Report on the approaches implemented in the Mediterranean countries for GES descriptor 8

Proposition of a road map for a better harmonization

Date: June 2019

DISSEMINATION LEVEL: Public

MEDCIS

SUPPORT MEDITERRANEAN MEMBER STATES TOWARDS COHERENT AND COORDINATED IMPLEMENTATION OF THE SECOND PHASE OF THE MSFD

medcis.eu

Support Mediterranean Member States towards Coherent and coordinated Implementation of the second phase of the MSFD

11.0661/2016/748067/SUB/ENV.C2

Coordinator

Dr. Kalliopi Pagou

Project start date and duration

1st March 2017, 24 months

www.medcis.eu

The research leading to these results has received funding from the European Commission DG Environment] under grant agreement n° 11.0661/2016/748067/SUB/ENV.C2–MEDCIS project (Support Mediterranean Member States towards coherent and Coordinated Implementation of the second phase of the MSFD)

This deliverable should be referenced as follows:

Mauffret et al., 2019. Report on the approaches implemented in the Mediterranean countries for GES descriptor 8 - Proposition of a road map for a better harmonization

Authors: A. Mauffret, O. Bajt, J. Bellas, O. Chalkiadaki, M. Dassenakis, L. Giannoudi, E. Giubilato, I. Hatzianestis, A. Marcomini, T. Paramana, C. Tsangaris, J. Tronczynski, C. Zeri

Contact author: Aourell Mauffret (Aourell.Mauffret@ifremer.fr)

Table of Contents

Scope

This document presents the detaile results of the study carried out in MEDCIS Activity 1 on the approaches implemented for Descriptor 8 in serveral Mediterranean countries.

Summary

Based on the data gap analysis performed in the first step of MEDCIS, the Medcis team on contaminant proposed a road map associated with a time-schedule in order to improve harmonization in Mediterranean region for 2024 GES assessment. Partner country shared information on monitored substances and biological effects, thresholds used, matrix/matrices used for the monitoring of each substance/family of substances, the limit of quantification (LQ) of each chemical measurement, and the proportion of censored data (<LQ) in the samples assessed and used for GES assessment. Deep-analysis of this large inventory, enable the team to propose actions to improve **D8C1 and C2** implementation in Mediterranean region:

Action 1. Now in 2019 (to limit waste of public credits and to provide useful data for next 2024 GES assessment). Need for urgent and concrete actions regarding monitoring at the EU level:

1. How to deal with PS reported <LQ in >95% samples by 4 partner countries (15 substances out of the 45 PS)? Types of questions, which might help the discussion: Are these substances also reported <LOQ by the other member states? Should we –temporarily- suspend the monitoring of these PS until a sampling/analytical methodology has proven its applicability? Should national/EU funds be dedicated to improve analytical sensibility (LQ)? Should specialized laboratories per family substances be designated at a subregional levels to mutualize the cost and effort?

2. Recommend monitoring in a relevant matrix and NOT in water for hydrophobic substances (most of the PS, see Figure 5.B) unless a sampling/analytical methodology has proven its applicability.

Action 2. Before 2020 (to have time to implement a harmonized action and to collect data useful for next 2024 GES assessment): Indicator development and data analysis of a common dataset.

1. Sharing datasets for the WFD substances (e.g. via Emodnet).

    a. Comparison of GES assessment methodology between Mediterranean Member States (statistical approach to calculate the metric indicator and to aggregate substances or stations)

2. Threshold development:

    a. When a threshold has already been developed: investigate its applicability considering Mediterranean specificities (e.g. chemical input, geochemical background, water temperature, open/close systems…) which might impact biological responses of marine organisms. Otherwise, use the thresholds already developed.
    b. When there is no threshold for the “substance * matrix” combination, develop one at a regional/sub-regional level in order to ensure the applicability of the threshold, when relevant.

This action should be taken at RSC level to:

- ensure use of the developed methodology in MSFD assessment;
- propose thresholds relevant at Mediterranean or relevant subregion level.

Connections with other RSCs and EU (WFD) groups have to be considered to ensure consensus in the methodology developed and application of the thresholds to be developed.

Action 3. Before 2020 (to have time to implement a harmonized action and to collect data useful for next 2024 GES assessment): Harmonize and consolidate spatial extent of the monitoring (offshore, deep-sea…).

This action might be taken based on national initiatives although an international project with joint monitoring campaign would enable to reach broader outcomes. The objectives might, for instance, include to:

- Target in scope (comparable, harmonized, wide-regional) innovative and more cost-effective assessments schemes for MSFD GES;

- Integrate European research Oceanographic Fleet for conducting periodic MSFD marine assessments (every six years?). Mutualized campaigns may create appropriate frame towards better collaboration and interoperability of MSFD Member States, emerging areas of activity, sharing the methodological advancements and coherent approaches.

Such schemes should include examination of organizational commitments (European oceanographic fleet), identification of stakeholders, financial aspects and opportunities) and sound scientific arguments and bases. On national basis, such initiative for sea campaign optimization have shown its strong importance to consolidate spatial extent of the monitoring to offshore and deep-sea for all MSFD descriptors (Baudrier et al 2018).

Action 4. Before 2020 (to have time to implement a harmonized action and to collect data useful for next 2024 GES assessment). Further prioritization and/or monitoring of substances.

Criteria for extending the priority and /or monitoring list of substances:

- Discussion among partner countries on whether the substances should be prioritized and/or monitored, especially regarding:
  - Extending the list of metals, PAH, PCB, PFC…
  - What about compounds of emerging concern?
  - Consider the case of radioactive substances and national position on their integration in D8.
    - In Croatia, radionuclides haven't been monitored and weren't considered for the 2012 or 2018 GES assessment.
    - In France, radionuclides have not been considered in the 2018 GES assessment. They are monitored by IRSN (Institute for radioprotection and nuclear safety) and considered in the Euratom treaty. They, and earlier in 2012, radionuclides were mentioned with references to this treaty.
    - In Greece, radionuclides have not been considered for 2018 GES in Greece. In 2012 GES assessment radionuclides data for seawater and biota were just reported
    - In Italy, radionuclides were not included in 2018 GES. In 2012 GES assessment, they were considered, using 2006-2010 data from ISPRA Database on Environmental Radioactivity and data from monitoring of dismissed nuclear plants, but it was concluded that not enough data were available for a detailed assessment of individual environmental matrices.
    - In Slovenia, radionuclides were not considered in the 2012 nor the 2018 GES assessment.
    - In Spain, information is also collected by a separated entity than the D8 responsible one: the Environmental Radiological Surveillance Program coordinated from the Nuclear Safety Council. The Program has a network of environmental control stations, representative of the entire Spanish coastline, which includes coastal waters. In the stations, measurements are made of different radioactive activity parameters. Results are published annually and reported to national authorities and to the European Commission separately from the MSFD.

    A next step could be to discuss whether MSFD and Euratom treaty are fully redundant or if the environmental perspective in D8 could complete the radionuclide assessment

performed under the Euratom. It should also be considered that the chemical contaminant and radionuclides community are, until now, two distinct communities with common interest but few connections.

And then harmonize monitoring approach while taking into account national/regional specificity and different EU directives (WFD/MSFD…)

Action 5. Before 2020 (to have time to implement a harmonized action and to collect data useful for next 2024 GES assessment). Harmonize biomarker monitoring

The objectives to improve **D8C2** implementation in Mediterranean region are:

There are several national initiatives to monitor biological effects, it however needs to be coordinated at a subregional basis to ensure comparison between basins and mutualize the effort. Such project should be conducted in collaboration with RSC and MSFD national experts to ensure the use of the data in 2024 GES assessment. The objectives are:

1. To agree on a core set of biological responses and common methodologies from those proposed by Regional Seas Conventions.
2. To develop common reference values and thresholds of biological effect indicators for GES definition.
3. To develop an indicator linking D1 and D8.

Plus, the team shared the way acute pollution was monitored. The objectives to improve **D8C3 and C4** implementation in Mediterranean region are:

Action 6. Before 2020 (to have time to implement a harmonized action and to collect data useful for next 2024 GES assessment). Adaptation and harmonization of acute pollution events monitoring.

1. To adapt the actual monitoring program for the identification of acute accidental and/or operational pollution events to MSFD requirements, i.e. to include spatial and temporal extent of the polluting element, concentrations of the relevant contaminants, etc.
2. To develop thresholds or other judgment criteria to access GES in relation to D8C3.
3. To propose a common methodology to evaluate the "importance“/”significance” of acute pollution events.
4. To propose a methodology to monitor the effects of the pollution event to the marine organisms taking into account the national/regional specificity.

Finally, analysis of 2012 environmental targets and the methodology used by some countries to established 2018 environmental targets, enabled the team to propose the below action to improve **Environmental Targets** implementation in Mediterranean region:

Action 7. Before 2021 (to be taken into account for next 2024 GES assessment). Harmonization of the establishment of Environmental Targets (common understanding of the role of targets in relation to GES). Criteria for the establishment of Environmental Targets.

1. Targets should guide towards achieving GES, not overlapping GES definition under Article 9.
2. Targets should be consistent with Article 8 - the point of departure - and Article 9 - the final objective - and set in accordance with COM Dec (EU) 2017/848 criteria, both primary and secondary.

3. Targets should be precise and tackle particular issues; reduce pressures and impacts, address human activities.
4. Targets should be able to be assessed quantitatively, thus be directly measurable integrating threshold values.
5. Targets should be set in a specific timeframe.
6. Targets should Integrate existing EU legislation and follow the RSC.
7. Targets should be set at regional/subregional level in a coordinated manner where possible or needed.

For all these actions, a consensus should be reached to find the correct balance between the level of harmonization needed at EU or RSC levels to have comparable GES assessment between member states and the level of flexibility needed to represent regional specificity, with as global objective, to maintain or come closer to the good environmental status of the seas.

1 Introduction and second cycle MSFD implementation

1.1 Status, trends and effects of chemical contaminants in semi-enclosed European Seas, such as the Mediterranean

Context

The European semi-enclosed Seas, such as Baltic, Mediterranean, and Black Sea, share nowadays all marine ecosystems key challenges related to the growing anthropogenic pressures (biodiversity losses, climate change impacts, overfishing, and chemical pollution). There are major issues requiring coordinated policy and management responses in the coming years in order to stem the tide of degradation of Mediterranean ecosystems. These Seas are, for instance, recognized as particularly vulnerable to chemical pollution, because of long history of Europe's industrialization, high density of coastal populations, and also because of their natural characteristics such as large watersheds, high continental loads, and long water residence times (UNEP/UNECE 2016). Their surrounding coastlines are indeed characterized by a high population density, marked by the developing big coastal urban centers, which are often identified as hotspots of marine coastal chemical pollution (OSPAR 2010; HELCOM 2010, UNEP/MAP 2012). Moreover, several sea-based activities have been recognized as potential sources of contaminants that might occur in the marine environment; these activities include shipping, aquaculture, offshore activities (e.g., oil and gas exploration and extraction), seabed mining, dredging of sediments, and their dumping at sea (Tornero and Hanke, 2016). In addition, climate change is also emerging as a key driver of environmental change in the region (UNEP, 2016).

The recent assessments show that harmful substances are still above acceptable concentrations in many coastal areas and contamination of marine environment by certain substances and elements is widespread, including remote and off-shore zones (OSPAR 2010; HELCOM 2010; UNEP/MAP 2012; AMAP 2004; EEA 2015a; EEA 2015b; Carubelli et al. 2007; Martí-Cid et al. 2007). The chemicals of concern are historical legacy contaminants such as certain persistent organic pollutants (POPs) and heavy metals including mercury, cadmium and lead, and new emerging contaminants such as many novel organohalogenated compounds, including perfluorinated compounds (PFCs), brominated flame retardants (BFRs), some veterinary and human pharmaceuticals, certain agriculture pesticides, alternative anti-fouling biocides, personal care products and plasticizers, which now have been found in many European Seas (EEA 2011; EEA 2010; HELCOM 2010; Schwarzenbach et al. 2006; Kolpin et al. 2002). For certain emerging chemicals (for instances PFC and BFRs) significant upward trends of their concentrations over the last two decades in the marine biota and sediments are reported (HELCOM 2010; Law et al.2006; Johansson et al. 2006). There are several data and published works on contaminant levels in the sediments, biota and water column for the Mediterranean Sea. The below analysis is based mostly on the reviews made by UNEP (2012) and the PERSEUS Project (2013) and aim at emphasizing the contamination issue in marine ecosystems.

Persistent Organic Pollutants (POPs)

POPs include certain chlorinated pesticides and industrial chemicals such as polychlorinated biphenyls (PCBs), most of which have already been prohibited in Mediterranean countries. However, POPs can also be unintentionally released, mainly as a result of combustion processes or as by-products in some industrial processes (e.g. dioxins and furans, hexachlorobenzene, PCBs, or PAHs). Industrial and domestic-use POPs include brominated flame retardants (polybrominated diphenyl ethers, or PBDEs). POPs also include organotins, biocides formerly used in antifouling paints released by maritime traffic and boating. POPs are capable of long-range transport, they bioaccumulate in human and animal tissue, biomagnify along the marine food chain, and have potentially significant impacts on human health and the environment.

Pollution by organic contaminants in the Mediterranean coasts is mainly associated with harbors, intense urban, and/or industrial areas and areas subject to the main riverine discharges. For instance, PCBs levels

were lower in the eastern Basin as compared to western Basin, but medium to high levels of PCBs were measured in red mullets from Cyprus and Turkey and high values, related to industrial and urban effluents, offshore from the Athens port of Piraeus. Hotspots for those compounds are found in areas under the influence of large cities (e.g. Barcelona, Marseille, and Genoa in the Northwestern Mediterranean, Naples and the Bagnoli area in the Tyrrhenian sub-basin, Venice and Trieste in the Adriatic, Athens in the eastern Mediterranean) and also the mouth of the Mediterranean rivers (e.g. the Ebro and the Rhone Rivers in the Northwestern Mediterranean, the Sarno River in the Tyrrhenian Sea, the Po and the Drin Rivers in the Adriatic, the Evros/Marica River in the Aegean).

Oil pollution and polycyclic aromatic hydrocarbons (PAHs)

Maritime transport is a main source of petroleum hydrocarbon (oil) and PAH pollution in the Mediterranean Sea. Oil pollution occurs on routine ship operations including illegal ones and accidental events. Routine ship operations pollute the sea with oil by tank washings, release of ballast water, and discharges of bilge oil. It is estimated that approximately 0.1 % of the crude oil transported ends up deliberately dumped every year in the sea as the result of tank washing operations (Committee on Oil in the Sea, 2003). Crude oil is composed of thousands of complex compounds of which PAHs are the most toxic. In some areas PAHs levels are higher in offshore waters than they are closer to land that is attributed to intensive ship traffic and direct discharges from ships offshore (Committee on Oil in the Sea, 2003). PAHs are also introduced into the Mediterranean Sea by atmospheric particulates from the combustion of fossil fuel and incomplete combustion of biomass and solid waste. Atmospheric deposition is an important route for the introduction of hydrocarbons and contributes significantly to the introduction of PAHs in open-and deep-sea areas. Apart from the anthropogenic inputs of hydrocarbons, natural sources of hydrocarbons in the marine environment include terrestrial plant waxes, diagenetic transformation of biogenic precursors, marine phytoplankton, and bacteria. Oil discharges and spills to marine areas can have a significant impact on marine ecosystems.
Regarding accidental oil spills, Eastern Mediterranean accounts for two-thirds of the total reported quantity spilled in the last decade. Nevertheless, if the Lebanese spill of 2006 is taken out of the calculations, the Western Mediterranean, Central Mediterranean, and Eastern Mediterranean spilled roughly the same quantities (between 4.000 and 6.000 tons), while less than 100 tons was spilled in the Adriatic, according to the information made available to database managed by the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC, 2002).

Heavy metals

Atmospheric deposition, urban, and industrial wastewaters, run-off from metal contaminated sites, rivers and submarine ground water discharges constitute major sources of toxic metals. Heavy metals from localized land-based sources may not only accumulate in the coastal zone but may also move into the deeper areas of the continental margin through advection, and even into the deep basin through downslope transfer processes. Atmospheric deposition is the main pathway for heavy metals to enter open-water regions (Theodosi et al., 2010, 2013; Heimbürger et al., 2010, 2011). Natural metal enrichment is considered important for the Mediterranean Sea, due to hydrothermal activity, seeps, volcanism, local inland mineralogy, and diagenetic processes in the sediments.

Regarding heavy metal contamination, hotspots and areas of concern were predominantly found at sites close to mining, industrial, and/or urban areas. Significant concentrations of cadmium have been reported in sediments along the coast of France (Marseille-Fos), Spain (Cartagena), Morocco (Tangier-Martil and Nador), in the northeastern corner of the Levantine Basin between Cyprus and Turkey (including Iskenderun Bay), and the northern coast of Syria. In biota, relatively high levels of cadmium were recorded in biota at sites along the southern and southeastern coasts of Spain (Cabo de Gata, Almeria, and Cartagena), an intensely mined region, and at a few sites along the western coast of Italy (Naples), the southern shores of the Tyrrhenian Sea (Messina and Palermo), western Sardinia, and France (Sete and Nice). In the Adriatic, high levels of cadmium are found in biota in the Po Delta, as well asin Kastela and Rijeka bays (Croatia), due to the discharge of untreated urban and industrial wastewaters.

There are some areas close to large urban centres and industrial poles, such as Barcelona, Tarragona, Cartagena - Portman, Valencia, and Vallcarca, and the surroundings of the Ebro River, where Pb and Hg values exceed the established thresholds (ERL - Effects Range Low- or EC). In the gulf of Naples, Hg values seem to be relatively high and even higher than those shown in the early 90s, when many industrial developments were located in the area. At the mouth of the Sarno River, high metal concentrations, particularly Cr, As, and Pb, were also reported for sediments. Here, As and Pb values did not comply with the proposed regulations of dangerous substances for coastal sediments. The coastal area facing the Bagnoli brownfield site is also strongly contaminated by trace elements, such as As, Cu, Pb, Zn, and Hg. Except for As, whose high values could be caused by the hydrothermal activity of the area, the other parameters seem to be correlated to the industrial plant.

Biological effects

It is also recognized that chemical contamination has effects in the marine environment, which are still incompletely known. For instance, there is growing evidence that chemical pollution can alter development, reproduction, behavior, survival and mortality rates of individual species and populations, thereby negatively affecting species diversity and the ecosystems as a whole (Walker *et al.* 2012; Pruss-Ustun et al. 2016). The long-term chronic exposure to hazardous toxic chemicals can cause thus reduced biodiversity in marine systems that can in turn indirectly affect their functional habitats resilience and functioning (Peterson et al. 2003). There is growing evidence that contaminants may be partly responsible for the observed increase in disease outbreaks in marine mammals by adversely affecting their immune systems. Some of these effects are known to have caused population declines or resulted in impoverished communities in the Baltic Sea and remote areas of Arctic (HELCOM 2010; AMAP 2004). Furthermore, it appears also that early-life or prenatal exposures, through the maternal transfer of contaminants, may be related to low survival and reproductive failures in marine mammals, birds and several reptiles groups. These processes might be trans-generational, with potential consequences for natural populations of long-lived marine species (Rowe 2008).

Integrated monitoring

Measuring pollutant concentrations in seawater presents “pro” (e.g., targeted analysis relatively easy to link with contamination sources) and “cons” (e.g., low concentrations and random spatial and temporal variations, neglecting the importance of bioavailability, mixture effects and environmental conditions). The use of living organisms (called bioindicators) is complementary to the substance monitoring; it allows to provide data on ecosystem’s health status *in situ*. Contamination bioaccumulation in organisms reflects only the bio-available fraction of potential ecotoxicological significance.

While several environmental criteria for biomarkers and bioassays have been agreed within the OSPAR/CIEM working group, these thresholds do not cover all the species monitored and long-term monitoring data are still scarce indicating the need for further research and scientific discussion. Assessing the impacts of contaminants on the health of aquatic organisms and ecosystems is challenging due to the presence of multiple stressors and the complexity of ecosystems. Currently, evidence of direct relationships between exposure to pollutants and their effects on organisms under field conditions is limited. The influence of various environmental factors on the biological responses to pollution, or the interactions between toxicants present in the marine matrices, limit the understanding of the observed biological effects.

1.2 Analysis of existing approaches for determination of GES and targets (D8)

1.2.1 Definition and assessment of GES under Descriptor 8

In the above context, the definition and assessment of Good Environmental Status (GES) under Descriptor 8 “Concentrations of contaminants are at levels not giving rise to pollution effects” remain a challenging

task. For the purpose of implementing Descriptor 8 under the first cycle of the MSFD (2012), two core elements of data assessment were defined: (8.1) concentrations of contaminants and (8.2) effects of contaminants. The European Commission Decision 2010/477/EU has also laid down for these criteria methodological standards to allow better consistency in approach between marine regions or subregions. This included the use of threshold values of contaminant concentrations to protect the ecosystem from pollution effects. Environmental Quality Standards (EQSs) for priority substances were provided for the Water Framework Directive (WFD; 2008/105/EC). Environmental assessment criteria are designed at the level of the Regional Sea Conventions (RSCs). Furthermore, the importance of designing consistent monitoring programs which are compatible and integrated with WFD and Regional Sea Conventions by Member States, was also underlined. It was also necessary to set out the geographic scales for D8 assessment along with the need to cover open- and deep-sea areas in a representative and efficient way.

For the MSFD second cycle, the new Commission Decision (EU) 2017/848 provides now the revision of criteria and methodological standards on good environmental status of marine waters as well as specifications and methods for monitoring and assessment for all descriptors. In this Decision, for the Descriptor 8 the following aspects are defined:

- "**criteria elements**" which are for instance: list of contaminants being potentially assessed in coastal, territorial, and beyond territorial waters; list of species and habitats which are at risk from contaminants; significant acute pollution events involving polluting substances…
- "**primary or secondary criteria**" providing for instance: the contaminant concentrations that do not exceed threshold values which are set (for instance in accordance with WFD Directive 2000/60/EC) or established by Member States through regional and subregional cooperation in the coastal, territorial, and beyond territorial waters and, when relevant, in specified matrix (water, sediment or biota); the health of species and the condition of habitats established by adverse effects and their threshold values through regional or subregional cooperation; the spatial extent and duration of significant acute pollution events and adverse effects of significant acute pollution events, on the species and their habitats…
- **"methodological standards"** providing for instance: scale of assessment in coastal, territorial and beyond territorial waters, subdivisions of the region or subregion… and use of the criteria that are being assessed for each contaminant, whether the threshold values set have been achieved…and for each species and habitat being assessed an estimate of the abundance of its population in the assessment area that is adversely affected and the extent in the assessment area that is adversely affected…and an estimate of the total spatial extent of significant acute pollution events and their distribution and total duration for each year.

1.2.2 Linkages with international and Regional Sea Conventions (RSCs) and with existing relevant EU legislations

Contaminants have long history of their monitoring and assessments in respective European marine regions (the North-East Atlantic, the Mediterranean, the Baltic Sea, the Black Sea) being mainly addressed through the Regional Sea Conventions - RSCs (i.e. Barcelona Convention, Bucharest Convention, OSPAR, and HELCOM).

The linkages with RSCs concern largely the integration of the results of chemical monitoring programs obtained within the Conventions. There are considerable benefits to be gained from the international experience in monitoring program design, measurement methodology protocols and guidelines, data management, aggregation and interpretation, available from the RSC programs. For instance, the selection of mandatory determinants (e.g. common indicators) proposed by RSCs results in better coherence of the assessment outcomes. The IMAP Ecological Objective related to contaminants (**EO9**) is addressed with the following Common Indicators:

- **Common Indicator 17:** Concentration of key harmful contaminants measured in the relevant matrix (EO9, related to biota, sediment, seawater);
- **Common Indicator 18:** Level of pollution effects of key contaminants where a cause and effect relationship has been established (EO9);
- **Common Indicator 19:** Occurrence, origin (where possible), extent of acute pollution events (e.g. slicks from oil, oil products and hazardous substances), and their impact on biota affected by this pollution (EO9);
- **Common Indicator 20:** Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in commonly consumed seafood (EO9);
- **Common Indicator 21:** Percentage of intestinal enterococci concentration measurements within established standards (EO9).

The 19th Meeting of the Contracting Parties to the Barcelona Convention adopted the Integrated Monitoring and Assessment Program of the Mediterranean Sea and Coast and Related Assessment Criteria (IMAP 2016 – 2021). It is introduced first in an initial phase (2016-2019) in line with Decision IG. 21/3, during which the existing national monitoring and assessment programs will be integrated, in line with the IMAP structure and principles and based on the agreed common indicators. This implies in practice that the existing national monitoring and assessment programs will be reviewed and revised as appropriate so that national implementation of IMAP can be fulfilled in a sufficient manner (UNEP/MAP, 2017). The IMAP thus aims at improving harmonization between the various existing monitoring programs, based on the agreed common indicators.

1.2.3 Short description of relative recent research projects for the Descriptor 8 implementation in the Mediterranean region and originality of MEDCIS

An overview of recent projects related to the implementation of Descriptor 8 has been detailed in the first MEDCIS deliverable. They include:

- ACTION MED
- MERMAID (2013-2015)
- IRIS SES (2013-2015)
- PERSEUS (http://www.perseus-net.eu)
- MERMEX /MERITE (*http://mermex.pytheas.univ-amu.fr/)*

1.2.4 MSs Implementation of MSFD in the first implementation cycle (2012)

An overview of the 2012 GES assessment performed by Mediterranean countries has been presented in the deliverable 1 and showed that all the participating countries reported a quantitative D8 GES assessment. All MSs, except Cyprus, have incorporated in their definitions or thresholds / baselines references to the WFD and the EQSD (Directive 2008/105/EC, Directive 2013/39/EU). The 1881/2006/EU for fish and seafood (and in some cases its amendment 1259/2011/EU) is mentioned by Spain, Slovenia and Greece. The 2006/118/EC is also mentioned. Spain, France, Slovenia, Greece, and Croatia have referred to OSPAR's Environmental Assessment Criteria and Background concentrations in their GES definition. France, Croatia, and Malta have also included a reference to the Barcelona Convention and Spain has referred to MEDPOL's Background Concentrations for certain substances.

1.2.5 The revised Commission Decision

The revised COM Dec 2017/848 laid down criteria and methodological standards on GES of marine waters and specifications and standardized methods for monitoring and assessment, repealing Decision

2010/477/EU, identifying for Descriptor 8: Concentrations of contaminants are at levels not giving rise to pollution effects (*Table **1***).

Table 1. Criteria, criteria elements, and methodological standards for D8.

CRITERIA ELEMENTS	CRITERIA	METHODOLOGICAL STANDARDS
D8C1 — Primary (1) Within coastal and territorial waters: (a) contaminants selected in accordance with Directive 2000/60/EC: (i) contaminants for which an environmental quality standard is laid down in Part A of Annex I to Directive 2008/105/EC; (ii) River Basin Specific Pollutants under Annex VIII to Directive 2000/60/EC, in coastal waters; (b) additional contaminants, if relevant, such as from offshore sources, which are not already identified under point (a) and which may give rise to pollution effects in the region or subregion. Member States shall establish that list of contaminants through regional or subregional cooperation. (2) Beyond territorial waters: (a) the contaminants considered under point (1), where these still may give rise to pollution effects; (b) additional contaminants, if relevant, which are not already identified under point (2)(a) and which may give rise to pollution effects in the region or subregion. Member States shall establish	Within coastal and territorial waters, the concentrations of contaminants do not exceed the following threshold values: (a) for contaminants set out under point 1(a) of criteria elements, the values set in accordance with Directive 2000/60/EC; (b) when contaminants under point (a) are measured in a matrix for which no value is set under Directive 2000/60/EC, the concentration of those contaminants in that matrix established by Member States through regional or subregional cooperation; (c) for additional contaminants selected under point 1(b) of criteria elements, the concentrations for a specified matrix (water, sediment or biota) which may give rise to pollution effects. Member States shall establish these concentrations through regional or subregional cooperation, considering their application within and beyond coastal and territorial waters. Beyond territorial waters, the concentrations of contaminants do not exceed the following threshold values: (a) for contaminants selected under point 2(a) of criteria elements, the values as applicable within coastal and territorial waters; (b) for contaminants selected under point 2(b) of criteria elements, the concentrations for a specified matrix (water, sediment or biota) which may give rise to pollution effects. Member States shall establish these	*Scale of assessment*: — within coastal and territorial waters, as used under Directive 2000/60/EC, — beyond territorial waters, subdivisions of the region or subregion, divided where needed by national boundaries. *Use of criteria*: The extent to which good environmental status has been achieved shall be expressed for each area assessed as follows: (a) for each contaminant under criterion D8C1, its concentration, the matrix used (water, sediment, biota), whether the threshold values set have been achieved, and the proportion of contaminants assessed which have achieved the threshold values, including indicating separately substances behaving like ubiquitous persistent, bioaccumulative and toxic substances (uPBTs), as referred to in Article 8a(1)(a) of Directive 2008/105/EC; (b) for each species assessed under criterion D8C2, an estimate of the abundance of its population in the assessment area that is adversely affected; (c) for each habitat assessed under criterion D8C2, an estimate of the extent in the assessment area that is adversely affected. The use of criterion D8C2 in the overall assessment of good environmental status for Descriptor 8 shall be agreed at regional or subregional level. The outcomes of the assessment of criterion D8C2 shall contribute to assessments under Descriptors 1 and 6, where appropriate

that list of contaminants through regional or subregional cooperation.	concentrations through regional or subregional cooperation.	
D8C2 — Secondary Species and habitats which are at risk from contaminants. Member States shall establish that list of species, and relevant tissues to be assessed, and habitats, through regional or subregional cooperation.	The health of species and the condition of habitats (such as their species composition and relative abundance at locations of chronic pollution) are not adversely affected due to contaminants including cumulative and synergetic effects. Member States shall establish those adverse effects and their threshold values through regional or subregional cooperation.	
D8C3 — Primary Significant acute pollution events involving polluting substances, as defined in Article 2(2) of Directive 2005/35/EC of the European Parliament and of the Council(1), including crude oil and similar compounds.	The spatial extent and duration of significant acute pollution events are minimised.	*Scale of assessment*: Regional or subregional level, divided where needed by national boundaries. *Use of criteria*: The extent to which good environmental status has been achieved shall be expressed for each area assessed as follows: an estimate of the total spatial extent of significant acute pollution events and their distribution and total duration for each year. This criterion shall be used to trigger assessment of criterion D8C4.
D8C4 — Secondary (to be used when a significant acute pollution event has occurred) Species of the species groups, as listed under Table 1 of Part II, and benthic broad habitat types, as listed under Table 2 of Part II.	The adverse effects of significant acute pollution events on the health of species and on the condition of habitats (such as their species composition and relative abundance) are minimised and, where possible, eliminated.	*Scale of assessment*: As used for assessment of the species groups or benthic broad habitat types under Descriptors 1 and 6. *Use of criteria*: The outcomes of assessment of criterion D8C4 shall contribute, where the cumulative spatial and temporal effects are significant, to the assessments under Descriptors 1 and 6 by providing: (a) an estimate of the abundance of each species that is adversely affected; (b) an estimate of the extent of each broad habitat type that is adversely affected. The use of criterion D8C4 in the overall assessment of good environmental status for Descriptor 8 shall be agreed at regional or subregional level.
(1) Directive 2005/35/EC of the European Parliament and of the Council of 7 September 2005 on ship-source pollution and on the introduction of penalties, including criminal penalties, for pollution offences (OJ L 255, 30.9.2005, p. 11).		

Specifications and standardized methods for monitoring and assessment

1. For criteria elements under D8C1, the selection under points 1(b) and 2(b) of additional contaminants that may give rise to pollution effects shall be based on a risk assessment. For these contaminants, the matrix and threshold values used for the assessment shall be representative of the most sensitive species and exposure pathway, including hazards to human health via exposure through the food chain.

2. For the purposes of this Decision:

(a) Criterion D8C1: for the assessment of contaminants in coastal and territorial waters, Member States shall monitor the contaminants in accordance with the requirements of Directive 2000/60/EC and the assessments under that Directive shall be used where available. Information on the pathways (atmospheric, land- or sea-based) for contaminants entering the marine environment shall be collected, where feasible.

(b) Criteria D8C2 and D8C4: biomarkers or population demographic characteristics (e.g. fecundity rates, survival rates, mortality rates, and reproductive capacity) may be relevant to assess the health effects.

(c) Criteria D8C3 and D8C4: for the purposes of this Decision, monitoring is established as needed once the acute pollution event has occurred, rather than being part of a regular monitoring program under Article 11 of Directive 2008/56/EC.

(d) Criterion D8C3: Member States shall identify the source of significant acute pollution events, where possible. They may use the European Maritime Safety Agency satellite-based surveillance for this purpose.

3. Contaminants shall be understood to refer to single substances or to groups of substances. For consistency in reporting, the grouping of substances shall be agreed at Union level.

4. Species composition shall be understood to refer to the lowest taxonomic level appropriate for the assessment.

Units of measurement for the criteria:

— D8C1: concentrations of contaminants in micrograms per litre (µg/l) for water, in micrograms per kilogram (µg/kg) of dry weight for sediment and in micrograms per kilogram (µg/kg) of wet weight for biota,

— D8C2: abundance (number of individuals or other suitable units as agreed at regional or subregional level) per species affected; extent in square kilometres (km2) per broad habitat type affected,

— D8C3: duration in days and spatial extent in square kilometres (km2) of significant acute pollution events per year,

— D8C4: abundance (number of individuals or other suitable units as agreed at regional or subregional level) per species affected; extent in square kilometres (km^2) per broad habitat type affected.

1.2.6 GES assessment under 2018 MSFD reporting by Member States for descriptor 8 and the need for a road map for better D8 harmonization between countries

The first MEDCIS deliverable reviewed how Mediterranean partner countries have implemented MSFD for the 2nd cycle GES assessment, including a precise description of their methodologies and field monitoring strategies:

⇨ Description of methodology used for D8 GES **assessment** by each partner country
- National governance and body in charge of D8 reporting in 2018
- For each criteria D8C1, C2, C3 and C4:
  - **Matrices** (biota (species, tissues); sediments (normalization parameters); seawater)
  - **Indicators**: Monitored substances (costal and marine waters…) or effects
  - **Statistical approach**
  - **List of thresholds used for the assessment**
  - **Gap analysis and blocking points**
- GES reporting scale in 2018
  - **Aggregation inter and intra criteria, spatial scale of the assessment**
  - **Gap analysis and blocking points for the MSFD implementation**

⇨ Description of contaminant **monitoring** by each partner country
- National governance and body in charge of D8 monitoring in 2018
- For each criteria D8C1, C2, C3 and C4:
  - **Frequency, number of stations, area covered, matrices (**sediments/biota (species)/seawater, with a special emphasis on long-term monitoring and offshore stations**)**
  - **Gap analysis and blocking points**

⇨ Data collection and availability
- **Format of the database or available datasets (spatial data structure, metadata,…)**
- **Who is collecting the data, where are they stored (database, project results…)**
- **Gap analysis and blocking points**

The analysis of the data gaps, based on this extensive work (*Table **2***), was presented at the MEDCIS workshop (February 2018, Athens, http://medcis.eu/parallel-medcis-workshop-pollution/) where the need for a **road map to be used at regional level to improve GES assessment harmonization for the next GES assessment has been identified**. The roadmap is presented in the actual document (deliverable 2) and identifies a series of actions to be undertaken on a short and medium-term basis. Harmonization should take into account different levels:

- Harmonization at regional levels between Europe, regional sea convention (RSC) and national layers;
- Harmonization between directives approaches (e.g. MSFD, WFD for D8).

A consensus should be reached to find the correct balance between the level of harmonization needed at EU or RSC levels to have comparable GES assessment between member states and the level of flexibility needed to represent regional specificity, with as global objective, to maintain or come closer to the good environmental status of the seas.

Table 2. Summary of the gap analysis and blocking points for the MSFD implementation

Criteria	Monitoring	GES assessment
D8C1	- **Offshore**: Need for regular monitoring beyond the 12 miles for sediment and fish (and within 6 miles for Greece). Currently, monitoring is mostly performed on the coastal portion of the marine environment. - **Biota**: Need for an appropriate approach to monitor biota when native mussels are not sufficiently present on a portion of coast. Note that there is also difference in bioaccumulation ability for the different mussel species. Are limpets a suitable alternative for Canary Island? Are caged mussel a suitable alternative? Which tissues to be used (especially for fish)? - **Number of substances:** Need to prioritize the substance families to be monitored. - **Regionalize the assessment**: Need to divide the Mediterranean coast within relevant sub-region (e.g. Gulf of Trieste…)	- **Thresholds**: Need to develop assessment criteria for contaminants and to review existing ones at the level of the Mediterranean sea or at subregional levels - **Indicator development:** Need develop indicator at subregional level (per type of monitoring), for a standardized approach to process censored data (<LQ), improve the use in analytical uncertainty and analyze temporal trends.
D8C2	- **Ecotoxicological tools**: • Need to implement regular bivalve and fish biological effects monitoring • Need to establish a minimal list of biomarkers assessed in fish and mussels. • Need for infrastructures for biological effects monitoring - Because of few data for biological effects, assess the possibility to collect data from research projects.	- **Thresholds:** Need to develop assessment criteria for biological effects for relevant species and a minimal list of biomarkers. - Need for inter-calibration frameworks - **Indicator development:** • Need for a standardized approach to process censored data (<LQ), improve the use in analytical uncertainty and analyze temporal trends • Need to establish appropriate tools to integrate chemical and biological effect data.
D8C3	- Need to assess adequacy of current monitoring program and of data availability with MSFD D8C3 requirement.	- **Thresholds:** Need for thresholds including normalization procedure (monitoring duration…)
D8C4	- Need to implement acute pollution monitoring in the Mediterranean subregion	- No MEDCIS member State partner has been able to inform on D8C4 due to the lack of monitoring data

Additional remarks

- **Need for appropriate governance for an efficient MSFD implementation at national levels (GES, Monitoring, Data availability)**
- **Funding/Organization**

- Budgetary (as material and working time) constraints for the implementation of monitoring programs and for the training of human resources
- Delays in contract processing
- Coordination with different organisms and institutions

- **To promote GES comparison between Member States, to 1) have a broad view of the contamination (which has no boarder) and 2) to share cost, effort and expertise, it is needed to:**
  1. Select a core list of chemicals
  2. Agree at the EU level on which thresholds to be used or on an approach to select thresholds at national level.
  3. Define a strategy for data/metadata collection when not located in public databases:
     - Need to organize internal data and to collect and organize data from other organisms and institutions.
     - Pay attention to the metadata associated to the data: establish a minimum list for the data to be usable.
  4. Harmonize sampling and analysis methods.

2 D8C1: Road map for a better implementation of chemical contaminant assessment for the third cycle (2024)

2.1 Methodology

JRC prepared a reference list of substances and circulated through MSFD Expert Network on Contaminants with the aim of identifying the substances that Member States (MSs) intended to include in the 2018 MSFD reporting (updates of Articles 8, 9 and 10) and the thresholds used. This list includes 390 substances from 16 substance families: PBDE, Chlorophenols, Cyclodiene pesticides, DDTs, Dioxins and dioxin-like compounds, HBCDD, HCH, nonylphenols, PFAS, Phthalates, PAHs, PCB, Organotin compounds, Trichlorobenzenes, xylenes, Radionuclides (Tornero and Hanke, 2018).

This JRC table was also circulated through the MEDCIS D8 team and completed by the partner countries with additional information especially on the **matrix/matrices** used for the monitoring of each substance/family of substances, the **limit of quantification (LQ)** of each chemical measurement, and the **proportion of censored data (<LQ)** in the samples assessed and used for GES assessment (*Table **3***). Medcis partners were able to collect these data data when they were in charge of or closely related to the MSFD D8 monitoring and GES assessment. This highlight the importance of MSFD governance at member state level on information sharing and transparency. The data available are presented below for each matrix. For Italy, data from MSFD monitoring programs used for 2018 MSFD reporting were made publicly available through the "Centralized Information System for MSFD monitoring data" (SIC-MSFD; http://www.db-strategiamarina.isprambiente.it/app/#/) only at the end of March 2019, after the end of MEDCIS project, therefore they could not be used for the preparation of this report.

Water. For water monitoring, three out of the six MEDCIS partners were able to provide additional information on the JRC table. Croatia, Greece and Slovenia informed on the proportion of censored data (<LQ) and on LQ values for some of the substances (as provided by the analytical laboratory) (***Table 6***).

- Croatia reported on LQ values provided by different laboratories that carried out the analyses. Some of these laboratories are accredited and should provide LQ (mandatory information), while others do not provide the LQ values unless the measured concentrations fall below the LQ value. Therefore, the info on LQ values was not provided/available for all of the analyzed substances.
- UNIVE (Italy) is not responsible for MSFD monitoring. At the time of the report, LQ are public only for a subset of substances because they do not come from monitoring results but from the survey among regional environmental agencies (on selected substances) (Ausili et al., 2018).
- Spain did not have access to the water monitoring results and/or LQ;, water is not monitored under the WFD monitoring which is not managed by IEO (MEDCIS partner) but by Autonomous Communities. Each Autonomous Communities, would have a different LQ, which is not available.
- Slovenia inform on a subset of substances which are monitored regularly, for some substances only a very 6-year monitoring is performed.
- No data: France does not monitor contaminants in the water.

Sediment. For sediment monitoring, the six MEDCIS partners were able to provide additional information on the JRC table. Croatia, France, Greece and Slovenia informed on the proportion of censored data (<LQ) and on LQ values for some of the substances (as provided by the analytical laboratory); Spain and Italy informed on LQ values (Table 7).

- Croatia reported on LQ values provided by different laboratories that carried out the analyses. Some of these laboratories are accredited and should provide LQ (mandatory information),

while others do not provide the LQ values unless the measured concentrations fall below the LQ value. Therefore, the info on LQ values was not provided/available for all of the analyzed substances.

- France reported LQ and percentage of censored data for all the substances monitored. For the substances newly monitored, only LQ was available.
- UNIVE (Italy) is not responsible for MSFD monitoring. At the time of the report, LQ are public only for a subset of substances because they do not come from monitoring results but from the survey among regional environmental agencies (on selected substances) (Ausili et al., 2018).
- Slovenia inform on a subset of substances which are monitored regularly, for some substances only a very 6-year monitoring is performed.
- Spain reported information on substances monitored specifically for MSFD and before 2018, not for newly monitored ones (monitoring is being implemented and LQ are not yet available) and not for the WFD monitoring (see *"Water"* section above).

Bivalve. For bivalve monitoring, the six MEDCIS partners were able to provide additional information on the JRC table. France and Slovenia informed on the proportion of censored data (<LQ) and on LQ values for some of the substances (as provided by the analytical laboratory); Greece, Spain and Italy informed on LQ values (Table 8) and Croatia informed on the proportion of censored data (<LQ) (for 2 substances).

- Croatia reported on LQ values provided by different laboratories that carried out the analyses. Some of these laboratories are accredited and should provide LQ (mandatory information), while others do not provide the LQ values unless the measured concentrations fall below the LQ value. Therefore, the info on LQ values was not provided/available for all of the analyzed substances.
- Greece has not started the bivalve monitoring, it will start in 2020 and therefore has no data yet.
- France reported LQ and percentage of censored data for all the substances monitored. For the substances newly monitored, only LQ was available.
- Spain reported information on substances monitored specifically for MSFD and before 2018, not for newly monitored ones (monitoring is being implemented and LQ are not yet available) and not for the WFD monitoring (see *"Water"* section above).
- UNIVE (Italy) is not responsible for MSFD monitoring. At the time of the report, LQ are public only for a subset of substances because they do not come from monitoring results but from the survey among regional environmental agencies (on selected substances) (Ausili et al., 2018).

Fish. For fish monitoring, France and Croatia informed on the proportion of censored data (<LQ) and on LQ values for some of the substances (as provided by the analytical laboratory); Spain informed on LQ values (***Table 9***).

- Croatia reported on LQ values provided by different laboratories that carried out the analyses. Some of these laboratories are accredited and should provide LQ (mandatory information), while others do not provide the LQ values unless the measured concentrations fall below the LQ value. Therefore, the info on LQ values was not provided/available for all of the analyzed substances.
- France reported LQ and percentage of censored data for all the substances used for 2018 GES assessment. These data comes from an optimization of the fishery campaign, performed in 2014/2015.
- No data: Greece, Slovenia and Italy do not monitor contaminants in fishes yet.

Table 3. Data available on LQ and censored data obtained by MEDCIS partner country (X and cell in green=some data available, when the available information concern less than 5 substance families, these families are indicated in bracket; cell in blue: no monitoring for 2018 GES, cell with no color: no available data while a monitoring exists).

		Croatia	France	Greece	Italy [1]	Slovenia	Spain [1]
	Substances types [2]	Selected WFD, LBS, others	WFD, LBS, others	WFD, LBS, others	Selected WFD	Selected WFD, LBS, others	Selected WFD
Water	% censored	X	No monitoring	X	No available data	X	No available data
Water	LQ	X	No monitoring	X	X	X	No available LQ
Sediment	% censored	X	X	X (monitoring started in 2019)	No available data	X	No available data
Sediment	LQ	X	X	X	X (metals, HCB, HCH, PAH)	X	X
Bivalve	% censored	X (PAH)	X	Monitoring will start in 2020	No available data	X	No available data
Bivalve	LQ	No available data	X	X (PCB-DL, HCB, Heptachlor, HCH, PAH)	X (Hg, PBDE, HCB, HCBut, PAH)	X	X (Metals, PCB-DL, HCH, PAH)
Fish	% censored	X	X (Metals, dioxin + DL)	No monitoring	No available data	No monitoring[3]	No available data
Fish	LQ	X	X (Metals, dioxin + DL)	No monitoring	No available data	No monitoring	X (Metals, PCB-DL, HCH)

[1] Monitoring managed by Autonomous Communities or Regional Environmental Agencies under the coordination of the Ministry of Environment (Italy). Data not fully available to the Medcis partner from the same country. IEO (Spain) did not have access to WFD monitoring data, UNIVE (Italy) did not have access to the MSFD monitoring data.

[2] "Selected" indicates that only information on LQ and censored data were available compared to the substances reported as "monitored" (Table 5)

[3]: data obtained in 2017, as a test to implement a monitoring)

For the current exercise, substances were divided into 3 categories based on their priority according to the WFD (EU) or the Barcelona convention (Mediterranean seas) and their monitoring status (Figure 1):

- **Category 1: Substances identified as priority by Water Framework Directive (WFD),** i.e. Priority Substance (PS) and Priority Hazardous Substance (PHS)**.** They are expected to be widely monitored.
- **Category 2: Substances not identified as priority by WFD but identified by the Land Based sources protocol (LBS),** one of the three major protocols of the Barcelona Convention (with the Dumping Protocol and Hazardous Waste Protocol).
- **Category 3: Substances not identified by WFD or Barcelona convention,** for which ones the monitoring could be on a national initiative**.**

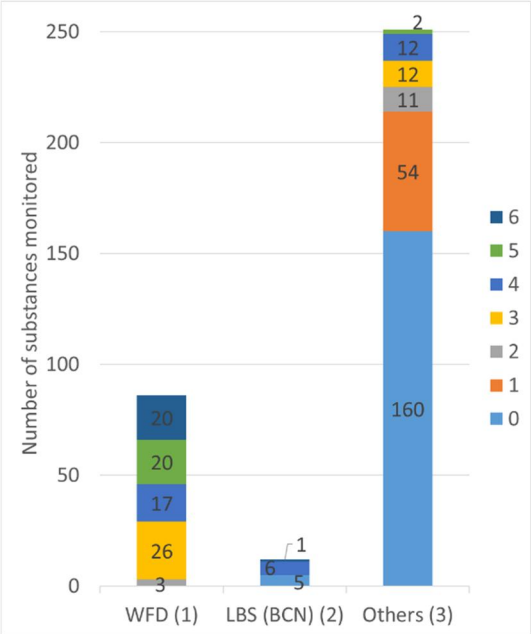


Figure 1. Number of countries among the 6 partner countries, monitoring each substance listed in 2018 JRC table, according to their identification as priority substances by EU ("WFD") or by Barcelona Convention ("LBS (BCN)") or "Others" (not identified as priority substances by WFD nor LBS). (1) The 45 PS include 86 individuals substances: PS 18 is divided in 5 substances (HCH mixture, g-HCH, α-HCH, β-HCH, d-HCH), PS 24 in 3 substances (nonylphenols, 4-nonylphenol (branched) and 4-nonylphenol), PS 28 in 6 substances (PAH sum, BaP, BbF, BghiP, BkF and I(1,2,3-cd)P), PS 30 in 2 substances (TBT and TBT cation), PS 37 in 30 substances (dioxin+dioxin-like and the 29 individual PSCDD, PCDF and PCB congeners). (2) Separately from PS, LBS includes 12 substances, mainly pesticides, metals and chloroalkanes. (3) Separately from PS and LBS, JRC table includes 251 substances (+ family names).

Substances of emerging concern outside the JRC table were not considered in the present exercise. However, MEDCIS/D8 team stresses out the importance for the authorities/research institutes in charge of D8 monitoring and GES assessment at the national level to be linked to the actions undertaken at EU (e.g. NORMAN network) or national level (e.g. Aquaref in France, Slovenian environmental agency) on substance prioritization to make GES assessment as relevant as possible. Plus, it seems important to link POMs to substances of emerging concern (not regulated yet). Monitoring historical contaminants is however of high relevancy as case study to assess processes driving fate and effects of main chemical families in the marine environment.

2.2 Monitoring of PS and PHS (WFD)

The 45 substances identified as PS or PHS by the Directive 2013/39/EC (amending Directives 2000/60/EC and 2008/105/EC) corresponds to 86 congeners, isomers or sum of substances.

2.2.1 The 33 initial PS and why countries have chosen not to monitoring some

The 33 substances initially identified as PS or PHS by the Article 16(4) of Directive 2000/60/EC and Article 8 of Directive 2008/105/EC are monitored by the 6 partner countries (Annex 1), except:

- 4-nonylphenol (branched) (CAS 84852-15-3, EU 284-325-5), the nonylphenol isomer on which one the nonylphenol EQS has been developed, which is not monitored by 2 countries: Greece which monitors 4-n-nonylphenol and not the branched isomers, and Croatia which monitors the mixture of nonylphenol isomers in 2015;
- 1,2-dichloroethane

- Dichloromethane
- Di(2-ethylhexyl)phthalate (DEHP)
- Nickel
- Octylphenols = isomer 4-(1,1',3,3'-tetramethylbutyl)-phenol (CAS 140-66-9, EU 205-426-2)
- Pentachlorobenzene
- Trichlorobenzenes
- Trichloromethane (chloroform)
- Trifluralin

2.2.2 The additional 11 newly identified PS

According to Directive 2013/39/EC, the 11 newly identified PS should be taken into account in the establishment of supplementary monitoring programs and in preliminary programs of measures to be submitted by the end of 2018. Consequently, these 11 newly priority substances are monitored by less countries than the PS, which could be expected as it is a developing process. However, dioxin and dioxin-like compounds as well as heptachlor and heptachlor epoxide are already monitored by 5 of the 6 partner countries (Annex 1).

2.2.3 The choice of the monitoring matrices and corresponding assessment criteria: limit of quantification (LQ) and proportion of censored data (<LQ) in water, biota or sediment samples used for GES assessment

While there is a good substance coverage by actual monitoring programs, matrices in which PS are monitored vary among countries, with a higher proportion of analysis in water in Croatia, Greece, Italy, Spain and Slovenia and in sediment and biota (bivalve or fish) in France (*Figure **2***).

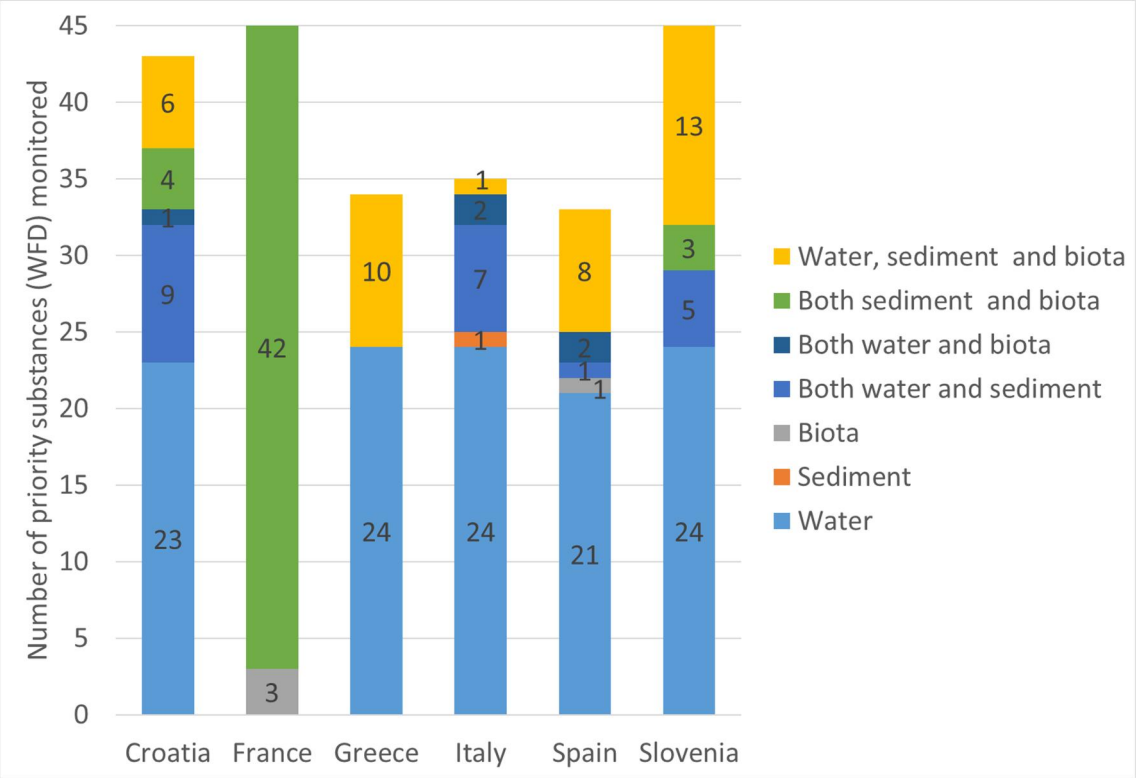


Figure 2 – Matrices in which PS or PHS (as individual substances or list of isomers/congeners/sum) are monitored in the MEDCIS partner countries

2.2.3.1 Water monitoring

LQ and % censored. Based on the available information, metals are quantified in a large majority of samples in Croatia and Greece, while in Slovenia they are mainly below the LQ (*Table **6***, *Figure **4***). Reported LQ for metals in water are higher in Slovenia than in Croatia and Greece (*Table **6***, *Figure **6***). On the opposite, organic compounds are largely below LQ in the 3 countries, stressing the need to adapt the monitoring matrix to have useful information out of the monitoring program (*Table **6***, *Figure **5***).

Thresholds. Thresholds values applied to water samples are EQS. Threshold values to assess the environmental status based on water monitoring have not been derived at the Mediterranean level (*Table **5***).

2.2.3.2 Sediment monitoring

LQ and % censored. Metals are quantified in a large majority of samples in the 4 responding countries (*Table **7***, *Figure **4***). Some organic substances (20 out the 57 ones) are also quantified in a majority of samples in at least one of the responding country; these are mainly PAH and PCB (DL-like since non-DL PCB are not identified as PS by WFD) (in yellow in *Table **7***, *Figure **5***), and also:

- Chloroalkanes, C10-13, and Dioxins and DL (sum) in Croatia and Slovenia;

- Heptachlor and heptachlor epoxide, and HBCDD in Croatia; on the opposite, France reports a majority of samples <LQ, both countries having similar LQ values;

- Hexachlorobenzene in Croatia and Greece; on the opposite, France and Slovenia report a majority of samples <LQ, France having a higher LQ than the other countries and Slovenia a lower one.

- gamma-HCH (lindane) in Greece; on the opposite, France reports a majority of samples <LQ with a higher LQ than Greece

- DEHP in France and Slovenia. Percentage of censored data was higher in France (n = 93 / 234, 40%) than in Slovenia (n= 7 / 20, 35%), while LQ was lower in France than Slovenia. In Croatia, 10 samples were quantified (above LOQ).

Thresholds. Two European regional sea conventions (RSC) proposed thresholds (or assessment criteria) for PS applicable to sediment samples:

- HELCOM, which derived sediment values from EQS dossiers;
- OSPAR, which suggested to use US EPA ERL (Effect Range Low), except for CB118 and TBT for which an EAC (Environmental Assessment Criteria) has been developed (as common indicator for OSPAR).

For Cd, Pb and Anthracene, both RSC provide thresholds. Values are in the same order of magnitude for Pb and Anthracene (OSPAR being 3 to 4 times more protective than HELCOM) (*Table **5***). However, for Cd, the US ERL (OSPAR approach) is 20 times more protective than the QS derived from EQS (HELCOM approach).

- For 2018 GES assessment, France, Spain and Croatia used thresholds recommended by OSPAR. Italy used EQS. Croatia performed a general assessment of the state of the environment at the national level (apart from GES) using the Bakke derived Norvegian system general assessment of the state of the environment (Bakke et al, 2010).
- Greece will start the sediment monitoring in 2019, and no data have been reported for 2018 GES assessment.

Threshold values to assess the environmental status based on sediment monitoring have not been derived at the Mediterranean level, but some countries are trying to derive some thresholds (e.g. Greece and Slovenia are working on developing PAH thresholds).

2.2.3.3 Bivalve

LQ and % censored. Metals are quantified in nearly all the samples in the 2 responding countries (France and Slovenia, *Table **8***, *Figure **4***). Some organic substances or group of substances (17 out the 50 ones) are also quantified in a majority of samples in at least one of the responding country; these are mainly PAH and PCB (DL-like since non-DL PCB are not identified as PS by WFD) (*Figure **5***), and also:

- PBDE and DEHP in France and Slovenia

- Dioxins, 4-nonylphenol (branched), PFOS in France

- gamma-HCH (lindane) in France; LQ for lindane varies by 2 orders of magnitude between countries, from 0.01 in Greece to 1 µg/kg dw in France

- DEHP in France and Slovenia.

- Tributyltin compounds in Slovenia.

Thresholds. Threshold values are mainly developed at RSC level (*Table **5***). For some substances, no EAC has been developed, so BAC is indicated in the table (in other words, BACs are not indicated when an EAC/EQS has been developed). Only 2 thresholds have been derived for bivalve monitoring at the EU level (EQS): for BaP and Fluoranthene. While EQS for Fluoranthene is similar to the EAC, EQS for BaP is more than 20 times below the OSPAR EAC. Both are based on human health via consumption of fishery products, which may pose question regarding their applicability to assess the good environmental status according to D8 (D8 is dedicated to the marine ecosystem while human health is dealt under D9). Threshold values to assess the environmental status based on bivalve monitoring have not been derived at the Mediterranean level. BAC for one PS (indeno(1,2,3-cd)pyrene) has been developed by MEDPOL, which is close to the OSPAR BAC.

- In Croatia, OSPAR BAC and EAC values were used for the 2012 GES assessment, whereas EQS values have been used for the evaluation of chemical status of water bodies in the scope of the current monitoring program required by the WFD. At this point, there hasn't been any official decision on which of the thresholds will be applied for future GES evaluations.
- For 2018 GES assessment, France used the most conservative thresholds, which conducted to use the OSPAR recommendation except for BaP.
- There is no biota monitoring in Greece yet, and no data have been reported for 2018 GES assessment.
- Italy used EQS.
- Spain used both OSPAR thresholds and EQS.

2.2.3.4 Fish

LQ and % censored. Mercury is quantified in all the fish samples, while Cd and Pb are quantified in a minority of fish samples, which is in line with the bioaccumulative capacity of Hg, especially as methyl mercury, while the other metals tends more to be biodiluted through increasing trophic levels (*Table **9***, *Figure **4***). Much fewer organic substances are monitored in fish samples than in water, sediment or bivalve samples. Organic substances or group of substances (14 out the 26 ones) are also quantified in a majority of samples in at least one of the responding country; these are mainly PCB (DL-like since non-DL PCB are not identified as PS by WFD) (*Figure **5***), and also:

- Dioxins, in France and Croatia

- Heptachlor heptachlor epoxide, HBCDD (sum) and Hexachlorobenzene in Croatia.

Thresholds. Threshold values for fish samples are developed at EU or at RSC levels (*Table **5***). Thresholds values for mercury has been developed at both levels, with the EQS (0.020 mg/kg ww) developed under WFD being 50 to 100 times lower than sanitary thresholds and below BAC levels (Med BAC: 0.101

mg/kg ww and OSPAR BAC: 0.035 mg/kg ww). Threshold values to assess the environmental status based on fish monitoring has not been derived at the Mediterranean level.

- In Croatia, OSPAR BAC and EAC values were used for the 2012 GES assessment, whereas EQS values have been used for the evaluation of chemical status of water bodies in the scope of the current monitoring program required by the WFD. At this point, there hasn't been any official decision on which of the thresholds will be applied for future GES evaluations.
- For 2018 GES, France and Spain used the OSPAR recommendations. Croatia did not monitor contaminant in fish. There is no biota monitoring in Greece yet, and no data have been reported for 2018 GES assessment.
- Italy used EQS.

2.2.4 Conclusions and actions

PS metals (Hg, Pb, Cd, Ni) are mostly quantified (>LQ) in each considered matrix (seawater, sediment, biota) (*Figure **4***). Several organic substances are below LQ in every analyzed samples independently of the matrix (*Figure **5***.A). In addition, all organic compounds analyzed in water samples are below LQ in the majority of samples (*Figure **5***.B). This observation stresses out the importance to consider analytical capabilities and matrices selection in developing a monitoring program. Water is not the appropriate matrix for hydrophobic compounds (which is the case of most of the WFD organic substances). MEDCIS team strongly suggests going on with integrative matrices for MSFD monitoring, unless the country has specific analytical capacities. Also, the NORMAN methodology (Dulio and von der Ohe, 2013) provides, among others, recommendations for the selection of the appropriate matrix and this approach could be applied to harmonize and improve MSFD monitoring. According to the NORMAN methodology, the selection of the relevant matrix for each target substance should be based on the evaluation of results of fugacity models plus the assessment of the logKow, Koc and water solubility for a given substance. Also, the need to rationalize the spatial extent of the monitoring has also been observed during the first phase of the project (*Table **1***).

Based on the analysis of the monitoring of WFD substances by the partner countries, three actions are proposed:

Action 1. Now in 2019 (to limit waste of public credits and to provide useful data for next 2024 GES assessment). Need for urgent and concrete actions regarding monitoring at the EU level:

1. How to deal with PS reported <LQ in >95% samples by 4 partner countries (15 substances out of the 45 PS)? Types of questions, which might help the discussion: Are these substances also reported <LOQ by the other member states? Should we –temporarily- suspend the monitoring of these PS until a sampling/analytical methodology has proven its applicability? Should national/EU funds be dedicated to improve analytical sensibility (LQ)? Should specialized laboratories per family substances be designated at a subregional levels to mutualize the cost and effort?

2. Recommend monitoring in a relevant matrix and NOT in water for hydrophobic substances (most of the PS, see Figure 5.B) unless a sampling/analytical methodology has proven its applicability.

Action 2. Before 2020 (to have time to implement a harmonized action and to collect data useful for next 2024 GES assessment): Indicator development and data analysis of a common dataset.

3. Sharing datasets for the WFD substances (e.g. via Emodnet).

b. Comparison of GES assessment methodology between Mediterranean Member States (statistical approach to calculate the metric indicator and to aggregate substances or stations)

4. Threshold development:

c. When a threshold has already been developed: investigate its applicability considering Mediterranean specificities (e.g. chemical input, geochemical background, water temperature, open/close systems…) which might impact biological responses of marine organisms. Otherwise, use the thresholds already developed.

d. When there is no threshold for the "substance * matrix" combination, develop one at a regional/sub-regional level in order to ensure the applicability of the threshold, when relevant.

This action should be taken at RSC level to:

- ensure use of the developed methodology in MSFD assessment;
- propose thresholds relevant at Mediterranean or relevant subregion level.

Connections with other RSCs and EU (WFD) groups have to be considered to ensure consensus in the methodology developed and application of the thresholds to be developed.

Action 3. Before 2020 (to have time to implement a harmonized action and to collect data useful for next 2024 GES assessment): Harmonize and consolidate spatial extent of the monitoring (offshore, deep-sea…).

This action might be taken based on national initiatives although an international project with joint monitoring campaign would enable to reach broader outcomes. The objectives might, for instance, include to:

- Target in scope (comparable, harmonized, wide-regional) innovative and more cost-effective assessments schemes for MSFD GES;

- Integrate European research Oceanographic Fleet for conducting periodic MSFD marine assessments (every six years?). Mutualized campaigns may create appropriate frame towards better collaboration and interoperability of MSFD Member States, emerging areas of activity, sharing the methodological advancements and coherent approaches.

Such schemes should include examination of organizational commitments (European oceanographic fleet), identification of stakeholders, financial aspects and opportunities) and sound scientific arguments and bases. On national basis, such initiative for sea campaign optimization have shown its strong importance to consolidate spatial extent of the monitoring to offshore and deep-sea for all MSFD descriptors (Baudrier et al 2018).

2.3 Monitoring of MED POL Land Based Substances and other substances (not considered as PS and PHS by WFD)

2.3.1 MED POL Land Based Substances

Separately from the WFD substances (which are already discussed under the section 2.2), MED POL (the UN *Programme* for the Assessment and Control of Pollution in the Mediterranean) identifies as Land Based Substances (LBS) metals and organochlorine pesticides:

- Metals, DDT and chlorinated cyclodienes (aldrin, dieldrin, mirex and endrin) are monitored by 4 to 6 out of the 6 partner countries (***Table 9***). Metals LBS are quantified in a majority of samples (Figure 8), on the opposite organic LBS are <LQ in nearly all the samples (>90% of the samples independently on the matrices) (***Figure 9***).
- Mirex, Chlordane, chloroalkanes (C14-17) and Chlorobenzene are monitored by none of the partner countries (***Table 9***).

EAC is available for dieldrin in bivalve and ERL for Cr, Cu, Zn and dieldrin in sediment. A BAC (Background Assessment Concentration) has been developed by OSPAR for Cu in bivalve.

2.3.2 Other substances (Non WFD and non Medpol substances)

Slovenia and France reported to monitor metals not considered as PS or PHS by WFD nor LBS by MED POL (*Table **10***). Both countries reported (*Figure **8***):

- mostly *censored* values in water samples, except for Mn and Mo with 25/72 and 0/327 censored samples, respectively;

- mostly *quantified* samples in sediment samples, except for radionuclides Cs-137 and Ra-226 with 28/137 and 109/114 censored samples, respectively;

- mostly *quantified* samples in biota samples, except for As in bivalve with 9/9 censored samples, while As was quantified in the 41 fish samples analyzed.

Regarding organic substances, Greece has monitored 38 substances, mainly pesticides, in water in addition to the ones considered as PS or PHS by WFD and LBS by MED POL. They are all below quantification limit (*Figure **9***). This monitoring was performed in 2012-2015 and was used for 2018 GES assessment, but these substances will not be monitored during 2019-2023.

Regarding organic substances (non WFD, non LBS) in sediment and biota, PAH and alkylated PAH, as well as TBT metabolites (DBT, MBT), PCB, BDE and several perfluorinated compounds (PFC), especially PFCA and PFSA, are quantified in most of the analyzed samples (*Figure **9***). On the opposite, Perfluorobutanesulfonate (PFBS), Perfluorobutanoic acid (PFBA), PFDS, PFHpS, PFHxA, PFHxS were mostly below LQ. All the PFC analyses were reported by France and concerned a very limited set of samples (n = 4) (*Figure **9***). Even though, it supports other studies on the high occurrence of perfluorinated compounds in marine ecosystem (e.g., Houde et al. 2011; Benskin et al. 2012, Gonzaler-Gaya et al. 2014, Munschy et al 2015) and the need to integrate in monitoring program other forms of PFC than the mainly studied PFOS or PFOA.

2.3.3 Conclusions and actions

Action 4. Before 2020 (to have time to implement a harmonized action and to collect data useful for next 2024 GES assessment). Further prioritization and/or monitoring of substances.

Criteria for extending the priority and /or monitoring list of substances:

- Discussion among partner countries on whether the substances should be prioritized and/or monitored, especially regarding:
  - Extending the list of metals, PAH, PCB, PFC…
  - What about compounds of emerging concern?
  - Consider the case of radioactive substances and national position on their integration in D8.
    - In Croatia, radionuclides haven't been monitored and weren't considered for the 2012 or 2018 GES assessment.
    - In France, radionuclides have not been considered in the 2018 GES assessment. They are monitored by IRSN (Institute for radioprotection and nuclear safety) and

considered in the Euratom treaty. They, and earlier in 2012, radionuclides were mentioned with references to this treaty.

- In Greece, radionuclides have not been considered for 2018 GES in Greece. In 2012 GES assessment radionuclides data for seawater and biota were just reported
- In Italy, radionuclides were not included in 2018 GES. In 2012 GES assessment, they were considered, using 2006-2010 data from ISPRA Database on Environmental Radioactivity and data from monitoring of dismissed nuclear plants, but it was concluded that not enough data were available for a detailed assessment of individual environmental matrices.
- In Slovenia, radionuclides were not considered in the 2012 nor the 2018 GES assessment.
- In Spain, information is also collected by a separated entity than the D8 responsible one: the Environmental Radiological Surveillance Program coordinated from the Nuclear Safety Council. The Program has a network of environmental control stations, representative of the entire Spanish coastline, which includes coastal waters. In the stations, measurements are made of different radioactive activity parameters. Results are published annually and reported to national authorities and to the European Commission separately from the MSFD.

A next step could be to discuss whether MSFD and Euratom treaty are fully redundant or if the environmental perspective in D8 could complete the radionuclide assessment performed under the Euratom. It should also be considered that the chemical contaminant and radionuclides community are, until now, two distinct communities with common interest but few connections.

- And then harmonize monitoring approach while taking into account national/regional specificity and different EU directives (WFD/MSFD…)

3 D8C2: Road map for a better implementation of biological effect assessment for the third cycle (2024)

3.1 Methodology and criteria to select biological responses

A variety of biological responses and techniques can be used to establish the link between exposure to toxic substances and effects on organisms. Responses at the lowest levels of biological organization (molecular and cellular) can be sensitive and specific for particular toxicants. They can be measures of exposure, but their biological significance in terms of the structure and function of the population or ecosystem is not clear. At the other end, we have responses at the highest levels of biological organization, such as changes in population abundance or biodiversity, which are directly relevant in terms of ecological effects, but cannot always prove that observed differences are due to pollutants or natural ecological factors. That is, as we ascend at the level of biological organizational we gain ecological relevance, but we lose specificity, speed and ease of standardization as a routine technique of environmental monitoring, and *vice versa*. In any case, it is desirable that the biological effects to be measured meet three fundamental conditions: sensitivity to provide an *early-warning* signal, ecological relevance (indicating effects on the *fitness* -growth, reproduction or survival of populations), and simple standardization, rapidity and limited cost.

A set of biological responses, which have been used in various studies to investigate the effects of chemical pollution, was selected by member states for the assessment of the GES. In general, these biological responses have been validated in field studies, and are used in national environmental monitoring programs in Europe, being recommended in the regional programs of MED POL and OSPAR / CEMP. Both indicator species and selected variables vary at the subregional level, depending on the biogeographical singularities and the recommendations of the Regional Seas Conventions.

MEDCIS, within task 1.4, has the objective of preparing a roadmap on criteria to select biological responses from the list of biological effects as presented (*Table **11***), or add new ones. The roadmap would serve to propose some guidelines for harmonization among member states at subregional level, with the aim of agreeing on a set of biological effect techniques and common methodological standards.

For the selection of biological responses to asses GES, it should be considered:

- A battery of biological effects methods that covers a range of mechanisms of action and that targets important biological functions;
- The existence of a background document (e.g. ICES TIMES document) elaborated for the proposed methods.

Criteria for the selection of biological responses are:

- Sensitivity to pollutants. Biological responses should be sensitive enough to provide an *early-warning* signal to pollution, in order to detect a pollution problem before it affects the ecosystem.
- Dose–response relationship. Evidence of a dose-response relationship between the presence of pollutants and the biological response measured is important in order to quantify the degree of pollution.
- Background response and Assessment criteria. For some biological responses, baseline values and assessment criteria, needed to differentiate polluted from non-polluted environments, have been developed for certain species. It will be necessary to develop new thresholds for other species at the subregional level.
- Ecological relevance. An added value is the existence of a link between the measured response and the effect at population or community level, in order to understand the meaning of the

obtained data and to better interpret and integrate different responses and measured pollutants concentrations.

- Natural variability. Biological responses to pollution are usually affected not only by pollution, but also by environmental and endogenous variables such as age, sex, reproduction, food availability or temperature, that alter the organisms' responses to pollution, what hinders establishing links between pollutant exposure and biological effects. Baseline data for the concentration/activity of the biological responses should be known in order to be able to distinguish between natural variability and contaminant induced stress (signal).
- Quality assurance. Quality assurance is important for the development of robust ecotoxicological tools that serve to assess marine pollution. It is important that quality assurance for biological response techniques is updated to ensure comparability of data obtained by different laboratories and, ultimately, to provide coherent and harmonized assessments at the subregional level.
- Biomarker determination methodology. A relevant issue to consider is the methodology needed for the biomarker's determination. If a biomarker is easy to measure (depending on: cost, time needed for determination and expertise) its application in monitoring programs would be easier.

A review of compliance of these criteria by each of the proposed biological response methods has been conducted (*Table **11***).

3.2 Biological effects monitored under RSCs

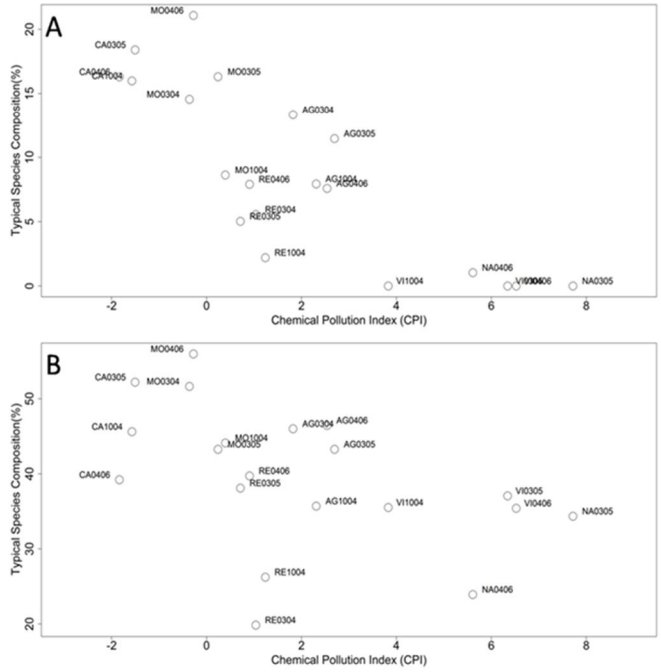
Among the set of biological effects proposed by the member states, those that are currently monitored by Barcelona and/or OSPAR Conventions have been identified. Of these, OSPAR-CEMP 'mandatory' (OSPAR, 2016) and 'recommended' methods (OSPAR, 2007, 2008), as well as MEDPOL 'primary' and 'research phase' biomarkers (UNEP/MAP, 2017) are shown in *Table **11***. Also, from the whole set of biological effects, those recommended by ICES are also denoted, including 'core methods' and 'additional methods' from the components of the framework for an integrated monitoring program (Davies and Vethaak, 2012).

3.3 Perspective for D8C2: Link with descriptor 1

As mentioned above, ultimately, the impact of pollution is manifested at the highest levels of biological organization (e.g. biological communities). 'Community ecotoxicology' has been defined as the study of the effects of chemicals on species abundance, diversity and interactions (Newman and Clements 2008). The inclusion of benthic community studies in integrated monitoring programs of marine pollution has been discussed, taking into account the requirements of the current European legislation (WFD, MSFD). The aim to assess the current state of the marine environment and to identify areas that cannot potentially achieve the desired environmental status.

Regarding GES assessment within MSFD descriptor 8, the study of biological communities will be undertaken in descriptor 1, and a link between both descriptors (D1 and D8) will be appropriate. In this line, the indicator "Typical species composition (BH1)", related to the MSFD and Habitats Directive, has recently been developed by the OSPAR ICG-COBAM and proposed to be adopted within the Coordinated Environmental Monitoring Program (CEMP) by the OSPAR Commission as a 'common indicator' (OSPAR, 2017). This indicator relates the survival of 'typical species' with the environmental/conservation status of a given habitat type in the long-term, in comparison to reference conditions.

The BH1 indicator was tested for a set of stations distributed across the Ría de Vigo (Galicia, NW Iberian Peninsula). A set of pollutants was measured in each station, namely: Hg, Cu, Zn, Cd, Pb, Cr, As, PAHs, PCBs, and DDT. For each sampling site, the Chemical Pollution Index (CPI) was calculated according to Bellas et al. (2011), in order to combine all the pollutants in one value. This index takes positive values when pollutants exceed on average the quality criteria and negative values otherwise (*Figure **3***).



	SPECIES FORMING THE SET
Scenario A (Only species from Group I were considered typical species)	*Ampelisca sp., Atylus sp., Calyptraea chinensis, Chamelea striatula, Euclymene oerstedi, Eudorella truncatula, Lumbrineris scopa, Maldane glebifex, Metaphoxus fultoni, Musculus costulatus, Nucula sp.*
Scenario B (species from Group I, II and III were considered typical species)	*Abra alba, Ampelisca sp., Aonides oxycephala, Atylus sp., Calyptraea chinensis, Chamelea striatula, Euclymene oerstedi, Eudorella truncatula, Eumida sanguinea, Exogone hebes, Glycera sp., Harmothoe sp., Lumbrineris gracilis, Lumbrineris scopa, Maldane glebifex, Melinna palmata, Metaphoxus fultoni, Musculus costulatus, Myrtea spinifera, Mysella bidentata, Notomastus latericeus Nucula sp., Ophiodromus, flexuosus Paradoneis lyra, Paraonis gracilis , Pholoe minuta, Prionospio multibranchiata, Thyasira flexuosa*

Table 35. Species composition for each tested scenario

Figure 3 Typical benthic species composition value (%) and Chemical Pollution Index (CPI) for each station from Ria de Vigo (Spain) for both A and B scenarios (from OSPAR, 2017).

3.4 Conclusions and actions

Action 5. Before 2020 (to have time to implement a harmonized action and to collect data useful for next 2024 GES assessment). Harmonize biomarker monitoring

The objectives to improve **D8C2** implementation in Mediterranean region are:

There are several national initiatives to monitor biological effects, it however needs to be coordinated at a subregional basis to ensure comparison between basins and mutualize the effort. Such project should be conducted in collaboration with RSC and MSFD national experts to ensure the use of the data in 2024 GES assessment. The objectives are:

1. To agree on a core set of biological responses and common methodologies from those proposed by Regional Seas Conventions.
2. To develop common reference values and thresholds of biological effect indicators for GES definition.
3. To develop an indicator linking D1 and D8.

4 D8C3 and D8C4: Road map for a better implementation of acute pollution assessment for the third cycle (2024)

4.1 Methodology and criteria for acute pollution events monitoring

Acute pollution events are events which can cause short time and severe pollution to the marine environment and they can be deliberate or accidental. Chemical substances potentially being spilled at sea are referred to as "Hazardous and Noxious Substances (HNS)" and, in addition to oil, they include other liquid substances which, if introduced into the marine environment, can create hazards to human health, harm living resources and marine life, damage amenities, or interfere with other uses of the sea (MARPOL 73/78). While major oil spills can have extreme impacts on the marine environment, frequent smaller spills and discharges can also exert significant pressures and must be considered appropriately. These can derive from ship traffic, pipelines or platforms for oil and gas exploration or be related to other marine activities, constructions etc.

In addition to MSFD, there are several relevant international agreements and conventions focusing on the protection of the Mediterranean marine environment from acute accidental or operational pollution events:

1) The International Convention for the Prevention of Pollution from Ships (MARPOL) and the International Convention for the Prevention of Pollution from Ships established in 1973, and then modified by the Protocol of 1978 (MARPOL 73/78).

This Convention, established within the framework of IMO (International Maritime Organisation), is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes.

2) The International Convention on Oil Pollution Preparedness, Response and Co-operation established in 1990 (OPRC Convention)

This Convention, also established in the framework of IMO, decides all appropriate measures to be taken, nationally or in co-operation with other countries, to prepare for and respond to oil pollution incidents arising from ships, offshore oil exploration and production, sea ports and oil handling facilities and to mitigate the consequences of such events. OPRC convention was extended by the Protocol on Preparedness, Response and Co-operation to Pollution Incidents, by Hazardous and noxious Substances in 2000 (OPRC-HNS Protocol). This protocol includes dangerous goods and substances that, when released into the environment, could potentially be harmful to human health and marine life. They can be flammable, explosive, toxic, corrosive or reactive. Examples of hazardous and noxious substances include chemicals shipped as bulk solids or liquids, or dangerous goods being transported in container ships.

3) The Barcelona Convention for the Protection of the Mediterranean Sea against Pollution.

This Convention, established within the UNEP framework, includes seven protocols and three of them are of particular relevance to pollution events. One of the Regional Activity Centers of the Mediterranean Action Plan (UNEP/MAP) is the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC). REMPEC was established in 1976, is administered by IMO and assists the Mediterranean coastal States in ratifying, implementing and enforcing international maritime conventions related to the prevention of, preparedness for and response to marine pollution from ships.

4) The 2005/35/EC Directive on ship-source pollution and on the introduction of penalties for infringements

In Mediterranean countries, it seems that no regular monitoring of acute pollution events exists or are available for MSFD reporting. The identification of acute pollution events is usually based on citizen alerts and/or coast guard/military watching programs. Each partner country manages the acute pollution event according to its National Contingency Plan and any environmental data produced are usually not connected to the MSFD implementation.

None of the partner country has reported on D8C3 and D8C4 in the 2nd cycle GES assessment.

A guidance on monitoring of acute pollution events should ensure that all aspects are being covered under the various frameworks, that monitoring information is exchanged between the networks and that potential for a cost effective integrated monitoring is used. In order to respond to MSFD requirements for occurrence, origin and extent identification of pollution events, monitoring efforts could use the following methods: a) quantification of oil and other chemical spills and their size by observation and reporting, b) satellite radar images, c) plane observation and imaging approaches, d) backtracking of oil spills to their source by hind cast modeling, c) chemical analysis in seawater and sediments and application of fingerprinting methods for source identification. Observation should be normalized by the observation duration.

According to the International Tanker Owners Pollution Federation Limited (ITOPF), oil spills are classified as small, medium and large according to the quantity of the spilled oil: <7 tonnes, 7-700 tonnes and >700 tonnes. In addition, the threshold for the Mediterranean countries for reporting under their emergency protocols to the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC) is 100m^3 of spilled oil. There is no classification which can be adopted or adapted for other chemical spills. Nevertheless, this classification does not necessarily reflect 'significance' in terms of the MSFD requirements. For defining the "importance"/"significance" of acute pollution events, the following should be taken into account: a) the volume of the spill and its physico-chemical properties b) the distance from the coastline and from "sensitive"/"protected" areas and c) the environmental conditions. The use of models predicting the pollutant dispersion could be very helpful (e.g. Liubartseva et al. 2015).

According to D8C4, when a significant pollution event takes place, its effects on the biological communities and habitats should be studied in relation with D1 and D6. Taking into account the national/regional specificity, the following aspects could be investigated: a) the vulnerability of the marine protected areas, b) the losses of natural resources e.g. number of oiled sea birds, c) the effect on benthic species composition and relative abundance, d) the damage on fisheries,e) the biological effects on marine organisms e.g. study of biomarkers.

4.2 Conclusions and actions

Action 6. Before 2020 (to have time to implement a harmonized action and to collect data useful for next 2024 GES assessment). Adaptation and harmonization of acute pollution events monitoring.

The objectives to improve **D8C3 and C4** implementation in Mediterranean region are:

1. To adapt the actual monitoring program for the identification of acute accidental and/or operational pollution events to MSFD requirements, i.e. to include spatial and temporal extent of the polluting element, concentrations of the relevant contaminants, etc.

2. To develop thresholds or other judgment criteria to access GES in relation to D8C3.
3. To propose a common methodology to evaluate the "importance“/”significance” of acute pollution events.
4. To propose a methodology to monitor the effects of the pollution event to the marine organisms taking into account the national/regional specificity.

5 Road map for a better implementation of Article 10 on Environmental targets

5.1 Introduction

According to Article 10 of the MSFD, MSs establish a comprehensive set of environmental targets and associated indicators for their marine waters on the basis of their initial assessment. The aim of the targets and indicators is to guide progress towards achieving GES in the marine environment, taking into account the indicative lists of pressures and impacts set out in Table 2a of the revised Annex III to the Directive and of characteristics set out in MSFD Annex IV.

According to Article 3(7), 'environmental target' means a qualitative or quantitative statement on the desired condition of the different components of, and pressures and impacts on, marine waters in respect of each marine region or subregion. When devising those targets and indicators, MS have to consider the continuing application of relevant existing environmental targets laid down at national, Community or international level in respect of the same waters, ensuring that these targets are mutually compatible and that relevant transboundary impacts and transboundary features are also taken into account, to the extent possible.

5.2 Lessons learnt from MSFD Article 10 1st implementation cycle

In 2014, the Commission conducted an assessment of MSs' reported information under Articles 8, 9 and 10 as required in Article 12 (EC, 2014) and concluded that the environmental targets established differ in their level of ambition and specificity, in some cases they are not sufficient to achieve GES, whereas the logical link between the initial assessment (the point of departure), the determination of GES (the final objective) and the targets (the effort needed to reach the objective, starting from the point of departure) has not been recognised by all MSs (**Erreur ! Source du renvoi introuvable.**).

Table 4 Level of adequacy of Environmental Targets (ET) and Associated Indicators (AI) established by MSs for Descriptor 8 at regional scale (Country/Number of ET _Number of AI) as assessed by the Commission (EC, 2014).

Regional scale	Adequate	Partially adequate	Inadequate
MEDITERRANEAN SEA		Spain/ 13_13 France/ 11_21 Slovenia/ 6_1	Greece/ 1_2 Cyprus/ 1_0 Italy/ 2_0 Croatia / 3_0
NORTH EAST ATLANTIC	Belgium / 11_11	Germany/ 5_9 Denmark /2_2 Spain /8_8 Ireland /3_2 Netherlands/ 4_3 Sweden /2_4 UK/ 3_3	France / 11_21 Portugal/ 1_3
BALTIC SEA		Finland / 7_21 Latvia/ 0_0	Esthonia/ 2_18 Lithuania/ 0_22
BLACK SEA		Romania /10 _0	Bulgaria / 2_2

In addition, the overall level of coherence within each region, for Article 10 for Descriptor 8, was deemed low for the Mediterranean and the Black Sea, medium for the Baltic Sea and high for NE Atlantic. It is obvious that MSs did not provide Environmental targets adequate to reach GES in their marine waters whereas there is a completely different approach in the application of Article 10 and understanding of what constitutes an environmental target.

5.3 Environmental Targets in the Mediterranean Region - Analysis results for Descriptor8 under Article 10

The analysis of the reported data by Mediterranean MSs for Article 10 under D8, focusing on the environmental targets and associated indicators established, was presented in detail in MEDCIS Deliverable 1.1 and showed significant differences in the way MSs implemented the article.

The number of the targets set varied considerably among the MSs (*Table **4***).

MSs' approach to Descriptor 8 was quantitative (50%) as the targets were defined against specific reference levels (WFD, EQS, EAC). However, there were MSs (25%) which set both qualitative and quantitative targets and others (25%) which only provided quantitative targets. Generally, thresholds were either absent or not established clearly throughout so it is not possible to have a quantification of the results and assess progress towards GES.

The targets established for Descriptor 8 try to address issues related to the state of the environment, the pressures and their impacts, monitoring, as well as knowledge, awareness, policy and legislation. The dominant types of targets were state (30%), pressure (21%), monitoring (17%) and knowledge (15%).

Most prominent legislation items were incorporated in the targets (e.g. WFD), whereas there was reference to the Barcelona Convention and its Protocols, OSPAR, as well as other international conventions and agreements. The established targets did not contain any time frame, therefore their achievement is not time-bound. Finally, there were no targets set at subregional or regional level in order to address transboundary issues.

Overall, the targets were not clearly related to the initial assessment. They vaguely addressed pressures and their impacts or tried to capture the state of the MSs' marine waters. They did not formulate the effort needed to lead from the current status of marine waters to GES. In some cases, MSs did not distinguish between the determination of GES and the targets, thus, they completely overlap.

Therefore, the level of coherence among Mediterranean MSs in the implementation of Article 10 for D8 is low and as presented in the previous section, no Mediterranean MS has established environmental targets considered adequate to reach GES.

Concerning the establishment of targets in the second cycle of the MSFD implementation due in 2018, most Mediterranean MSs followed the same pattern in the application of Article 10.

For Croatia, Cyprus, Greece, Italy and Malta environmental targets remain so far the same as those established in the first implementation cycle.

Slovenia has presented a document (still in public consultation, http://www.mop.gov.si/si/medijsko_sredisce/novica/8819/), in which environmental targets established in the first MSFD cycle have been revised, reduced and set for primary criteria D8C1 and D8C3 only.

France has presented a document, still in public consultation. It has abolished some of the targets established in 2012 as they were no longer deemed necessary. Certain targets remained the same either using the same definition as in 2012 or modifying the definition. Finally, some targets were reformulated with the 2012 definition modified.

Spain, has presented a document (still in public consultation /www.miteco.gob.es/es/costas/participacion-publica/000-eemm-segundo-ciclo.aspx), assessing the progress of the Environmental targets set in 2012. The assessment concludes that there are targets that achieved their goal, targets whose progress is detected and it is necessary to continue in this line, targets where advances are detected and the situation has worsened and targets that cannot be evaluated.

Overall, it can be said that there have not been major changes in the way Mediterranean MSs establish their targets.

5.4 Conclusions and actions

During the updating of Article 10, MSs will need to assess the progress towards GES with each of the targets defined in the previous implementation cycles, reflect on their appropriateness and ensure that targets allow for a consistent approach between the different provisions of the directive.

Action 7. Before 2021 (to be taken into account for next 2024 GES assessment). Harmonization of the establishment of Environmental Targets (common understanding of the role of targets in relation to GES). Criteria for the establishment of Environmental Targets.

The objectives to improve **Environmental Targets** implementation in Mediterranean region are:

8. Targets should guide towards achieving GES, not overlapping GES definition under Article 9.
9. Targets should be consistent with Article 8 - the point of departure - and Article 9 - the final objective - and set in accordance with COM Dec (EU) 2017/848 criteria, both primary and secondary.
10. Targets should be precise and tackle particular issues; reduce pressures and impacts, address human activities.
11. Targets should be able to be assessed quantitatively, thus be directly measurable integrating threshold values.
12. Targets should be set in a specific timeframe.
13. Targets should Integrate existing EU legislation and follow the RSC.
14. Targets should be set at regional/subregional level in a coordinated manner where possible or needed.

Annex 1. Monitoring of the PS and PHS identified by the WFD: Tables

Table 5. Monitoring by responding partner countries of the PS and PHS identified by the WFD (L 226/12 Official Journal of the European Union 24.8.2013 EN)

WFD Num and CAS		Name of priority substance (PS)	Croatia	France	Greece	Italy	Spain	Slovenia	WATER (AA-EQS - MAC-EQS, µg/l)	SEDIMENT	BIOTA	Monit. country
1	15972-60-8	Alachlor	water	sed;biota	water	water	water	water	0.3 - 0.7			6
2	120-12-7	Anthracene	water;sed	sed;biota	water;sed; biota	water; sed	water;sed; biota	water ;sed;biota	0.1 - 0.1	OSPAR : US ERL 85 µg/kg dw HELCOM : QS from EQS = 24 µg/kg dw	BIVALVE OSPAR : EAC = 290 µg/kg dw	6
3	1912-24-9	Atrazine	water	sed;biota	water	water	water	water	0.6 - 2			6
4	71-43-2	Benzene	water	sed;biota	water	water	water	water	8 - 50			6
5	not applicable	Brominated diphenyls (Σ congen. 28, 47, 99, 100, 153 & 154 BDE)	water;sed; biota	sed;biota	water	water	water	water ;sed;biota	0.014		FISH WFD EQS (hh) = 0.0085 µg/kg w.w.	6
6	7440-43-9	Cadmium	water;sed	sed;biota	water;sed; biota	water; sed	water;sed; biota	water ;sed;biota	0.2 - ≤0.45 (Class 1); 0.45 (Class 2); 0.6 (Class 3); 0.9 (Class 4); 1.5 (Class 5)	OSPAR : US ERL 1.2 mg/kg dw HELCOM : QS from EQS = 23 mg/Kg	OSPAR : EC = 5263 µg/kg dw *bivalve* = 1000 ww *fish liver*; 0.10 sardine; 0.05 other fish species mg/kg ww (*fillet*)	6
7	85535-84-8	Chloroalkanes, C10-13	water;sed	sed;biota	water	water	water	water ;sed	0.4 - 1.4			6
8	470-90-6	Chlorfenvinphos	water	sed;biota	water	water	water;sed; biota	water	0.1 - 0.3			6
9	2921-88-2	Chlorpyrifos (Chlorpyrifos-ethyl)	water	sed;biota	water	water	water	water	0.03 - 0.1			6
10	107-06-2	1,2-dichloroethane	water	sed;biota	water	water		water	10			5
11	75-09-2	Dichloromethane	water	sed;biota	water	water		water	20			5
12	117-81-7	Di(2-ethylhexyl) phthalate (DEHP)	water;sed	sed;biota	water	water		water ;sed	1.3			5
13	330-54-1	Diuron	water	sed;biota	water	water	water	water	0.2 - 1.8			6

WFD Num and CAS		Name of priority substance (PS)	Croatia	France	Greece	Italy	Spain	Slovenia	WATER (AA-EQS - MAC-EQS, µg/l)	SEDIMENT	BIOTA	Monit. country
14	115-29-7	Endosulfan	water	sed;biota	water	water	water	water	0.0005 - 0.004			6
15	206-44-0	Fluoranthene	water;sed; biota	sed;biota	water;sed; biota	water;	water;sed; biota	water;sed; biota	0.0063 - 0.12	OSPAR :US ERL = 600 µg/kg dw	BIVALVE OSPAR EAC = 110 µg/kg dw BIVALVE WFD EQS (hh) = 30 µg/kg ww ~ 150 µg/kg dw France/bivalve: EAC Spain, Slovenia, Croatia,Italy/bivalve: EQS Greece: no data in biota in 2018 GES	6
16	118-74-1	Hexachlorobenzene	water;sed; biota	sed;biota	water;sed; biota	water; biota	water;sed; biota	water ;sed;biota	0.05	OSPAR : ERL = 20 µg/kg dw	BIVALVE OSPAR BAC = 0.63 µg/kg dw FISH WFD EQS (hh) =30 µg/kg ww	6
17	87-68-3	Hexachlorobutadiene	water;sed; biota	sed;biota	water	water; biota	water;biot a	water ;sed;biota	0.6		FISH WFD EQS (hh) = 55 µg/kg ww	6
18	608-73-1	HCH (mixt. isomers α-HCH, β-HCH, g-HCH, and d-HCH)	water;sed	sed;biota	water;sed; biota	water	water;sed; biota	water ;sed	0.002			6
18	319-84-6	α-HCH		sed;biota	water;sed; biota	sed	water;sed; biota				BIVALVE OPSAR BAC = 0.64 µg/kg dw	4
18	319-85-7	β-HCH		sed;biota	water;sed; biota	sed	water;sed; biota					4
18	58-89-9	-HCH (lindane)	water;sed	sed;biota	water;sed; biota	sed	water;sed; biota				BIVALVE OPSAR EAC = 1.45 µg/kg dw	5
18	319-86-8	d-HCH		biota	water;sed; biota	in JRC table	water;sed; biota					4
19	34123-59-6	Isoproturon	water	sed;biota	water	water	water	water	0.3 - 1			6

WFD Num and CAS		Name of priority substance (PS)	Croatia	France	Greece	Italy	Spain	Slovenia	WATER (AA-EQS - MAC-EQS, µg/l)	SEDIMENT	BIOTA	Monit. country
20	7439-92-1	Lead	water;sed	sed;biota	water;sed; biota	water; sed	water;biota	sed;biota	1.3 - 14	OSPAR : US ERL 47 mg/kg dw HELCOM QS from EQS = 120 mg/kg	OSPAR : EC = 7895 µg/Kg dw *bivalve* = 1.5 ww *fish liver*; 0.3 mg/kg ww fish *fillet*	6
21	7439-97-6	Mercury	water;sed; biota	sed;biota	water	water; sed; biota	water;sed; biota	water;sed; biota	0.07	OSPAR : US ERL = 0.15 mg/kg dw	OSPAR : EC = 2632 µg/Kg dw *bivalve* = 500 ww *fish liver*; 1.0 *shark* and 0.5 *other fish* species mg/kg ww (*fillet*) FISH WFD EQS (sec. pois.) = 20 µg/kg ww France, Spain/fish and bivalve: EC Croatia,Italy, Slovenia/bivalve:EQS Greece: no data in biota in 2018 GES	6
22	91-20-3	Naphthalene	water	sed;biota	water;sed; biota	water; sed	water	water;sed; biota	2 -130	OSPAR : US ERL = 160 µg/kg dw	BIVALVE OPSAR EAC = 340 µg/kg dw	6
23	7440-02-0	Nickel	water	sed;biota	water;sed; biota	water; sed		water	8.6- 34	OSPAR : US ERL = 21 000 µg/kg dw		5
24	not applicable	Nonylphenols including :										2
24	104-40-5	isomers 4-nonylphenol	water	sed	water		water					4
24	84852-15-3	4-nonylphenol (branched)	water	sed;biota		water	water	water	0.3 - 2			4
25	not applicable	Octylphenols(isomer 4-(1,1',3,3'-tetra	water	sed;biota	water	water		water	0.01			5

WFD Num and CAS		Name of priority substance (PS)	Croatia	France	Greece	Italy	Spain	Slovenia	WATER (AA-EQS - MAC-EQS, µg/l)	SEDIMENT	BIOTA	Monit. country
		methylbutyl)-phenol (CAS 140-66-9)										
26	608-93-5	Pentachlorobenzene	water;sed	sed;biota	water	water		water ;sed	0.0007			5
27	87-86-5	Pentachlorophenol	water	sed;biota	water	water	water	water	0.4 - 1			6
28	not applicable	PAH Including :	biota;water	sed;biota	water;sed; biota	water	water;sed; biota	water;sed; biota				6
28	50-32-8	benzo(a)pyrene	biota;water	sed;biota	water;sed; biota	water; sed	water;sed; biota	water ;sed;biota	1.7 × 10 –4 - 0.027	OSPAR : US ERL = 430 µg/kg dw	BIVALVE OSPAR EAC = 600 µg/kg d.w. WFD BIVALVE EQS (hh) = 5 µg/kg dw France+Slovenia+Spain+Italy+Croatia/bivalve: EQS Greece: no data in biota in 2018 GES	6
28	205-99-2	benzo(b)fluoranthene	water(bz[b]fl+bz[k]fl)	sed;biota	water;sed; biota	water; sed	water;sed; biota	water;sed; biota	0.017			6
28	191-24-2	benzo(g,h,i)perylene	water(bz[g,h,i]+i[1,2,3]p)	sed;biota	water;sed; biota	water; sed	water;sed; biota	water ;sed;biota	8.2 × 10 –4	OSPAR : US ERL = 85 µg/kg dw	BIVALVE OSPAR EAC = 110 µg/kg dw	6
28	207-08-9	benzo(k)fluoranthene	water(bz[b]fl+bz[k]fl)	sed;biota	water;sed; biota	water; sed	water;sed; biota	water ;sed;biota	0.017		BIVALVE OSPAR EAC = 260 µg/kg dw	6
28	193-39-5	indeno(1,2,3-cd)pyrene	water(bz[g,h,i]+i[1,2,3]p)	sed;biota	water;sed; biota	water; sed	sed;biota	water;sed; biota		OSPAR : US ERL = 240 µg/kg dw	BIVALVE BAC = 2.4 (ATL); 2.9 (MED) µg/kg dw	6
29	122-34-9	Simazine	water	sed;biota	water	water	water	water	1 - 4			6
30	not applicable	Tributyltin compounds	water;sed	sed;biota	water	water; sed	sed	sed;biota			BIVALVE OSPAR EAC = 12 µg/kg dw	6
30	36643-28-4	tributyltin-cation				water	water;sed	water	0.0002 - 0.0015	HELCOM: QS from EQS = 1.6 µg/kg dw		3

WFD Num and CAS		Name of priority substance (PS)	Croatia	France	Greece	Italy	Spain	Slovenia	WATER (AA-EQS - MAC-EQS, µg/l)	SEDIMENT	BIOTA	Monit. country
31	12002-48-1	Trichlorobenzenes	water	biota	water	water		water	0.4			5
32	67-66-3	Trichloromethane (chloroform)	water	sed;biota	water	water		water	2.5			5
33	1582-09-8	Trifluralin	water	sed;biota	water	water		water	0.03			5
34	115-32-2	Dicofol	sed;biota	sed;biota				water;sed; biota	3.2 × 10 –5		FISH WFD EQS (sec. pois) = 33 µg/kg ww	3
35	1763-23-1	Perfluorooctane sulfonic acid and its derivatives (PFOS)	water;sed; biota	biota			water	sed;biota	1.3 × 10 –4 7.2		FISH WFD EQS (hh) = 9.1 µg/kg ww	4
36	124495-18-7	Quinoxyfen	water;sed	sed;biota			water	water;sed	0.015 - 0.54			4
37	not applicable	Dioxins and dioxin-like (Σ7 PCDD+10 PCDF+12 PCB-DL)	sed;biota	biota	water	sed	biota	water ;sed;biota			FISH WFD EC = EQS (hh) = 0.0065 µg/kg ww TEQ	6
37	32598-13-3	PCB 77		sed;biota		sed	biota					3
37	70362-50-4	PCB 81		biota		sed	biota					3
37	32598-14-4	PCB 105		sed;biota	water;sed; biota	sed	sed;biota				BIVALVE OSPAR EAC = 0.75 µg/kg dw	4
37	74472-37-0	PCB 114		biota	water	sed	biota					4
37	31508-00-6	PCB 118		sed;biota	water;sed; biota	sed	sed;biota			OSPAR EAC = 0.6 µg/kg dw	OSPAR EAC = 2.63 (dw *bivalve*) - 25 (lp, *fish*) µg/kg	4
37	65510-44-3	PCB 123		biota		sed	biota					3
37	57465-28-8	PCB 126		biota		sed	biota					3
37	38380-08-4	PCB 156		sed;biota	water;sed; biota	sed	sed;biota					4
37	69782-90-7	PCB 157		biota		sed	biota					3
37	52663-72-6	PCB 167		biota		sed	biota					3

WFD Num and CAS		Name of priority substance (PS)	Croatia	France	Greece	Italy	Spain	Slovenia	WATER (AA-EQS - MAC-EQS, µg/l)	SEDIMENT	BIOTA	Monit. country
37	32774-16-6	PCB 169		sed;biota	water;sed; biota	sed	biota					4
37	39635-31-9	PCB 189		biota		sed	biota					3
37	1746-01-6	2,3,7,8-T4CDD		biota		sed	biota					3
37	40321-76-4	1,2,3,7,8-P5CDD		biota		sed	biota					3
37	39227-28-6	1,2,3,4,7,8- H6CDD		biota		sed	biota					3
37	57653-85-7	1,2,3,6,7,8-H6CDD		biota		sed	biota					3
37	19408-74-3	1,2,3,7,8,9-H6CDD		biota			biota					2
37	35822-46-9	1,2,3,4,6,7,8-H7CDD		biota		sed	biota					3
37	3268-87-9	1,2,3,4,6,7,8,9-O8CDD		biota		sed	biota					3
37	51207-31-9	2,3,7,8-T4CDF		biota		sed	biota					3
37	57117-41-6	1,2,3,7,8-P5CDF		biota		sed	biota					3
37	57117-31-4	2,3,4,7,8-P5CDF		biota		sed	biota					3
37	70648-26-9	1,2,3,4,7,8-H6CDF		biota		sed	biota					3
37	57117-44-9	1,2,3,6,7,8-H6CDF		biota		sed	biota					3
37	72918-21-9	1,2,3,7,8,9-H6CDF		biota		sed	biota					3
37	60851-34-5	2,3,4,6,7,8-H6CDF		biota		sed	biota					3
37	67562-39-4	1,2,3,4,6,7,8-H7CDF		biota		sed	biota					3
37	55673-89-7	1,2,3,4,7,8,9-H7CDF		biota		sed	biota					3
37	39001-02-0	1,2,3,4,6,7,8,9-O8CDF		biota		sed	biota					3
38	74070-46-5	Aclonifen	water	sed;biota			water	water	0.012 -0.012			4
39	42576-02-3	Bifenox	water	sed;biota		water		water	0.0012 - 0.004			4
40	28159-98-0	Cybutryne	water	sed;biota			water	water	0.0025 - 0.016			4
41	52315-07-8	Cypermethrin (Σ isomers α-, β-, q-, z-)		sed;biota			water	water	8×10^{-6}- 6×10^{-5}			3
42	62-73-7	Dichlorvos		sed;biota				water	6×10^{-5} -7×10^{-5}			2

WFD Num and CAS		Name of priority substance (PS)	Croatia	France	Greece	Italy	Spain	Slovenia	WATER (AA-EQS - MAC-EQS, µg/l)	SEDIMENT	BIOTA	Monit. country
43	not applicable	Hexabromocyclododecanes (mixt. 1,3,5, 7,9,11-, 1,2,5,6,9,10-, α-, β- & γ-HBCDD)	sed;biota	sed;biota			water	sed;biota	0.0008 - 0.05	HELCOM : QS from EQS = 170 µg/kg dw	FISH WFD EQS (sec. pois.) = 0.167 mg/kg ww	4
44	76-44-8/ 1024-57-3	Heptachlor and heptachlor epoxide	sed;biota	sed;biota	water;sed; biota		water	water;sed; biota	1×10^{-8} - 3×10^{-5}		FISH WFD EQS (hh) = 0.0067 µg/kg ww	5
45	886-50-0	Terbutryn	water once	sed;biota			water	water	0.0065 - 0.034			4

EQS (hh): Environmental Quality Standard based on human health, monitoring in fish fillet, except for PAH (fluoranthene and B(a)P for which ones monitoring should be conducted in crustean and mollusks (whole organisms).

EQS (sec.pois.): Environmental Quality Standard based on secondary poisoning, monitoring in whole fish

EAC: Environmental Assessment criteria (mainly developed by OSPAR)

BAC: Background assessment concentration (mainly developed by OSPAR, except for indeno(1,2,3-cd)pyrene for which one MEDPOL also developed a BAC)

ERL: Effect-low range sediment concentration derived by US EPA and used by OSPAR in their assessment

Table 6. Percentage of censored data (<LQ) and limit of quantification (LQ) values for Priority Substance (PS and PHS by WFD in Directive 2013/39/EC) in water samples. These data are issued from the dataset used for 2018 GES assessment or from the current monitoring program by Croatia, Greece (2012-2015 WFD monitoring program), Slovenia (GES assessment was undergoing) and Italia (Ausili et al., 2018). Range of percentage of censored data per contaminant types (min-max) and the unit for the LQ are indicated in the black line for metals and organic compounds. Substances quantified in a majority of samples (%data<LQ < 50%) in at least one country are highlighted in yellow.

WFD Num	CAS	PS name	Croatia		Greece		Slovenia		Italy
			%data <LQ water	LQ water	%data <LQ water	LQ water	%data <LQ water	LQ water	LQ water
Metals			0%		0-16%	µg/L	82-100%	µg/L	µg/L
6	7440-43-9	Cadmium	0%		6%	0.005	82%	0.06	0.005-0.3
20	7439-92-1	Lead	0%		16%	0.09	98%	1	<0.01 - 1
21	7439-97-6	Mercury			0%	0.0004	94%	0.01	<0.005 – 0.1
23	7440-02-0	Nickel	0%		1%	0.19	100%	6	0.1 – 2.5
Organic compounds			73-100%	ng/L	58-100%	µg/L	100%	µg/L	µg/L
1	15972-60-8	Alachlor			100%	0.01			0.0005-0.1
2	120-12-7	Anthracene			100%	0.0002- 0.0035			
3	1912-24-9	Atrazine			100%	0.01			0.0005-0.4
4	71-43-2	Benzene			100%	0.25			0.008-1
5	not applicab.	PBDE Sum	73%	0.12	100%	0.00015			0.000001-0.02
7	85535-84-8	Chloroalkanes, C10-13			100%	0.4			
8	470-90-6	Chlorfenvinphos			100%	0.01			0.0003-0.01
9	2921-88-2	Chlorpyrifos (-ethyl)			100%	0.005			0.0003-0.01
10	107-06-2	1,2-dichloroethane			100%	0.25	100%	0.2	0.008-0.1
11	75-09-2	Dichloromethane			100%	0.25			0.01-1
12	117-81-7	DEHP			58%	0.02			0.005-0.43
14	115-29-7	Endosulfan	100%	0.5	100%	0.0008			0.0001-0.1
16	118-74-1	Hexachlorobenzene			100%	0.005-0.02	100%	0.002	0.0001-0.1
17	87-68-3	Hexachlorobutadiene			100%	0.1-0.25	100%	0.01	
18	319-84-6	α-HCH			100%	0.003		0.002	
18	319-85-7	β-HCH			100%	0.003		0.004	
18	58-89-9	γ-HCH			100%	0.003		0.003	
18	319-86-8	d-HCH			100%	0.003		0.004	
19	34123-59-6	Isoproturon			100%	0.01			0.0005-0.4
24	104-40-5	isomers 4-nonylphenol			100%	0.01			0.003-0.1
26	608-93-5	Pentachlorobenzene	100%	0.1	100%	0.0005-0.0015			0.0001-0.1
28	50-32-8	benzo(a)pyrene			100%	0.0002-0.0008			0.00005-0.1
28	205-99-2	benzo(b)fluoranthene			100%	0.0002-0.0008			0.00005-0.1

WFD Num	CAS	PS name	Croatia %data <LQ water	Croatia LQ water	Greece %data <LQ water	Greece LQ water	Slovenia %data <LQ water	Slovenia LQ water	Italy LQ water
28	191-24-2	benzo(g,h,i)perylene			100%	0.0002-0.0008			0.00005-0.1
28	207-08-9	benzo(k)fluoranthene			100%	0.0002-0.004			0.00005-0.1
29	122-34-9	Simazine			100%	0.01			0.0005-0.2
30	not applicab.	Tributyltin compounds	76%	0.2					0.00001-0.02
30	36643-28-4	tributyltin-cation			100%	0.001			
32	67-66-3	Trichloromethane			100%	0.25	100%	0.1	0.008-0.2
33	1582-09-8	Trifluralin			100%	0.003			0.0003-0.1
37	32598-14-4	PCB 105			100%	0.003			
37	74472-37-0	PCB 114			100%	0.002			
37	38380-08-4	PCB 156			100%	0.002			
37	32774-16-6	PCB 169			100%	0.002			
40	28159-98-0	Cybutryne	87%	0.5					
44	76-44-8/ 1024-57-3	Heptachlor and heptachlor epoxide			100%	0.003-0.01			
45	886-50-0	Terbutryn	100%	0.5					

Table 7. Percentage of censored data (<LQ) and limit of quantification (LQ) values for Priority Substance (PS and PHS by WFD in Directive 2013/39/EC) in sediment samples. These data are issued from the dataset reported for 2018 GES assessment and from the current monitoring program by Croatia, France (used for GES), Greece (research projects, MSFD monitoring program will start in 2019), Spain, Slovenia (used for GES) and Italy (ISPRA, 2012). Range of percentage of censored data per contaminant types (min-max) and the unit for the LQ are indicated in the black line for metals and organic compounds. Substances quantified in a majority of samples (%data<LQ < 50%) in at least one country are highlighted in yellow.

WFD Num	PS name	Croatia %data <LQ sed	Croatia LQ sed	France[1] %data <LQ sed	France[1] LQ sed	Greece %data <LQ sed	Greece LQ sed	Spain LQ sed	Slovenia %data<LQ sed	Slovenia LQ sed	Italy LQ sed
Metals		0%	mg/kg dw	0-10%	mg/kg dw	0%	mg/kg dw	mg/kg dw	0-33%	mg/kg dw	mg/kg dw
6	Cadmium	0%	0.01	10%	0.025		0.1	0.0002	33%	0.1	0.0003-0.6
20	Lead	0%	0.23	0%	2.5	0%	1	0.01	0%		0.003-9
21	Mercury	0%	0.02	5%	0.015			0.0002	0%		0.001-0.3
23	Nickel			0%	2.5	0%	1	0.005	0%		
Organics		0-100%	µg/kg dw	2-100%	µg/kg dw	0-100%	µg/kg dw	µg/kg dw	28-100%	µg/kg dw	µg/kg dw
38	Aclonifen				5						
1	Alachlor			100%	0.2						
3	Atrazine			100%	1						
4	Benzene			99%	30						
39	Bifenox				5						

WFD Num	PS name	Croatia		France[1]		Greece		Spain	Slovenia		Italy
		%data <LQ sed	LQ sed	%data <LQ sed	LQ sed	%data <LQ sed	LQ sed	LQ sed	%data<LQ sed	LQ sed	LQ sed
5	PBDE Sum								100%	0.1	
5	Individual BDE congeners (6)			98-100%	0.001-0.005						
8	Chlorfenvinphos			100%	1						
7	Chloroalkanes, C10-13	40%	3	98%	5				40%	0.5	
9	Chlorpyrifos			99%	1						
40	Cybutryne				1						
41	Cypermethrin (sum)				5						
10	1,2-dichloroethane			99%	30						
11	Dichloromethane			74%	30						
42	Dichlorvos				1						
34	Dicofol				2				100%	70	
37	Dioxins and DL (sum)	10%	0.00005						28%	0.0005	
37	Individual PCB-DL (12 congen.)			0-71%[2]	0.0005	0%[3]	0.01				
37	Individual PCDD/ PCDF congeners				0.05						
13	Diuron			97%	1						
14	Endosulfan			100%	alpha: 1 beta: 1				100%	10	
44	Heptachlor, heptachlor epoxide	40%	0.03		1	58%	0.01				
43	HBCDD	40%	0.1	83%	0.1						
16	Hexachlorobenzene	10%	0.03	95%	1	25%	0.01		100%	5	0.001-5
17	Hexachlorobutadiene	80%	0.02	98%	1				100%	20	
18	HCH	100%	0.03						100%	10	0.001-5
18	α-HCH				1	100%	0.01	0.03-0.05			0.001-5
18	β-HCH			100%	1	100%	0.01	0.03-0.05			0.001-5
18	γ-HCH			76%	1	42%	0.01	0.03-0.05			0.001-5
18	d-HCH				1	100%	0.01				
19	Isoproturon			98%	1						
24	4-nonylphenol			100%	5						

WFD Num	PS name	Croatia		France[1]		Greece		Spain	Slovenia		Italy
		%data <LQ sed	LQ sed	%data <LQ sed	LQ sed	%data <LQ sed	LQ sed	LQ sed	%data<LQ sed	LQ sed	LQ sed
24	4-nonylphenol (branched)			67%							
25	Octylphenols			75%	0.1						
26	Pentachlorobenzene	10%	0.02	100%	1				100%	10	
27	Pentachlorophenol			95%	0.1						
35	PFOS	20%	0.1		0.5						
12	DEHP	0%		40%	5				35%	50	
2	Anthracene	0%		25%	0.5	0%	0.5	0.02-0.12	100%	10	
28	benzo(a)pyrene	0%		6%	0.5	0%	0.5	0.02-0.12	24%	10	0.01-15
28	benzo(b)fluoranthene			2%	0.5	0%	0.5	0.02-0.12	14%	10	0.01-15
28	benzo(g,h,i)perylene			17%	0.5	0%	0.5	0.02-0.12	31%	10	0.01-15
28	benzo(k)fluoranthene			6%	0.5	0%	0.5	0.02-0.12	59%	10	0.01-15
15	Fluoranthene	0%		2%	0.5	0%	0.5	0.02-0.12	0%	10	0.01-15
28	indeno(1,2,3-cd)pyrene				0.5	0%	0.5	0.02-0.12	38%	10	0.01-15
22	Naphthalene			35%	0.5	0%	0.5		100%	50	0.01-15
36	Quinoxyfen	100%	0.03		2						
29	Simazine			100%	1						
45	Terbutryn			100%	1						
30	TBT- compounds	80%	1						60%	3	
30	TBT-cation			83%	0.2						
32	Trichloromethane			99%	30						
33	Trifluralin			100%	0.1						

[1] France reports a LQ with no "%data<LQ" for substance monitors from 2019

[2] % refers to 5 out of the 12 PCB-DL: PCB 77, PCB 105, PCB 118, PCB 156, PCB 169

[3] % refers to 4 out of the 12 PCB-DL: PCB 105, PCB 118, PCB 156, PCB 169

Table 8. Percentage of censored data (<LQ) and limit of quantification (LQ) values for Priority Substance (PS and PHS by WFD in Directive 2013/39/EC) in bivalve samples. These data are issued from the dataset reported in 2018 GES assessment and from the current monitoring program by Croatia, France (used for GES), Greece (research projects, MSFD monitoring program will start in 2019), Spain and Slovenia and Italy (ISPRA, 2017). Range of percentage of censored data per contaminant types (min-max) and the unit for the LQ are indicated in the black line for metals and organic compounds. Substances quantified in a majority of samples (%data<LQ < 50%) in at least one country are highlighted in yellow.

WFD Num	PS name	Croatia		France[1]		Greece	Spain	Slovenia		Italy
		%data< LQ bival.	LQ bival.	%data< LQ bival.	LQ bivalve	LQ bival.	LQ bival.	%data< LQ bival.	LQ bival.	LQ bivalve
	Metals	no data	no data	0-5%	mg/kg dw	no data	mg/kg ww	0%	mg/kg ww	µg/kg dw
6	Cadmium			0%	0.077		0.009	0%	0.01	
20	Lead			0%	0.062		0.020	0%	0.02	
21	Mercury			4%	0.015		0.010	0%	0.005	2-20
23	Nickel			0%	0.11					
	Organics	0	no data	0-100%	µg/kg dw	µg/kg dw	µg/kg ww	0-100%	µg/kg ww	µg/kg dw
38	Aclonifen				10					
1	Alachlor			100%	1					
3	Atrazine			100%	1					
4	Benzene			100%	30					
39	Bifenox				10					
5	PBDE (sum)							16%	0.001	$1x10^{-6}$-5
5	Individual BDE congeners (6)			0-8%	0.001					
8	Chlorfenvinphos			100%	1					
7	Chloroalkanes, C10-13			100%	10			27%	0.5	
9	Chlorpyrifos			100%	2					
40	Cybutryne				1					
41	Cypermethrin (sum)				10					
10	1,2-dichloroethane			100%	30					
11	Dichloromethane			74%	30					
42	Dichlorvos				10					
34	Dicofol				2					
37	Individual PCB-DL (12) congeners			0-12%	0.001-0.0005	0.01	0.05-0.1			
37	Individual PCDD (7)/PCDF(10) congeners			0-28%	0.001-0.002					
13	Diuron			75%	1					
14	Endosulfan			93%	α: 5; β: 5					

WFD Num	PS name	Croatia		France[1]		Greece	Spain	Slovenia		Italy
		%data< LQ bival.	LQ bival.	%data< LQ bival.	LQ bivalve	LQ bival.	LQ bival.	%data< LQ bival.	LQ bival.	LQ bivalve
44	Heptachlor, heptachlor epoxide				1	0.01				
43	α-HBCDD			0%						
16	Hexachlorobenzene			86%	1	0.01		100%	3	0.05-5
17	Hexachlorobutadiene			100%	2			100%	15	0.05-10
18	α-HCH			79%	1	0.01	0.05-0.1		3	
18	β-HCH			100%	1	0.01			3	
18	g-HCH			34%	1	0.01	0.05-0.1		3	
18	d-HCH			100%	1	0.01			3	
19	Isoproturon			100%	1					
24	4-nonylphenol (bran.)			0%	100					
25	Octylphenols			100%	5					
26	Pentachlorobenzene			100%	1			100%	3	
27	Pentachlorophenol			100%	10					
35	PFOS			32%	0.5					
12	DEHP			0%	5			9%	10	
2	Anthracene				0.2	0.5	0.04-0.1	100%	2	
28	benzo(a)pyrene	0%		30%	0.05	0.5	0.04-0.1	91%	2	0.5-5
28	benzo(b)fluoranthene			21%	0.05	0.5	0.03-0.1	91%	2	
28	benzo(g,h,i)perylene			20%	0.05	0.5	0.05-0.1	91%	2	
28	benzo(k)fluoranthene			15%	0.05	0.5	0.04-0.1	100%	2	
15	Fluoranthene	0%		2%	0.2	0.5	0.04-0.1	58%	2	0.5-9
28	indeno(1,2,3-cd)pyrene			11%	0.05	0.5	0.09-0.2	96%	2	
22	Naphthalene			0%	0.2	0.5		65%	2	
36	Quinoxyfen				2					
29	Simazine			100%	1					
45	Terbutryn				1					
30	Tributyltin comp.							0%	0.03	
30	TBT-cation			100%	0.2					
32	Trichloromethane			100%	30					
33	Trifluralin			100%	5					

[1] France reports a LQ with no "%data<LQ" for substance monitors from 2019

Table 9. Percentage of censored data (<LQ) and limit of quantification (LQ) values for Priority Substance (PS and PHS by WFD in Directive 2013/39/EC) in fish samples. These data are issued from the dataset used for 2018 GES assessment by France (from 2014-2015 mutualized sea campaign, used for GES) and from the current monitoring program by Croatia, and Spain. Range of percentage of censored data per contaminant types (min-max) and the unit for the LQ are indicated in the black line for metals and organic compounds. Substances quantified in a majority of samples (%data<LQ < 50%) in at least one country are highlighted in yellow.

WFD Num	PS name	Croatia		France		Spain
		%data <LQ fish	LQ fish	%data< LQ fish	LQ fish	LQ fish
	Metals		µg/kg dw	0-73%	µg/kg dw	µg/kg ww
6	Cadmium			73%	0.077	0.009
20	Lead			68%	0.062	0.020
21	Mercury	0%	0.007	0%	0.015	0.010
	Organics	0-100%	µg/kg dw	0-95%	µg/kg dw	µg/kg ww
34	Dicofol	100%	10			
37	Dioxins and DL (sum)	11%	0.00001			
37	Individual PCB-DL (12 congeners)			0%	0.001 (except CB105 : 0.0005)	0.05-0.1
37	Individual PCDD/PCDF congeners			0-95%	0.001-0.002	
44	Heptachlor, heptachlor epoxide	11%	0.05			
43	HBCDD (sum)	56%	0.1			
16	Hexachlorobenzene	0%				0.05
17	Hexachlorobutadiene	100%	0.1			
18	α-HCH					0.05-0.1
18	g-HCH					0.05-0.1
35	PFOS	56%	0.1			

Annex 2. PS and PHS identified by the WFD: percentages of censored (figures)

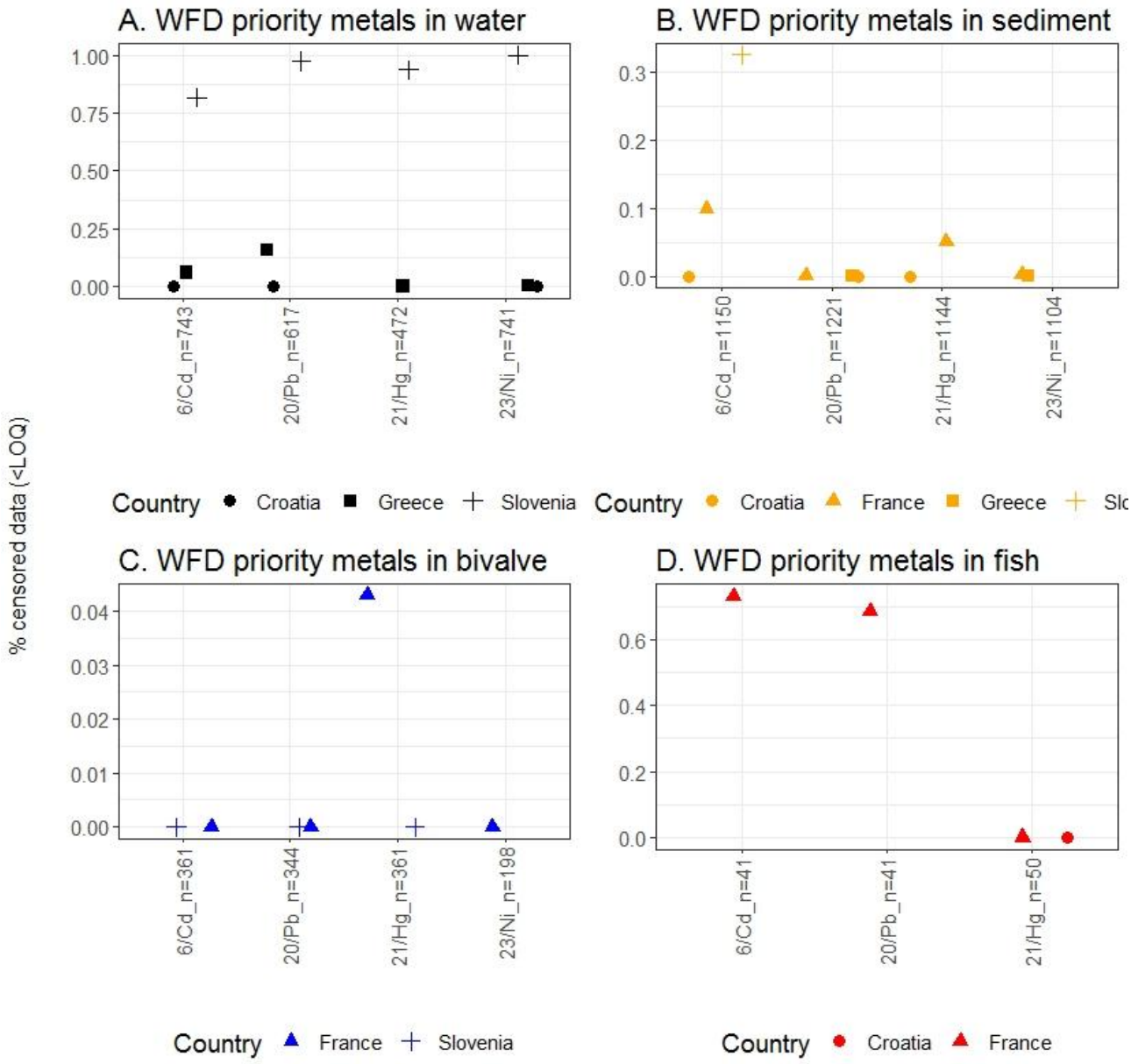
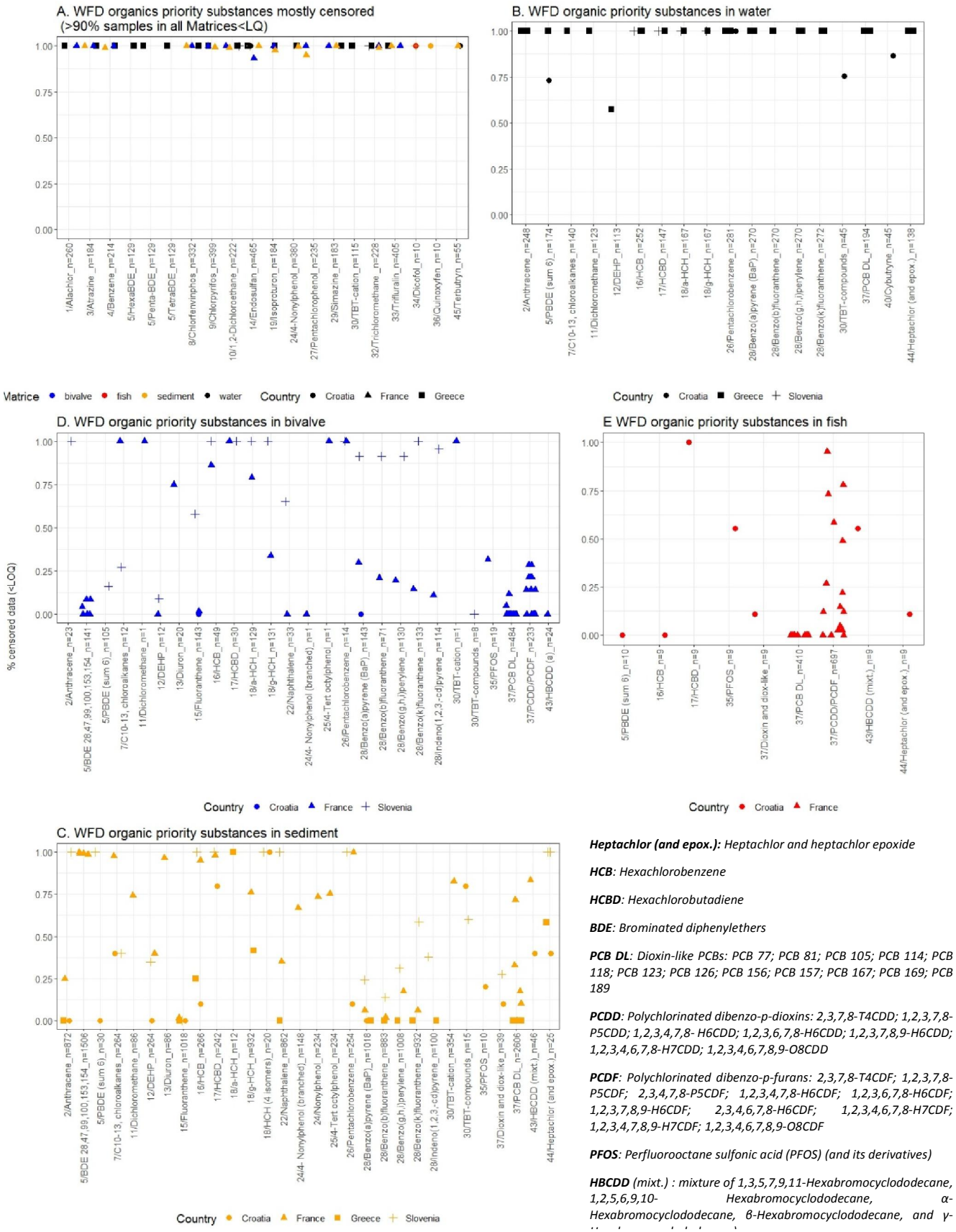


Figure 4. Percentage of censored data (<LQ) as reported by responding partner countries for WFD PS metals in water, sediment, bivalve and fish samples. Abscise legend corresponds to the WFD identification number / substance name_sum of total number samples reported by each country.



Heptachlor (and epox.): *Heptachlor and heptachlor epoxide*

HCB*: Hexachlorobenzene*

HCBD*: Hexachlorobutadiene*

BDE*: Brominated diphenylethers*

PCB DL*: Dioxin-like PCBs: PCB 77; PCB 81; PCB 105; PCB 114; PCB 118; PCB 123; PCB 126; PCB 156; PCB 157; PCB 167; PCB 169; PCB 189*

PCDD*: Polychlorinated dibenzo-p-dioxins: 2,3,7,8-T4CDD; 1,2,3,7,8-P5CDD; 1,2,3,4,7,8- H6CDD; 1,2,3,6,7,8-H6CDD; 1,2,3,7,8,9-H6CDD; 1,2,3,4,6,7,8-H7CDD; 1,2,3,4,6,7,8,9-O8CDD*

PCDF*: Polychlorinated dibenzo-p-furans: 2,3,7,8-T4CDF; 1,2,3,7,8-P5CDF; 2,3,4,7,8-P5CDF; 1,2,3,4,7,8-H6CDF; 1,2,3,6,7,8-H6CDF; 1,2,3,7,8,9-H6CDF; 2,3,4,6,7,8-H6CDF; 1,2,3,4,6,7,8-H7CDF; 1,2,3,4,7,8,9-H7CDF; 1,2,3,4,6,7,8,9-O8CDF*

PFOS*: Perfluorooctane sulfonic acid (PFOS) (and its derivatives)*

HBCDD *(mixt.) : mixture of 1,3,5,7,9,11-Hexabromocyclododecane, 1,2,5,6,9,10- Hexabromocyclododecane, α-Hexabromocyclododecane, β-Hexabromocyclododecane, and γ-*

Figure 5. Percentage of censored data (<LQ) as reported by responding partner countries for WFD organic PS in water, sediment, bivalve and fish samples. Abscise legend corresponds to the WFD identification number / substance name_sum of total number samples reported by each country (and for all matrices in A. Non WFD organics substances mostly censored)).

Annex 3. PS and PHS identified by the WFD: limit of quantification (figures)

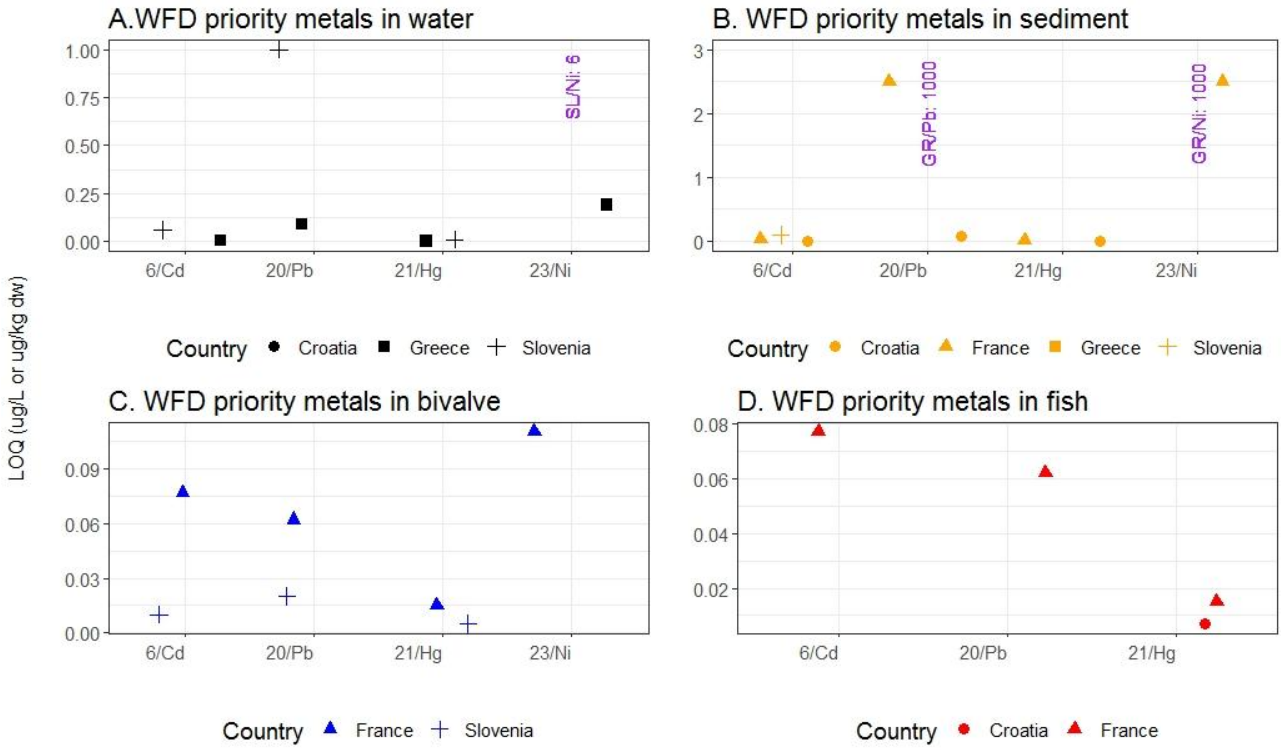
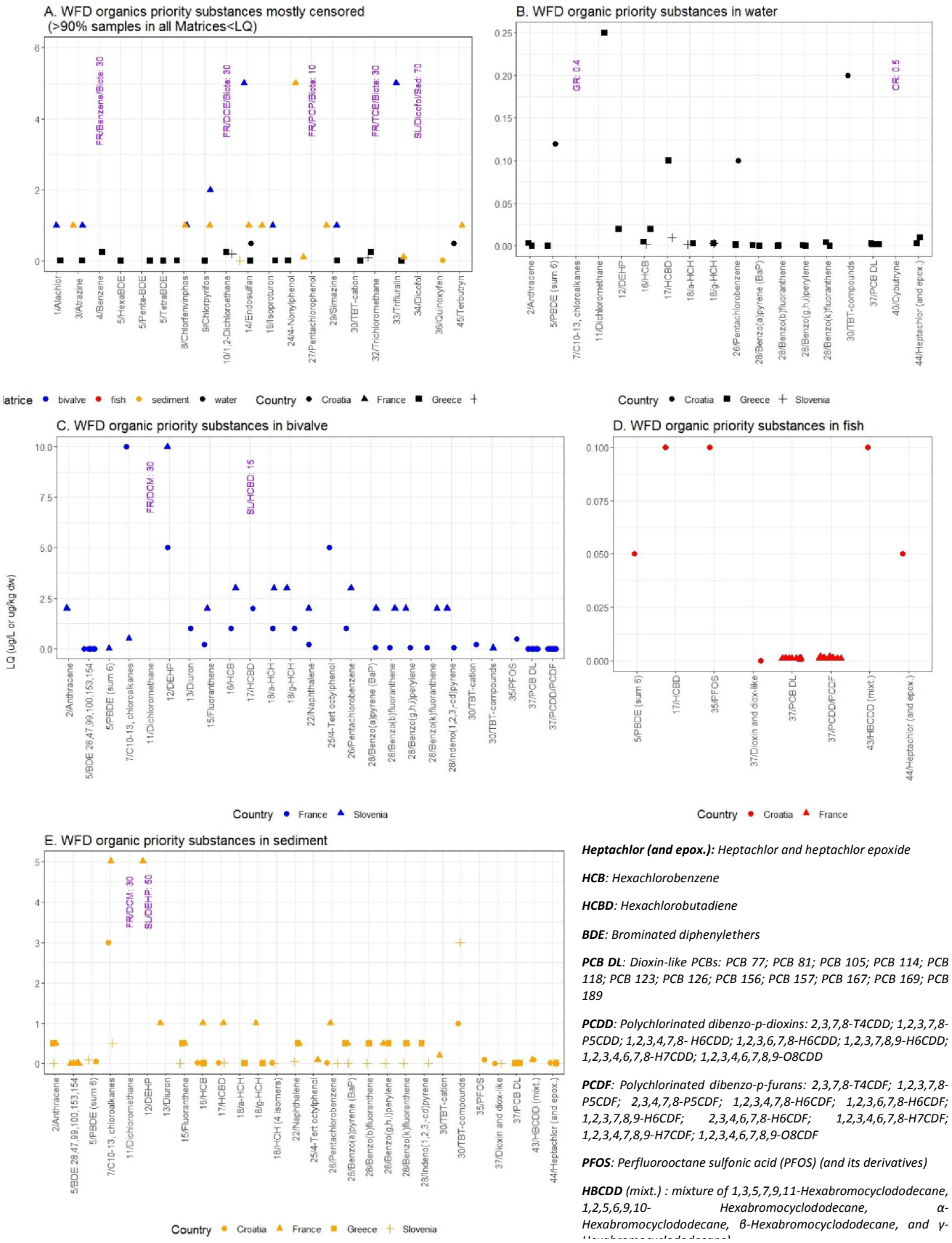


Figure 6. Limit of quantification (LOQ) for WFD PS metals in water, sediment, bivalve and fish samples reported by Croatia, France, Greece and Slovenia (LOQ reported by Spain and Italy are indicated in Table 6, Table 7, Table 8, Table 9, they have been reported too late to be incorporated in the Figures). Abscise legend corresponds to the WFD identification number / substance name.



Heptachlor (and epox.): *Heptachlor and heptachlor epoxide*

HCB*: Hexachlorobenzene*

HCBD*: Hexachlorobutadiene*

BDE*: Brominated diphenylethers*

PCB DL*: Dioxin-like PCBs: PCB 77; PCB 81; PCB 105; PCB 114; PCB 118; PCB 123; PCB 126; PCB 156; PCB 157; PCB 167; PCB 169; PCB 189*

PCDD*: Polychlorinated dibenzo-p-dioxins: 2,3,7,8-T4CDD; 1,2,3,7,8-P5CDD; 1,2,3,4,7,8- H6CDD; 1,2,3,6,7,8-H6CDD; 1,2,3,7,8,9-H6CDD; 1,2,3,4,6,7,8-H7CDD; 1,2,3,4,6,7,8,9-O8CDD*

PCDF*: Polychlorinated dibenzo-p-furans: 2,3,7,8-T4CDF; 1,2,3,7,8-P5CDF; 2,3,4,7,8-P5CDF; 1,2,3,4,7,8-H6CDF; 1,2,3,6,7,8-H6CDF; 1,2,3,7,8,9-H6CDF; 2,3,4,6,7,8-H6CDF; 1,2,3,4,6,7,8-H7CDF; 1,2,3,4,7,8,9-H7CDF; 1,2,3,4,6,7,8,9-O8CDF*

PFOS*: Perfluorooctane sulfonic acid (PFOS) (and its derivatives)*

HBCDD *(mixt.) : mixture of 1,3,5,7,9,11-Hexabromocyclododecane, 1,2,5,6,9,10- Hexabromocyclododecane, α-Hexabromocyclododecane, β-Hexabromocyclododecane, and γ-*

Figure 7. Limit of quantification (LOQ) for WFD PS organic substances in water, sediment, bivalve and fish samples reported by Croatia, France, Greece and Slovenia (LOQ reported by Spain and Italy are indicated in Table 6, Table 7, Table 8, Table 9, they have been reported too late to be incorporated in the Figures). Abscise legend corresponds to the WFD identification number / substance name.

Annex 4. Monitoring of the Medpol LBS (not identified as priority by WFD) by responding partner countries: Tables

Table 10. Monitoring of LBS by responding partner countries (apart from the WFD substances)

CAS number	Substance name	Croatia	France	Greece	Italy	Spain	Slovenia	WATER	SEDIMENT µg/kg dw	BIVALVE µg/kg dw	Monit. country
Metals											
7440-47-3	Chromium		sed; biota	water; sed; biota	sed		water		ERL = 81 000		4
7440-50-8	Copper	water	sed; biota	water; sed; biota			water		ERL = 34 000	BAC = 6000	4
7440-66-6	Zinc	water	sed; biota	water; sed; biota			water		ERL = 150 000		4
Organics											
Not applicable	DDT total (Σ p,p′-DDT, o,p′-DDT, p,p′-DDE, p,p‘-DDD)		biota	water;sed; biota	water EQS; biota EQS		water		ERL = 1.6		4
72-54-8	p,p′-DDD	water	sed; biota	water; sed; biota	water; sed; biota	sed; biota			ERL = 2		5
72-55-9	p,p′-DDE		sed;biota	water;sed; biota	sed	sed;biota			ERL = 2.2	EAC = 500	4
309-00-2	Aldrin		sed; biota	sed; biota	water[2]	sed; biota					4
60-57-1	Dieldrin		sed; biota	sed; biota	water[2]	sed; biota			ERL = 0.02	EAC = 5	4
72-20-8	Endrin		sed; biota	sed; biota	water[2]	sed; biota					4
2385-85-5	Mirex										0
57-74-9	Chlordane, pur										0
85535-85-9	C14-17, chloroalkanes										0
108-90-7	Chlorobenzene										0

1 : Slovenian Level. The thresholds for Cu and Zn have been derived according to the national guidelines and directive for quality of waters which were adapted from the Directive 2006/113/EC and Directive 2006/44/EC. The criteria for Cu and Zn are as follows: Copper: Average annual concentration: 5000 ng/L, Zinc: Average annual concentration: 40000 ng/L.

2 : as a sum of cyclodiene pesticides

Annex 5. Non WFD substances: Percentage of censored data (figures)

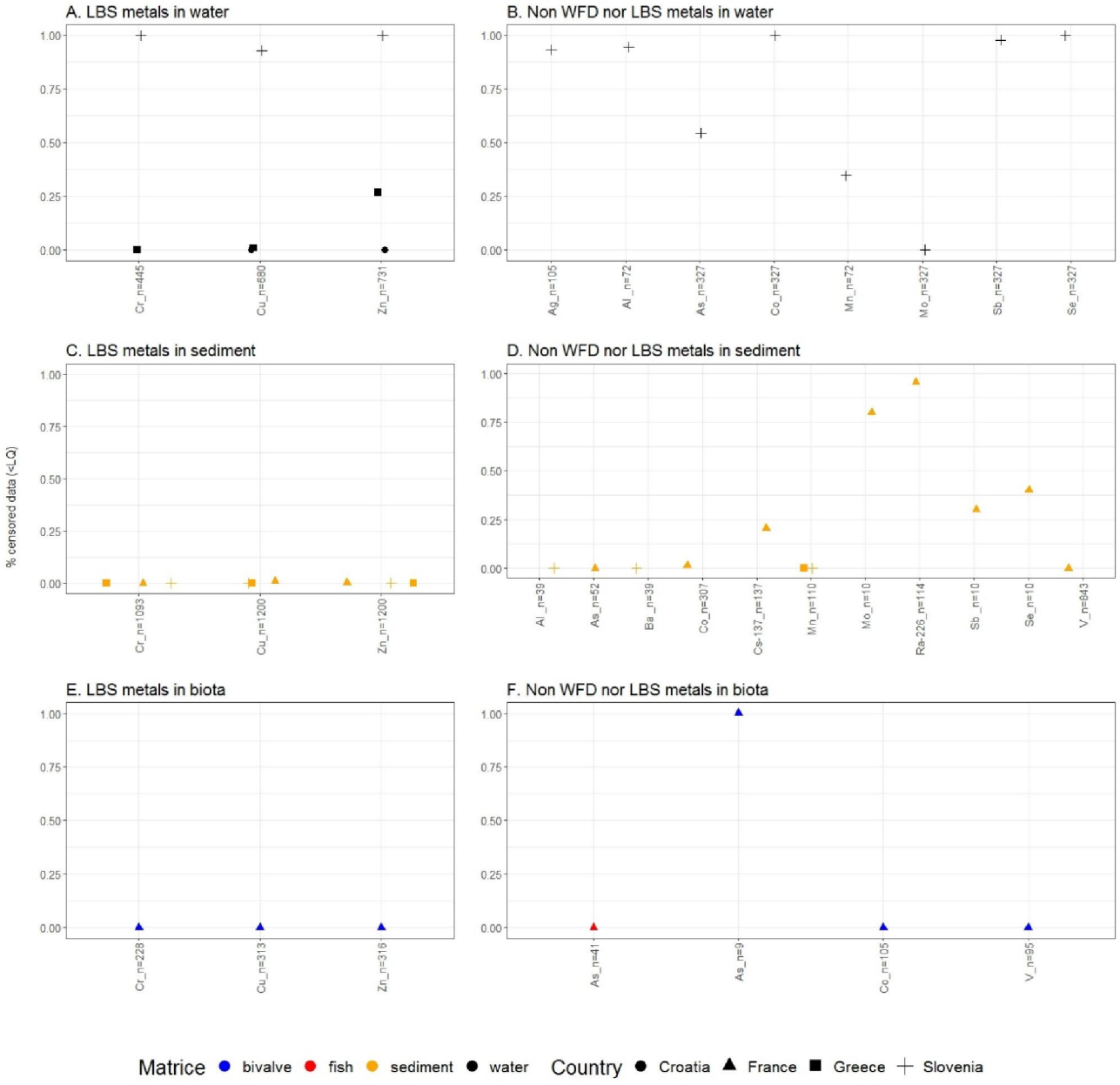
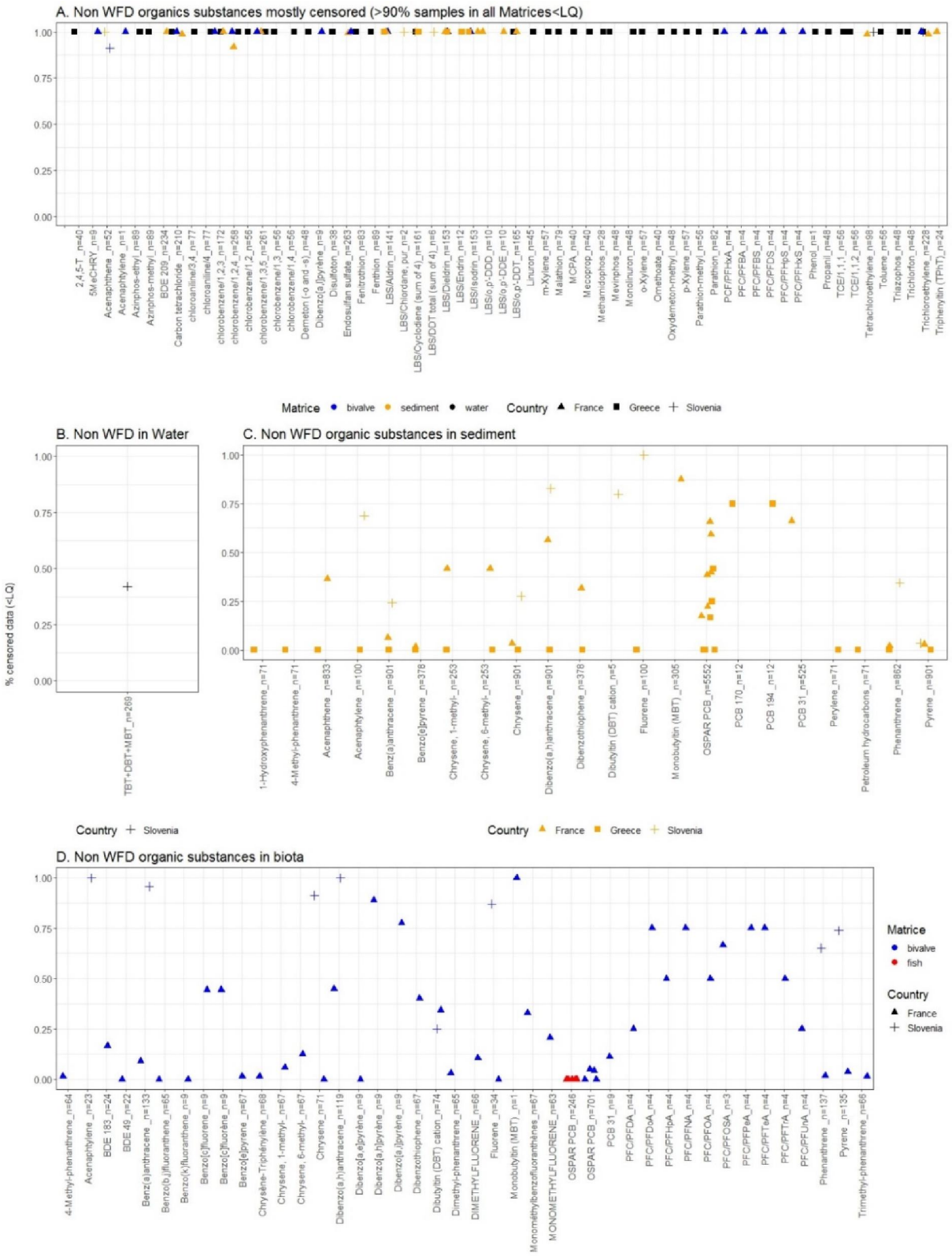


Figure 8. Percentage of censored data (<LQ) as reported by responding partner countries for non WFD metals in water, sediment, bivalve and biota samples. Abscise legend corresponds to the substance name_sum of total number samples reported by each country.



PFC: Perfluorinated compounds, a family composed by perfluoroalkyl carboxylic acids (PFCA: PFDA, PFDoA, PFHpA, PFNA, PFOA, PFPeA, PFTeA, PFTrA, PFUnA), perfluoroalkane sulfonates (PFSA: PFOSA, this is the same family as PFOS), perfluorobutanesulfonate (PFBS) and perfluorobutanoic acid (PFBA), PFDS, PFHpS, PFHxA, PFHxS); **BDE**: Brominated diphenylethers; **OSPAR PCB**: PCB identified as common indicator by OSPAR, i.e. PCB 28, 52, 101, 138, 153 and 180. Figures does not include the CB118, which is already displayed in the WFD graphs as dioxin-like PCB; **LBS**: substances identified as common indicator by the Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources

Figure 9. Percentage of censored data (<LQ) as reported by responding partner countries for non WFD organic substances in water, sediment, bivalve and fish samples. Abscise legend corresponds to the substance name_sum of total number samples reported by each country (and for all matrices in A. Non WFD organics substances mostly censored).

Annex 6. Non WFD substances: limit of quantification (figures)

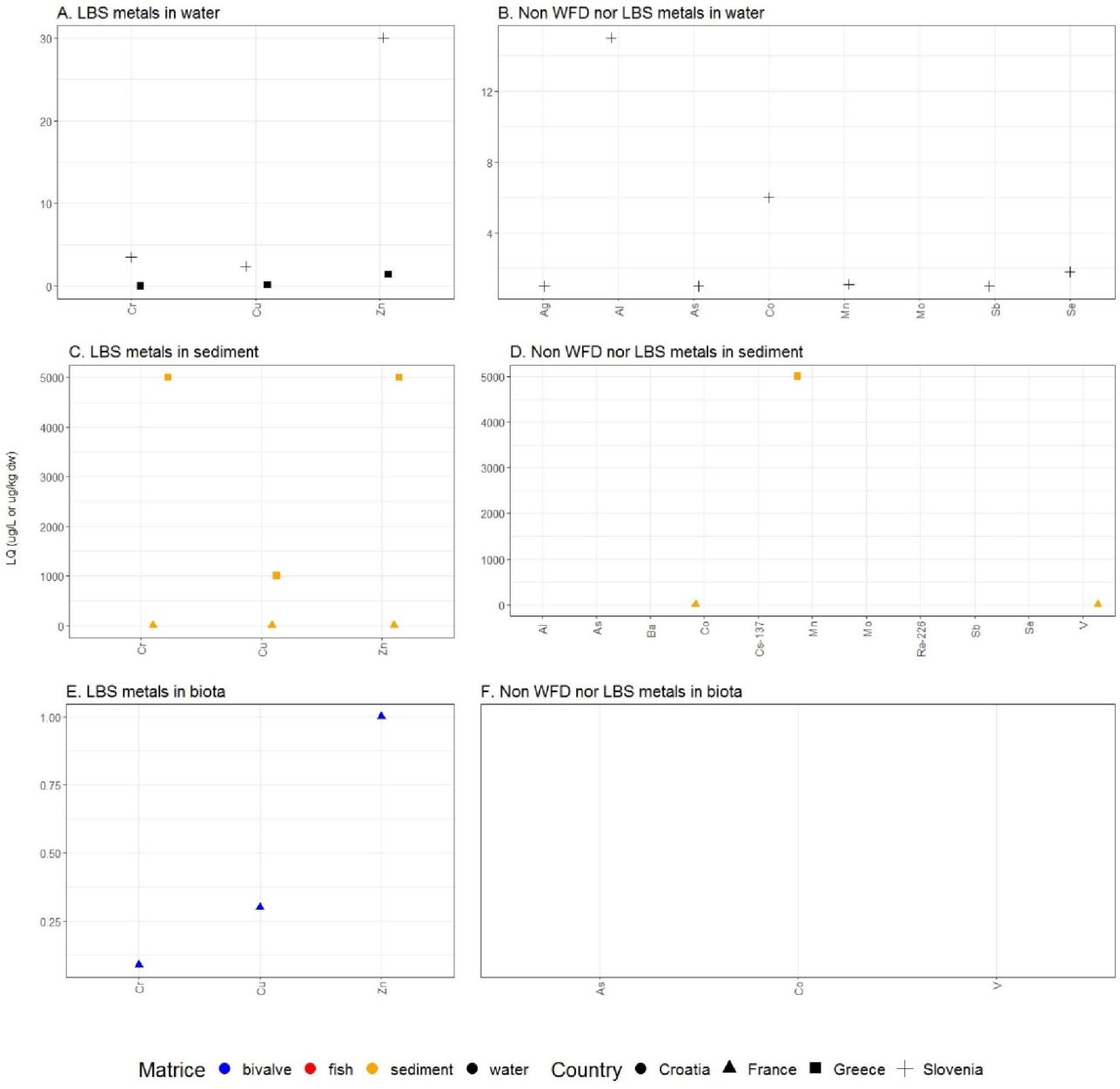
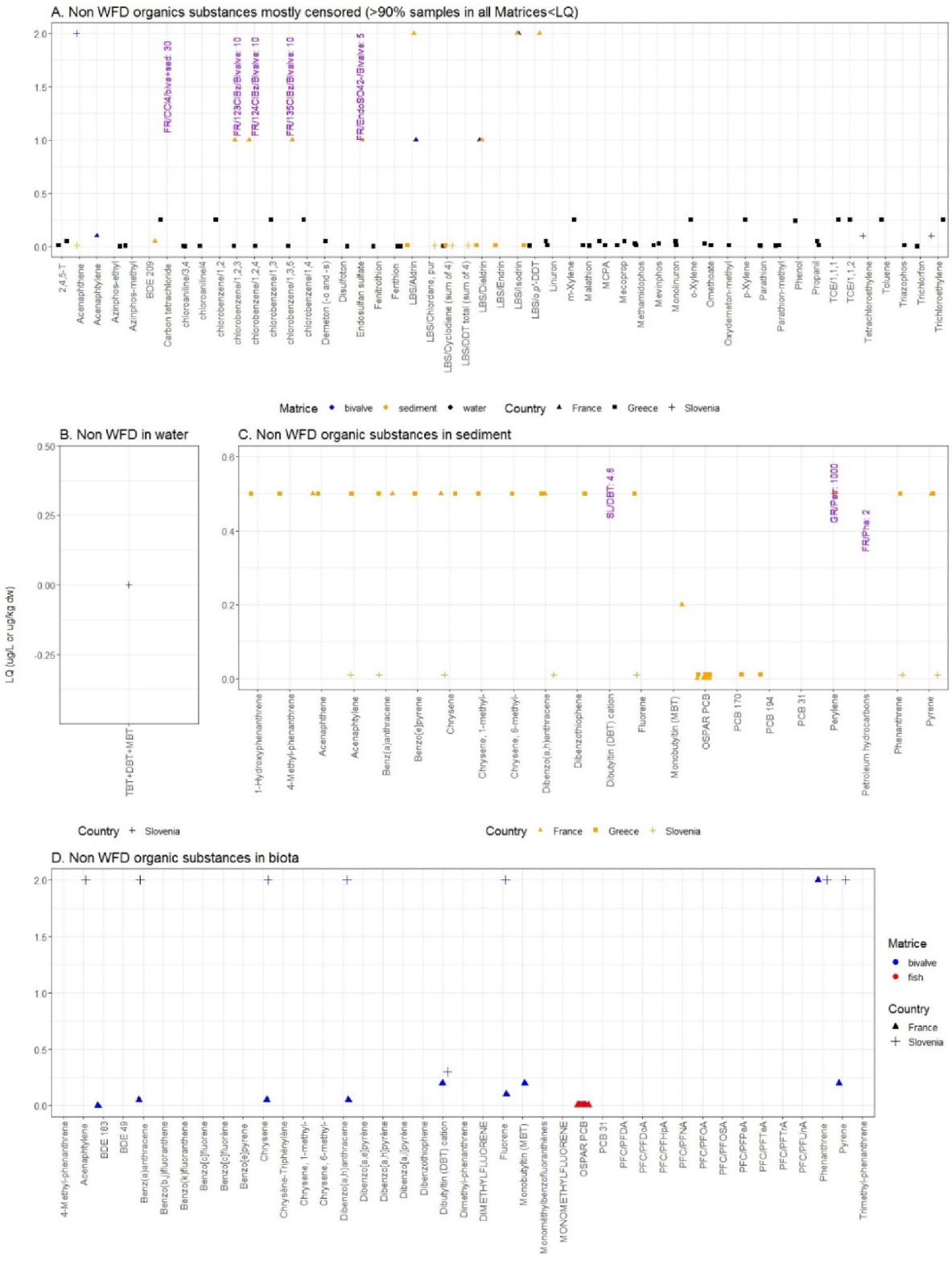


Figure 10. Limit of quantification (LOQ) for non WFD PS metals in water, sediment, bivalve and fish samples reported by Croatia, France, Greece and Slovenia (LOQ reported by Spain and Italy are indicated in Table 6, Table 7, Table 8, Table 9, they have been reported too late to be incorporated in the Figures). Abscise legend corresponds to the WFD identification number / substance name.



PFC: Perfluorinated compounds, a family composed by perfluoroalkyl carboxylic acids (PFCA: PFDA, PFDoA, PFHpA, PFNA, PFOA, PFPeA, PFTeA, PFTrA, PFUnA), perfluoroalkane sulfonates (PFSAs) (PFSA: PFOSA, this is the same family as PFOS), perfluorobutanesulfonate (PFBS) and perfluorobutanoic acid (PFBA), PFDS, PFHpS, PFHxA, PFHxS); **BDE**: Brominated diphenylethers; **OSPAR PCB**: PCB identified as common indicator by OSPAR, i.e. PCB 28, 52, 101, 138, 153 and 180. Figures does not include the CB118, which is already displayed in the WFD graphs as dioxin-like PCB; **LBS**: substances identified as common indicator by the Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources

Figure 11. Limit of quantification (LOQ) for non WFD PS organic substances in water, sediment, bivalve and fish samples reported by Croatia, France, Greece and Slovenia (LOQ reported by Spain and Italy are indicated in Table 6, Table 7, Table 8, Table 9, they have been reported too late to be incorporated in the Figures). Abscise legend corresponds to the WFD identification number / substance name.

Annex 7. Monitoring of biological effects (biomarkers)

Table 11. Monitoring of biological effects induced by chemical contamination (Croatia: biological effects were monitored in the scope of MSFD monitoring in Croatia – in 2016 and 2017. Due to funding restraints the monitoring was not carried out in 2018. France: biological effect monitoring are performed by IFREMER since 2016; data will be used for 2024 GES assessment. For 2018 GES, research projects outcomes on biological effects were used. Greece: biological effects monitoring will start in 2022 and will be used for the 2024 GES assessment. Greek reference sites will be chosen in areas away from known pollution sources and considering MYTIMED project results. Italy: biological effect monitoring are performed by CNR since 2016; data will be included in 2024 GES. Spain: biological effect monitoring are performed by IEO since 2007; data will be used for 2024 GES assessment. Slovenia: no biological effect monitoring.

Biological effects indicators	Abbreviation	Croatia	France	Italy	Greece	Spain	Slovenia	Biological effects monitored in RSCs			Criteria to select biological responses						
								Barcelona[1]	OSPAR	Recommended by ICES[6]	Sensitivity: "early warning"	Dose–resp relationship		Ecological relevance	Relevance confounding factors	Quality assurance
General stress / condition factors																	
Lysosomal membrane stability in fish	LMS-f		EAC					X[2]	X[5]	X[8]	X		X		X	X	
Lysosomal membrane stability in mussels	LMS-m	Ref sites	EAC	X		Spain EAC/BAC		X[2]	X[5]	X[7]	X		X		X	X	
External and hepatic pathology in fish			EAC						X[5]	X[7]			X	X	X	X	
Hepato- and gonado- somatic ratios in fish	HSR and GSR		X						X[5]	X[7]							
Scope for Growth in mussels	SFG					Spain EAC/BAC				X[8]			X	X	X	X	
Stress on stress in mussels	SOS	Ref sites	EAC		UNEP/MAP ; Ref sites	EAC/BAC		X[3]		X[7]			X		X		
Sea-urchin larval growth	LG					EAC/BAC			X[5]	X[7]	X	X	X	X	X	X	
Biomarkers of exposure to specific pollutants																	
Ethoxyresorufin-O-deethylase activity in fish	EROD		BAC	X		Spain BAC			X[5]	X[7]	X	(X)	X		X	X	
PAHs metabolites in fish bile	BM		EAC	X		X			X[5]	X[7]	X	X	X		X	X	

Biological effects indicators	Abbreviation	Croatia	France	Italy	Greece	Spain	[illegible]	Biological effects monitored in RSCs			Criteria to select biological responses					
								Barcelona[1]	OSPAR	Recommended by ICES[6]	Sensitivity: "early warning"	Dose–resp relationship	[illegible]	Ecological relevance	Relevance confounding factors	Quality assurance
Neutral lipids - effect of organic pollutants		Ref sites														
Metallothioneins in fish	MTs-f								X[5]		X					X
Metallothioneins concentration in mussels	MTs-m			X	UNEP/MAP ; Ref sites	Spain BAC			X[5]	X[8]	X	X				X
Neurotoxicity																
Acetylcholinesterase activity in fish	AChE-f		EAC	X		X		X[2]		X[7]	X	(X)	X	X	*X*	
Acetylcholinesterase activity in mussels	AChE-m	Ref sites	EAC	X	UNEP/MAP ; Ref sites	Spain EAC/BAC		X[2]		X[7]	X	(X)	X	X	*X*	
Oxidative Stress																
Glutathione S Transferases activity in mussels	GST				Ref sites						X					
Catalase activity in mussels	CAT		X		Ref sites				X[5]		X					
Lipid peroxidation in mussels	LPO				Ref sites						X					
Endocrine/reproductive disruption																
Vitellogenine in fish	VTG		BAC						X[5]	X[7]				X		
Intersex in fish									X[5]	X[7]				X	*X*	
Imposex in gastropods	IMP		EAC (= EcoQO)			EcoQO			X[4]	X[7]	X			X		
Genotoxicity																
Micronuclei frequency in fish	MN-f		BAC	X				X[2]		X[8]	X		X	X	*X*	X
Micronuclei frequency in mussels	MN-m		BAC	X		Spain BAC		X[2]		X[7]	X		X	X	*X*	X
Comet in fish			BAC							X[7]	X					

Biological effects indicators	Abbreviation	Croatia	France	Italy	Greece	Spain	[illegible]	Biological effects monitored in RSCs			Criteria to select biological responses					
								Barcelona[1]	OSPAR	Recommended by ICES[6]	Sensitivity: "early warning"	Dose–resp relationship	[illegible]	Ecological relevance	Relevance confounding factors	Quality assurance
Comet in mussels			BAC							X[8]	X					
DNA adduct in fish			EAC						X[5]	X[8]	X		X			
DNA integrity by Fast micromethod (Batel et al., 1999) in mussels		Ref sites									X					

[1]UNEP MAP (2017). UNEP(DEPI)/MED WG.444/8. [2]Primary biomarkers. [3]Research phase biomarkers. [4]CEMP mandatory. [5]JAMP Guidelines for General Biological Effects Monitoring. JAMP Guidelines for Contaminant-Specific Biological Effects. [6]Davies and Vethaak (2012). [7]Core methods. [8]Additional methods.

References

AMAP, 2004. AMAP Assessment (2002) Persistent Organic Pollutants in the Arctic. Arctic Monitoring and Assessment Programme (AMAP), Oslo, Norway. xvi +310 pp.

Ausili A., Berducci M.T., Maggi C., Sesta G., 2018. Analysis of priority substances in marine matrices. Part I. Review of existing official methodologies and their applicability to marine matrices. ISPRA – Manuals and guidelines 175/2018. Rome, 2018. In Italian. Available at: https://www.snpambiente.it/wp-content/uploads/2018/12/linee_guida_snpa_9_2018.pdf

Bakke, T., Källqvist, T., Ruus, A., Breedveld, G.D., Hylland, K. (2010) Development of sediment quality criteria in Norway. J. Soils Sediments 10: 172-178.

Baudrier Jerome, Lefebvre Alain, Galgani Francois, Saraux Claire, Doray Mathieu (2018) Optimising French fisheries surveys for marine strategy framework directive integrated ecosystem monitoring . Marine Policy, 94, 10-19

Bellas J, Nieto O, Beiras R. (2011) Integrative assessment of coastal pollution: development and evaluation of sediment quality criteria from chemical contamination and ecotoxicological data. Continental Shelf Research, 31: 448-456

Benskin, J. P.; Muir, D. C.; Scott, B. F.; Spencer, C.; De Silva, A. O.; Kylin, H.; Martin, J. W.; Morris, A.; Lohmann, R.; Tomy, G.; Rosenberg, B.; Taniyasu, S.; Yamashita, N. (2012) Perfluoroalkyl acids in the Atlantic and Canadian Arctic Oceans. Environ. Sci. Technol. 46 (11), 5815−23.

Carubelli G., Fanelli R., Mariani G., Nichetti S., Crosa G., Calamari D., Fattore E. (2007) *Chemosphere* 68, 1630-1635.

Committee on Oil in the Sea (2003) Inputs, Fates, and Effects. National Research Council, ISBN 0-309-08438-5; DOI 10.17226/10388.

Davies, I. M. and Vethaak, A. D. (2012) Integrated marine environmental monitoring of chemicals and their effects. ICES Cooperative Research Report No. 315. 277 pp.

Dulio and von der Ohe, NORMAN Priorisation framework for emerging substances, Published by : NORMAN Association. ISBN : 978-2-9545254-0-2, 2013

EC (2014) Report from The Commission to the Council and the European Parliament, The First Phase of Implementation of the Marine Strategy Framework Directive' (COM(2014) 97 FINAL)

EEA (2011) *Hazardous substances in Europe's fresh and marine waters — An overview.* EEA Technical report. European Environment Agency, Copenhagen http://www.eea.europa.eu/publications/hazardous-substances-in-europes-fresh /at_download/file

EEA (2015a) *The European environment — State and outlook 2015: Synthesis report.* European Environment Agency, Copenhagen http://www.eea. europa.eu/soer-2015/synthesis/report/action-download-pdf

EEA (2015b) *State of Europe's seas.* European Environment Agency, Copenhagen http://www.actu-environnement.com/media/pdf/state-of-seas.pdf

Gonzalez-Gaya, B.; Dachs, J.; Roscales, J. L.; Caballero, G.; Jimenez, B. (2014) Perfluoroalkylated Substances In The Global Tropical And Subtropical Surface Oceans. Environ. Sci. Technol. 48 (22), 13076−13084.

Heimbürger, L.E., Migon, C., Cossa, D. (2011) Impact of atmospheric deposition of anthro-pogenic and natural trace metals on Northwestern Mediterranean surface waters: A box model assessment. Environmental Pollution, 159 (6), 1629-1634.

Heimbürger, L.E., Migon, C., Dufour, A., Chiffoleau, J.F., Cossa, D., 2010. Trace metal con-centrations in the North-western Mediterranean atmospheric aerosol between 1986 and 2008: Seasonal patterns and decadal trends. Science of The Total Environment, 408 (13), 2629-2638.

HELCOM (2010) *Ecosystem health of the Baltic sea 2003-2007: HELCOM initialholistic assessment.* Baltic Sea Environment Proceedings. Helsinki Commission, Helsinki http://www.helcom.fi/Lists/Publications/BSEP122.pdf

Houde Magali, Amila O. De Silva, Derek C. G. Muir, and Robert J. Letcher (2011) Monitoring of Perfluorinated Compounds in Aquatic Biota: An Updated Review PFCs in Aquatic Biota. Environ. Sci. Technol. 2011, 45, 7962–7973; dx.doi.org/10.1021/es104326w.

ISPRA, 2017. Guidelines on the assessment of priority substances in marine matrices. Review of existing analytical methodologies and their applicability to marine matrices. (In Italian)

ISPRA, 2018, Guidelines on the analysis of priority substances in marine environmental matrices – assessment of current official analytical methods and applicability to marine matrices.

Johansson Inger, Moisan Karine, Guiot Nadege, Munschy Catherine, Tronczynski Jacek (2006) Polybrominated diphenyl ethers (PBDEs) in mussels from selected French coastal sites: 1981-2003. Chemosphere, 64(2), 296-305 . http://doi.org/10.1016/j.chemosphere.2005.12.014

Kolpin, D., Furlong, E., Meyer, M., Thurman, E.M., Zaugg, S., Barber, L. and Buxton, H. (2002) 'Pharmaceuticals, hormones, and other organic wastewater contaminants in US streams, 1999-2000: A national reconnaissance'. *Environmental Science & Technology* 36(6), 1202-11 http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1064&context=usgsstaffpub

Law Robin J., Allchin Colin R, De Boer Jacob, Covaci Adrian, Herzke Dorte, Lepom Peter, Morris Steven, Tronczynski Jacek, De Wit Cynthia A (2006) Levels and trends of brominated flame retardants in the European environment. Chemosphere, 64(2), 187-208 http://doi.org/10.1016/j.chemosphere.2005.12.007.

Liubartseva S., De Dominicis, M., Oddo, P., Coppini, G., Pinardi, N., Greggio, N. (2015) Oil spill hazard from dispersal of oil along shipping lanes in the Southern Adriatic and Northern Ionian Seas, Marine Pollution Bulletin 90, 259–272

MARPOL (73/78). International Convention for the Prevention of Pollution from ships. www.imo.org

Martí-Cid R., Bocio A., Llobet J. M., Domingo J. L. (2007) Food and Chemical Toxicology: *An International Journal Published for the British Industrial Biological Research Association* 45(10), 1 968–1 974.

Munschy Catherine, Olivier Nathalie, Veyrand B., Marchand P. (2015) Occurrence of legacy and emerging halogenated organic contaminants in marine shellfish along French coasts . Chemosphere, 118, 329-335

Newman, M. C., Clements, W. H. (2007) Ecotoxicology: a comprehensive treatment. CRC Press.

OSPAR (2007) JAMP Guidelines for General Biological Effects Monitoring. OSPAR Agreement 1997-7.

OSPAR (2008) JAMP Guidelines for Contaminant-Specific Biological Effects. OSPAR Agreement 2008-09.

OSPAR (2010) *Quality status report 2010.* OSPAR Commission, London http://qsr2010.ospar.org/en/media/chapter_pdf/QSR_complete_EN.pdf

OSPAR (2016) OSPAR Coordinated Environmental Monitoring Program (CEMP). OSPAR Agreement 2016-01.

OSPAR (2017) Biodiversity Indicators. Candidate Indicator Typical Species Composition (BH1). Generic guidelines for Coordinated Environmental. Monitoring Program (CEMP).

PERSEUS (2013) Baseline analysis of pressures, processes and impacts on Mediterranean and Black Sea ecosystems, Policy-oriented marine Environmental Research in the South-ern EUropean Seas, Deliverable 1.3. www.perseus-net.eu

Peterson Ch. H., Rice S. D. Short J. W., Esler D., Bodkin J. L., Ballachey B. E., Irons D.B. (2003) Long-Term Ecosystem Response to the Exxon Valdez Oil Spill. Science V. 302, 2082-2086.

Pruss-Ustun, A., Wolf, J., Corvalan C., Bos, R. and M., N. (2016) *Preventing disease through healthy environments: A global assessment of the burden of disease from environmental risks.* World Health Organization, Geneva http:// www.who.int/quantifying_ehimpacts/publications/preventing-disease/en/.

REMPEC (2002). Protecting the Mediterranean against Maritime Accidents and Illegal Discharges from Ships; IMO/UNEP/MAP report p.38.

Rowe, C.L. (2008) '"The calamity of so long life": life histories, contaminants,and potential emerging threats to long-lived vertebrates'. *BioScience* 58(7),623-631 http://bioscience.oxfordjournals.org/content/58/7/623.full.pdf+html

Schwarzenbach, R.P., Escher, B.I., Fenner, K., Hofstetter, T.B., Johnson, C.A. and von Gunten, B.W. (2006) 'The challenge of micropollutants in aquatic systems'. *Science* 313, 1072-1077. doi: 10.1126/science.1127291 https://www. sciencemag.org/content/313/5790/1072.full.

Theodosi, C., Markaki, Z., Tselepides, A., Mihalopoulos, N. (2010) The significance of at-mospheric inputs of soluble and particulate major and trace metals to the eastern Medi-terranean seawater. Marine Chemistry 120(1-4): 154-163

Tornero V. and Hanke G. (2016) Identification of marine chemical contaminants released from sea-based sources: A review focusing on regulatory aspects. JRC Technical Report. EUR 28039. Luxembourg (Luxembourg): Publications Office of the European Union.

Tornero and Hanke (2018) Marine chemical contaminants – support to harmonized MSFD reporting: Substances considered for MSFD descriptor 8, EUR 29281, Publications Office of the European Union, ISBN 978-92-79-88542-6, doi:10.2760/804610, JRC112387

UNEP/MAP (2012) State of the Mediterranean Marine and Coastal Environment, UNEP/MAP – Barcelona Convention, Athens.

UNEP (2016) Agenda item 5. Review of Proposed Background Concentrations (BC)/Background Assessment Criteria (BACs)/Environmental Assessment Criteria (EACs) for Contaminants and Biomarkers at Mediterranean and Regional Scales (UNEP(DEPI)/MED WG.427/7, version 18 September 2016), 2016.

UNEP/MAP (2017) Quality Status Report (Pollution and Litter). Agenda item 3: Review of Quality Status Report QSR (Pollution and Litter). 6th Meeting of the Ecosystem Approach Coordination Group. Athens, Greece, 11 September 2017. United Nations Environment Program Mediterranean Action Plan. UNEP(DEPI)/MED WG.444/8.

UNEP/UNECE (2016) GEO-6 Assessment for the pan-European region. Job No: DEW/1965/NA - ISBN: 978-92-807-3545-1 . Report : http://archimer.ifremer.fr/doc/00341/45213/.

Walker, C.H., Sibly, R.M., Hopkin, S.P. and Peakall, D.B. (2012) *Principles of ecotoxicology.* CRC Press Taylor and Francis Group, London http://www.amazon.com/Principles-Ecotoxicology-Fourth-C-H-Walker/dp/1439862664.

MEDCIS