. Despite the simplifications and limitations, this estimate allows, for the first timer a preview, at a national scale, the degree of distribution variability of noise due to navigation along the Portuguese mainland subdivision.

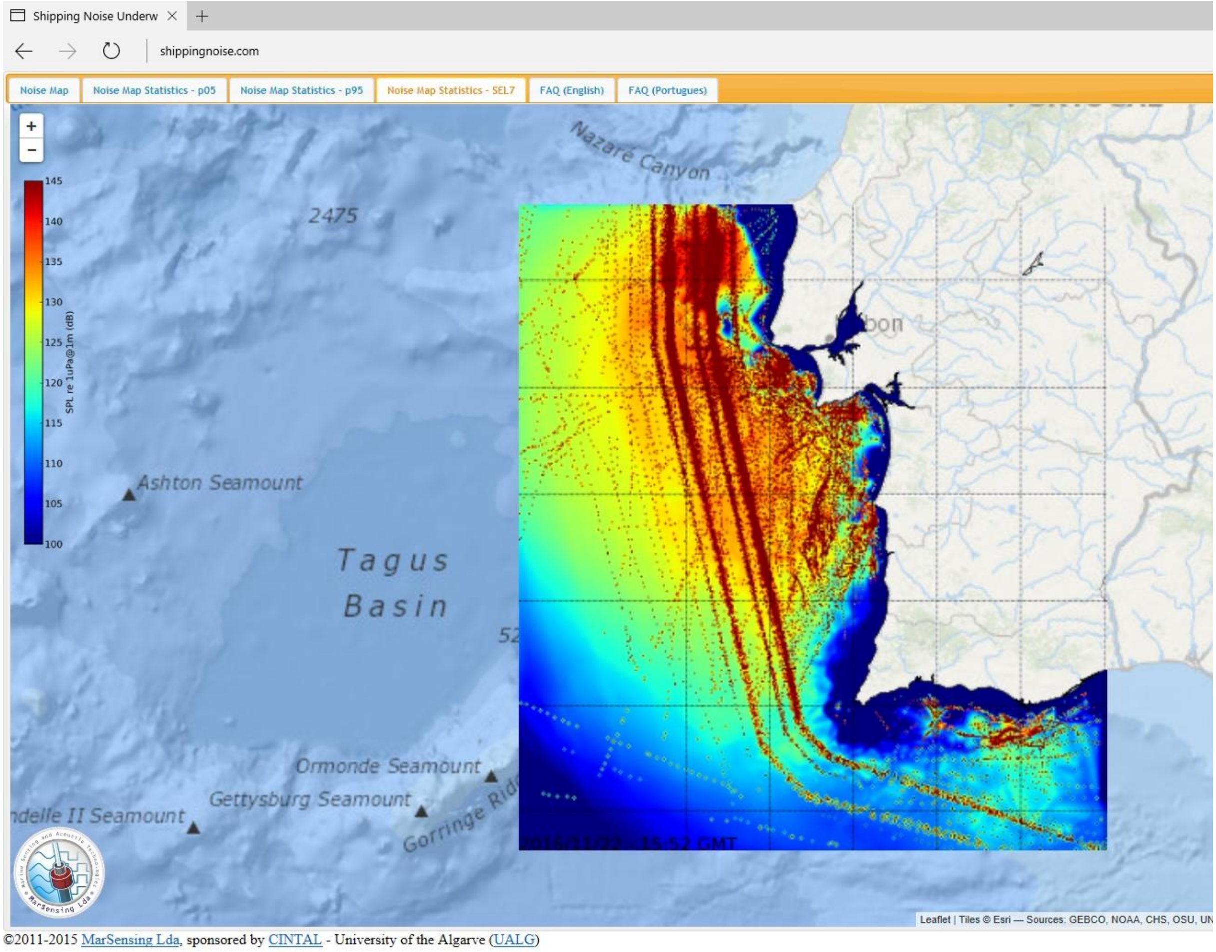


Figure 62 : Example of noise distribution map (cumulated sound exposure level) according to www. shippingnoise.com (national scale model produced by Marsensing Lda.)

5 CONCLUSION

Multiple pressures have been reviewed in this document. The identification of general areas where human activities and ecosystem components could conflict is a key step in MSP implementation.

The limited extent of the continental shelf in Region IV, especially around the Iberian Peninsula, and the demand for space for human activities including marine renewable energy developments, mean improved marine spatial management is particularly urgent.

6 ANNEXES

6.1 Annex I. Maritime and coastal activities to environmental factor matrix.

Maritime and coastal activities to environmental factors matrix

		ENVIRONMENTAL FACTORS																							
		Physical													Chemical							Biological			
Coastal & Maritime Activities / Events	Sub-activites /events	Substratum loss	Smothering	Suspended sediment	Desiccation	Changes in emergence regime	Changes in water flow rate	Changes in temperature	Changes in turbidity	Changes in wave exposure	Noise disturbance	Visual presence	Abrasion / Physical disturbance	Displacement	Synthetic compound contamination	Heavy metal contamination	Hydrocarbon contamination	Radionuclide contamination	Changes in nutrient levels	Changes in salinity	Changes in oxygenation	Introduction of microbial pathogens / parasites	Introduction of non-native species	Selective extraction of target species	Selective extraction of non-target species
Aquaculture	Fin-fish		R	R			R		R		P	P	R		R				R		R	R	R		
	Macro-algae		P	P			P		P		P	P							P		P	R	R	R	R
	Predator control										R	R			P										
	Shellfisheries		R	R			R		R		R	R	R		R				R		R	R	R	R	R
Climate change	Current change						R	R	R										R	P		R	R		
	Sea level change				R	R	R			R										R					
	Temperature change				R			R	R										R		R	R	R		
	Weather pattern change				R			R														R	R		
Coastal defence	Barrage	R	R	R	R	R	R		R	R	R	R	R	R	P	P	P		R	R	R				
	Beach replenishment	P	R	R	R	R	R		R	R	R	R	R	R	P	P	P		R		R				
	Groynes	P	P	R	R		R		R	R		R		P							P				
	Sea walls / breakwaters	P	P	R	R	R	R		R	R		R		P							P				
Collecting	Bait digging	R	R	R	R				R		R	R	R	R										R	
	Bird eggs										R	R	R											R	
	Curios										P	P	R	R										R	R
	Higher plants	R		R			R				R	R	R	R					R					R	R
	Kelp & wrack harvesting	R		R	R		R		R	R	R	R	R	R					R		R			R	R
	Macro-algae	R			R		R				R	R	R	R	P									R	R
	Peelers (boulder turning)		R		R	R	R				R	R	R	R										R	
	Shellfish	R	R	R	R				R		R	R	R	R										R	R
Development	Construction phase	R	R	R	R	R	R	P	R	R	R	R	R	R	P	P	P	P	R	R	R				
	Artificial reefs		P	R			R		R	R					P	P	P		R		R				
	Communication cables		P	R			R		R			R													
	Culverting lagoons			R	R	R	R	R	R	P									R	R	R				
	Dock/port facilities		R	R			R	P	R	R	R	R	R	R	R	P	R	P	R	P	R	R	R		
	Land claim	R	R	R	R	R	R		R	R									R	R	R				
	Marinas		R	R	R	P	R	P	R	R	R	R	R	R	R	P	R		R		R	R	R		
	Oil & gas platforms		R				R		R		R	R	R		R	R	R		R		R				
	Urban			R					R		R	R	R		R	R	R		R	R	R	R			
Dredging	Captial dredging	R	R	R	R	R	R		R	R	R	R	R	R	P	P	P	P	R	P	R				
	Maintenance dredging	R	R	R					R		R	R	R	R	P	P	P	P	R		R				

Energy generation	Nuclear power generation		P	R				R	R		R	R			R	P		P	R	P	R				
	Power stations		P	R				R	R		R	R			R	R	P		R	P	R				
	Renewable (tide/wave)		P	P	P	P	R		P	R	P	P			R		P				P				
	Wind farms	R					R			R	R	R	R	R	P	P	P								
Extraction	Maerl	R	R	R			R		R		R	R	R	R					R		R			R	R
	Rock/minerals (coastal quarrying)	R	R	R					R		R	R	R	R	R	R	R		R		R				
	Oil & gas		R								R	R			R	R	R		R		R				
	Sand / gravel (aggregates)	R	R	R			R		R	P	R	R	R	R	P	P	P	P	R		R				
	Water resources (abstraction)				P	P	R												R	R	R				
Fisheries/ Shellfisheries	Benthic trawls (e.g. scallop dredging)	R	R	R					R		R	R	R	R	P	P	P		R		R			R	R
	Netting (e.g. fixed nets)										R	R	R	R										R	R
	Pelagic trawls										P	P												R	R
	Potting / creeling		R								R	R	R	R										R	R
	Suction (hydraulic) dredging	R	R	R					R		R	R	R	R	P	P	P		R		R			R	R
Recreation	Angling										R	R	R	P										R	R
	Boating / yachting								P		R	R	R		R	P	R		R		R	R	R		
	Diving / dive site										R	R	R	R										R	
	Public beach										R	R	R						P						
	Tourist resort			R					R		R	R	R		R	R	R		R		R				
	Water sports										R	R	R		R	P	R								
Uses	Animal sanctuaries										P	P	P						P			P	P		
	Archaeology	R	R	R					R		R	R	R	R	P	P	P		R		R				R
	Coastal farming		R	R					R		R	R	R		R	P	R		R		R	P			
	Coastal forestry		R	R					R		R	R	R		R	P	R		R		R				
	Education/interpretation										R	R	R	R										R	R
	Military										R	R	R		P	P	P	P							
	Mooring / beaching / launching		R	R			R		R		R	R	R	R	R	P	R					P	P		
	Research	P									R	R	R	P	P	P	P		P			P	P	R	P
	Shipping		P	R					R		R	R	R	R	R	R	R	P	R		R	R	R		
Wastes	Fishery & agricultural wastes		R	R					R						R				R		R	R			
	Industrial effluent discharge		R	R					R						R	R	R		R		R				
	Industrial / urban emissions (air)			P					P						R	R	R								
	Inorganic mine and particulate wastes		R	R					R				R		P	R	P	P	R		R				
	Land / waterfront runoff		R	R					R						P	P	P		R	R	R				
	Litter and debris		R										R		P	P	P								
	Nuclear effluent discharge			R					R							R		R							
	Sewage discharge		R	R					R						R	R	R	P	R		R	R			
	Shipping wastes		P	R					R						R	R	R		R		R	R	R		
	Spoil dumping		R	R					R				P		P	P	P	P	R		R				
	Thermal discharges (cooling water)			R				R	R						R	R	P			P	R	P	P		
Other	Removal of substratum	R	R	R	P	P	P		R	P	R	R	R	R	P	P	P		R		R				

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PROBABLE EFFECT	-	R
POSSIBLE EFFECT	-	P

(Tyler-Walters et al. 2001)

The physical 'environmental factors' used in the MarLIN 'activities to environmental factors matrix' (Annex II. Non-indigenous species in the OSPAR area that have been identified as problematic) are defined in the following document: http://www.marlin.ac.uk/assets/pdf/App15_benchmarks.pdf

6.2 Annex II. Non-indigenous species in the OSPAR area that have been identified as problematic

	Taxonomic group	Common names	Regions affected	Vector	First reported	Probable impacts
Plants, algae and phytoplankton	*Spartina anglica*	Common cord-grass, Townsend's grass or ricegrass	I, III, IV		France 1906	
	Sargassum muticum	Wireweed, Japweed, Strangleweed	II, III, IV		UK 1973	
	Undaria pinnatifida	Wakame, Japanese kelp	II, IV		France 1972 France 1983	
	Gracilaria vermiculophylla	Asian red alga	II, III		France 1996	
	Codium fragile ssp. *fragile*	Green sea fingers	I, II, III, IV		Netherlands ~1900	
	Bonnemaisonia hamifera	Red alga	I, II, III, IV, V		UK 1893	
	Coscinodiscus wailesii	A centric diatom	II, III, IV		UK 1977 Norway 1979	
Invertebrates	*Mnemiopsis leidyi*	A comb jelly	II		Netherlands, Sweden, Norway 2006	
	Marenzelleria spp. (complex)	Red gilled mud worm	II, III		UK 1979	
	Crepidula fornicata	Slipper limpet	II, III, IV		UK 1872	
	Ensis americanus (=*directus*)	Jackknife clam, razor clam	II		Germany 1979	
	Crassostrea gigas	Pacific oyster	II, IV		France 1980s	
	Mya arenaria	Soft-shelled clam, soft clam, long-necked clam	I, II, III, IV		1245	
	Rapana venosa	Rapa whelk, veined whelk	IV		France 1997 North Sea 2005	
	Venerupis philippinarum	Japanese clam, Manila clam	II, IV		UK 1992	
	Teredo navalis	Ship worm	II, III, IV, V		Netherlands >1730	
	Eriocheir sinensis	Chinese mitten crab, Mitten crab, Chinese freshwater edible crab	II, III, IV		Germany 1912	
	Hemigrapsus sanguineus	Asian shore crab	II, IV		France 1999	
	Hemigrapsus takanoi	Asian shore crab	II, IV		France 1994	
	Paralithodes camtschaticus	Red king crab	I		Norway 1976	
	Marsupenaeus japonicus	Kuruma prawn	IV	?	Portugal 1985	
	Ficopomatus enigmaticus	A tubeworm	II, III, IV		France 1921	
	Austrominius (=*Elminius*) *modestus*	An acorn barnacle	I, II, IV		UK 1945	
	Caprella mutica	Skeleton shrimp	II, III, IV		Belgium 1998	
	Telmatogeton japonicus	A chironomid (insect)	II, III		Germany 1963	
	Bugula stolonifera	A bryozoan	II, IV, V		Netherlands 1993	
	Styela clava	Leathery sea squirt, Asian sea squirt	II, III, IV		France 1968	
	Didemnum vexillum	A sea squirt or tunicate	I, III		Netherlands 1991	
	Tricellaria inopinata	A bryozoan	II, IV		Spain 1996 UK 1998	
Protozoa	*Bonamia ostreae*	None	II, III, IV		France 1976	

Vectors for introduction have been classified as: Planting; Secondary spread; Importation for aquaculture; Ballast water; Fishing nets; Fouling; Aquaculture; ? Not known **Probable impacts have been classified as:** Habitat modification; Damage to structures; Biodiversity loss; Competition; Food web impacts; Predation; Fouling; Nutrient regeneration; Algal blooms

Non-indigenous species in the OSPAR area that have been identified as problematic, from OSPAR Quality Status Report, 2010 (OSPAR Commission 2010).

6.3 Annex III. Physical pressures categories and activities (Spanish MSFD assessment)

Impactos / Presiones			Sectores / Actividad humana	Descriptores
		Extracción de sólidos: explotación de yacimientos submarinos y dragados portuarios	Defensa costera, actividad portuaria	
		Buceo deportivo	Recreación	
	Extracción selectiva (física)	Extracción de sólidos: explotación de yacimientos submarinos y dragados portuarios	Defensa costera, actividad portuaria	
		Exploración y explotación de hidrocarburos. Plataformas	Industria energética	
Otras perturbaciones físicas	Ruido subacuático	Cables y tuberías	Transporte de mercancías y telecomunicaciones	1, 11
		Exploración y explotación de hidrocarburos. Plataformas	Industria energética	
		Sísmica marina	Investigación	
		Vertidos de material portuario dragado	Actividad portuaria	
		Extracción de sólidos: explotación de yacimientos submarinos y dragados portuarios	Defensa costera, actividad portuaria	
		Infraestructuras portuarias y de defensa, obras marinas	Defensa costera, actividad portuaria e industrial	
		Navegación o en su defecto, instalaciones portuarias.	Tráfico marítimo de mercancías, pasajeros, náutica deportiva y de recreo y pesca comercial	
	Desechos marinos	Basura marina	Turismo, pesca comercial, tráfico marítimo de mercancías, pasajeros, náutica deportiva y de recreo, gestión de residuos sólidos urbanos	1, 6, 10
		Naufragios	Pesca comercial, tráfico marítimo de mercancías, pasajeros, náutica deportiva y de recreo	
		Municiones y armamento obsoleto	Actividad militar	
	Otras perturbaciones físicas	Estructuras permanentes offshore	Seguridad, actividades industriales	1, 4, 6
		Extracción de sólidos: explotación de yacimientos submarinos y dragados portuarios	Defensa costera y actividad portuaria	
		Almacenes de CO2	Industria energética, lucha contra el cambio climático	

Physical pressures categories and related human activities (Instituto Espanol de Oceanografia et Asistencia Tecnica TRAGSATEC SA 2012a)

6.4 Annex IV. Physical pressures categories and definitions **(La Riviere et al. 2017)**

Pressure category	Pressure	Definition
Physical loss (permanent change)	**Habitat loss**	The permanent loss of an existing marine habitat to land or to a freshwater water habitat. All habitats are considered « very highly sensitive » to this pressure, although deep-sea habitats are considered « not exposed ».
	Habitat change (to another type)	The permanent replacement of one marine habitat by another marine habitat, through a change in substratum and/or a change in biological zone (depth band). This can be caused by i) the addition of a new substratum or ii) the extraction of existing substratum permanently exposing a different seabed type. For soft sediment habitats, a change in substratum is defined here as a change in 1 class of the modified Folk classification (see Annex 1). This includes change to artificial substratum. NB: This pressure can arise from other physical pressures (physical disturbance or hydrological changes) where the magnitude, frequency or duration of exposure leads to a permanent change in habitat type.
Physical disturbance or damage (temporary and/or reversible change) (1/2)	**Substratum extraction**	Substratum removal (including of biogenic habitats) which i) exposes substratum of the same type, or ii) temporarily exposes substratum of another type. NB: This pressure becomes « habitat change » if: - The removal exposes substratum of a different type and environmental/hydrodynamic conditions do not allow the newly exposed seabed to return to its original substratum type - The depth of extraction leads to a change in bathymetry.
	Trampling	The vertical compression of the seabed and its associated species.
	Surface abrasion	Mechanical action resulting in disturbance of the seabed surface and associated species (epifauna and epiflora), yet with limited or no loss of substratum.
	Light sub-surface abrasion	Mechanical action resulting in disturbance of the seabed and associated species either i) penetrating the sediment down to 5 cm depth or ii) scouring hard substrata.
	Heavy sub-surface abrasion	Mechanical action resulting in disturbance of the seabed and associated species either i) penetrating the sediment beyond 5 cm depth or ii) scouring hard substrata.
	Reworking of the sediment	The displacement and rearrangement of seabed sediment without any net loss of substratum. This pressure does not apply to hard substrata

Category of pressures	Pressure	Definition
Physical disturbance or damage (temporary and/or reversible change) (2/2)	**Light deposition**	The addition of up to 5 cm of material on the seabed. This pressure concerns the addition i) of material of the same type as the original substratum, or ii) of a different type but where hydrodynamic conditions allow its rapid removal. NB: This pressure becomes « habitat change » if the original biological communities are not able to recolonize the deposited substratum.
	Heavy deposition	The addition of more than 5 cm of material on the seabed. This pressure concerns the addition i) of material of the same type as the original substratum, or ii) of a different type but where hydrodynamic conditions allow its rapid removal. NB: This pressure becomes « habitat change » if the original biological communities are not able to recolonize the deposited substratum

Physical pressures categories and definitions (La Riviere et al. 2017)

6.5 Annex V. Benthic habitats sensitivity to physical pressures

Sensitivity of benthic habitats to physical pressures was assessed in a recent French study (La Riviere et al. 2017). The study focuses on Natura 2000 habitats that are present in OSPAR IV region (n° 1110, 1130, 1140, 1150, 1160, 1170, and 8330). It provides a qualitative score of sensitivity to physical pressures (Very High, High, Medium, Low, Very Low, Variable, Not Applicable, along with a confidence index (High, Medium, Low).

Physical pressures types that were considered are defined in Annex III. Physical pressures categories and activities (Spanish MSFD assessment) and Annex IV. Physical pressures categories and definitions (La Riviere et al. 2017) to this document.

6.5.1 Factors affecting benthic species' sensitivity

The following factors may affect the resistance and/or resilience (and thus sensitivity) of

benthic species:

- → Size and shape (growth form);
- → Substratum position (e.g. epibenthic, infaunal, free-living);
- → Depth in substratum (e.g. shallowly or deeply burrowed);
- → Mobility/ability to move freely (e.g. permanently/temporarily attached, burrower, crawler, swimmer etc.);
- → Flexibility and fragility;
- → Dependence on type of substratum;
- → Dependence on hydrodynamic conditions;
- → Lifespan, growth rate, regeneration rate, age at sexual maturity;
- → Reproduction mode and rate, larval dispersion capacity, recruitment rate, vegetative propagation, propagules.

6.5.2 Sensitivity to physical loss

All considered habitats have a 'very high' sensitivity to physical loss. They are all considered to have no resistance to physical loss, being unable to recover after a permanent habitat loss (change from marine to terrestrial or freshwater habitat).

6.5.3 Sensitivity to physical disturbance

Maerl beds were found to have 'Very High' or 'High' sensitivities to many types of physical pressures:

- → 1110 Sandbanks which are slightly covered by sea water all the time – **Maerl beds fraction**
  - o **Very high sensitivity to substrate extraction**
  - o **Very high sensitivity to deep abrasion. Estimated resilience of 25 years**
  - o **Very high sensitivity to dumping of large amounts of material** High sensitivity to shallow abrasion
  - o High sensitivity to dumping of small amounts of material
- → 1160 Large shallow inlets and bays – **Maerl beds fraction**
  - o **Very high sensitivity to substrate extraction**
  - o **Very high sensitivity to trampling**
  - o **Very high sensitivity to shallow and deep abrasion.**
  - o **Very high sensitivity to reworking of the sediment**
  - o **Very high sensitivity to dumping of small or large amounts of material**

Zostera marina beds were found to have 'Very High' or 'High' sensitivities to many types of physical pressures:

- → 1110 Sandbanks which are slightly covered by sea water all the time – **Zostera marina beds fraction**

- High sensitivity to substrate extraction
- High sensitivity to shallow and deep abrasion
- High sensitivity to dumping of large amounts of material

6.6 Annex VI. Summary of impacts by ecosystem components, for the marine region 'Bay of Biscay' according to French MSFD Initial Assessment in 2011

1 Pertes physiques d'habitats (étouffement, colmatage)	2 Dommages physiques : abrasion, extraction de matériaux	3 Modification turbidité et sédiment	4 Perturbations sonores sous-marines	5 Déchets marins	6 Dérangement, collisions	7 Modifications hydrologiques	8 Contamination par des substances dangereuses
**	*		**	*	*	*	*
**	*	*	+	+	**	*	*
*	*	*	+	**	**	*	+
**	**	*	*	**	*	**	*
**	**	*	*	**	*	**	*
**	**	*	**	*	***	**	+
***	*	**	***	**	***	**	**
*	*	*	***	*	***	**	+
**	*	*	**	***	*	*	+
**	*	*	**	*	*	*	+
**	*	*	+	**	*	*	+
**	**	**	+	**	**	*	+
**	**	*	+	**	***	*	+
**	**	*	*	*	***	***	+
**	**	*	*	*	*	**	*
*	*	*	**	*	*	*	*
*	*	*	**	**	**	*	*
*	*	*	**	*	*	*	*
***	***	***	***	*	***	***	**

Version révisée du tableau de synthèse de la sous-région marine « golfe de Gascogne », suite aux commentaires des participants de l'atelier du 13-15 septembre 2011.(Agence des Aires Marines Protégées et Ifremer 2011)

Explications des impacts jugés « significatifs » ou « élevés » :

Case	Couleur	Explication (pour la SRM golfe de Gascogne)
A8	*	L'exposition aux différents polluants organiques persistants provoque chez les mammifères marins dans le golfe de Gascogne des pathologies embryonnaires et fœtales, une diminution de la survie de nourrissons, diverses perturbations et lésions du cycle de reproduction et une suppression du système immunitaire. Ceci représente un risque pour les populations locales, notamment pour les populations de phoques veau marin et de grands dauphins.
A12	**	Les mortalités accidentelles liées à la pêche sont élevées chez plusieurs petits cétacés, notamment dauphins communs et marsouins, pour lesquelles elles représentent près de la moitié des causes de mortalité sur les individus retrouvés échoués. L'impact du chalut français et espagnol sur le dauphin commun est relativement suivi tout comme l'impact des filets sur les marsouins.
B6	**	Certains oiseaux marins (notamment les sternes) et certains limicoles côtiers, sont sensibles au dérangement visuel ou acoustique par des activités humaines, qui peuvent affecter leur succès de reproduction. L'impact est jugé « significatif » et non « élevé » en raison des mesures de prévention qui sont prises dans de nombreux espaces protégés.
B8	*	La contamination des oiseaux par les substances chimiques est considérée comme ayant un impact significatif sur le succès de reproduction de certaines espèces. Les oiseaux marins sont également touchés par les pollutions accidentelles. Chez les oiseaux marins certains polluants organiques persistants (POP) provoquent la diminution et le retard de la production d'œufs, une diminution d'épaisseur des coquilles d'œufs, l'augmentation de la mortalité et de la déformation d'embryons, une nette diminution d'éclosion etc. Ces impacts s'avèrent significatifs en zones contaminés par les POP.
C5	**	Des déchets ont été retrouvés dans 30 % des tortues autopsiées ; des cas d'occlusion ont été observés sur les tortues Luth, ainsi que des cas d'emmêlement, d'étranglement dans des orins de casier.
C12	*	L'impact des activités de pêche sur les tortues est important en proportion du nombre d'observations, notamment par la pêche fantôme.
D1	**	Des habitats fonctionnels (notamment, des vasières estuariennes servant de nourriceries) de multiples espèces de poissons marins et céphalopodes, sont touchées par des pertes physiques dues à des constructions de génie civil et à de la poldérisation (en amont des zones marines).

D8	*	La contamination des poissons par les substances chimiques est considérée comme ayant un impact significatif sur plusieurs espèces de poissons démersaux, notamment au sein des nourriceries littorales. La forte variation de niveau de la contamination est liée à une disparité comportementale chez la même espèce et entre les espèces, et à plusieurs facteurs ontogéniques tels que le sexe, l'âge, la reproduction, ainsi que le régime alimentaire.
D12	**	Les captures par pêche de plusieurs espèces démersales (ex : sole, seiche, baudroie, merlu) sont importantes, et les rejets d'espèces commerciales et non commerciales peuvent également être importants (ex : merlu).
E8	*	La contamination des poissons par les substances chimiques est considérée comme ayant un impact significatif sur plusieurs espèces de poissons pélagiques, notamment les Clupéidés au sein des nourriceries littorales. La forte variation de niveau de la contamination est liée à une disparité comportementale chez la même espèce et entre les espèces, et à plusieurs facteurs ontogéniques tels que le sexe, l'âge, la reproduction, ainsi que le régime alimentaire.
E12	**	Les captures par pêche de plusieurs espèces pélagiques (ex : maquereau, sardine, bar) sont importantes ; les rejets d'espèces commerciales et non commerciales peuvent également être importants.
F9	*	L'enrichissement en nutriments et, en conséquence, en phytoplancton, a des conséquences sur les structures de populations et de communautés de zooplancton. L'impact sur le zooplancton se fait via le réseau trophique : l'eutrophisation peut entraîner des décalages temporels avec des conséquences en termes de transfert d'énergie d'un niveau trophique vers un autre. De même, la présence de certains taxons (*Phaeocystis* par exemple) peut modifier la voie de transfert de l'énergie et diminuer le rendement trophique.
G3	**	Le phytoplancton a besoin de lumière pour croître, il est donc affecté par des modifications de turbidité (productivité limitée par une augmentation de turbidité), notamment dans les zones d'extraction de granulats, de clapage de sédiments de dragage.
G8	**	Les métaux ont des effets notables sur le phytoplancton. En milieu pélagique, un faible changement dans la biodisponibilité des métaux engendre un changement de la structure phytoplanctonique. A l'inverse, dans des milieux fortement contaminés tels que les milieux côtiers, les espèces phytoplanctoniques développent une tolérance plus importante aux métaux. La toxicité des métaux est dépendante ainsi de nombreux facteurs (la forme chimique du métal étudié, l'espèce étudiée, la densité cellulaire) entraînant une réduction ou une inhibition partielle du taux de croissance de certaines espèces phytoplanctoniques. Des impacts liés aux apports fluviaux (Loire et Gironde et des fleuves côtiers) des produits phytosanitaires influencent localement les réponses et les structures des communautés phytoplanctoniques.
G9	***	L'enrichissement en nutriments provoque un développement anormal de certaines communautés phytoplanctoniques dont certaines sont nuisibles à l'homme et/ou à l'environnement (ex : blooms de *pseudo-nitzschia et lepidodinium chlorophorum*).
H3	*	Le phytobenthos a besoin de lumière pour croître et est donc affecté par des modifications de turbidité, notamment à proximité des zones d'extraction de matériaux marins, de chalutage en zone peu profonde (dragues à coquillages notamment) et de clapage de sédiments de dragage. Les herbiers de phanérogames, les ceintures d'algues, et les bancs de maërl, sont connus pour être sensibles à cette pression.
H9	*	L'enrichissement excessif en nutriments provoque des blooms phytoplanctoniques qui limitent les possibilités de photosynthèse des macroalgues subtidales. Cela provoque également des efflorescences massives de macroalgues opportunistes (rouges, brunes ou vertes), qui affectent les autres espèces de producteurs primaires benthiques. Dans ses stades ultimes, l'eutrophisation peut se traduire par une disparition des macroalgues benthiques.
H11	*	Les espèces non indigènes invasives, telles que les crépidules, certaines algues rouges (*Heterosiphonia japonica, Gracilaria etc.*), une éponge (*Celtodoryx girardae*, même si ce n'est que très local pour le moment), et plusieurs espèces de balanes, impactent les communautés de phytobenthos indigène.
H12	*	L'extraction de maërl a des impacts directs significatifs sur ces espèces. Il y a d'autres prélèvements d'algues localement qui sont réalisés parfois à échelle non négligeable : *Ascophyllum*, *Palmaria* (ormeaux), *Corralina* etc.
I1	**	Les constructions littorales empiétant le DPM, notamment ports et ouvrages de protection contre la mer, affectent principalement l'étage médiolittoral et ont un impact localisé mais définitif sur les biocénoses associées.
I5	***	Les biocénoses du médiolittoral meuble ne sont pas directement affectées par les déchets marins, mais elles sont fortement affectées par le ramassage de ceux-ci, lorsque celui-ci est réalisé de façon mécanique.
I9	***	Le médiolittoral meuble est par endroit le siège d'échouages massifs de macroalgues de type *ulva* sp. (marées vertes) qui affectent cette biocénose notamment par privation d'oxygène, de lumière etc. et par les opérations de ramassage mécanique des ulves.
I12	**	La pêche à pied, localement importante dans ces habitats (sédiments meubles à coquillages) a un impact sur les biocénoses associées. La pêche professionnelle de bivalves dans l'intertidal a des effets non négligeables sur les biocénoses de cet étage : palourdes (herbiers de zostère), coques (bancs à Lanice), donax (nurseries de poissons plats). Certaines de ces pêches se pratiquent par bateau et drague à marée haute.
J1	**	Les constructions littorales empiétant le DPM, notamment les ports et ouvrages de protection contre la mer, affectent principalement l'espace médiolittoral et ont un impact localisé mais définitif sur les biocénoses associées.
J9	*	Les biocénoses du médiolittoral rocheux sont affectées par l'enrichissement en nutriments et par

		l'eutrophisation : on observe localement des proliférations d'algues vertes sur les milieux rocheux intertidaux, dues à l'eutrophisation. Certaines algues brunes peuvent aussi se développer en excès pour les même raisons.
J11	*	Le médiolittoral rocheux est impacté significativement par l'introduction d'espèces non indigènes telles que l'huître creuse, le bigorneau perceur du Pacifique, le parasite *Bonamia* de l'huître plate, diverses balanes notamment *B. amphitrite* etc.
K3	*	Les macroalgues, poussant sur substrat dur, ont besoin de lumière pour croître, et sont donc affectées par des modifications de turbidité. Des impacts de ces changements sur la profondeur de la limite basse des ceintures algales ont été relevés. De plus, toute la biocénose est affectée si le substrat rocheux s'envase.
K9	**	Les blooms planctoniques générés par les enrichissements en nutriments vont limiter les possibilités de photosynthèse des macroalgues subtidales.
K11	**	L'introduction d'espèces non indigènes est dangereuse pour la faune locale : l'éponge *Celtodoryx ciocalyptoides* recouvre tout type de substrat qu'il soit rocheux ou vivant (gorgones, anémones, hydraires etc.).
K12	*	La pêche professionnelle et de plaisance prélève de nombreuses espèces des habitats de substrat dur infra- et circalittoral (ex : bar, lieu jaune, dorade, crustacés etc.) et en modifie donc les biocénoses.
L2	**	Les biocénoses des habitats de substrat meuble infralittorales sont impactées par l'abrasion, notamment par les engins de pêche (impact modéré mais d'une très vaste échelle), et par l'extraction de matériaux marins tels que les matériaux siliceux et calcaires, les sables coquilliers et le maërl (impacts très localisés mais élevés).
L3	**	Les herbiers de zostères marines ont besoin de lumière pour croître, et sont donc affectés par des modifications de turbidité. Des impacts de ces changements sur la productivité et la profondeur de la limite basse des herbiers ont été relevés. Plus généralement, tout l'habitat est sensible à la nature de son substrat
L11	***	La crépidule américaine (*Crepidula fornicata*) colonise des territoires très importants de l'infralittoral, sur fonds meubles. Ceci entraîne une modification du substrat, une compétition spatiale et trophique voire l'homogénéisation des peuplements avec perte de biodiversité.
M2	**	Les biocénoses des habitats de substrat meuble circalittorales sont impactées (de façon modérée mais à très vaste échelle) par l'abrasion par les engins de pêche. Les extractions de matériaux touchent de manière localisée la frange supérieure de l'étage circalittoral.
M12	**	La pêche (notamment la pêche au chalut de fond) est intensive dans ces habitats (substrat meuble du circalittoral) et a un impact significatif sur les biocénoses associées.
N2	**	Les dommages physiques ont des impacts significatifs sur les coraux profonds.
N12	**	Les espèces profondes de la pente continentale (ex : hoplostète orange, grenadier, petit squale, etc.) ont été fortement exploitées par du chalutage profond. L'extraction de ces espèces a un impact significatif sur les populations dont certaines se renouvèlent lentement.
O1	**	Les habitats fonctionnels (notamment, des vasières estuariennes servant de nourriceries) de plusieurs espèces de poissons et céphalopodes exploités (par exemple, la sole) sont touchées par des pertes physiques dues à des constructions de génie civil et à de la poldérisation (en amont des zones marines).
O12	*	La majorité des stocks évalués ne satisfont pas les critères de précaution et ne sont pas exploités au rendement maximal durable (évaluation CIEM à l'échelle des stocks). Cependant, pour une majorité des stocks, la biomasse des reproducteurs est stable ou en hausse.
P2	*	Les chalutages ont un impact significatif sur le substrat et sur les araignées de mer et les langoustines.
P8	*	Les crustacés accumulent facilement les métaux lourds et produits toxiques notamment dans les grands estuaires (Loire, Gironde).
P12	*	Les captures par pêche de plusieurs espèces de crustacés, comme l'araignée européenne, la langoustine, le tourteau sont importantes ; on observe également des rejets importants de langoustines.
Q8	*	Les coquillages concentrent de nombreuses substances chimiques (bioaccumulation) dont les impacts sont mal connus. Le tributylétain (TBT) modifie la physiologie de certains mollusques (ex : nucelle, *Nucella lapillus* qui n'est pas exploitée).
Q9	**	Les mollusques filtreurs peuvent être impactés positivement par un enrichissement en matière organique et en cellules phytoplanctoniques, mais aussi négativement par la présence de macroalgues de type *ulves* sur le fond et par d'éventuelles conditions hypoxiques.
Q10	**	L'émergence d'agents infectieux viraux (ex : *Ostreid herpes virus*, *vibrio*, *Bonamia, Mikrocytos*) entraîne des épisodes de mortalité chez l'huître creuse (*Crassostrea gigas*), l'huître plate (*Ostrea edulis*) et le flion tronqué (*Donax trunculus*).
Q11	***	La crépidule (voir L11) est nuisible aux populations de coquilles St Jacques. Par ailleurs, l'huître creuse du Pacifique (*Crassostrea gigas*) importée dans les années 70 est devenue localement invasive. Sa forte densité peut entraîner une compétition spatiale et trophique importante avec les autres coquillages suspensivores. D'autre part, la présence de *Bonamia ostreae*, parasite de l'huître creuse a des conséquences désastreuses sur la production d'huître plate (*Ostrea edulis*).
R9	***	L'enrichissement en nutriments et ses conséquences sur les producteurs primaires (blooms de phytoplancton et d'ulves, notamment) ont un impact fort sur les réseaux trophiques des zones littorales affectées et également sur les fonctions de nurseries de zones peu profondes, desquelles les poissons ne peuvent pas fuir.

R12	**	L'extraction d'espèces a un impact sur les abondances et la structure en classe de taille des populations et communautés de proies et de prédateurs.
S8	**	En 2007, 9 % des mesures en cadmium dans les huîtres et les moules sont supérieures au seuil maximal règlementaire fixé à 5 mg/kg en poids sec. Ces concentrations en cadmium ont été notées en 3 points de suivi de l'estuaire de la Gironde avec des concentrations pouvant être 6 fois supérieures au seuil sanitaire (données du réseau RNO).
S9	**	Les phycotoxines produites par certaines espèces de phytoplancton sont susceptibles en s'accumulant dans les coquillages de provoquer un risque pour la santé humaine. Ces risques, sont actuellement en France liés à trois familles de toxines : (i) toxines lipophiles incluant les diarrhéiques ou DSP, (ii) toxines paralysantes ou PSP, (iii) toxines amnésiantes ou ASP. En 2009, 34 % des zones marines suivies dans le golfe de Gascogne montrent une toxicité lipophile avérée dans les coquillages. De plus, 8 % des zones marines suivies montrent une toxicité ASP avérée dans les coquillages (données du réseau REPHY).
S10	**	Les coquillages peuvent concentrer des organismes pathogènes pour l'homme. La qualité microbiologique des zones de production de coquillages, basée sur la contamination des coquillages par la bactérie *Escherichia Coli*, est en grande majorité classée « moyenne » (nécessitant purification ou reparcage avant mise sur le marché), avec très peu de zones de « bonne qualité ». Une dégradation de la qualité est observée sur ces dix dernières années sur les côtes du Morbihan tandis qu'une amélioration est notée sur les côtes de Charente-Maritime et de Vendée. Les introductions d'autres bactéries, pathogènes (présence de *Salmonella*, *Listeria*, *E.Coli* producteurs de toxines) sont également observées dans les coquillages, avec également des impacts sanitaires.

Table 35 : texte explicatif pour chaque voyant orange ou rouge, utilisant autant que possible les résultats de l'EI DCSMM.

	Impact élevé
	Impact significatif
	Impact faible
	Pas d'impact (pas d'interaction, ou absence de la pression dans la SRM)
+	Interaction existante, mais impact non déterminé
	Interaction méconnue, impact non déterminé

*	faible confiance dans le diagnostic
**	confiance moyenne dans le diagnostic
***	forte confiance dans le diagnostic

6.7 Annex VII. Water Framework Directive Ecological Status

Water Framework Directive: 'Ecological Status' and information related to eutrophication

In 2000, the Water Framework Directive (2000/60/EC) introduced – amongst other requirements – a comprehensive **Ecological Status** assessment of all surface waters, based on a number of biological, hydromorphological, chemical and physico-chemical **quality elements**.

The WFD does not explicitely consider eutrophication, and has no holistic eutrophication assessment model that takes into account pelagic and benthic components, since the WFD evaluates subsets of these as individual quality elements.

The Water Framework Directive requires Member States to classify the Ecological Status of surface water bodies into one of **five ecological status classes**; high, good, moderate, poor or bad ecological status. The ecological status of a water body is an expression of the quality of the structure and functioning of its aquatic ecosystem. Under the WFD, Ecological Status is assessed by using **quality elements**. Biological, hydro-morphological and physico-chemical quality elements have relative roles in classifying Ecological States. The relationships between biological, hydromorphologcal and physic-chemical quality elements in status classification are presented in Figure 63.

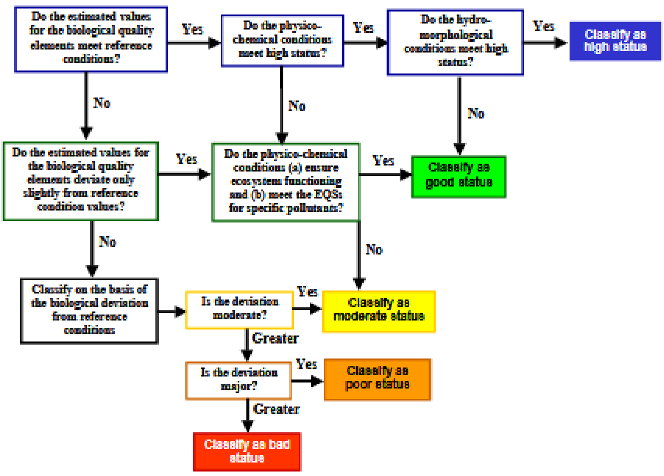

Figure 63: The relative roles of biological, hydromorphologcal and physico-chemical quality elements in classifying Ecological Status (European Commission 2009)

Many of these quality elements are traditionally used for assessing eutrophication, in particular 'nutrient conditions' as well as the 'composition, abundance and biomass of phytoplankton and macrophytes'.

As a consequence of these relationships, for example, high nutrient concentrations without any corresponding biological impacts may not necessarily result in down grading Ecological Status.

The WDF requires the assessment of physicochemical quality elements (every 3 months), phytoplankton (every 6 months), aquatic flora (every 3 years), macroinvertebrates (every 3 years) and fish (every 3 years).

Remark: The WFD also assesses the status of terrestrial and coastal water bodies as compared to a 'good chemical status'.

6.8 Annex VIII. International and EU instruments and respective tools and objectives related to eutrophication

EU Urban Waste Water Treatment Directive (91/271/EEC)

- → **Connection of industry and households to wste water treatmen**
- → **Higher level treatment of waste water**
- → **Designation of water areas sensitive to nutrient inputs**

EU Nitrates Directive (91/676/EEC)

- → **Good Agricultural practice**
- → **Designation of water zones vulnerable to nitrogen losses**

EU Integrated Pollution Prevention and Control (IPCC) Directive (2008/1/EC)

- → **Normative definitions describing good ecological status of a water body**
- → **River basin management plans**

EU National Emissions Ceiling Directive (2001/81/EC)

- → **Ceilings for air emissions of nitrogen**

MARPOL Annex VI

- → **Emission control standards for ships**
- → **Emission control sea areas with stricter ship standards**

UNECE Convention on Long-range Transboundary Air Pollution (Gothenburg Protocol)

- → **Industrial and agricultural point source**
- → **Emission targets for nitrogen**
- → **Transboundary air transport of nitrogen**

European and international instruments to combat eutrophication and their respective tools. Adapted from (OSPAR Commission 2010)

6.9 Annex IX. International and EU instruments and respective tools and objectives related to contaminants

EC Integrated Pollution Prevention and Control (IPPC) Directive (2008/1/EC)
→ **Permit requirements for installations**
→ **Best available techniques**
→ **Emission and discharge limits**
→ **European Emission Pollution Release and Transfer Register**
EU Marketing and Use Directive (76/769/EEC, repealed by Annex XVII REACH Regulation)
→ **Restrictions on the marketing and use of substances**
→ **Risk assessment**
EU Biocides Directive (98/8/EC)
→ **Restrictions on the marketing and use of substances as biocides**
EU Pesticides Directive (91/414/EC)
→ **Restrictions on the marketing and use of substances as pesticides**
EU REACH Regulation (EC No. 1907/2006)
→ **Registration, evaluation, authorisation and restriction of chemicals**
EU Water Framework Directive (2000/60/EC) and Daughter Directive (2008/105/EC)
→ **Normative definitions describing good chemical status**
→ **River Basin Management Plans**
→ **Priority (hazardous) substances**
UNECE Convention on Long-range Transboundary Air Pollution – POPs and Heavy Metals protocols (both adopted 1998/effective 2003)
→ **Transboundary air transport of contaminants**
→ **Use restrictions or ban**
→ **Emission reduction of unintentionally produced POPs**
→ **Environmentally safe disposal of wastes**
→ **International Emission Pollution Release and Transfer Register**
UNEP Stockholm POPs Convention (adopted 2001/effective 2004)
→ **Transboundary air transport of POPs**
→ **Use restrictions and elimination of POPs**
→ **Restrictions on import/export of substances**
→ **Safe handling of stockpiles**
→ **Emission reduction of unintentionally produced POPs**
Rotterdam Convention on Prior Informed Consent (PIC) procedure for certain hazardous substances and pesticides in international trade (adopted 1998/effective 2004)
→ **Control of international trade in certain hazardous substances**
Information exchange prior to import of pesticides and industrial chemicals

Main international and EU instruments and respective tools and objectives. Adapted from OSPAR QSR 2010

6.10 Annex X. OSPAR List of Chemicals for Priority Action (Revised 2013)

From OSPAR document reference number 2004-12

CAS No	***Group of substances / substances***	***Function***	***Last revision of the background document (Lead country)***	***Review statement on Background document***
A: CHEMICALS WHERE A BACKGROUND DOCUMENT HAS BEEN OR IS BEING PREPARED[8]				
		Aromatic hydrocarbon		
	cadmium	*Metallic compound*	2004 (Spain)	2010
	lead and organic lead compounds	*Metal/organometallic compounds*	2009 (Norway)	
	mercury and organic mercury compounds		2004 (UK)	2009
	organic tin compounds ♣	*Organometallic compounds*	2011 (The Netherlands)	
51000-52-3	**neodecanoic acid, ethenyl ester**	*Organic ester*	2011 (UK)	
1763-23-1	**perfluorooctanyl sulphonic acid and its salts (PFOS)** ♦	*Organohalogens*	2006 (UK)	2011
79-94-7	**tetrabromobisphenol A (TBBP-A)**		2011 (UK)	
87-61-6	**1,2,3-trichlorobenzene**		2005 (Belgium & Luxembourg)	2010
120-82-1	**1,2,4-trichlorobenzene**		2005 (Belgium & Luxembourg)	2010
108-70-3	**1,3,5-trichlorobenzene**		2005 (Belgium & Luxembourg)	2010
	brominated flame retardants		2009 (Sweden)	
	polychlorinated biphenyls (PCBs) ♠		2004 (Germany & Belgium)	2008
	polychlorinated dibenzodioxins (PCDDs) **polychlorinated dibenzofurans (PCDFs)**		2007 (Denmark & Belgium)	
	short chained chlorinated paraffins (SCCP)		2009 (Sweden)	

[8] OSPAR 2005 agreed to remove 4-*tert*-butyltoluene (CAS no 98-51-1), hexachlorocyclopentadiene (HCCP) (CAS No 77-47-4) and triphenylphosphine (CAS No 603-35-0) from the list since they are not PBT substances (see OSPAR 2005 Summary Record, OSPAR 05/21/1 paragraph 7.5).

OSPAR 2007 agreed to deselect hexamethyldisiloxane (HMDS) (CAS No 107-46-0) from the List of Chemicals for Priority action since it is not a PBT substance (see OSPAR 2007 Summary Record, OSPAR 07/24/1 paragraph 8.3).

The reasons for deselection are set out in the Agreement 2004-13 available on the OSPAR website.

793-24-8	**4-(dimethylbutylamino)diphenylamin (6PPD)**	*Organic nitrogen compound*	2006 (Germany)	
		Organophosphate		
115-32-2	**dicofol**	*Pesticides/Biocides/*	2004 (Finland)	2008
115-29-7	**endosulfan**	*Organohalogens*	2004 (Germany)	2008
	hexachlorocyclohexane isomers (HCH)		2004 (Germany)	2008
72-43-5	**methoxychlor**		2004 (Finland)	2008
	pentachlorophenol (PCP)		2004 (Finland)	
1582-09-8	**trifluralin**		2005 (Germany)	2012
23593-75-1	**clotrimazole**	*Pharmaceutical*	2013 (France)	
732-26-3	**2,4,6-tri-tert-butylphenol**	*Phenols*	2006 (UK)	2009
	nonylphenol/ethoxylates (NP/NPEs) and related substances		2009 (Sweden)	
140-66-9	**octylphenol**		2006 (UK)	2009
	certain phthalates: dibutylphthalate (DBP), diethylhexylphthalate (DEHP)♥	*Phthalate esters*	2006 (Denmark & France)	
	polyaromatic hydrocarbons (PAHs) §	*Polycyclic aromatic compounds*	2009 (Norway)	
	musk xylene	*Synthetic musk*	2004 (Switzerland)	

CAS No	Group of substances / substances	*Function*	Identified at †
B:CHEMICALS WHERE NO BACKGROUND DOCUMENT IS BEING PREPARED BECAUSE THEY ARE INTERMEDIATES IN CLOSED SYSTEMS ‡			
4904-61-4	**1,5,9 cyclododecatriene‡**	*Aliphatic hydrocarbons*	OSPAR 2002
294-62-2	**cyclododecane‡**		OSPAR 2002

CAS No	Group of substances / substances	*Function*	Identified at †
C : CHEMICALS WHERE NO BACKGROUND DOCUMENT IS BEING PREPARED BECAUSE THERE IS NO CURRENT PRODUCTION OR USE INTEREST*			
59447-55-1	**2-propenoic acid, (pentabromo)methyl ester**	*Organohalogens*	OSPAR 2003
36065-30-2	**2,4,6-bromophenyl 1-2(2,3-dibromo-2-methylpropyl) ***		OSPAR 2001
85-22-3	**pentabromoethylbenzene***		OSPAR 2001
28680-45-7 2440-02-0	**heptachloronorbornene***		OSPAR 2001
1825-21-4	**pentachloroanisole***		OSPAR 2001

CAS No	Group of substances / substances	*Type*	Identified at †
	polychlorinated naphthalenes*' ††	*Organohalogens (cont.)*	
1321-65-9	trichloronaphthalene*		OSPAR 2001
1335-88-2	tetrachloronaphthalene*		OSPAR 2001
1321-64-8	pentachloronaphthalene*		OSPAR 2002
1335-87-1	hexachloronaphthalene*		OSPAR 2001
32241-08-0	heptachloronaphthalene*		OSPAR 2001
2234-13-1	octachloronaphthalene*		OSPAR 2001
70776-03-3	naphthalene, chloro derivs. *		OSPAR 2002
55525-54-7	**3,3'-(ureylenedimethylene)bis(3,5,5-trimethylcyclohexyl) diisocyanate***	*Organic nitrogen compound*	OSPAR 2001
2104-64-5	**ethyl O-(p-nitrophenyl) phenyl phosphonothionate (EPN)***	*Pesticides/Biocides*	OSPAR 2001
70124-77-5	**flucythrinate***		OSPAR 2001
465-73-6	**isodrin***		OSPAR 2001
2227-13-6	**tetrasul***		OSPAR 2001
512-04-9	**diosgenin***	*Pharmaceutical*	OSPAR 2001

6.11 Annex XI. Priority chemicals in the OSPAR List of Chemicals for Priority Action

Status in relation to the cessation target of the 26 substances (including groups) on the OSPAR List of Chemicals for Priority Action ('priority chemicals') (March 2010) (OSPAR Commission 2010).

	OSPAR priority (groups of) chemicals	Naturally occurring	Key sources	Control measures	WFD	Outlook 2020	Priorities for action
Metals	Cadmium	Yes	Metallurgic processes, fossil fuel	OSPAR, EU, UNECE	●	* *	
	Lead and organic lead compounds	Yes	Mining, petrol	OSPAR, EU, UNECE	●	* *	
	Mercury and organic mercury compounds	Yes	Metallurgic industry, fossil fuel, incineration, chlor-alkali industry, dental amalgam	OSPAR, EU, UNECE, PIC	●	* *	
Organometals	Organotin compounds including:					Group	
	Tributyltin (TBT)		Anti-fouling agent	OSPAR, EU, PIC, IMO	●	*	
	Other organotin compounds (e.g. disubstituted compounds)		Consumer products, polymer industry			*	
Organohalogens	Short-chain chlorinated paraffins (SCCPs)		Rubber working plants, products, waste streams	OSPAR, EU, UNEP-cand., UNECE-cand.	●	*	
	Perfluorooctane sulphonates (PFOS)		Industrial applications, waste streams	EU, UNEP, UNECE-cand.	○	*	
	Polychlorinated dibenzodioxins, dibenzofurans (PCDDs, PCDFs)	Yes	Incineration, forest fire	OSPAR, EU, UNEP, UNECE	○	* *	
	Polychlorinated biphenyls (PCBs)		Industrial products, oils, legacies	OSPAR, EU, UNEP, UNECE, PIC	○	* *	
	Brominated flame retardants including:		Manufacture, products, waste streams			Group	
	PentaBDE and octaBDE			EU, UNEP, UNECE-cand.	⦿	*	
	Other polybrominated diphenyl ethers (PBDEs)			EU	⦿	*	
	Hexabromocyclododecane (HBCD)			EU, UNEP-cand., UNECE-cand.		*	
	Tetrabromobisphenol-A (TBBP-A)		Polymer industry, products, wastes			*	
	Trichlorobenzenes		Industrial processes	EU	●	*	
Pesticides/biocides	Endosulfan		Pesticides, biocides, industrial processes, legacies	EU, UNEP-cand., UNECE-cand.	●	*	
	Hexachlorocyclohexane (HCH) isomers, including lindane			EU, UNEP, UNECE, PIC	●	*	
	Dicofol			EU, UNECE-cand.	○	*	
	Methoxychlor					*	
	Pentachlorophenol (PCP)			EU, UNECE-cand., PIC	●	*	
	Trifluralin			EU, UNECE-cand.	●	*	
Phenols	2,4,6-tri-tert-butylphenol		Industrial processes, oil production				
	Nonylphenol/ Nonylphenol-ethoxylates	Yes	Industrial applications, products, oil production	OSPAR, EU	●	*	
	Octylphenol	Yes	Industrial applications, products, oil production	EU	●	*	
Phthalates	Dibutylphthalate (DBP), diethylhexylphthalate (DEHP)		Polymer industry, products	EU	⦿	*	
Polycyclic aromatics	Polycyclic aromatic hydrocarbons (PAHs)	Yes	Oil production, fossil fuel	OSPAR, EU, UNEP, UNECE	⦿	*	
Pharmaceuticals, personal care and other substances	Clotrimazole		Domestic and hospital waste water			*	
	Musk xylene		Domestic waste water	EU	○	*	
	4-(dimethylbutylamino) diphenylamine (6PPD)		Abrasion from products (tyres)				
	Neodecanoic acid, ethenyl ester		Polymer industry, paints, coatings, adhesives	EU			

Control measures
OSPAR: Abatement and use restriction
EU: Use restriction
UNEP: Stockholm POPs Convention
UNECE: Convention on Long-range Transboundary Air Pollution
PIC: Rotterdam Convention on Prior Informed Consent Procedure
IMO: Convention on Anti-fouling Systems
cand.: Candidate substance for inclusion

EU Water Framework Directive (WFD)
List of WFD priority (hazardous) substances:
● (Group of) substance covered
⦿ One or more individual substances of group covered
○ Group or individual substance under review for inclusion

Outlook
2020 cessation target is likely to be met with existing efforts:
Yes
No
Not known

Confidence
* * * High
* * Moderate
* Low

Priorities for action
Point sources
Diffuse sources
Implement existing measures
Support global initiatives
Collect and assess information to direct action
Continue environmental monitoring
Keep under review

https://qsr2010.ospar.org/en/media/content_pdf/ch05/QSR_CH05_EN_Tab_5_1.pdf)

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