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Athens, Greece, 12-15 September 2017

Agenda items 5: Specific Matters for Consideration and Action by the Meeting

Draft 2017 Quality Status Report

* Reissued for technical reasons on 31 August 2017

UNEP/MAP
Athens, 2017

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ENVIRONMENT PROGRAMME
MEDITERRANEAN ACTION PLAN

11 July 2017
Original: English

6th Meeting of the Ecosystem Approach Coordination Group

Athens, Greece, 11 September 2017

Agenda item 3: Review of Quality Status Report QSR (Pollution and Litter)

Quality Status Report (Pollution and Litter)

UNEP/MAP
Athens, 2017

Note by the Secretariat

In line with the article 12 of the Barcelona Convention and several monitoring related provisions under different protocols, the 2017 Quality Status Report (QSR 2017) is the first report based on IMAP Common Indicators. It is prepared following the mandate given to Secretariat by the Decision IG.22/20 of the 19th Meeting of the Contracting Parties on the Programme of Work and Budget 2016-2017 (Athens, Greece, February 2016).

QSR 2017 follows a model that has been prepared by the Secretariat in cooperation with the Contracting Parties through the Ecosystem Approach Correspondence Groups on Monitoring (COR MONs) and the Ecosystem Approach Coordination Group. It also considered the approach taken by other Regional Seas (i.e. OSPAR), and work implemented at global level, such as the Regional Process on a second World Ocean Assessment(s) and the process on implementing the 2030 Agenda, especially in relation to oceans related Sustainable Development Goals (SDGs).

Given the fact that the IMAP implementation is still at an early phase, the approach for the preparation of the QSR 2017 accommodates the time limitations and data gaps on the IMAP Common Indicators. During the preparation of the QSR 2017, countries were still in the process of revising their national monitoring programmes as to align them with IMAP, and therefore, it has not been possible to compile a full set of data for IMAP indicators for the QSR 2017. Hence the approach followed was to use all available data for the IMAP Common Indicators and to complement and address data gaps with inputs from numerous sources where appropriate.

Apart of the MED POL monitoring database, QSR 2017 has the links to all information sources and case studies relevant for different IMAP Common Indicators, provided from the Contracting Parties and other partners. During the initial steps, additional sources of information were identified and mapped, including information related to national reports on implementation of Barcelona Convention and its protocols, implementation of the National Action Plans (NAPs), Coastal Area Management Programmes (CAMPs), as well as the results of regionally and nationally driven implementation of relevant policies, programmes and projects.

As the result, QSR 2017, through systematic compilation of the Assessment Factsheets for all IMAP Common Indicators, provides the findings on the status of implementation of the appropriate assessment methods, identifies the status of information availability that are necessary for evaluation of the IMAP Common Indicators, provides the findings related to the status of marine and coastal ecosystems and where possible, identifies the trends that are expressed through qualitative and quantitative assessment, including the graphics and animations as appropriate. It also determines the knowledge gaps and defines key directions to overcome them with the aim to enable success of the initial phase of IMAP (2016-2019). For each cluster it provides the case studies that have been submitted by Contracting Parties and Partners.

The QSR Assessment Factsheets for all IMAP Common Indicators were presented at and reviewed by the relevant meetings of the Ecosystem Approach Correspondence Groups (on biodiversity, pollution, marine litter and coast and hydrography), the Ecosystem Approach Coordination Group and the meetings of the respective MAP Components Focal Points (MED POL, SPA/RAC, REMPEC, PAP/RAC), and were revised accordingly.

In conclusion the delivery of this report is a unique MAP achievement based on a joint and integrated efforts of the Contracting Parties, Secretariat, MAP Components and Partners.

Ecological Objective 5 (EO5): Eutrophication

EO5: Common Indicator 13. Key nutrients concentration in water column

GENERAL

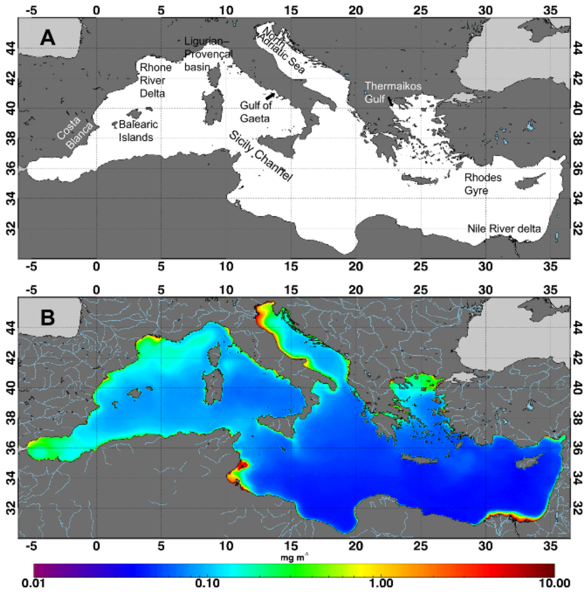
Reporter:	UNEP/MAP/MED POL
Geographical scale of the assessment:	Regional, Mediterranean Sea
Contributing countries:	Albania, Bosnia and Herzegovia, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Montenegro, Morocco, Slovenia, Spain, Syria, Tunisia, Turkey
Mid-Term Strategy (MTS) Core Theme	1-Land and Sea Based Pollution
Ecological Objective	EO5. Human-induced eutrophication is prevented, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algal blooms and oxygen deficiency in bottom waters
IMAP Common Indicator	CI13. Chlorophyll-a concentration in water column (EO5**)**
Indicator Assessment Factsheet Code	EO5CI13

RATIONALE/METHODS

Background (short)

Eutrophication is a process driven by enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus, leading to: increased growth, primary production and biomass of algae; changes in the balance of nutrients causing changes to the balance of organisms; and water quality degradation (UNEP(DEPI)/MED, WG.411./3). Seawaters depending on nutrient loading and phytoplankton growth are classified according to their level of eutrophication. Low nutrient/ phytoplankton levels characterize oligotrophic areas, water enriched in nutrients is characterized as mesotrophic, whereas water rich in nutrients and algal biomass is characterized as eutrophic. The Mediterranean is one of the most oligotrophic seas in the world and most of its biological productivity takes place in the euphotic zone (UNEP, 1989). The development of nutrient/phytoplankton concentration scales has been a difficult task for marine scientists because of the seasonal fluctuations of nutrient and phytoplankton concentrations, phytoplankton patchiness and small-scale eutrophication phenomena. Although long-term scientific research (UNEP/FAO/WHO1996; Krom *et al.*, 2010) has shown that the main body of the Mediterranean Sea is in good condition, there are coastal areas, especially in enclosed gulfs near big cities in estuarine areas and near ports, where marine eutrophication is a serious threat. In the Mediterranean Sea, the Barcelona Convention adopted in 1976 was the first legally-binding instrument for its environmental protection and included a number of protocols, such as the pollution land-based sources (LBS) Protocol. Since 2000, other international and national policies, such as the European Water Framework Directive and the European Marine Strategy Framework Directive are developing programmes, which sums to its environmental protection at sub regional levels and collaborate with UNEP/MAP. At the 19th Ordinary Meeting in 2016 of the Contracting Parties to the Barcelona Convention (Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean and its Protocols) adopted the Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Coast and Sea and Related Assessment Criteria, which includes the targets to achieve the Good Environmental Status

(UNEP/MAP, 2016). The initial targets of GES for IMAP Common Indicator 14 are reflecting the scope of the current MED POL Programme and the availability of suitable agreed assessment criteria.



The Mediterranean basin and its chlorophyll *a* concentration pattern. (A) Geographic regions (B) chlorophyll *a* concentration climatology over the Mediterranean Sea relative to 1998–2009 time period. Highest chlorophyll *a* concentrations are generally found in coastal water, in proximity of the river outflow, and are obviously conditioned by the nutrient of natural origin carried by rivers. From: Colella *et al.*, 2016.

Background (extended)

In the Mediterranean area eutrophication is caused by both regional sources such as urban effluents, industrial discharges, and aquaculture activities as well as transboundary components such as agricultural runoffs, riverine outflows, and airborne nutrient deposition. The variables related to eutrophication are influenced by water circulation and to regional sources of pollution including eutrophication (UNEP, 2003).

The highly populated coastal zone in the Mediterranean and the riverine input from a draining area of 1.5 10^6 km^2 (Ludwig *et al.*, 2009) induce eutrophic trends in coastal areas. The offshore waters of the Mediterranean have been characterized as extremely oligotrophic with a clear gradient toward east (Turley, 1999). Eutrophication and oligotrophy in the Mediterranean is illustrated as chlorophyll *a* distribution in remote sensing imagery (Fig. 1)

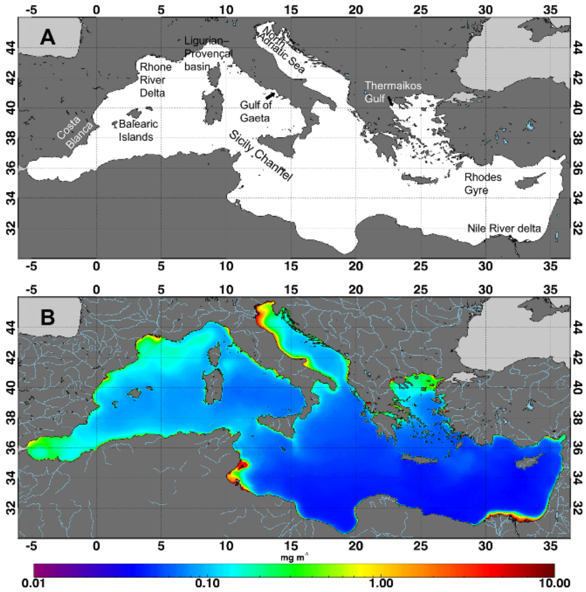


Figure 1. The Mediterranean basin and its chlorophyll a concentration pattern. (A) Geographic regions (B) chlorophyll a concentration climatology over the Mediterranean Sea relative to 1998–2009 time period. From: Colella et al., 2016.

At the moment only some of the countries developed boundary approach for the assessment of eutrophication and no general assessment criteria were accepted for the Mediterranean area for the key nutrient concentrations in the water column.

In the Mediterranean Sea, the Barcelona Convention adopted in 1976 was the first legally binding instrument for its environmental protection and included a number of protocols, such as the pollution land-based sources (LBS) Protocol. Since 2000, other international and national policies, such as the European Water Framework Directive and the European Marine Strategy Framework Directive are developing programmes, which sums to its environmental protection at sub regional levels and collaborate with UNEP/MAP. At the 19th Ordinary Meeting in 2016 of the Contracting Parties to the Barcelona Convention (Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean and its Protocols) adopted the Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Coast and Sea and Related Assessment Criteria, which includes the targets to achieve the Good Environmental Status (UNEP/MAP, 2016). The initial targets of GES for IMAP Common Indicator 13 are reflecting the scope of the current MED POL Programme and the availability of suitable agreed assessment criteria.

Assessment methods

At the moment only some of the countries developed boundary approach for the assessment of eutrophication and no general assessment criteria were accepted for the Mediterranean area for the key nutrient concentrations in the water column. This assessment effort was only based on the presentation of the geographical variability of some key nutrients (DIN – dissolved inorganic nitrogen and TP- total phosphorous; µmol L^{-1}).

In this assessment, aware that for most of the northern Mediterranean countries data are available also in other databases (EEA, EIONET, EMODnet…), only datasets obtained from the MED POL Database for nutrients were used. Data availability by country were as follows:

Albania (2005-2006), Bosnia and Herzegovina (2006-2008) Croatia (2009, 2011-2014), Cyprus (1999-2015), Egypt (2009, 2010), France (2009, 2012), Greece (2004-2006), Israel (2001-2012), Montenegro (2008-2011), Morocco (2006,2007), Slovenia (1999-2013, 2015), Tunisia (2002-2013), Turkey (2005-2009, 2011, 2013)

RESULTS

Results and Status, including trends (brief)

The trophic status of the Mediterranean Sea is controlled by the highly populated coastal zone and the riverine input. Offshore waters of the Mediterranean have been characterized as extremely oligotrophic with an increasing tendency for oligotrophy eastwards, the EMS has been characterized as the largest phosphorus-limited body of water in the global ocean.

The coastal area of the south-eastern part of the Mediterranean shows clearly eutrophic trends. The sewage effluents of Cairo and Alexandria mainly induce eutrophic conditions in the area. The Northern Aegean shows mesotrophic to eutrophic trends. This can be explained by the river inputs from northern Greece and the water inflow from the nutrient rich Black Sea.

The nutrient regime and primary productivity in the Western Mediterranean Sea (WMS) are relatively higher compared to the EMS. There is a limited nutrient supply through the Strait of Gibraltar due to different nutrient concentrations between the Atlantic and Mediterranean waters.

The main coastal areas in the Mediterranean with permanent eutrophic trends are the Gulf of Lions, the Adriatic, Northern Aegean, and the SE Mediterranean (Nile–Levantine).

The available data show that in areas were assessment is possible the key nutrient concentrations are in ranges characteristic for coastal areas and in line with the main processes undergoing in the interested area. The result also confirm the validity of this indicator in assessing eutrophication.

Coastal Water type assessment criteria for reference condition and boundaries for key nutrients in the water column have to be built and harmonised through the Mediterranean region. In this effort greatly will help the implementation of a clear sampling strategy with a simplified approach in monitoring design and data handling.

Results and Status, including trends (extended)

The trophic status of the Mediterranean Sea is controlled by the highly populated coastal zone and the riverine input from a draining area of 1.5 million km^2 (Ludwig *et al.* 2009) that induce eutrophic trends in coastal areas. The blue offshore waters of the Mediterranean have been characterized as extremely oligotrophic with an increasing tendency for oligotrophy eastwards (Turley 1999). Eutrophication and oligotrophy in the Mediterranean is illustrated as chlorophyll *a* distribution in remote sensing imagery (Fig. 1). It is observed that the Eastern Mediterranean Sea (EMS) is still the most oligotrophic area of the whole Mediterranean basin. This is due to the low nutrient content of EMS; the maximum concentrations recorded for nitrate were about 6 μM, for phosphate 0.25 μmol L^{-1}, and for silicate 10–12 μmol L^{-1}, with the nitrate to phosphate ratio (N/P) >20 and in deep waters about 28:1, the EMS has been characterized as the largest phosphorus-limited body of water in the global ocean.

The coastal area of the southeastern part of the Mediterranean shows clearly eutrophic trends. Although the River Nile is the major water resource in the area, its freshwater fluxes are getting limited because of the Aswan Dam and increasing trends in anthropogenic water use in the lower Nile. Eutrophic conditions in the area are mainly induced by the sewage effluents of Kairo and Alexandria. The Northern Aegean shows mesotrophic to eutrophic trends. This can be explained by the river inputs from northern Greece and the water inflow from the nutrient rich Black Sea.

The nutrient regime and primary productivity in the Western Mediterranean Sea (WMS) are relatively higher compared to the EMS. There is limited nutrient supply through the Strait of Gibraltar due to different nutrient concentrations between the Atlantic and Mediterranean waters. The surface water entering from the Atlantic carries nutrients directly available for photosynthesis (EEA 1999) but at low concentrations. The phosphorus (phosphate) concentrations in the inflowing waters ranges from 0.05 to 0.20 μmol L^{-1}, the nitrogen (nitrate) concentrations being about 1–4 μM, and the silicon (silicate) concentration is about 1.2 μmol L^{-1} (Coste *et al.* 1988). The nutrients of the surface layer are reduced as they propagate eastwards due to mixing with poor basin water and nutrient use by phytoplankton.

However, the primary productivity of the main WMS, away from the coastal areas and influenced by rivers and urban agglomerations, is still higher than the primary productivity in the EMS.

The main coastal areas in the Mediterranean with permanent eutrophic trends are the Gulf of Lions, the Adriatic, Northern Aegean, and the SE Mediterranean (Nile–Levantine).

A recent work on nutrient and phytoplankton distribution along a large-scale longitudinal east–west transect (3,188 km) of the Mediterranean Sea extended over nine stations was published by Ignatiades et al. (2009). The results confirmed the oligotrophic character of the area and the nutrient and chlorophyll gradient characterized by decreasing concentrations from Gibraltar to the sea of Levantine. Phosphate maxima ranged from 0.05 to 0.26 μmol L^{-1}, nitrate from 4.04 to 1.87 μmol L^{-1}, chlorophyll *a* (chl*a*) from 0.96 to 0.39 mg L^{-1}.

The results of assessment and status of the key nutrients concentration in the water column are presented on Figs 3-5 showing a rather limited figure of the Mediterranean region. The main reason is the data availability and quality. On the Fig. 2 are clearly visible that for the great part of the region data are missing. The implementation of water type criteria for the purpose of IMAP are also limited. Even a rather weak criteria (10 samples in 10 years in surface layer **-** <= 10 m) were adopted the data availability for assessment were low.

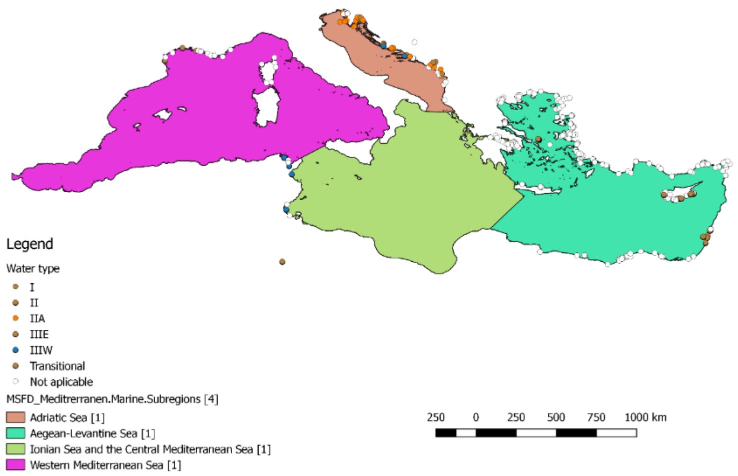


Figure 2. Stations in the Mediterranean region for which nutrient concentrations were sampled. Also are shown the water types (applicable for phytoplankton; IMAP. 2017) were minimal statistical requirements were satisfied (10 samples in the last 10 years and in the surface layer, <= 10 m)

On Figs 3-5 data for the Adriatic and Aegean-Levantine subregions for dissolved inorganic nitrogen (DIN) and total phosphorus (TP) were presented. DIN and TP concentration show a characteristic variability for both coastal sea (Adriatic and Aegean-Levantine Sea) indicating that no hotspot is present for DIN and TP.

When harmonised reference and boundary criteria for key nutrients concentration in the water column will be accepted, no meter the level is, regional, subregional or country based, through a such simplified approach (Box and whisker plot) assessment can be performed efficiently, on both the geographical or time scale. Taking in account the fact that a great part of the Mediterranean countries have undergoing eutrophication monitoring programmes and are contributing to other databases, the IMAP goals can be maintained.

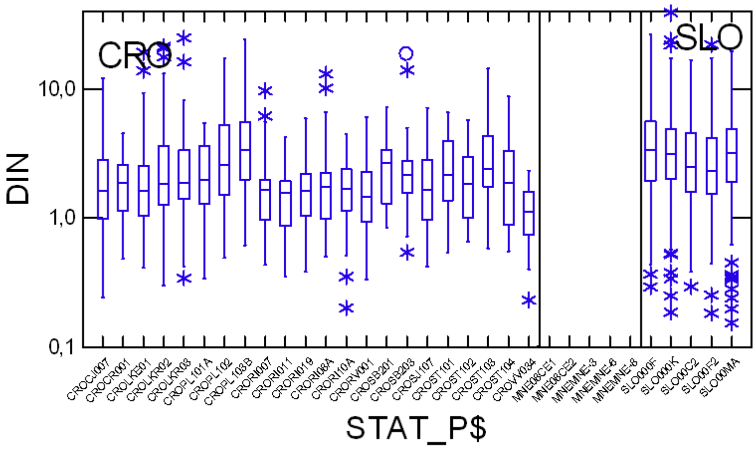


Figure 3. Box and whisker plot for dissolved inorganic nitrogen (DIN) concentration (µmol L^{-1}) in the Adriatic Sea subregion (water type IIA)

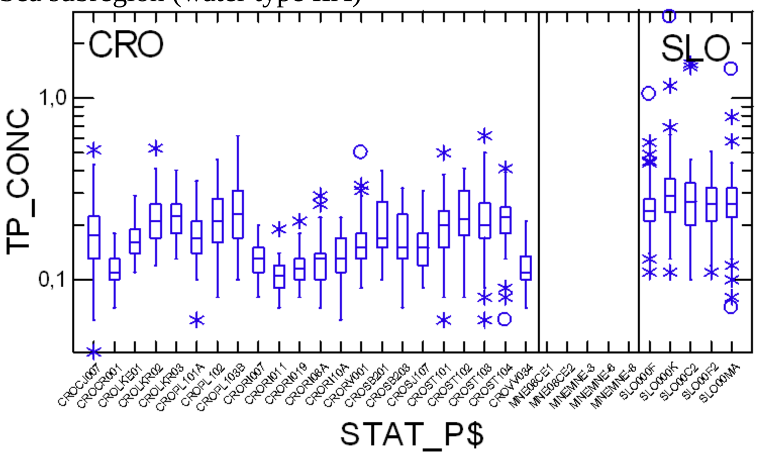


Figure 4. Box and whisker plot for Total Phosphorous (TP) concentration (µmol L^{-1}) in the Adriatic Sea subregion (water type IIA)

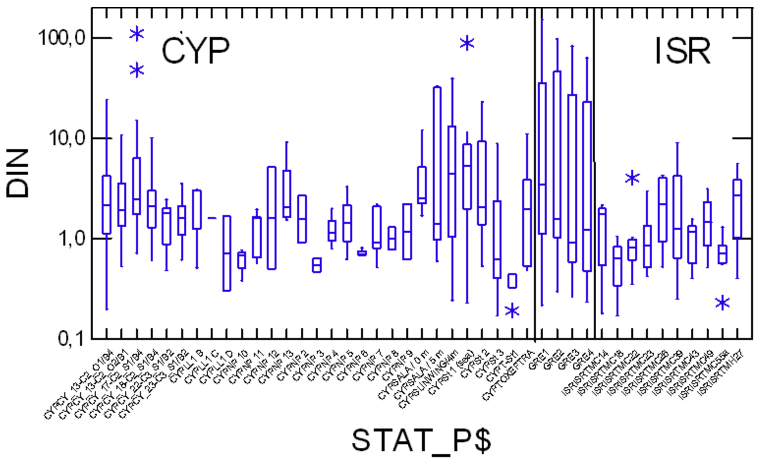


Figure 5. Box and whisker plot for dissolved inorganic nitrogen (DIN) concentration (µmol L^{-1}) in in the Aegean-Levantine Sea subregion (water type IIIE)

The available data show that in areas were assessment is possible the key nutrient concentrations are in ranges characteristic for coastal areas and in line with the main processes undergoing in the interested area. The result also confirm the validity of this indicator as support in assessing eutrophication.

Coastal Water type assessment criteria for reference condition and boundaries for key nutrients in the water column have to be built and harmonised through the Mediterranean region. In this effort greatly will help the implementation of a clear sampling strategy with a simplified approach in monitoring design and data handling.

At the eutrophication hot spots in the Mediterranean Sea a comprehensive key nutrient concentrations in the water column trend analysis would be beneficial. Significant trends need to be detected from long time series that are able to capture nutrient concentrations changes in coastal waters as the analysis of short time series can erroneously lead to interpret some spatial patterns produced by random processes nutrients concentration trends. For that reason data availability have to be improved. A possible approach is to use data stored in other databases were some of the Mediterranean countries regularly contribute.

CONCLUSIONS

Conclusions (brief)

The available data show that in areas were assessment is possible the key nutrient concentrations are in ranges characteristic for coastal areas and in line with the main processes undergoing in the interested area. The result also confirm the validity of this indicator as support in assessing eutrophication.

Coastal Water type assessment criteria for reference condition and boundaries for key nutrients in the water column have to be built and harmonised through the Mediterranean region. In this effort greatly will help the implementation of a clear sampling strategy with a simplified approach in monitoring design and data handling.

Conclusions (extended)

The available data show that in areas were assessment is possible the key nutrient concentrations are in ranges characteristic for coastal areas and in line with the main processes undergoing in the interested area. The result also confirm the validity of this indicator as support in assessing eutrophication.

Coastal Water type assessment criteria for reference condition and boundaries for key nutrients in the water column have to be built and harmonised through the Mediterranean region. In this effort greatly will help the implementation of a clear sampling strategy with a simplified approach in monitoring design and data handling.

Key messages

- Criteria for reference condition and boundaries for key nutrients in the water column have to be built and harmonised through the Mediterranean region.

Knowledge gaps

Criteria for reference condition and boundaries for key nutrients in the water column have to be built and harmonised through the Mediterranean region. Data availability have to be improved. A possible approach is to use data stored in other databases were some of the Mediterranean countries regularly contribute.

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Ecological Objective 5 (EO5): Eutrophication

EO5: Common Indicator 14. Chlorophyll-a concentration in water column

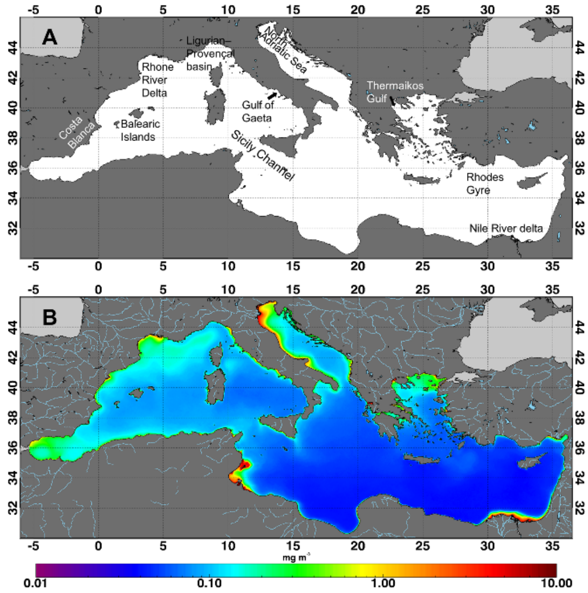
GENERAL

Reporter:	UNEP/MAP/MED POL
Geographical scale of the assessment:	Regional, Mediterranean Sea
Contributing countries:	Albania, Bosnia and Herzegovina, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Montenegro, Morocco, Slovenia, Spain, Syria, Tunisia, Turkey
Mid-Term Strategy (MTS) Core Theme	1-Land and Sea Based Pollution
Ecological Objective	EO5. Human-induced eutrophication is prevented, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algal blooms and oxygen deficiency in bottom waters
IMAP Common Indicator	CI14. Chlorophyll-a concentration in water column (EO5**)**
Indicator Assessment Factsheet Code	EO5CI14

RATIONALE/METHODS

Background (short)

Eutrophication may be defined as the nutrient enrichment of the marine environment with nutrients primarily nitrogen and phosphorus that stimulate primary production and algal growth (Vollenweider, 1992). Seawaters depending on nutrient loading and phytoplankton growth are classified according to their level of eutrophication. Low nutrient/ phytoplankton levels characterize oligotrophic areas, water enriched in nutrients is characterized as mesotrophic, whereas water rich in nutrients and algal biomass is characterized as eutrophic. The Mediterranean is one of the most oligotrophic seas in the world and most of its biological productivity takes place in the euphotic zone (UNEP, 1989). The development of nutrient/phytoplankton concentration scales has been a difficult task for marine scientists because of the seasonal fluctuations of nutrient and phytoplankton concentrations, phytoplankton patchiness and small-scale eutrophication phenomena. Although long-term scientific research (UNEP/FAO/WHO1996; Krom *et al.*, 2010) has shown that the main body of the Mediterranean Sea is in good condition, there are coastal areas, especially in enclosed gulfs near big cities in estuarine areas and near ports, where marine eutrophication is a serious threat. In the Mediterranean Sea, the Barcelona Convention adopted in 1976 was the first legally binding instrument for its environmental protection and included a number of protocols, such as the pollution land-based sources (LBS) Protocol. Since 2000, other international and national policies, such as the European Water Framework Directive and the European Marine Strategy Framework Directive are developing programmes, which sums to its environmental protection at sub regional levels and collaborate with UNEP/MAP. At the 19th Ordinary Meeting in 2016 of the Contracting Parties to the Barcelona Convention (Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean and its Protocols) adopted the Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Coast and Sea and Related Assessment Criteria, which includes the targets to achieve the Good Environmental Status (UNEP/MAP, 2016). The initial targets of GES for IMAP Common Indicator 14 are reflecting the scope of the current MED POL Programme and the availability of suitable agreed assessment criteria.



The Mediterranean basin and its chlorophyll *a* concentration pattern. (A) Geographic regions (B) chlorophyll *a* concentration climatology over the Mediterranean Sea relative to 1998–2009 time period. Highest chlorophyll *a* concentrations are generally found in coastal water, in proximity of the river outflow, and are obviously conditioned by the nutrient of natural origin carried by rivers. From: Colella *et al.*, 2016.

Background (extended)

In the Mediterranean area, eutrophication is caused by both regional sources such as urban effluents, industrial discharges, and aquaculture activities as well as transboundary components such as agricultural runoffs, riverine outflows, and airborne nutrient deposition. The variables related to eutrophication are influenced by water circulation and to regional sources of pollution including eutrophication (UNEP, 2003).

The highly populated coastal zone in the Mediterranean and the riverine input from a draining area of 1.5 10^6 km^2 (Ludwig *et al.*, 2009) induce eutrophic trends in coastal areas. The offshore waters of the Mediterranean have been characterized as extremely oligotrophic with a clear gradient toward east (Turley, 1999). Eutrophication and oligotrophy in the Mediterranean is illustrated as chlorophyll *a* distribution in remote sensing imagery (Fig. 1).

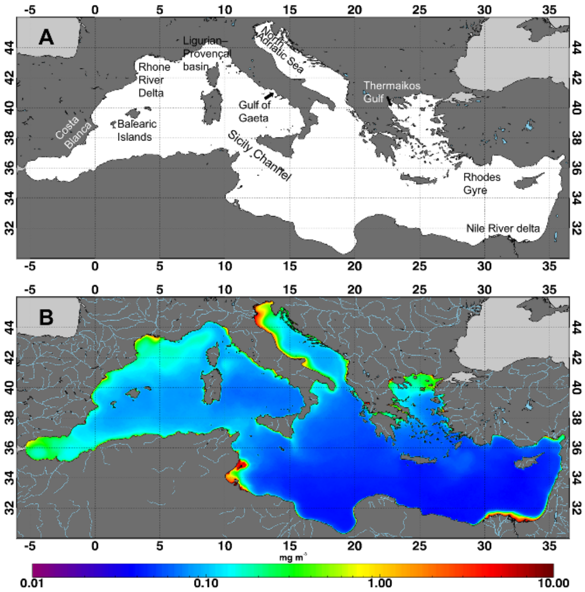


Figure 1. The Mediterranean basin and its chlorophyll *a* concentration pattern. (A) Geographic regions (B) chlorophyll a concentration climatology over the Mediterranean Sea relative to 1998–2009 time period. From: Colella *et al.*, 2016.

The assessment of eutrophication face a fairly complex matter, since, in the case of coastal environments, “abundance and composition of phytoplankton are characterized by a high degree of space-time variability: the complexity of these areas, due mainly to the high variability of environmental factors and to the responses of the communities, make it difficult to define a regular annual cycle of phytoplankton" (Pugnetti *et al.*, 2007. In Italian). This statement clearly show that in the field of eutrophication the statistical requirement are essential for an acceptable assessment strategy. The applied WFD requirements in regards of Coastal Water types reference conditions and boundaries in the Mediterranean now is the best compromise.

In the Mediterranean Sea, the Barcelona Convention adopted in 1976 was the first legally binding instrument for its environmental protection and included a number of protocols, such as the pollution land-based sources (LBS) Protocol. Since 2000, other international and national policies, such as the European Water Framework Directive and the European Marine Strategy Framework Directive are developing programmes, which sums to its environmental protection at sub regional levels and collaborate with UNEP/MAP. At the 19th Ordinary Meeting in 2016 of the Contracting Parties to the Barcelona Convention (Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean and its Protocols) adopted the Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Coast and Sea and Related Assessment Criteria, which includes the targets to achieve the Good Environmental Status (UNEP/MAP, 2016). The initial targets of GES for IMAP Common Indicator 14 are reflecting the scope of the current MED POL Programme and the availability of suitable agreed assessment criteria.

Assessment methods

At the moment only some of the countries developed boundary approach for the assessment of eutrophication and this effort is integrated in the Coastal Water types reference conditions and boundaries in the Mediterranean (applicable for phytoplankton; IMAP, 2017). These criteria were for the first time applied on the data available for the Mediterranean through the MED POL Database.

For eutrophication, it is accepted that surface density is adopted as a proxy indicator for static stability of a coastal marine system. More information on typology criteria and setting is presented in document UNEP(DEPI)/MED WG 417/Inf.15:

Type I coastal sites highly influenced by freshwater inputs, Type IIA coastal sites moderately influenced not directly affected by freshwater inputs (Continent influence),

Type IIIW continental coast, coastal sites not influenced/affected by freshwater inputs (western Basin),

Type IIIE not influenced by freshwater input (Eastern Basin),

Type Island coast (western Basin).

Coastal water type III was split in two different sub basins, the western and the Eastern Mediterranean ones, according to the different trophic conditions and is well documented in literature.

It is recommended to define the major coastal water types in the Mediterranean for eutrophication assessment (applicable for phytoplankton only; Table 1).

Table 1. Major coastal water types in the Mediterranean

	Type I	Type IIA, IIA Adriatic	Type IIIW	Type IIIE	Type Island-W
σ_t (density)	<25	25<d<27	>27	>27	All range
salinity	<34.5	34.5<S<37.5	>37.5	>37.5	All range

With the view to assess eutrophication, it is recommended to rely on the classification scheme on Chlorophyll *a* concentration (µg/L) in coastal waters as a parameter easily applicable by all Mediterranean countries based on the indicative thresholds and reference values presented in Table 2.

Table 2. Coastal Water types reference conditions and boundaries in the Mediterranean

Coastal Water Typology	Reference conditions of Chl*a* (µg L^{-1})		Boundaries of Chl*a* (µg L^{-1}) for G/M status	
	G_mean	90% percentile	G_mean	90% percentile
Type I	1,4	3,33* - 3,93**	6,3	10* - 17,7**
Type II-FR-SP		1,9		3,58
Type II-A Adriatic	0,33	0,8	1,5	4,0
Type II-B Tyrrhenian	0,32	0,77	1,2	2,9
Type III-W Adriatic			0,64	1,7
Type III-W Tyrrhenian			0,48	1,17
Type III-W FR-SP		0,9		1,80
Type III-E		0,1		0,4
Type Island-w		0,6		1,2 – 1,22

* applicable to Gulf of Lion

** applicable to Adriatic

In this assessment, aware that for most of the northern Mediterranean countries data are available also in other databases (EEA, EIONET, EMODnet…), only datasets obtained from the MED POL Database for chlorophyll *a* were used. Data availability by country were as follows:

Albania (2005-2006), Bosnia and Herzegovina (2006-2008) Croatia (2009, 2011-2014), Cyprus (1999-2015), Egypt (2009, 2010), France (2009, 2012), Greece (2004-2006), Israel (2001-2012), Montenegro (2008-2011), Morocco (2006,2007), Slovenia (1999-2013, 2015), Tunisia (2002-2013), Turkey (2005-2009, 2011,2013).

RESULTS

Results and Status, including trends (brief)

The trophic status of the Mediterranean Sea is controlled by the highly populated coastal zone and the riverine input. Offshore waters of the Mediterranean have been characterized as extremely oligotrophic with an increasing tendency for oligotrophy eastwards, the EMS has been characterized as the largest phosphorus-limited body of water in the global ocean.

The coastal area of the southeastern part of the Mediterranean shows clearly eutrophic trends. Eutrophic conditions in the area are mainly induced by the sewage effluents of Kairo and Alexandria. The Northern Aegean shows mesotrophic to eutrophic trends. This can be explained by the river inputs from northern Greece and the water inflow from the nutrient rich Black Sea.

The nutrient regime and primary productivity in the Western Mediterranean Sea (WMS) are relatively higher compared to the EMS. There is a limited nutrient supply through the Strait of Gibraltar due to different nutrient concentrations between the Atlantic and Mediterranean waters.

The main coastal areas in the Mediterranean with permanent eutrophic trends are the Gulf of Lions, the Adriatic, Northern Aegean, and the SE Mediterranean (Nile–Levantine).

The available data show that in areas were assessment is possible the IMAP assessment criteria for eutrophication based on CI14 (Chlorophyll *a* concentration in the water column) are applicable and confirm the main status of eutrophication in the coastal area.

Coastal Water type reference condition and boundaries for CI14 (Chlorophyll *a* concentration in the water column) have to be harmonised through the south Mediterranean region which has not yet participated in the assessment effort. The assessment can also help to identify areas were the criteria have to be improved. Of great help will be the implementation of a sampling strategy with simplified approach in monitoring design and data handling.

Results and Status, including trends (extended)

The trophic status of the Mediterranean Sea is controlled by the highly populated coastal zone and the riverine input from a draining area of 1.5 million km^2 (Ludwig *et al.* 2009) that induce eutrophic trends in coastal areas. The blue offshore waters of the Mediterranean have been characterized as extremely oligotrophic with an increasing tendency for oligotrophy eastwards (Turley 1999). Eutrophication and oligotrophy in the Mediterranean is illustrated as chlorophyll *a* distribution in remote sensing imagery (Fig. 1). This is due to the low nutrient content of EMS; the maximum concentrations recorded for nitrate were about 6 μM, for phosphate 0.25 μM, and for silicate 10–12 μM, with the nitrate to phosphate ratio (N/P) >20 and in deep waters about 28:1, the EMS has been characterized as the largest phosphorus-limited body of water in the global ocean.

The coastal area of the southeastern part of the Mediterranean shows clearly eutrophic trends. Although the River Nile is the major water resource in the area, its freshwater fluxes are getting limited because of the Aswan Dam and increasing trends in anthropogenic water use in the lower Nile. Eutrophic conditions in the area are mainly induced by the sewage effluents of Kairo and Alexandria. The Northern Aegean shows mesotrophic to eutrophic trends. This can be explained by the river inputs from northern Greece and the water inflow from the nutrient rich Black Sea.

The nutrient regime and primary productivity in the Western Mediterranean Sea (WMS) are relatively higher compared to the EMS. There is limited nutrient supply through the Strait of Gibraltar due to different nutrient concentrations between the Atlantic and Mediterranean waters. The surface water entering from the Atlantic carries nutrients directly available for photosynthesis (EEA 1999) but at low concentrations. The phosphorus (phosphate) concentrations in the inflowing waters ranges from 0.05 to 0.20 μM, the nitrogen (nitrate) concentrations being about 1–4 μM, and the silicon (silicate) concentration is about 1.2 μM (Coste *et al.* 1988). The nutrients of the surface layer are reduced as they propagate eastwards due to mixing with poor basin water and nutrient use by phytoplankton. However, the primary productivity of the main WMS, away from the coastal areas and influenced by rivers and urban agglomerations, is still higher than the primary productivity in the EMS.

The main coastal areas in the Mediterranean with permanent eutrophic trends are the Gulf of Lions, the Adriatic, Northern Aegean, and the SE Mediterranean (Nile–Levantine).

A recent work on nutrient and phytoplankton distribution along a large-scale longitudinal east–west transect (3,188 km) of the Mediterranean Sea extended over nine stations was published by Ignatiades et al. (2009). The results confirmed the oligotrophic character of the area and the nutrient and chlorophyll gradient characterized by decreasing concentrations from Gibraltar to the sea of Levantine. Phosphate maxima ranged from 0.05 to 0.26 μM, nitrate from 1.87 to 4.04 μM, chlorophyll *a* (chl*a*) from 0.39 to 0.96 mg L^{-1}.

The results of assessment and status of chlorophyll *a* concentration in the water column are presented on Figs 2-8 showing a rather limited figure of the Mediterranean region. The main reason is the data availability and quality. On the Fig. 2 are clearly visible that for the great part of the region data are missing. The implementation of water type criteria for the purpose of IMAP are also limited. Even a rather weak criteria (10 samples in 10 years in surface layer - <= 10 m) were adopted the data availability for assessment were low.

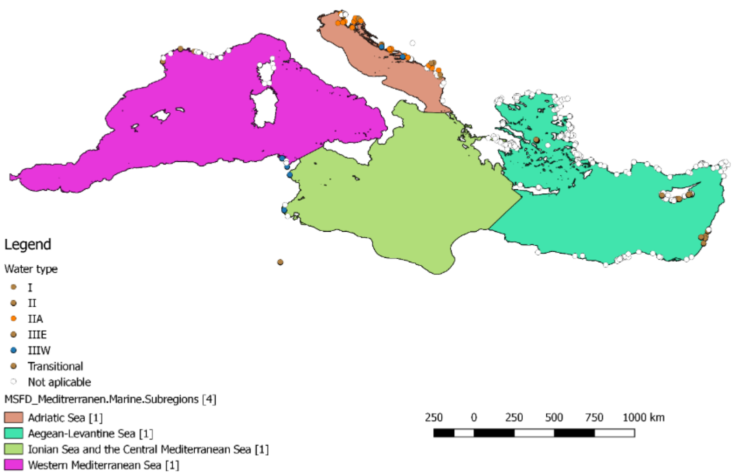


Figure 2. Stations in the Mediterranean region for which eutrophication parameter were sampled. Also are shown the water types (applicable for phytoplankton; IMAP. 2017) were minimal statistical requirements were satisfied (10 samples in the last 10 years and in the surface layer, <= 10 m)

On Figs 3-8 assessment data for all four subregions applying the Coastal Water types reference conditions and boundaries in the Mediterranean (applicable for phytoplankton; IMAP. 2017) are presented. For the Western Mediteranean Sea subregion (Fig. 3) only a limited set of data for France (from 2009 and 2012) were assessed indicating that none of the stations in the Golf of Lyon were in moderate state.

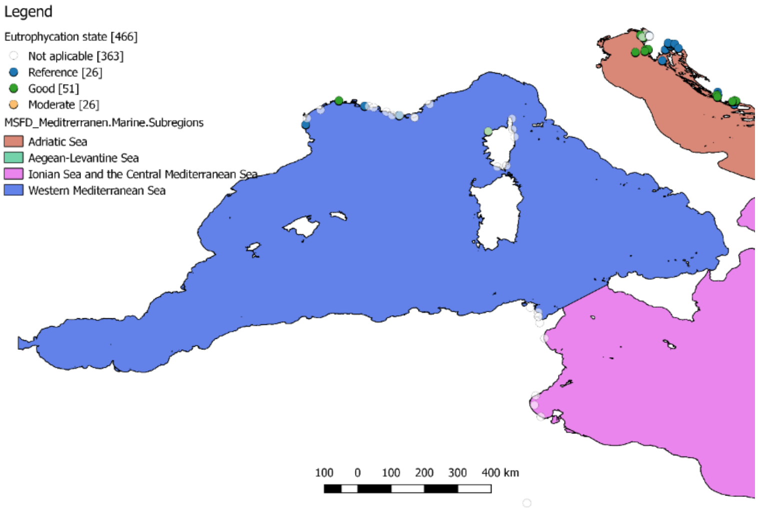


Figure 3. Stations in the Western Mediterranean Sea subregion for which eutrophication were assessed. Coastal Water types reference conditions and boundaries in the Mediterranean were applied (applicable for phytoplankton; IMAP. 2017) for were minimal statistical requirements were satisfied (10 samples in the last 10 years and in the surface layer, <= 10 m)

In the Adriatic Sea subregion (Figs 4-5) only the eastern part were assessed (Slovenia, Croatia and Montenegro). The applied criteria showed that all the stations in the assessed area are at list in good status. The Box and Whisker plot (Fig. 5) shows even more details. Such a graphical representation is very useful for a geographical assessment and represent a good potential for the time series analysis.

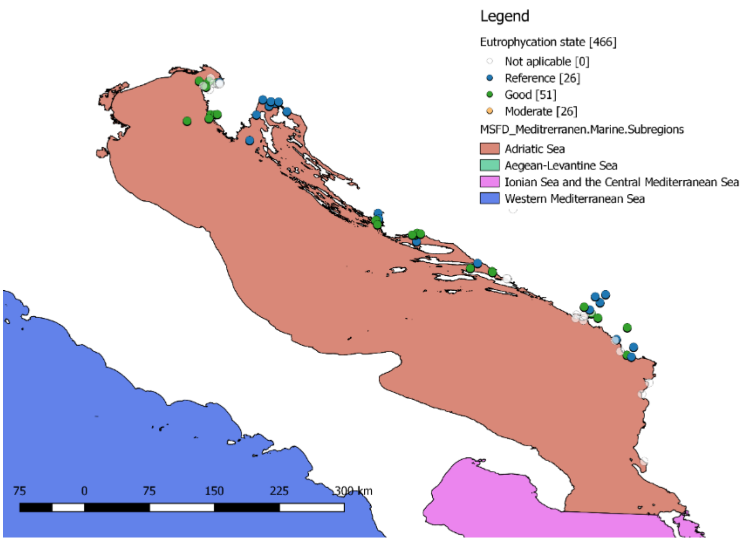


Figure 4. Stations in the Adriatic Sea subregion for which eutrophication were assessed. Coastal Water types reference conditions and boundaries in the Mediterranean were applied (applicable for phytoplankton; IMAP. 2017) for were minimal statistical requirements were satisfied (10 samples in the last 10 years and in the surface layer, <= 10 m)

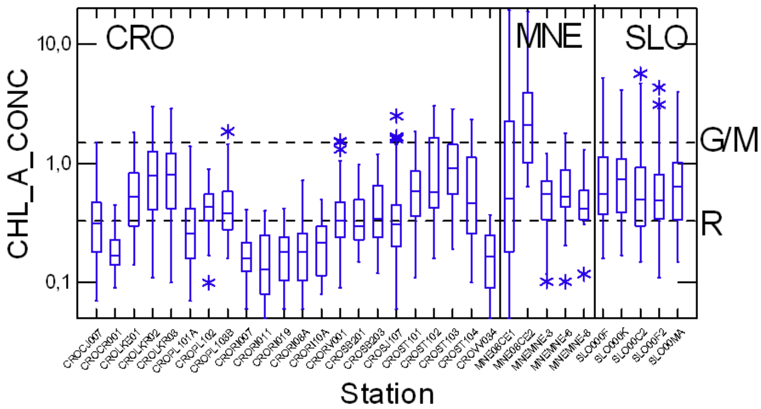


Figure 5. Box and whisker plot for chlorophyll *a* concentration in the Adriatic Sea subregion (water type IIA) for which coastal Water types reference conditions and boundaries in the Mediterranean were applied (applicable for phytoplankton; IMAP. 2017)

For the Ionian Sea and the Central Mediterranean Sea subregion (Fig 6) the assessment was not performed as no data were available.

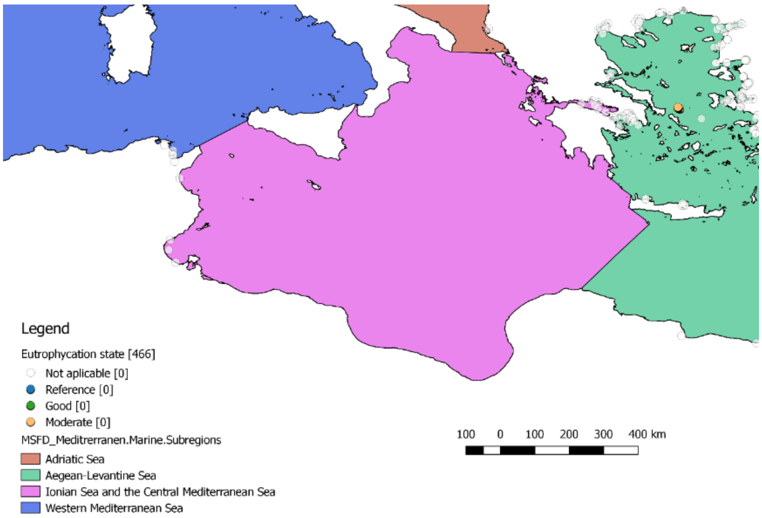


Figure 6. Stations in the Ionian Sea and the Central Mediterranean Sea subregion for which eutrophication were assessed. Coastal Water types reference conditions and boundaries in the Mediterranean were applied (applicable for phytoplankton; IMAP. 2017) for were minimal statistical requirements were satisfied (10 samples in the last 10 years and in the surface layer, <= 10 m)

In the Aegean-Levantine Sea subregion (Figs 7-8) the assessed country were Cyprus and Israel. Partially data for Turkey (Mersin area) were also used the applied criteria (Water type IIIE) showed that practically all the stations in the Cyprus area are at list in good status. The Box and Whisker plot (Fig. 8) shows even more details. The data for Israel and Mersin area (Turkey) indicate that the areas were in moderate state. Probably the criteria for Water type IIIE in this area are too rigorous due to the fact that this area a close to the coast and ports.

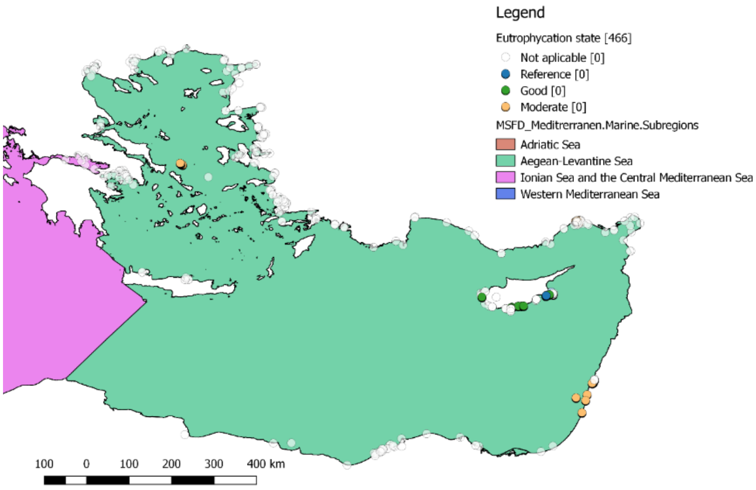


Figure 7. Stations in the Aegean-Levantine Sea subregion for which eutrophication were assessed. Coastal Water types reference conditions and boundaries in the Mediterranean were applied (applicable for phytoplankton; IMAP. 2017) for were minimal statistical requirements were satisfied (10 samples in the last 10 years and in the surface layer, <= 10 m)

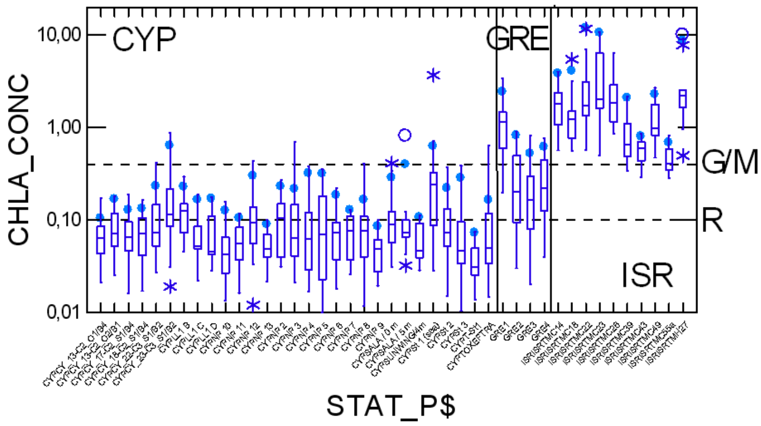


Figure 8. Box and whisker plot for chlorophyll *a* concentration in the Aegean-Levantine Sea subregion (water type IIIE) for which coastal Water types reference conditions and boundaries in the Mediterranean were applied (applicable for phytoplankton; IMAP. 2017). The blue dots represent the 90-percentile value

At the eutrophication hot spots in the Mediterranean Sea a comprehensive chlorophyll *a* trend analysis would be beneficial. Significant chlorophyll *a* trends need to be detected from long time series that are able to capture biomass changes in coastal waters as the analysis of short time series can erroneously lead to interpret some spatial patterns produced by random processes as chlorophyll *a* concentration trends.

Satellite synoptic measurements for the estimation of chlorophyll *a* concentration trends have the potential to detect anomalous, local biogeochemical processes and to assess the different applications of environmental regulations. Recent use of this data (Colella *et al.*, 2016) allowed for a consistent monitoring of biogeochemical issues in the Mediterranean basin. At large scale, positive trends off the South-East Spanish coast, in the Ligurian–Provençal basin, and in the Rhodes Gyre region, while an intense negative trend in the North Adriatic Sea, off the Rhone River mouth, and in the Thermaikos Gulf (Aegean Sea) were detected.

This potential to assess eutrophication problems is welcome, however, the satellite framework might need of larger, multi-sensor datasets and it surely requires to be combined with the analysis of in situ supplementary, biogeochemical data.

CONCLUSIONS
Conclusions (brief)

The trophic status of the Mediterranean Sea is controlled by the highly populated coastal zone and the riverine input from a draining area. Offshore waters of the Mediterranean have been characterized as extremely oligotrophic with an increasing tendency for oligotrophy eastwards.

The main coastal areas in the Mediterranean with permanent eutrophic trends are the Gulf of Lions, the Adriatic, Northern Aegean, and the SE Mediterranean (Nile–Levantine).

The available data show that in areas were assessment is possible the IMAP assessment criteria for eutrophication based on CI14 (Chlorophyll *a* concentration in the water column) are applicable and confirm the main status of eutrophication in the coastal area. In term of GES achievement in these areas (Eastern Adriatic and Cyprus) it is maintained.

Conclusions (extended)

The trophic status of the Mediterranean Sea is controlled by the highly populated coastal zone and the riverine input from a draining area. Offshore waters of the Mediterranean have been characterized as extremely oligotrophic with an increasing tendency for oligotrophy eastwards. The Eastern Mediterranean Sea (EMS) is still the most oligotrophic area of the whole Medirerranen basin, and the largest phosphorus-limited body of water in the global ocean.

The coastal area of the southeastern part of the Mediterranean shows clearly eutrophic trends. Although the River Nile is the major water resource in the area, its freshwater fluxes are getting limited because of the Aswan Dam and increasing trends in anthropogenic water use in the lower Nile. Eutrophic conditions in the area are mainly induced by the sewage effluents of Kairo and Alexandria. The Northern Aegean shows mesotrophic to eutrophic trends explained by the river inputs from northern Greece and the water inflow from the nutrient rich Black Sea.

The nutrient regime and primary productivity in the Western Mediterranean Sea (WMS) are relatively higher compared to the EMS. However, the primary productivity of the main WMS, away from the coastal areas and influenced by rivers and urban agglomerations, is still higher than the primary productivity in the EMS.

The main coastal areas in the Mediterranean with permanent eutrophic trends are the Gulf of Lions, the Adriatic, Northern Aegean, and the SE Mediterranean (Nile–Levantine).

The available data show that in areas were assessment is possible the IMAP assessment criteria for eutrophication based on CI14 (Chlorophyll *a* concentration in the water column) are applicable and confirm the main status of eutrophication in the coastal area. In term of GES achievement in these areas (Eastern Adriatic and Cyprus) it is manteined.

Coastal Water type reference condition and boundaries for CI14 (Chlorophyll *a* concentration in the water column) have to be harmonised through the south Mediterranean region which has not yet participated in the assessment effort. The assessment can also help to identify areas were the criteria have to be improved. Of great help will be the implementation of a sampling strategy with simplified approach in monitoring design and data handling.

Satellite synoptic measurements for the estimation of chlorophyll *a* concentration trends have the potential to detect anomalous, local biogeochemical processes and to assess the different applications of environmental regulations.

Key messages

- offshore waters of the Mediterranean have been characterized as extremely oligotrophic with an increasing tendency for oligotrophy eastwards,

- the main coastal areas in the Mediterranean with permanent eutrophic trends are the Gulf of Lions, the Adriatic, Northern Aegean, and the SE Mediterranean (Nile–Levantine), and
- the available data show that in areas were assessment is possible the IMAP assessment criteria for eutrophication based on CI14 (Chlorophyll *a* concentration in the water column) are applicable and confirm the main status of eutrophication in the coastal area.

Knowledge gaps

There are no main gaps identified in the Mediterranean Sea concerning the assessment of the Common Indicator 14. However, significant chlorophyll *a* trends need to be detected from long time series that are able to capture biomass changes in coastal waters, and for that purpose data availability have to be improved. A possible approach is to use data stored in other databases were some of the Mediterranean countries regularly contribute. Satellite synoptic measurements for the estimation of chlorophyll *a* concentration trends have the potential to detect anomalous, local biogeochemical processes and to assess the different applications of environmental regulations.

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Ecological Objective 9 (EO9): Chemical pollution

EO9: Common Indicator 17: Concentration of key harmful contaminants measured in the relevant matrix (EO9, related to biota, sediment, seawater)

GENERAL

Reporter:	UNEP/MAP/MED POL
Geographical scale of the assessment:	Regional, Mediterranean Sea
Contributing countries:	Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Montenegro, Morocco, Slovenia, Spain, Syria, Tunisia, Turkey
Mid-Term Strategy (MTS) Core Theme	1-Land and Sea Based Pollution
Ecological Objective	EO9. Contaminants cause no significant impact on coastal and marine ecosystems and human health
IMAP Common Indicator	CI17. Concentration of key harmful contaminants measured in the relevant matrix (EO9, related to biota, sediment, seawater)
Indicator Assessment Factsheet Code	EO9CI17

RATIONALE/METHODS

Background (short)

The status of the chemical contamination in the marine environment is the result of the human activities (drivers and pressures) that take place all around the coastal and marine areas of the Mediterranean Sea and puts it away from the natural steady-state conditions. Primarily, harmful contaminants enter the marine ecosystem through different routes, such atmospheric deposition or inputs from land-based sources. For example, in the Mediterranean coasts, from small recreational marinas up to major commercial ports, which count thousands, have created a number of different pressures in terms of chemical pollution. At present, there are still old threats and new pressures, although the trends and levels of the so called legacy pollutants (e.g. heavy metals, persistent organic pollutants and pesticides), have decreased significantly in the most impacted areas in the Mediterranean Sea after the implementation of environmental measures (e.g. leaded-fuels ban, mercury regulations, anti-fouling paints ban), as observed in the Western Mediterranean Sea (UNEP/MAP/MEDPOL, 2011a). Today, there are still point and diffuse pollution sources releasing both priority and emerging chemical contaminants (e.g. pharmaceuticals, personal care products, flame retardants) in the Mediterranean Sea. The land-based sources (LBS) of contaminants impacting the coastal environment enter both via treated (or non-treated) wastewater discharges and represent a major input. In terms of diffuse pollution sources, land based run-off and atmospheric deposition (wet/dry deposition and diffusive transport) are the two major contributors to the coastal areas. The sea-based sources themselves are also accounted (i.e. direct inputs from maritime and industrial activities, such as shipping, fishing, oil refining oil and gas exploration and exploitation) which could be permanent chronic sources of pollution in the marine environment, including the potential for acute pollution events.

Good Environmental Status (GES) for Common Indicator 17 (CI 17) can be accomplished when levels of pollution would be below a determined threshold (e.g. Environmental assessment Criteria, EACs), defined for the area and species. To this regard, the concentrations of specific harmful chemicals should be maintained below EACs or reference concentrations without deterioration trends, as well as, the reduction of contaminant emissions form land-based sources should be achieved (UNEP/MAP, 2013, 2015).

Figure 1: Muddy sediment sample taken with a large grab sampler. The top 1 cm layer is collected for chemical pollution analyses. The oxic and anoxic layers can be clearly observed, Image provided: Mudsedimentsample_CGuitart.jpg

Background (extended)

In the Mediterranean Sea, the Barcelona Convention adopted in 1976 was the first legally-binding instrument for its environmental protection and included a number of protocols, such as the pollution land-based sources (LBS) Protocol. The MAP/MED POL (Programme for the Assessment and Control of Marine Pollution) was implemented and the coastal long-term monitoring networks developed. Its NBB/PRTR component (National Baseline Budget/ Pollutant Release and Transfer Register) allows the Contracting Parties of the Barcelona Convention to submit the data related to national loads of pollutants discharged directly or indirectly into the Mediterranean Sea for whom it is worth marine monitoring. Since 2000, other international and national policies, such as the European Water Framework Directive and the European Marine Strategy Framework Directive are developing strategies in the Mediterranean Sea which aims to its environmental protection at sub-regional levels and collaborate with UNEP/MAP. At the 19th Ordinary Meeting in 2016 of the Contracting Parties to the Barcelona Convention (Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean and its Protocols) adopted the Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Coast and Sea and Related Assessment Criteria, which includes the targets to achieve the Good Environmental Status (UNEP/MAP, 2016). The initial targets of GES for IMAP Common Indicator 17 are based upon data for a relatively small number of chemicals, reflecting the scope of the current MED POL Programme and the availability of suitable agreed assessment criteria.

Assessment methods

The method for the assessment of the CI 17 has been undertaken by evaluating the latest and available MED POL datasets of levels of chemical contaminants against set environmental criteria (for different matrices) at a regional scale. Heavy metals (Cadmium, Mercury and Lead), petroleum hydrocarbons and persistent organic pollutants (POPs) -from the national coastal monitoring networks reported to the MEDPOL Database- were initially evaluated. However, petroleum hydrocarbons and POPs show a data scarcity, a lack of regional coverage and mostly non-detected concentrations, and therefore, this assessment focus on heavy metals at a regional scale. Three different matrices have been considered, bivalves, fish and sediments, and their contaminant levels compared against background and environmental assessment criteria (BACs and EACs), as adopted by the COP19 in February 2016 for the Mediterranean Sea (Annex to the UNEP(DEPI)/MED IG. 22/7 Decision). The current EACs defining acceptable or non-acceptable environmental chemical status are based on European policy for biota (EC/EU 1881/2006 and 629/2008 Directives for maximum levels for certain contaminants in foodstuffs) and US ERL values (Effects Range Low toxicological criteria) for sediments (see the table below).

Table1: IMAP Assessment Criteria for Heavy Metals

Trace metal	[a]Mussel (MG) µg/kg d.w.			[b]Mussel µg/kg d.w.	[c]Fish (MB) µg/kg d.w.[f]			Sediment µg/kg d.w.		
	BC	Med BAC	EC	BAC	BC	Med BAC	(EC)	BC	[e]Med BAC	ERL
Cd	725	1088	5000	1000	4	8/16[d]	207	-	150	1200
Hg	125	188	2500	170	296	600	4150	-	45	150
Pb	2500	3800	7500	1000	279	558	1245	-	30000	46700

[a] preliminary data for the NW Mediterranean (Spain);
[b] additional BAC data provided by Lebanon for *Brachidontes variabilis* species;
[c] preliminary data for the NW Mediterranean (Spain);
[d] earlier estimation wet weight;
[e] estimated from sediment cores (UNEP(DEPI)/MED WG.365/Inf.8, 2011);
[f] a dry/wet ratio of 20 should be used to convert units for MG (f.w. units = d.w. units / 5)

The species of bivalves (*Mytilus galloprovincialis, MG; Mactra corralina, MC and Donax trunculus, DT)*) and fish (*Mullus barbatus MB)* were evaluated, as well as levels reported in coastal sediment samples. The methodology is based on the calculation of the percentages of stations (units) with levels below or above the BACs and above the EACs criteria (two thresholds and three groups, see graph), and plotted spatially (see GIS maps in Results Section).

In brief, tthe latest relevant year (or years) of non-evaluated MED POL datasets allowing a maximum spatial coverage were selected for each country and matrix in order to construct a regional state assessment integrated over time (*ca*. reflecting the temporal availability of the datasets). The datasets from countries reporting consecutive years were examined to evaluate their consistence (i.e. coordinates, values, methods, DLs) before the selection of the latest dataset for evaluation. Alternatively, the yearly datasets from CPs were mixed to provide a greater spatial coverage when locations changed over years. The data was also averaged when necessary (e.g. when reported yearly replicate samples for the same station).

The biota metrics employed for the assessment was µg/kg dry weight (ppb) for mussel samples (whole soft tissue) and µg/kg fresh weight (ppb) for fish (fillet tissue), for whom the methodologies and data format is harmonized through the MED POL countries. For sediments (in µg/kg dry weight), the data by stations was averaged (or by area when close stations were reported) when necessary, in line with the regional scale of the assessment and the volume of data available. The levels of contaminants in sediment samples includes different fractions as available at the MED POL Database submitted by the CPs and these were combined spatially for the evaluation (ranging from >60µm up to the whole sample).

The datasets used from the MED POL Database for each country and matrix were as follows:

- Bivalves: Croatia (2009, 2011-2014), Egypt (2009-10), France (2012), Israel (2012-13, including 2010 and 2011 for Pb), Italy (2009), Montenegro (2009-2011), Slovenia (2015), Spain (2011), Tunisia (2010-13), Turkey (2009, 2011)
- Fish: Cyprus (2014-2015), Greece (2005), Israel (2013), Spain (2006-08), Turkey (2013)

- Sediments: Croatia (2011, 2013), Egypt (2006, 2009, 2010), France (2009-2011), Greece (2005), Israel (2013), Italy (2009), Montenegro (2010-2011), Morocco (2007), Spain (2007-08, 2011), Syria (2007), Tunisia (2012-13), Turkey (2013).

The quality of the major MED POL legacy contaminant groups datasets were considered, in particular, for heavy metals were a major number of quality assured datasets were available.

In the course of preparing these assessments, several CPs provided new additional data that will be used to perform future assessments (e.g. Tunisia, Turkey, Cyprus, Croatia, Egypt, Israel, Morocco, Montenegro and Slovenia).

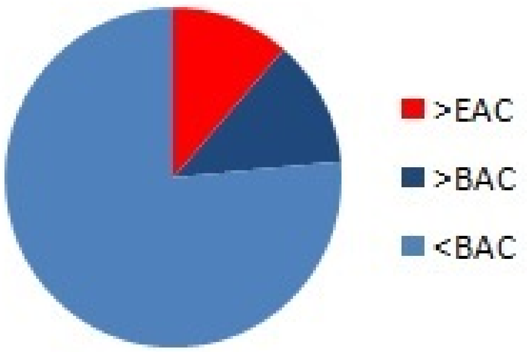

Figure 2. Graph showing the percentage of stations with contaminant concentrations below and above Background Assessment Criteria (BACs), and above Environmental Assessment Criteria (EACs that is either ECs or ERLs for biota and sediment, respectively).

RESULTS

Results and Status, including trends (brief)

The latest available datasets of contaminants reported to the MED POL Database continues to indicate lower levels of legacy pollutants and contaminants in the Mediterranean Sea biota (mainly bivalves), despite known hotspots, similarly to the previous assessment reports (UNEP/MAP, 2009; UNEP/MAP/MED POL, 2011a; UNEP/MAP, 2012a, 2012b) and temporal trends report (UNEP/MAP/MED POL, 2011b, 2016b), whilst chemicals show their accumulation and persistence in the coastal sediments. The monitored chemical contaminants in different matrices, namely mussel, fish and sediments and their assessment against Background Assessment Criteria (BACs) and Environmental Assessment Criteria (namely, ECs and ERLs, for biota and sediment) also point to this conclusion. In general terms, for biota (mussels and fish), the percentage of stations with acceptable environmental conditions, that is below the EC threshold criteria, range from 90% to 100% for Cd, Pb and HgT. Solely some stations assessed for Pb in mussels shows levels above Pb EC for a 10% of the stations at a regional scale. Therefore, all the MED POL assessed stations for biota show acceptable marine environmental conditions except a 10% of them for Pb. On the contrary, the calculated percentages of the monitored levels in the coastal sediments above the assessment criteria (ca. >ERLs), that is non-acceptable environmental conditions, are a 6%, 53% and 13% for Cd, HgT and Pb respectively. Mercury with a 53% of the monitored stations above the ERL in the coastal Mediterranean Sea sediments reflects the need of sub-regional assessment criteria, thus a mixture of natural and anthropogenic known sources might influence this result, especially in the Adriatic Sea and the Aegean and Levantine Seas.

To this regard, a revision of the current assessment criteria has been undertaken (UNEP/MAP/MED POL, 2016a) which should further refine these findings in future assessments. Figures 1 to 9 show the spatial results of the assessment performed at regional scale for the whole Mediterranean basin. The matrices evaluated were coastal populations of marine bivalves (such as *Mytilus galloprovincialis*), fish (such as *Mullus barbatus*) and sediments. Overall, both the calculations and spatial plots assessments reflect few non-acceptable environmental conditions, particularly, for Pb in mussels in some locations and both Pb and HgT in coastal sediments as mentioned (although some are known Mediterranean Sea hotspots and natural input areas); whilst for the rest of matrices and heavy metals evaluated the assessment could conclude acceptable environmental conditions. Clearly, to guarantee the control and achievement of targets (for example, with regard current acceptable conditions for Cd and HgT in biota), and to avoid future deteriorations of the environmental conditions the coastal marine environment needs continuous monitoring and assessment of levels and temporal trends.

Results and Status, including trends (extended)

Cadmium, mercury and lead in Mediterranean bivalves

The Figures 3 to 5 shows the distribution of the assessment performed for heavy metals in the Mediterranean Sea in bivalves. The stations are located mostly in the Western Mediterranean Sea and the Adriatic Sea sub-regions. The assessment primarily shows that Cd and HgT levels are not above the Environmental Assessment Criteria (*ca*. ECs), except for one station for HgT, thus indicating acceptable environmental conditions, which is an improvement of the earlier situation reported (UNEP/MAP/MEDPOL 2011a). A 80% and 69% of the monitored data for Cd and HgT in mussel, respectively, are also below the Background Assessment Criteria (BACs) which further indicates natural background levels. In the same way, the Pb assessment shows the environmental status situation in the Mediterranean basin, despite major mining and industrial activities with levels above the set ECs in the coasts of Spain, Italy and Croatia still known hotspots. A 90% of the stations below the EC value shows acceptable environmental Pb levels (72% below BAC and 18% above BAC), whilst a 10% above the EC indicates that the environmental situation should improve in these areas.

Cadmium, mercury and lead in Mediterranean fish

The new assessment for the pilot projects implemented by some Contracting Parties with regard the monitoring of levels of contaminants in fish shows an acceptable environmental situation (Figures 6 to 8). The assessment of the heavy metals indicates an acceptable environmental status with very few stations above the BACs and none above the ECs. Particularly, the 91%, 83% and 94% of the evaluated stations in both Western and Eastern geographical areas shows values below the BACs for Cd, HgT and Pb indicating naturally occurring levels in fish.

Cadmium, mercury and lead in Mediterranean coastal sediments

The Figures 9 to 11 show the assessment for coastal sediments against BACs and ERLs for the latest information available in the Mediterranean Sea. The concentrations of heavy metals in the coastal sediments show a different picture with respect the environmental information for biota, in particular for HgT and Pb. The number of samples over the ERLs values are higher in this matrix, which responds to the known environmental processes for chemical contaminants in the marine environment were the final compartment is known to be the coastal sediment. Cd shows only 6% and 49% of the evaluated stations above the ERL and BAC, respectively, therefore a 94% of sediment stations with acceptable environmental levels of cadmium. However, few of these 6% of stations are known to be impacted by anthropogenic sources, whilst others respond to different natural input processes, such as the input of Cd from the Atlantic waters through the Gibraltar Strait, the upwelling inputs in the Gulf of Lions or the atmospheric deposition processes in the Mediterranean island of Corsica.

Contrarily, HgT concentrations in coastal sediments reflect a situation far from a good environmental status (GES), according to the current regional assessment criteria, particularly in the NW

Mediterranean, the Adriatic Sea, the Aegean Sea and the Levantine Sea basins. All the data assessed in the different sub-regions shows a 53% of the stations above the ERL. Thus, a 30% above the BAC and 17% below BAC in the coastal sediment, sums a limited 47% of the monitored stations with acceptable environmental conditions. The main sources of this mercury in the marine environment are due to the industrial exploitation of mines of the Hg-rich natural land resources in these areas. It should be pointed out that the reference values agreed are based on information from core sediments collected in the Mediterranean Sea and the revision of these values has been proposed (UNEP/MAP MED POL, 2016a) to include sub-regional criteria to balance the potential geological background differences through the Mediterranean basins in future assessments. On the contrary, for Pb, a, different geographical composition between the Western and Eastern Mediterranean coastal sediments composition might overestimate the acceptable environmental conditions for the latter, if a single set of regional assessment criteria is used (UNEP/MAP/MED POL (2016a) In the Western Mediterranean a 11% of the stations are above the ERL, thus a 89% of stations with acceptable natural environmental conditions (only a 12% above the BAC). As mentioned above, however, none of the stations evaluated in the Eastern Mediterranean coasts show values above the ERL, and for the Levantine Sea none of the stations show even values above the BAC criteria, therefore, reflecting that different assessment criteria for Pb at sub-regional scales in the Mediterranean Sea should be considered, thus some known hotspots for Pb inputs are known in the Eastern Mediterranean Sea. As for the case of HgT, the Pb criteria, BACs and ERLs, for sediments are under proposal to refine the future assessments at a sub-regional scales (UNEP/MAP MED POL, 2016a).

Persistent Organic Pollutants (POPs) and Non-halogenated compounds

Persistent organic pollutants (POPs) include certain legacy chlorinated pesticides and industrial chemicals, such as the so called polychlorinated biphenyls (PCBs), most of which have already been prohibited at global scale under the Stockholm Convention. These chemical substances are resistant to environmental degradation processes, and therefore persistent and prone to long-range transport. In the marine environment the bioaccumulation and biomagnification in organisms have been largely investigated, as well as their implications for human health. The scarcity of recent POPs quality assured datasets in the MED POL Database and the fact that most of these show non-detectable levels, mainly in biota matrices, is in accordance with the earlier lowering levels and trends observed in previous reports (UNEP/MAP/MED POL 2011a, 2011b, 2012) and no further updates could be performed at present.

Similarly, the historical levels of petroleum hydrocarbons from a number of urban, industrial and sea activities in the marine environment have been reduced, probably the most significant example is the reduction of the spilled oil in the Mediterranean Sea (i.e. acute pollution) compared to previous decades. However, continuous chronic oil petroleum pollution continues associated to main harbors, sea-based sources and atmospheric inputs. Oil is composed of thousands of compounds and includes the group of the Polycyclic Aromatic Hydrocarbons (PAHs) which some of them are the current targeted compounds. . Further, it is interesting to point out the overlooked importance of inputs from particular marine operations, such as the oil exploitation, due to the introduction of PAHs in the marine environment but also of other chemicals (e.g. phenols) along with the produced-water from these installations.

Emerging chemical compounds

The occurrence of emerging compounds in the Mediterranean Sea has gained relevance over the last decade both in the northern and southern coasts. Different groups of chemicals, such as environmental phenols, pharmaceutical compounds, personal care products, polycyclic fragrances and many others are currently under investigation. Particularly, it is worth to mention as well, the recent focus on the occurrence of marine litter from nano to macro sizes in the marine ecosystems, a new major treat for the Mediterranean Sea.

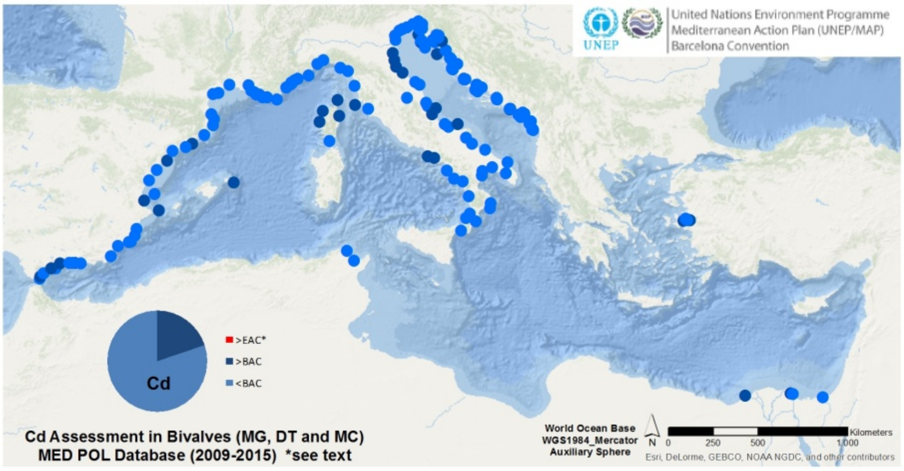

Figure 3. Regional Cadmium levels assessment against BAC/EAC (EC) criteria in bivalve sp. (*Mytilusgalloprovincialis, Donax trunculus and Mactra corralina*) for the Mediterranean Sea, Bivalve Cd.jpg

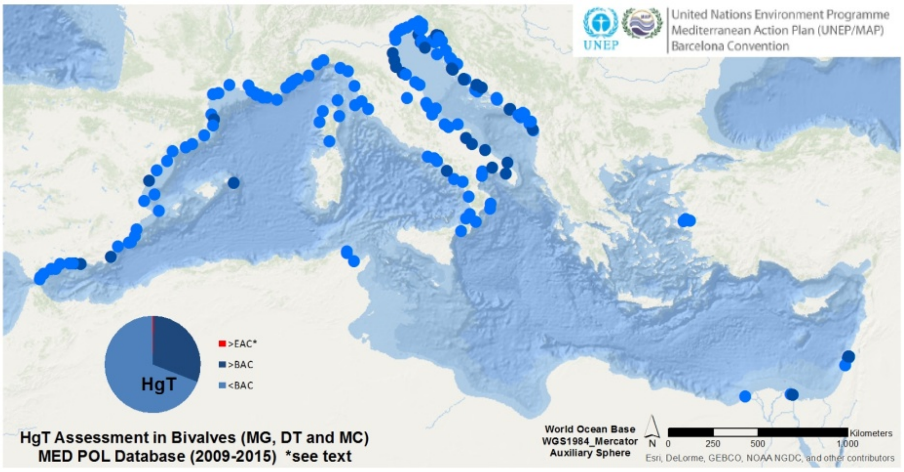

Figure 4. Regional Mercury levels assessment against BAC/EAC (EC) criteria in bivalve sp. (*Mytilusgalloprovincialis, Donax trunculus and Mactra corralina*) for the Mediterranean Sea, Bivalve HgT.jpg

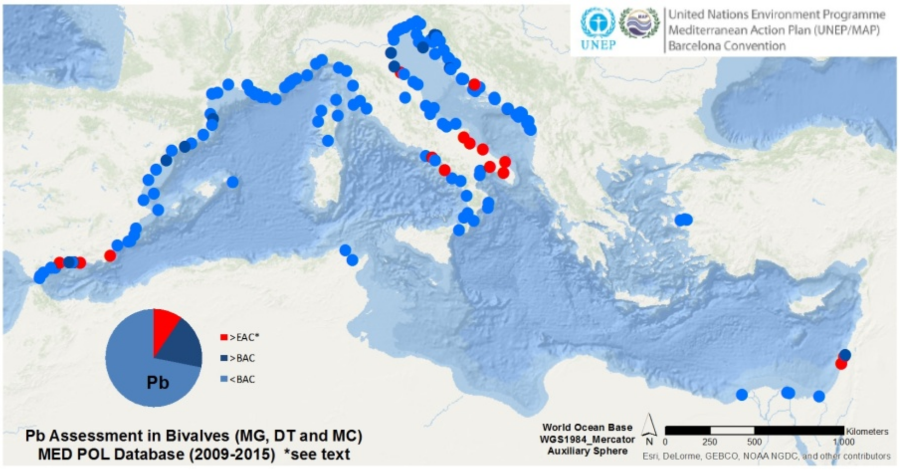

Figure 5. Regional Lead levels assessment against BAC/EAC (EC) criteria in bivalve sp. (*Mytilusgalloprovincialis, Donax trunculus and Mactra corralina*) for the Mediterranean Sea, Bivalve Pb.jpg

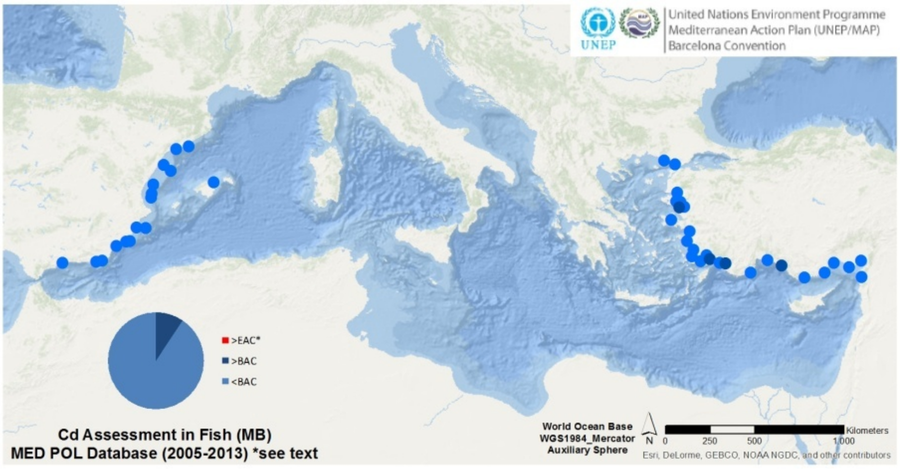

Figure 6. Regional Cadmium levels assessment against BAC/EAC (EC) criteria in fish sp. (*Mullus barbatus*) for the Mediterranean Sea, Mullus Cd.jpg

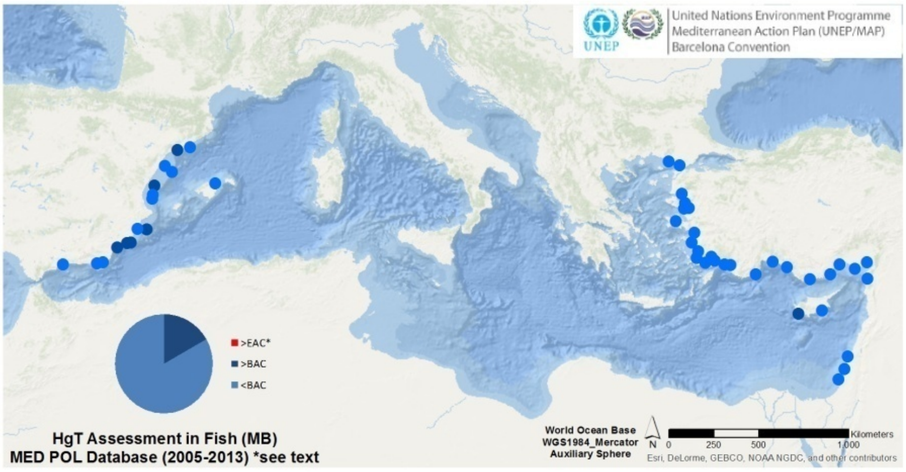

Figure 7. Regional Mercury levels assessment against BAC/EAC (EC) criteria in fish sp. (*Mullus barbatus*) for the Mediterranean Sea, Mullus HgT.jpg

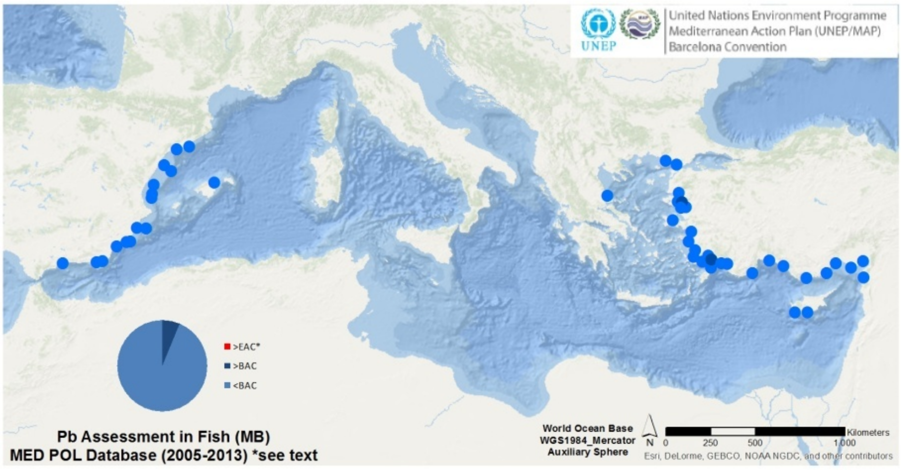

Figure 8. Regional Lead levels assessment against BAC/EAC (EC) criteria in fish sp. (*Mullus barbatus*) for the Mediterranean Sea, Mullus Pb.jpg

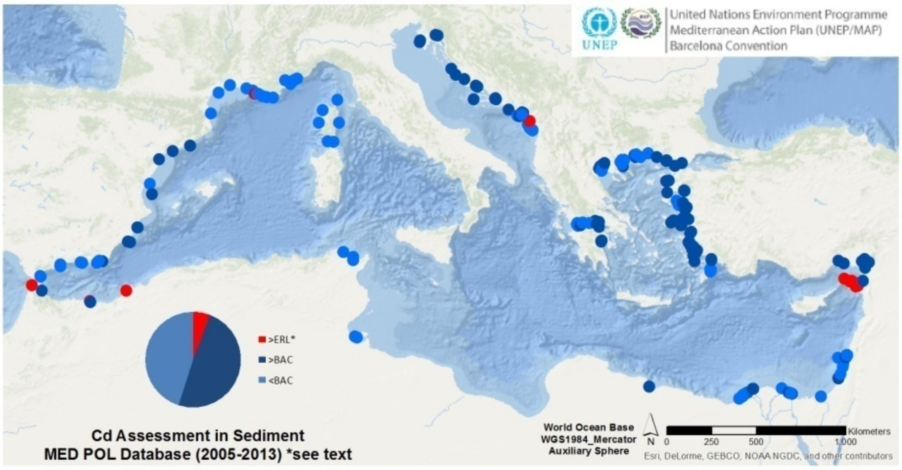

Figure 9. Regional Cadmium levels assessment against BAC/EAC (ERL) criteria in sediment for the Mediterranean Sea, Sediment Cd.jpg

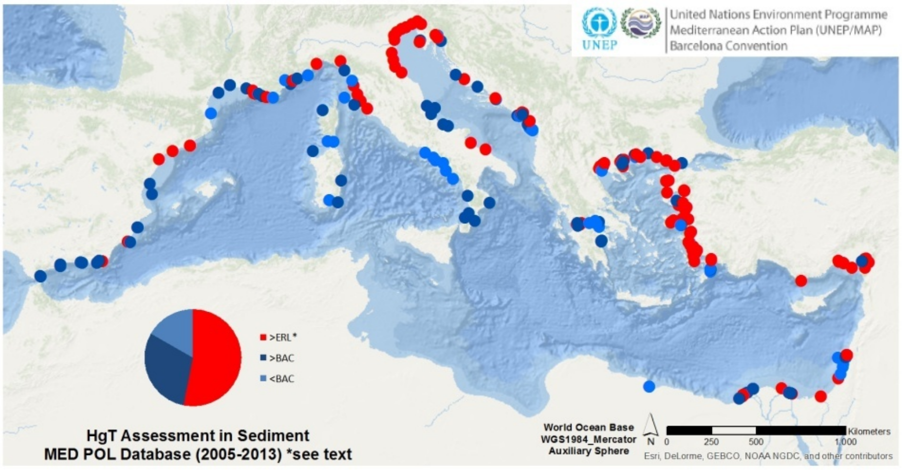

Figure 10. Regional Mercury levels assessment against BAC/EAC (ERL) criteria in sediment for the Mediterranean Sea, Sediment HgT.jpg

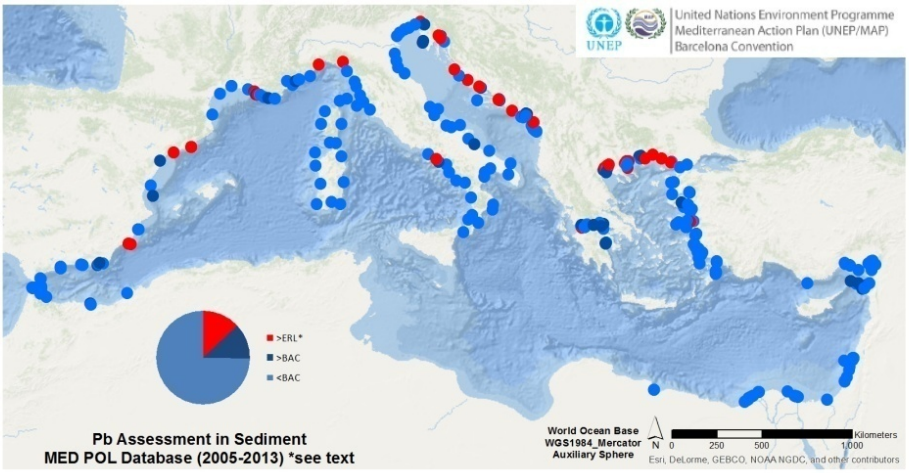

Figure 11. Regional Lead levels assessment against BAC/EAC (ERL) criteria in sediment for the Mediterranean Sea, Sediment Pb.jpg

CONCLUSIONS

Conclusions (brief)

A main conclusion of this first pollution assessment against assessment criteria performed for heavy metals in the Mediterranean Sea shows that environmental conditions differ largely between biota and coastal sediments. This current situation, in terms of environmental protection from chemical pollution and GES achievement, indicates that the LBS inputs in the coastal surface waters (and/or atmospheric inputs) from both urban or industrial activities shows little concern (ca. under control measures) with a high proportion of values in biota under the EACs (*ca*. ECs); and therefore, acceptable environmental conditions. On the contrary, the legacy of heavy metal pollution shows an accumulation in the coastal sediments close to both historical known Mediterranean hotspots and natural sources which should be locally assessed.

Conclusions (extended)

In terms of GES (Good Environmental Status) assessment, the biota (mussel and fish) show a situation where the acceptable conditions exist for coastal surface marine waters with levels below the assessment criteria (i.e. ECs), except for Pb in some mussel monitoring areas. These areas correspond to known coastal sites (hotspots) were measures and actions should be further considered to improve the marine environmental quality. The sediment evaluation in terms of GES show an impacted situation for the coastal benthic ecosystem, especially for HgT, to be further investigated and assessed. Therefore, these assessments should consider sub regional differences in the Mediterranean Sea basins, as well as the occurrence of natural and anthropogenic sources. Therefore, the development of assessment criteria for sub regional assessments should be a priority and these initial results should be taken with caution. To this regard, there is a need to consider the relationships between different policy standards and assessment metrics (i.e. WFD, MSFD, etc).

Key messages

- Levels of heavy metals in coastal water show an acceptable environmental status assessed from mussels and fish against BACs and EACs (*ca*. ECs).
- For Pb a 10% of the stations show levels above the set EC threshold for mussel samples.
- Heavy metal concerns are found in the coastal sediment compartment for Pb and HgT indicating an accumulation of these chemicals.
- For HgT, a 53% of the stations assessed are above the ERL set as regional assessment criteria for acceptable environmental conditions for the Mediterranean basin, although sub-regional differences have to be taken into account.
- Measures and actions should focus on known hotspots associated to urban and industrial areas along the coasts of the Mediterranean Sea, as well as to include sea-based sources, as these are also primary inputs.
- Background and Environmental Assessment Criteria (BACs and EACs) should be further improved to take in consideration sub-regional specificities for occurring natural compounds, such as heavy metals

Knowledge gaps

There are no new gaps identified in the Mediterranean Sea concerning the assessment of the Common Indicator 17. The improvements in the limited spatial coverage, temporal consistency and quality assurance for monitoring activities hinders to some extent the regional and sub-regional assessments, as previously observed (UNEP/MA/MED POL, 2011a and 2011b). The lack of sufficient synchronized datasets for a state assessment should be improved. To this regard, the criteria to undertake the assessment have further shown the necessity to explore the new criteria at sub regional

scale for the determination of background concentrations of those chemicals occurring also naturally, such a Pb in sediments. Two recent reports (UNEP/MAP MED POL, 2016a and 2016b) have reviewed and proposed the background and environmental assessment criteria (BACs and EACs) for the Mediterranean Sea. These reports were built in line with the 2011 reports (UNEP/MAP MED POL, 2011a and 2011b).
The current assessment period covered span for different periods including the most recent data available, despite the number of datasets did not increased significantly the potential evaluation of temporal trends. At present, the major studies are performed in the coastal population of marine bivalves (such as *Mytilus galloprovincialis*), fish (such as *Mullus barbatus*) and sediments.

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Ecological Objective 9 (EO9): Chemical pollution

EO9: Common Indicator 18: Level of pollution effects of key contaminants where a cause and effect relationship has been established

GENERAL

Reporter:	UNEP/MAP/MED POL
Geographical scale of the assessment:	Regional, Mediterranean Sea
Contributing countries:	Contracting Parties by research studies
Mid-Term Strategy (MTS) Core Theme	1-Land and Sea Based Pollution
Ecological Objective	EO9. Contaminants cause no significant impact on coastal and marine ecosystems and human health
IMAP Common Indicator	CI18. Level of pollution effects of key contaminants where a cause and effect relationship has been established
Indicator Assessment Factsheet Code	EO9CI18

RATIONALE/METHODS

Background (short)

In most Mediterranean countries, the coastal monitoring of a range of chemicals and biological effects parameters in different marine ecosystem compartments and organisms are undertaken in response to the UNEP/MAP Barcelona Convention (1975) and its Land-Based Sources (LBS)Protocol. A considerable amount of founding actions from the past decades are available through the pollution monitoring and assessment component of the UNEP/MAP MED POL Programme, including monitoring pilot programmes such as the ecotoxicological effects of contaminants (UNEP/MAP MED POL, 1997a, 1997b; UNEP/RAMOGE, 1999). When exposed to chemical substances some harmful effects can be observed at different levels in marine organism. These effects depending on the level of exposure could be classified in lethal, sublethal and chronic. These impair the normal development and life cycle of the marine organisms. The environmental assessments have been used for the identification and confirmation of significant occurrence, distributions, levels, trends of contaminants and their effects; as well as, for the continuous development of monitoring strategies. With respect to the Ecosystem Approach Process and the Integrated Monitoring and Assessment Programme (IMAP) and related Assessment Criteriatheir implementation will continue under the benefits gained from this past knowledge and the policy framework built in the Mediterranean Sea (UNEP/MAP, 2016; UNEP/MAP MED POL, 2016).

Good Environmental Status (GES) for Common Indicator 18 can be accomplish (UNEP/MAP, 2013) when contaminant effects (ca. biomarkers) are below the proposed assessment criteria (see Table 1).

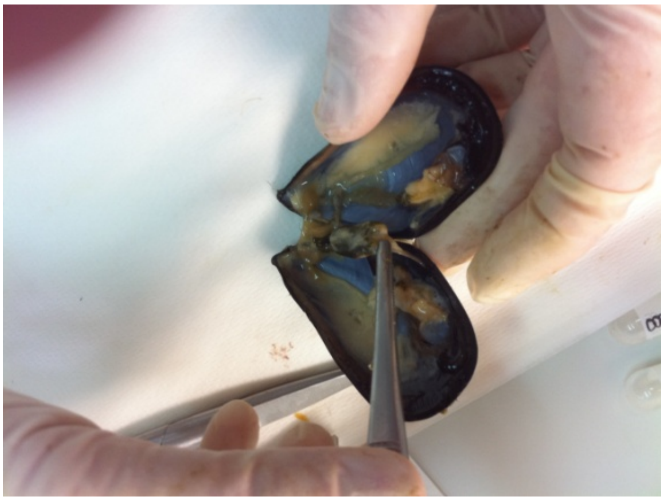


Figure 1: Preparation of a fresh mussel for both chemical and biological effects analysis by dissection of different organs, Musseldissectionforanalysis_CGuitart.jpg

Background (extended)

The marine organisms are exposed to the chemical substances released in the marine environment which cause harmful effects at subcellular and cellular organization levels of an individual, and therefore, have the potential to correlate with the disfunctioning of the populations and the ecosystem as a whole. Several pilot monitoring programmes were initiated developed by Contracting Parties (Croatia, France, Greece, Italy and Spain) with the objective to implement a biological effects monitoring onto the current national networks of sampling stations for chemical monitoring in the Mediterranean Sea under MED POL (UNEP, 1997a). The use of a number of biomarkers, bioassays and associated biological parameters in an integrated manner altogether with information on environmental chemicals should provide clearer information of the pollution effects in the marine environment; and therefore, through monitoring the biological effects, elucidate the potential of chemical pollution damages in the marine ecosystems. A number of toxicological tests have found consensus and were recommended by a number of CPs, namely, Lysosomal Membrane Stability (LMS) as a method for general physiological status screening, Acetylcholinesterase (AChE) assay as a method for assessing neurotoxic effects in aquatic organisms and Micronucleus assay (MN) as a tool for assessing cytogenetic/DNA damage in marine organisms (UNEP/RAMOGE, 1999).

Additionally, the survival on air (or Stress on Stress, SoS), was also incorporated as a general method to determine physiological condition in mussels. In the latest decade, scientific research has been intensified towards alternative biological effect-based tools for integrated pollution monitoring, thus the integrative assessment revealed a more complex panorama when real samples are exposed to lowered (environmental) concentrations (i.e. sublethal effects). A number of confounding factors (eg. nutritive status, temperature, etc.) might be hindering the cost-effectiveness and reliable use of these methods to determine the contaminant biological effects at physiological, cellular and sub-cellular levels (González-Fernández et al., 2015a and 2015b, ICES, 2012). As a consequence, most of these methods (ca. biomarkers), based on the premise of cause-effect relationship to chemical exposure, are envisaged to found applications to monitor high contaminant concentrations (hotpots stations), dredging materials assessments and local damage evaluations after acute pollution events rather than for long-term environmental monitoring (surveillance monitoring). Ongoing research (biomarkers, bioassays) and future research trends, such as ‘omics’ developments, will further shape the evaluation tools for this common indicat18 and its methodologies as recently reviewed by the European Union (EU, 2014).

Assessment methods

The present assessment has been mainly constructed based on the current status of bibliographic studies and scientific documents published in the Mediterranean Sea area, as the biological effects datasets through the MED POL Database are not yet fully available at regional scale. The full assessment of the Common Indicator 18 will be based on the integrated evaluation of the biomarkers selected for their monitoring in the Mediterranean Sea, namely, Acetylcholinesterase activity (AChE), Lysosomal membrane stability (LMS) and Micronuclei frequencies (MN) on first instance. Further, the enzyme 7-ethoxy-resorufin-O-deethylase (EROD) and Metallothionenin (MT) has been also indicated for fish and mussel samples, respectively. For the former parameters the environmental criteria has been developed in terms of Background Assessment Criteria (BACs) and Environmental Assessment Criteria (EACs) (see Table 1) and revised (UNEP/MAP/MED POL, 2016). Further, complementary biomarkers, bioassays and histology techniques and other methods are also recommended to be carried out on a country basis (such as, comet assay, hepatic pathologies assessment, etc) to contribute to the assessment of the CI18.The assessment of biomarker responses against Background Assessment Criteria (BACs) and Environmental Assessment Criteria (EACs) will allow to establish if the responses measured belong to the levels that are not causing deleterious biological effects (<BACs), levels where deleterious biological effects are possible (>BACs) or levels where deleterious biological effects are likely to occur (>EACs) in the long-term (UNEP/MAP MED POL, 2016; UNEP/MAP, 2016).

The assessment criteria (see below) was adopted by the COP19 in February 2016 for the Mediterranean Sea (UNEP/MAP, 2016) and new assessment criteria has been proposed based on Mediterranean reference stations datasets (UNEP/MAP/MED POL, 2016). Initial results with reference stations used to determine the background levels with datasets from the MED POL monitoring networks for this Common Indicator 18 are presented in the results section.

Table 1: Environmental Assessment Criteria for Biological Effects assessments under IMAP (UNEP/MAP, 2016).

Biomarkers/Bioassays	BAC levels in Mussels (*Mytilus galloprovincilais)*(mg/kg d.w.)	EAC levels in Mussels (*Mytilus galloprovincilais*) (mg/kg d.w.)
Stress on Stress (days)	10	5
Lysosomal membrane stability Neutral Red Retention Assay (minutes)	120	50
Lysosomal membrane stability Cytochemical method (minutes)	20	10
AChE activity (nmol min-1 mg-1 protein) in gills (French Mediterranean waters)	29	20
AChE activity (nmol min-1 mg-1 protein) in gills (Spanish Mediterranean waters)	15	10
Micronuclei frequency (0/00) in haemocytes)	3,9	-

RESULTS

Results and Status, including trends (brief)

In the Mediterranean Sea, the biological effects have recently been extended to studies in mussels exposed to outfall effluents and complex mixtures of pollutants using a battery of biomarkers (de los Ríos et al., 2012), pelagic fish (Fossi et al., 2002; Tomasello et al., 2012) and combining wild and caged mussels (Marigómez et al., 2013), as well as in acute pollution accidental episodes such as oil spills (Marigómez et al., 2013b, Capó et al., 2015). In the Eastern Mediterranean, the LMS (neutral red retention method, NRR) and the AChE levels have been evaluated in mussels *Mytilus* *galloprovincialis* collected from Thermaikos and Strymonikos Gulfs in the northern Greece (Dailanis et al., 2003) and more recently including a number of marine species from the Eastern Mediterranean and the Black Sea (Tsangaris et al., 2016). In the Adriatic Sea, the use of biomarkers has found applications in the monitoring of the anthropogenic impact due to the exploitation of gas fields (Gomiero et al. 2015) and studies of the genetic stability caused by pollution have been also investigated in Croatian laboratories (Stambuk et al. 2013). In the southern Mediterranean Sea, trials have been undertaken on the integrated use of biomarkers, and the development of biomarker indexes to study the spatial and temporal variations in locations with different levels of pollution in Algeria (Benali, et al., 2015) and in the Lagoon of Bizerte in Tunisia (Ben Ameur et al., 2015; Louiz et al., 2016). In the NW Mediterranean, investigations of benthic fish associated to the continental platform, (*Solea solea* and *Mullus barbatus)* have been investigated for hepatic and branchial biomarkers, and studies of a battery of biomarker responses for biological effects to elucidate the sentinel species in pollution monitoring (Siscar, et al., 2015, Martinez-Gómez et al., 2012). High value commercial species, such as tuna (*Thunnus thynnus*) have also been investigated in Mediterranean Sea (Maisano et al. 2016). In the coastal environment, the rivers flowing into the Mediterranean such as Llobregat River (Spain), have also been used as locations to investigate the biological effects in invertebrate communities (Prat, et al., 2013; de Castro-Català, 2015). Recently, within new methodological trends, such as metabolomic responses and differences in metabolite profiles, were observed in clams (*Ruditapes decussatus*) between control and polluted sites in the Mar Menor Lagoon in the Western Mediterranean (Campillo, et al. 2015). These biological effects based tools have been also tested for the direct effects of pharmaceuticals in laboratory experiments in the Mediterranean Sea (Mezzelani, et al., 2016).

Results and Status, including trends (extended)

The Figures 1 to 3 shows the biomarkers evaluation results for the MED POL reference stations datasets extracted from the proposed revision document (UNEP/MAP/MED POL, 2016) in the Mediterranean Sea showing differences at sub-regional levels and compared to the current IMAP assessment criteria.

In detail, it should be noticed in Figure 1, that the LMS-NRR results (median value) for the reference stations in the Mediterranean Sea are below the standard acceptable values (both <BACs and <EACs) set by OSPAR (ICES, 2012) to assess healthy biota specimens for this biomarker. Therefore, these discrepancies being datasets for reference stations might reflect the influence of confounding factors in the environment in relation to general stress biomarker responses (e.g. nutritive status, hypoxia, spawning state, temperature, etc.), and therefore, hinder the correlations with the exposure to hazardous chemical substances, as discussed recently in the literature (Minguez et al. 2012; Cuevas et al., 2015; González-Fernández et al., 2015a, 2015b). In any case, the further development of Med BCs and Med BACs in Mediterranean mussels with the number of datasets provided is not conclusive within the MEDPOL biological effects monitoring programme. In Figure 2, the Adriatic Sea sub-region show an AChE inhibition half way to unacceptable levels of biological effects (i.e. <BAC and >EAC) for reference stations, which should be further investigated, and contrasts with the median level determined in the WMS sub-region, thus being both reference areas from Croatia and Spain, respectively. Figure 3, shows that the sub-regions medians for reference stations are safely below the calculated Med BAC for metallothioneins, despite sub-regional BCs above the calculated Med BAC (Middle Adriatic Sea). Further information and details can be found in UNEP/MAP/MED POL (2016) report.

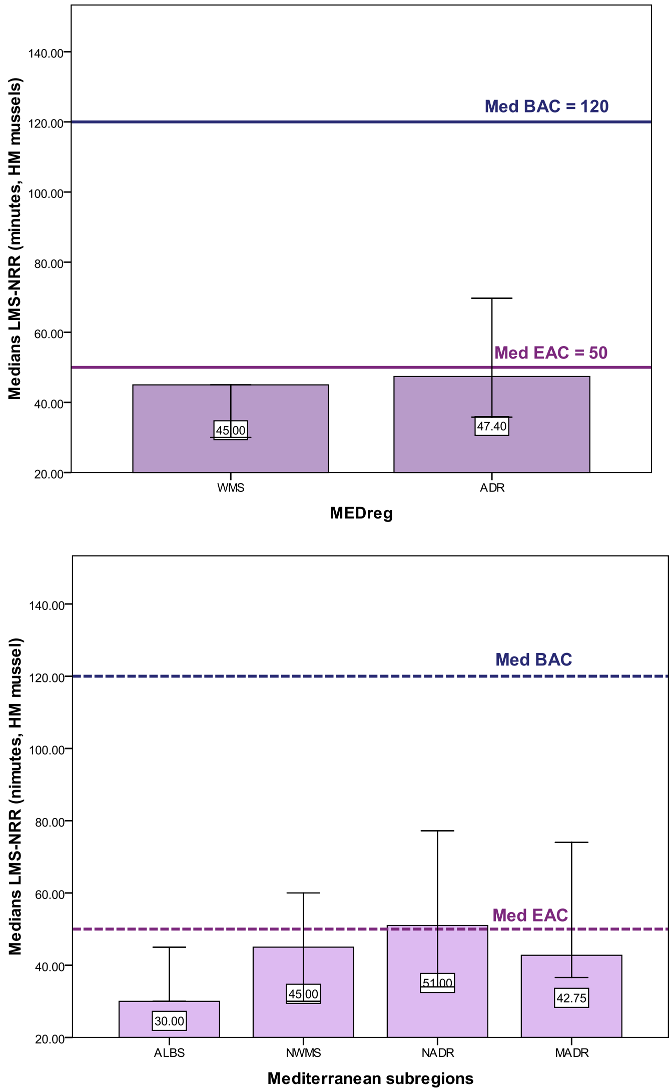
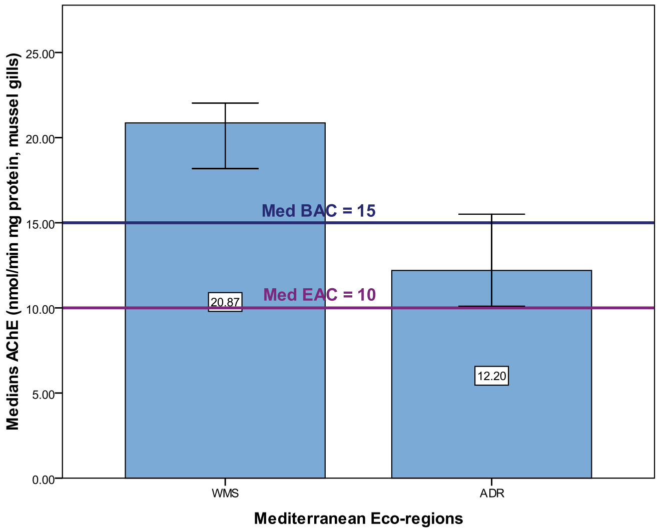


Figure 1. LMS-NRR (Neutral red retention) medians (BCs) in mussel by eco-region and sub-regions for selected reference stations in the Mediterranean Sea. The error bar is a 95% confidence interval for the mean.



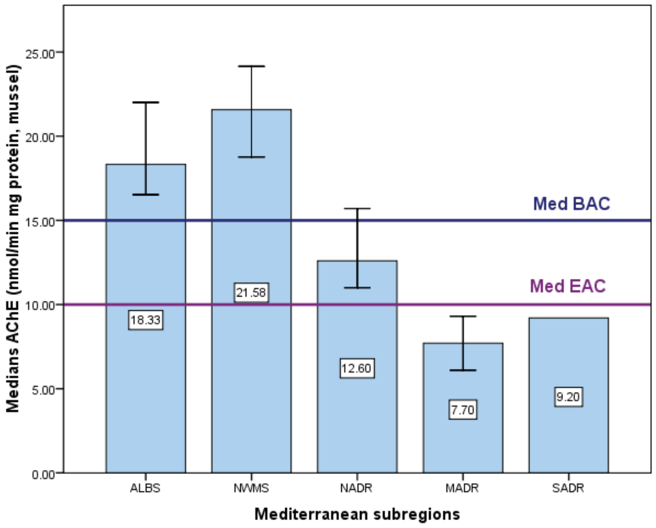


Figure 2. Metallothioneins medians (BCs) in mussel digestive gland by eco-region and sub-regions for selected reference stations in the Mediterranean Sea. The error bar is a 95% confidence interval for the mean.

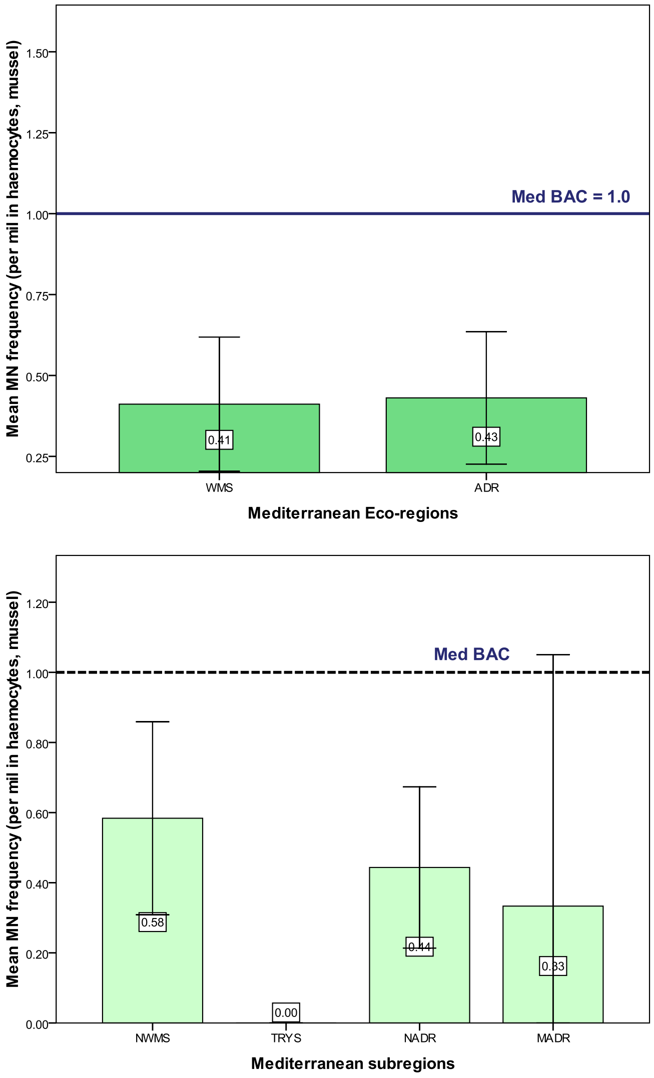


Figure 3. Micronuclei frequency medians (BCs) in mussel by eco-region and sub-regions for selected reference stations in the Mediterranean Sea. The error bar is a 95% confidence interval for the mean.

CONCLUSIONS

Conclusions (brief)

The ongoing research developments and controversy with regard biological effects and toxicological methods (*ca*. confounding factors) is one of the main reasons for the slow implementation of these techniques in marine pollution monitoring programs in the Mediterranean Sea, although as mentioned some are proposed. At present, in many Mediterranean countries, different research programmes and projects leaded by universities, research centers and government agencies are undergoing and will be the providers of the future quality assured and reliable measurements and tools to guarantee the correct implementation of a biological effects programme to assess the Common Indicator 18 in the Mediterranean Sea.

Conclusions (extended)

Assessing biological effects, in a similar manner to contaminant concentrations, ICES/OSPAR has proposed two/three categories and it has been the framework to evaluate the Mediterranean Sea MED POL datasets. Assessing biomarker responses against BAC and EAC allows establishing if the responses measured are at levels that are not causing deleterious biological effects, at levels where deleterious biological effects are possible or at levels where deleterious biological effects are likely in the long-term. In the case of biomarkers of exposure, only BAC can be estimated, whereas for biomarkers of effects both BAC and EAC can be established. However, unlike contaminant concentrations in environmental matrices, biological responses cannot be assessed against guideline values without consideration of factors such as species, gender, maturation status, season and temperature. It is expected that in the forthcoming years, the scope of experts groups would be to prepare an adapted manual establishing the BAC and when possible, the formulation of EAC for selected biomarkers in Mediterranean species.

Key messages

- Biological effects monitoring tools still in a research phase for biomarker techniques (i.e. method uncertainty assessment and confounding factors evaluation) which limits the implementation of these tools in the long-term marine monitoring networks.
- Lysosomal Membrane Stability (LMS) as a method for general status screening, Acetylcholinesterase (AChE) assay as a method for assessing neurotoxic effects and Micronucleus assay (MN) as a tool for assessing cytogenetic/DNA damage in marine organisms have been selected as primary biomarkers.

Knowledge gaps

Important development areas in the Mediterranean Sea over the next few years should include: confirmation of the added value of these batteries of biomarkers in long-term marine monitoring as ‘early warning’ systems; test of new research-proved tools such as ‘omics’, analytical quality harmonization, development of suites of assessment criteria for the integrated chemical and biological assessment methods, and review of the scope of the biological effects monitoring programmes. Through these and other actions, it will be possible to develop targeted and effective monitoring programmes tailored to meet the needs and conditions within the GES assessments.

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Ecological Objective 9 (EO9): Pollution

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

GENERAL

Reporter:	REMPEC
Geographical scale of the assessment:	Regional, Mediterranean Sea
Contributing countries:	Mediterranean assessment based on existing regional surveys, research and publications.
Mid-Term Strategy (MTS) Core Theme	Land and Sea Based Pollution
Ecological Objective	Ecological Objective 9 (EO9) – Pollution: Contaminants cause no significant impact on coastal and marine ecosystems and human health.
IMAP Common Indicator	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).
Indicator Assessment Factsheet Code	EO9CI19

RATIONALE/METHODS

Background (short)

Pollution from ships was one of the first issues addressed by the Mediterranean coastal States when they decided to act collaboratively to protect the Mediterranean Sea area in 1975. The 1967 Torrey Canyon oil spill accident, which resulted in massive oil pollution, raised the public awareness on pollution from shipping activities. Concern was expressed regarding possible oil and other harmful substances that may be released in the Mediterranean Sea, a semi-closed marine area. This led to the establishment of the Mediterranean Action Plan (MAP)’s first Regional Activity Centre (ROCC – Regional Oil Combating Centre, now REMPEC – Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea) and to the adoption, under the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (“the Barcelona Convention”), of the Protocol Concerning Co-operation in Combating Pollution of the Mediterranean Sea by Oil and other Harmful Substances in Cases of Emergency (“the 1976 Emergency Protocol”). This Protocol was revised in 2002 to include prevention of pollution from ships to emergency situations and is today referred to as the Protocol concerning Cooperation in Preventing Pollution from Ships and, in Cases of Emergency, Combating Pollution of the Mediterranean Sea (“the 2002 Prevention and Emergency Protocol”). The Protocol addresses pollution incidents, which includes both accidental pollution and illicit discharges. Pollution from oil and other hazardous substances were also addressed internationally in a number of conventions adopted under the aegis of the International Maritime Organization (IMO), some of which provides for stricter regime in the Mediterranean Sea. Although action at regional and international level has resulted in a significant decrease of massive oil pollutions from ships, incidents and illegal discharges are still responsible for the release of oil, oily mixtures and other Hazardous and Noxious Substances (HNS) at sea. It is on these grounds that the Contracting Parties to the Barcelona Convention included a Common Indicator (CI 19) on “*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*" under Ecological Objective 9.

Background (extended)

Increasing shipping and maritime activities are important drivers for anthropogenic pressure on the marine environment in the Mediterranean Sea. Pressure from maritime transport includes potential chemical pollution from oil and HNS, dumping of garbage at sea, release of sewage, biofouling and non-indigenous species introduction. As documented in a great number of scientific researches, chemical pollution by oil and other harmful substances has impacts on water, seabed, fauna and flora. The level of risk of an accident occurring in the Mediterranean Sea is driven by two factors: traffic density as well as routes for oil and chemical tankers. In addition, illicit discharges of oil from ships remain a concern.

- **Risk of accidents:**

The Mediterranean is a major shipping lane. It is estimated that around 80% of global trade by volume and over 70% of global trade by value are carried by sea (UNCTAD, 2015), with approximately 15% of global shipping activity by number of calls and 10% by vessel deadweight tons (dwt) (REMPEC, 2008) taking place in the Mediterranean. The area is an important transit route for shipping, with two of the narrowest and busiest straits in the world: the Strait of Gibraltar and the Bosphorus Strait. The Mediterranean is a major transit route. In 2006, around 10,000, mainly large, vessels transited the area en-route between non-Mediterranean ports. In addition to hosting an important transit lane for international shipping, the Mediterranean Sea is also a busy traffic area due to Mediterranean Sea born traffic (movement between a Mediterranean port and a port outside the Mediterranean), and short sea shipping activities. It is estimated that around 18% of the shipping traffic in the Mediterranean Sea takes place between two Mediterranean ports (REMPEC, 2008). Figure 1 is a representation of the maritime traffic in the Mediterranean Sea.

Although several factors contribute to maritime casualties, the correlation between traffic density and accidents causing a pollution is confirmed by the fact that "collisions allisions" represent the first cause of accidents (26%) resulting in an oil spill as recorded by the International Tankers Oil Pollution Federation (ITOPF) between 1970 and 2016. In the Mediterranean, the "collision/contact" category accounts for 17% of accidents reported to REMPEC, after "grounding" (21%). The contribution of other accident types are as follows: "fire/explosion": 14%, "cargo transfer failure": 11%, "sinking": 9%, and "other accidents": 28%. Several studies, based on the daily traffic crossing the Istanbul Strait and the Bosphorus, identified the east Mediterranean / Black Sea area as one of the top areas presenting the greatest probability of a shipping accident occurring.

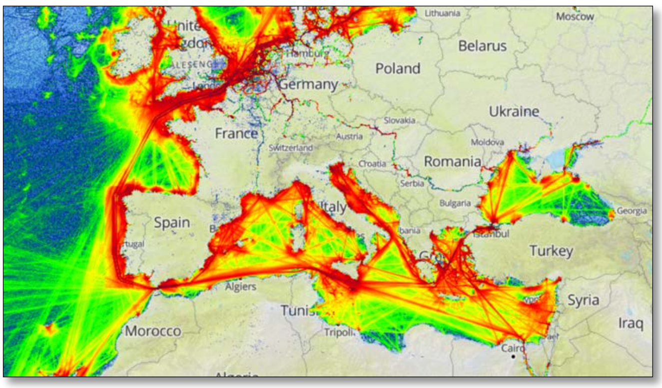

Figure 1: Density of maritime traffic in the Mediterranean Sea **(**Source: marinetraffic.com).

The Mediterranean is an important route for oil tankers' shipments. The Mediterranean Sea is also a major route for tankers. The REMPEC study mentioned above shows that the Mediterranean is both a major load and discharge centre for crude oil. Approximately 18%, or 421 million tonnes, of global seaborne crude oil shipments which in 2006 amounted to approximately 2.3 billion tonnes, take place within or through the Mediterranean. The following figures (Figure 2, Figure 3 and Figure 4) show the oil export areas and overseas destinations through the Mediterranean Sea.

Figure 2: Oil export source and destinations (North Africa) (Source: Tankers International website).

Figure 3: Oil export source and destinations (Middle East) (Source: Tankers International website).

Figure 4: Oil export source and destinations (Black Sea) (Source: Tankers International website).

Figures 3 and 4 above emphasis that the East Mediterranean area is at risk: in addition to being an area where traffic is dense, it is also a hot spot because of tanker routes from the Black Sea and the Middle East.

Deliberate discharges at sea

It was demonstrated, with the use of satellite imagery and other observation tools that deliberate oil pollution occurrences are high along busy traffic lanes. In the Mediterranean, there is evidence that the distribution of oil spills is correlated with the major shipping routes, along the major west-east axis connecting the Strait of Gibraltar through the Sicily Channel and the Ionian Sea with the different distribution branches of the Eastern Mediterranean, and along the routes towards the major discharge ports on the northern shore of the Adriatic Sea, east of Corsica, the Ligurian Sea and the Gulf of Lion (UNEP/MAP, 2012).

Assessment methods

Assessment of accidents:

In the Mediterranean region, under the 2002 Prevention and Emergency Protocol, assessment of occurrences, origins and extents of oil and HNS pollution from ships is carried out on the basis of pollution reports (POLREP) sent by the Contracting Parties to the Barcelona Convention to REMPEC and other affected States to notify a pollution or an event that could result in a pollution. These reports provide details on the incidents, including position, extent of pollution, characteristics of pollution, sources and cause of pollution, trajectory of pollution, forecast and likely impacts, as well as sea state and meteorological information.

The reports sent to REMPEC are also used to feed the database on alerts and accidents in Mediterranean Sea (the Mediterranean Alerts and Accidents Database) maintained by the Centre. Records of oil spills and accidents likely to cause spillages of oil in the Mediterranean started in 1977, while accidents involving other HNS are reported since 1988. Another main source of information used to populate the Alert and Accident Database is the Lloyd’s Casualty Reporting Services (LCRS).

Accidents recorded in this database are accidents that caused or were likely to cause pollution by oil or other HNS in the Mediterranean Sea area. Accidents included are:

- Accidents happening in the Mediterranean Sea as defined in the Barcelona Convention;
- Accidents involving any type of ship, which actually resulted in an oil spill, a spill or release of a HNS, or in a loss or damage to a container containing HNS;
- Accidents on land (terminals, storage tanks, pipelines, industries, power plants, etc.) that resulted in entry into the sea of oil or HNS;
- Accidents involving one or more oil tankers or chemical tankers (either laden or not);
- Collisions, groundings or other accidents causing serious damage to the ships involved, in particular if these carried or could carry significant quantities of fuel oil as bunkers;
- Accidents involving sinking of vessels that had on board any quantity of oil as bunkers; and
- Accidents involving sinking of vessels that carried HNS as cargo (either in bulk or in packaged form).

Assessment of illicit discharges:

Monitoring of illicit discharges is conducted to detect violations of requirements of the International Convention for the Prevention of Pollution from Ships (MARPOL) and collect evidence for prosecuting ships offenders. The POLREP can also be used by a Contracting Party to the Barcelona Convention to report a deliberate discharge to REMPEC.

Methods: The following methods are used to detect a pollution and assess its origin and extent:

- Oil:
  - Expert human eye observation;
  - Aerial observation (human eye observation and/or remote sensing equipment);
  - Satellite imagery analysis to assess the extent and fate of an oil slick; and
  - Sampling and analysis to determine the nature of the substance at sea, on shore and on board vessels. The Agreement for cooperation in dealing with pollution of the North Sea by oil and other harmful substances, 1983 (“the Bonn Agreement”) developed an internationally recognized procedure for sampling at sea, analysis and interpretation of results.

The following can be identified:

- Volume of oil: internationally recognized guidance is used based on oil type and appearance to assess thickness (mm) and volume of oil (m^3/km^2) at sea (Bonn Agreement Oil Appearance Code – BAOAC);
- Location and coverage of slick at sea (latitude and longitude – GPS);
- Characteristics of oil (persistent vs. non persistent / viscosity); and
- Origin of slick (if visible ship name and IMO number, offshore installations identification number). Backtracking oil using trajectory modelling methods help to identify ship source.

On-shore monitoring will be used to assess the extent of impacted shorelines, type and degree of contamination as well as impact on habitats and wildlife casualties.

- HNS:

Detection of HNS pollution events and assessment of impacts are primarily achieved on site by expert human eye observation, complemented with real time monitoring, sampling and analysis, as well as the use of modelling tools. Conclusions of any risk assessment for HNS will be based on a number of information including identification of incident circumstances and location, identification of the involved chemical, its properties / toxicity, and its form (packaged / bulk) as well as identification of sensitive neighboring areas and environment conditions.

RESULTS

Results and Status, including trends (brief)

On the one hand, statistical data analyses indicate a significant downward trend in accidental pollution from ships, for both oil and HNS. This decrease can also be seen both in the number of accidents causing these pollutions and in the volumes of pollutants discharged at sea. On the other hand, the same observation cannot be made with regard to illicit discharges from ships. There is no sufficient data to identify an upward or downward trend, but based on 2016 data provided by the European Maritime Safety Agency (EMSA), it can be argued that a significant number of illegal releases are still occurring.

Results and Status, including trends (extended)

<u>Key findings for accidents:</u>

- Decrease in the number of major oil spills worldwide

Maritime casualties involving oil have decreased substantially over the years, despite a growth in the volume of oil moved by ships. Today, according to ITOPF statistics, 99.99% of crude oil transported by sea arrives safely at its destination. As shown in Figure 5 below, the average number of large oil spills from tankers, i.e. greater than 700 tonnes, has progressively diminished over the years, to an average of 1.7 spills per year between 2010 and 2016.

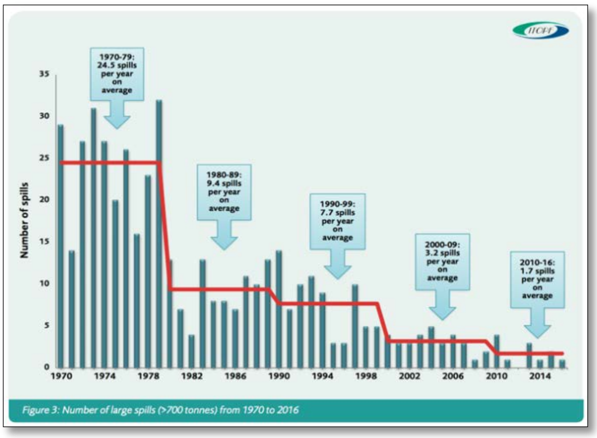

Figure 5: Number of Oil Spills Greater than 700 Tonnes Between 1970 and 2016.

- Decrease in the frequency of accidents causing a pollution in the Mediterranean

Oil:
The statistical analytical study prepared by REMPEC on the basis of its Mediterranean Alerts and Accidents Database shows that major oil spills occurred frequently between 1977 and 1981 but have become rare events since then, with the last major accident being the MT “HAVEN” accident off Genoa in April 1991, with 144,000 tonnes of crude oil spilled.

In terms of volume of oil released at sea, the 2014 REMPEC Study indicates that between 1 January 1994 and 31 December 2013, approximately 32,000 tonnes of oil entered into the Mediterranean Sea as a result of accidents.

This includes approximately 15,000 tonnes originating from the 2006 Eastern Mediterranean incident which occurred in the power plant of Jieh, Lebanon, between the 13th and 15th of July 2006. The fuel which did not burn was released in the marine environment. The exact quantity of the burnt fuel remains unknown but, according to the estimate communicated by the Lebanese authorities, between 13,000 and 15,000 tonnes were released as a consequence of the spill. The Lebanese spill is the fifth biggest spill reported since 1977 in the Mediterranean Sea, the largest spill being the spill related to the explosion of the MT HAVEN in 1991, which sunk with its cargo of 144,000 tonnes of crude oil in the Italian waters.

In terms of accidents causing pollution, the number of accidents resulting in an oil spill dropped from 56% of the total number of accidents for the period 1977 – 1993, to 40% for the period 1994 – 2013. 61% of the incidents resulted in a spillage inferior to 1 tonne.

HNS:
In the Mediterranean, the quantities of HNS accidentally spilled considerably decreased during the period 1994 – 2013. Since 2003, the release of HNS has become insignificant compared to the period 1994 – 2002.

The last two major accidents occurred in 1996 namely:
- the sinking of Kaptan Manolis I in Tunisia, with 5,000 tonnes of phosphates on board; and
- the sinking of Kira off Greece, releasing 7,600 tonnes of phosphoric acid.

The worst HNS spill in the Mediterranean was the sinking of the Continental Lotus in 1991 in the Eastern Mediterranean, with 51,600 tonnes of iron on board.

REMPEC’s statistical analysis related to geographical location of accidents indicates that the majority of accidents occur in the Eastern Mediterranean area (Cyprus, Egypt, Israel, Lebanon, Syrian Arab

Republic, Turkey) if Greece, which is treated separately in REMPEC's findings, is included, showing as Figure 6.

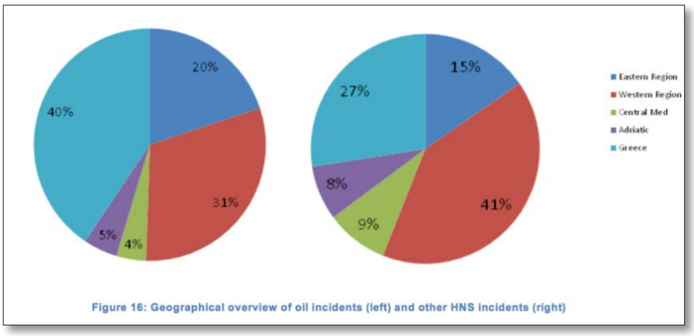

Figure 16: Geographical overview of oil incidents (left) and other HNS incidents (right)

Figure 6: Geographical distribution of accidents (Source: REMPEC, 2014).

<u>Key Findings for Illicit Discharges:</u>

REMPEC's Mediterranean Alerts and Accidents Database contains a category for "Illicit Discharges". Only 5 cases were reported (1 in 2012, 1 in 2013 and 3 in 2015). By nature, as they are illegal, illicit discharges of oil are not voluntarily reported by the ship source. The use of satellite imagery can be a useful tool to provide a better picture of the number of oil spills from ships, however, unless evidence is provided that a detected illicit discharge originates from a specific ship, no definite conclusion can be made as to whether or not the spill is caused by any ship, and therefore it is difficult to precisely assess the number of illicit discharges actually happening.

<u>Trends: oil pollution occurrences still an issue in the Mediterranean.</u>

In 2016, the CleanSeaNet platform of EMSA recorded a total of 1,073 detections of probable pollution occurrences, and a total of 1,060 detections of possible pollution occurrences in the area covering the Mediterranean Sea and the Atlantic Ocean coasts of Morocco, Portugal, Spain and France (Figure 7 below). Although there is no judicial evidence that all occurrences characterised as probably or possibly oil spills are actually discharges from ships, the map provides a clear indication that oil pollution incidents from ships is still of concern.

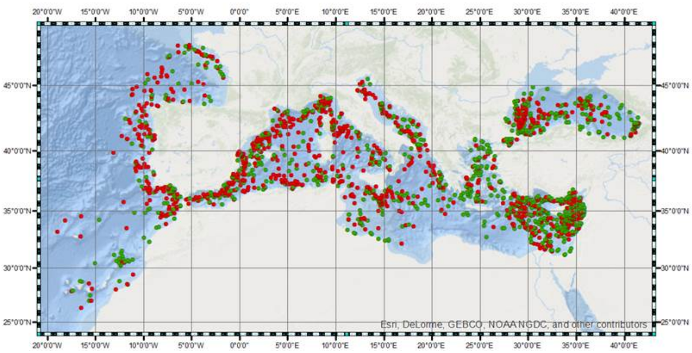

Figure 7: Number of spills detected in 2016 by satellite imagery (Source: CleanSeaNet, EMSA). Class A (red dots on the map): the detected spill is most probably oil (mineral or vegetable/fish oil) or a chemical product. Class B (green dots on the map): the detected spill is possibly oil (mineral/vegetable/fish oil) or a chemical product.

CONCLUSIONS

Conclusions (brief)

Accidents rates have gone down globally and regionally despite the increase in shipping transportation and it can be concluded that the impact of the international regulatory framework adopted through the IMO as well as technical cooperation activities undertaken at regional level is very positive, especially as far as prevention of accidental pollution is concerned. However, risks associated with the transport by ships of oil and HNS with possible harmful consequences on biota and ecosystems cannot be completely eliminated, especially in vulnerable areas such as the Mediterranean Sea. In addition, efforts have to be made to strengthen monitoring and reporting of illicit discharges from ships.

Conclusions (extended)

Decrease of pollution occurrences globally: accidents rates have gone down globally and regionally despite the increase in shipping transportation. Accidental pollution from both oil and HNS has decreased which can be related to the adoption and implementation of environmental maritime conventions addressing oil and HNS pollution prevention, preparedness and response. Indeed, statistical analysis indicates that there is a correlation between the period where the IMO regulatory framework was put in place (in the 70') and the years when this downward trend started to happen (in the 80'). It can therefore be concluded that the impact of the international regulatory framework adopted through the IMO as well as technical cooperation activities undertaken at regional level is very positive, especially as far as prevention of accidental pollution is concerned. However, the issue of illicit discharges from ships remains of concern, especially in semi-enclosed areas where the ability of the marine environment to regenerate is less likely to happen.

Oil pollution long-term effects: it is also important to keep in mind that recovery of habitats following an oil spill can take place from between a few seasonal cycles (plankton) to several years (within one to three years for sand beaches and exposed rocky shores; between 1 and 5 years for sheltered rocky shores; between 3 and 5 years for saltmarshes; and up to 10 years or greater for mangrove).

According to ITOPF, while considerable debate exists over the definition of recovery and the point at which an ecosystem can be said to have recovered, there is broad acceptance that natural variability in ecosystems makes a return to the exact pre-spill conditions unlikely. Most definitions of recovery instead focus on the re-establishment of a community of fora and fauna that is characteristic of the habitat and functions normally in terms of biodiversity and productivity.

Therefore, despite the progress achieved in mitigating oil spill incidents from ships, it is clear that continuous monitoring of illicit discharges occurrences as well as cumulative effects and impacts, and continuous monitoring of accidental post-spill consequences on biota and ecosystems are needed.

Key messages

Chronic sources (illicit discharges) of pollution into the marine environment from ships are the principal target for pollution reduction, as the trends for acute pollution (accidents) are controlled and decreasing.

Knowledge gaps

- The information collected via pollution reports is related to specific pollution events and not always useful or compatible with the information needed to assess the status of the marine environment.
- Maintaining the Mediterranean Alerts and Accidents Database is a prerequisite and the condition for being able to measure Common Indicator CI19.

- There is no obligation for countries to carry out environmental surveys of sea and shorelines affected by a spill. Systematic environmental shorelines assessment post spill is today recognised as a “must do” practice and can provide information on biota on a case by case basis.
- Very little data is available regarding illegal discharges from ships.

Environmental monitoring and reporting: the focus of IMO conventions and guidelines relating to prevention of marine pollution is on ships’ compliance monitoring rather than on monitoring or measuring the state of the marine and coastal environment. The same can be noted with respect to reporting obligations. Reporting is required in the case of an accident causing pollution or in case of an illegal pollution is discovered (operational discharges). This perspective is reflected in the 2002 Prevention and Emergency Protocol. Therefore, the information collected is related to specific pollution events and not always useful or compatible with the information needed to assess the status of the marine environment.

Accidents monitoring and reporting: there is an increase in the number of accidents reported to REMPEC, which is most likely due to a better compliance by the Contracting Parties to the Barcelona Convention to report casualties, as required by Article 9 of the 2002 Prevention and Emergency Protocol. It is of utmost importance that the Contracting Parties to the Barcelona Convention continue to report on accidents as accurately as possible, as it is paramount that REMPEC continues to maintain the Mediterranean Alerts and Accidents Database to keep track of pollution events. This is a prerequisite and the condition for being able to measure Common Indicator CI19.

Impact on biota affected by pollution: for the reason explained above, there is little information on the impact of pollution events caused by shipping on biota. Ship generated pollution impact is usually considered from a response perspective (protection of sensitive areas and facilities). There is no obligation for countries to carry out environmental surveys of sea and shorelines affected by a spill. However, systematic environmental shorelines assessment post spill is today recognized as a “must do” practice in terms of assessing the level of cleanliness of the affected area, as well as from a remediation perspective.

Illicit discharges from ships: very little data is available regarding discharges from ships. As these are illegal operations by nature (when not within the limits set by MARPOL), it is extremely difficult to get information on occurrences and extent of spills. Marine surveillance requires aerial means and equipment (planes, airborne radars and sampling sets) or special technology such as the use of satellite images. There is no regionally centralized system for surveying the Mediterranean waters as defined in the Barcelona Convention. The CleanSeaNet platform, the European satellite-based oil spill monitoring and vessel detection service, is a good resource, but only available in principle to countries that are Members States of the European Union.

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Ecological Objective 9 (EO9): Chemical 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

GENERAL

Reporter:	UNEP/MAP/MED POL
Geographical scale of the assessment:	Regional, Mediterranean Sea
Contributing countries:	Contracting Parties by research studies
Mid-Term Strategy (MTS) Core Theme	1-Land and Sea Based Pollution
Ecological Objective	EO9. Contaminants cause no significant impact on coastal and marine ecosystems and human health
IMAP Common Indicator	CI20. Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in commonly consumed seafood
Indicator Assessment Factsheet Code	EO9CI20

RATIONALE/METHODS

Background (short)

The human exposure to chemical contaminants through commercial fish and shellfish species (ca. fisheries and aquaculture, respectively) is one the main concerns with regard the occurrence of pollutants in the marine environment. Wild and farmed marine species are exposed to environmental chemical contaminants through different mechanisms and pathways according their thropic level, which include from filter feeding to predatory species (bivalves, crustaceans, fish, etc.). The understanding of the health risks to humans (maximum levels, intake, toxic equivalent factors, etc.), through the consumption of potentially contaminated seafood is a challenge and a priority policy issue for governments, as well as a major societal concern. GES for Common Indicator 20 can be achieved when the concentrations of contaminants in seafood are within regulatory limits set by legislation for human consumption.

Figure1: Major seafood species commercialized in the Mediterranean Sea in a fish market in Athens, Greece, CommonseafoodMediterranean_CGuitart.jpg

Background (extended)

There exist both bioaccumulation and biomagnification processes of the harmful chemicals released in the marine environment. Common examples are the well-known bioaccumulation processes of heavy metals and organic compounds in commercial bivalve species (such as *Mytillus galloprovincialis* in the Mediterranean Sea) or alkyl mercury compounds in fish (e.g. methylmercury in tuna fish), however, many of the current emerging chemicals have also been detected in commercial fisheries. There are different initiatives and regulations at national and international level, which have established public health recommendations and maximum regulatory levels for some contaminants (mainly, for legacy pollutants) in numerous marine commercial target species. The methylmercury potential poisoning continues as a global priority policy issue. In 2013 the Global Legally Binding Treaty (the Minamata Convention on Mercury) was relaunched by UNEP (UNEP, 2002). Further, the USFDA (US Food and Drugs Administration), the EFSA (European Food Safety Authority) and FAO/WHO (Food and Agriculture Organization and World Health Organisation) (FAO/WHO, 2011), are also leading national and international authorities with regard seafood safety and regulatory levels to assess this Common Indicator 20. In relation to this, as mentioned, the European Council (EC) has introduced maximum levels for chemical contaminants, and subsequent amendments, including recently PCDDs, PCDFs and dioxin-like-PCBs in fishery products (Official Journal of the European Union, 2006 and 2011) which could serve as a preliminary target levels in the Mediterranean Sea.

Assessment methods

The present assessment has been undertaken based on bibliographic studies and scientific documents in the Mediterranean Sea thus there are not yet representative MED POL datasets available for this Common Indicator 20. More, the assessment of the CI 20 will be based, tentatively, on the statistics about the number of detected contaminants and their deviations from legal permissions in commercial fish species set by national, European and international regulations within national jurisdictional areas. These areas will need to be further defined from a spatial scale perspective (i.e. limited by national jurisdiction boundaries, GFCM-FAO subdivisions, etc.) within IMAP. The levels set by the European Regulations (Official Journal of the European Union, 2006 and 2011, see Table 1) and other international standards (such as WHO) can be of initial application to harmonize and compare future available datasets in the Mediterranean Sea. However, at present, the majority of the available datasets are hold in databases from surveys by national food laboratories, as well as regulatory and inspection bodies. Therefore, the frequencies in the number and excess of the occurrence on a temporal basis would define the GES achievement with regard to this common indicator (UNEP/MAP, 2013).

Table 1. Summary of current regulatory levels set by the European Union (extracted from Maggi et al., 2014).

Table 1. Regulatory levels, reference legislation, code and foodstuff categories.

Category code	Legislation	Foodstuff	Regulatory levels
Cd 3.2.5	Reg.1881/2006/CE	Muscle meat of fish (footnote 24)	0,05 mg/kg w.w.
Cd 3.2.6	Reg.1881/2006/CE	Muscle meat of listened fish	0,10 mg/kg w.w.
Cd 3.2.8	Reg.1881/2006/CE	Crustaceans	0,50 mg/kg w.w.
Cd 3.2.9	Reg.1881/2006/CE	Bivalve molluscs	1,0 mg/kg w.w.
Cd 3.2.10	Reg.1881/2006/CE	Cephalopods	1,0 mg/kg w.w.
Hg 3.3.1	Reg.1881/2006/CE	Fishery products and muscle meat of fish (footnotes 24, 25, 26)	0,50 mg/kg w.w.
Hg 3.3.2	Reg.1881/2006/CE	Muscle meat of listened fish	1,0 mg/kg w.w.
Pb 3.1.5	Reg.1881/2006/CE	Muscle meat of fish (footnote 24)	0,3 mg/kg w.w.
Pb 3.1.6	Reg.1881/2006/CE	Crustaceans	0,50 mg/kg w.w.
Pb 3.1.7	Reg.1881/2006/CE	Bivalve molluscs	1,5 mg/kg w.w.
Pb 3.1.8	Reg.1881/2006/CE	Cephalopods	1,0 mg/kg w.w.
Dioxins 5.3	Reg.1259/2011/CE	Muscle meat of fish and Bivalve molluscs	3,5 pg/g w.w.
Sum dioxins and dioxin like PCBs 5.3	Reg.1259/2011/CE	Muscle meat fish and Bivalve molluscs	6,5 pg/g w.w.
Benzo(a)pyrene 6.1.4	Reg.1881/2006/CE	Muscle meat of fish (footnote 24)	2,0 µg/kg w.w.
Benzo(a)pyrene 6.1.5	Reg.1881/2006/CE	Crustaceans and Cephalopods	5,0 µg/kg w.w.
Benzo(a)pyrene 6.1.6	Reg.835/2011/CE	Bivalve molluscs	5 µg/kg w.w.
Sum PAH 6.1.6	Reg.835/2011/CE	Bivalve molluscs	30 µg/kg w.w.

doi:10.1371/journal.pone.0108463.t001

RESULTS

Results and Status, including trends (brief)

With regard the content of chemical contaminants fish and shellfish, different research studies have been recently conducted in the Mediterranean Sea taking into account a number of legacy and emerging chemicals. At present, scattered datasets all along the Mediterranean sub-basins mostly from research studies are available with few assessments recently undertaken under European marine policy (e.g. the Descriptor 9 under EU Marine Strategy Framework Directive) by European Contracting Parties of the Barcelona Convention. Future harmonization and data sharing will improve the assessment in the Mediterranean Sea at a regional scale for this CI 20.

Results and Status, including trends (extended)

In the Eastern Mediterranean, selected heavy and essential metals (Cd, Pb, Cu and Zn) have been determined in some different brands and types of fishery products in Turkey (Çelik and Oehlen, 2007; Mol, S., 2011). Dioxins, dioxin-like and non dioxin-like PCBs have been also determined in Greek farmed fish (Costopoulou et al., 2016) and the levels found were well below the limits set by EU Legislation. In the Ionian Sea, the levels of a large set of toxic metals (As, Cd, Cr, Pb, Mn, Ni, V and Zn) were assessed in fish and shellfish from the Gulf of Catania (Copat et al., 2013, 2014), and did not exceed the limits set by the EU legislation. However, a more recent study in the same area found levels exceeding the legal limits for some species, such as gastropods and fish (Giandomenico et al., 2016). The concentrations and congener specific profiles of legacy and emerging compounds, such as PCBs, PCDDs and PCDFs have been determined in various edible fish from the Adriatic Sea. The results obtained shown that levels were under the recommendations of the EU legislation (Storelli et al., 2011). Similarly, PCBs and PCDD/F concentrations and congener specific profiles were also determined in seafood (e.g. fish and cephalopods) in supermarkets in Southern Italy (Barone et al., 2014). Further, in terms of shellfish contamination levels transferred to seafood consumers, cultured and harvested bivalves have been recently evaluated in the Adriatic Sea (Croatia), and shown no risk (Milun, V., 2016). With regard an assessment performed under the context of the EU Marine Strategy Framework Directive (MSFD), Italy developed a full methodology and assessed the Descriptor 9 for heavy metals and PAH , which is equivalent to the EO9 Common Indicator 20 (Figure 1and 2). The conclusion, based on a statistical ranges of acceptance and defined criteria in Mediterranean sub-regions under Italian jurisdiction, was a good GES status. Nevertheless, the datasets for synthetic compounds and their spatial coverage were somehow limited (Maggi, et al., 2014). Fish, molluscs, and crustaceans of commercial size of 69 different species were sampled and analyzed for total mercury (HgT), and were evaluated for their compliance with the EU Maximum Residue Limits (MRLs, Table 1) (Bambrilla, et al., 2013).

In the NW Mediterranean, mercury contamination was studied in deep-sea organisms to understand the transfer, fate and human implications of contaminated commercial species (Koenig et al., 2013). France, as a part of a specific monitoring programme, determined, toxic metals in gastropods, echinoderms and tunicates, which are also consumed locally in the Mediterranean Sea (Noël, L. et al., 2011). In the southern Mediterranean countries, Morocco has investigated the exposure of the coastal population to mercury via seafood consumption (Elhsmri, H., 2007). From a human health perspective, beyond environmental levels and compliance regulatory limits, some studies have been investigated both for legacy and emerging chemical of concern to assess the intake of seafood products to end-consumers. To this regard, it is worth to mention the study of the intake of arsenic (As), cadmium (Cd), mercury (Hg), lead (Pb), polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs), polychlorinated biphenyls (PCBs), polychlorinated naphthalenes (PCNs), polybrominated diphenylethers (PBDEs), polychlorinated diphenylethers (PCDEs), hexachlorobenzene and polycyclic aromatic hydrocarbons (PAHs) through fish and seafood consumption by children of Spain (Martí-Cid et al., 2007). Similarly, the estimated dietary intake of dioxins and dioxin-like PCBs in food marketed were also studied for seafood consumers in Spain (Marin, et al., 2011).

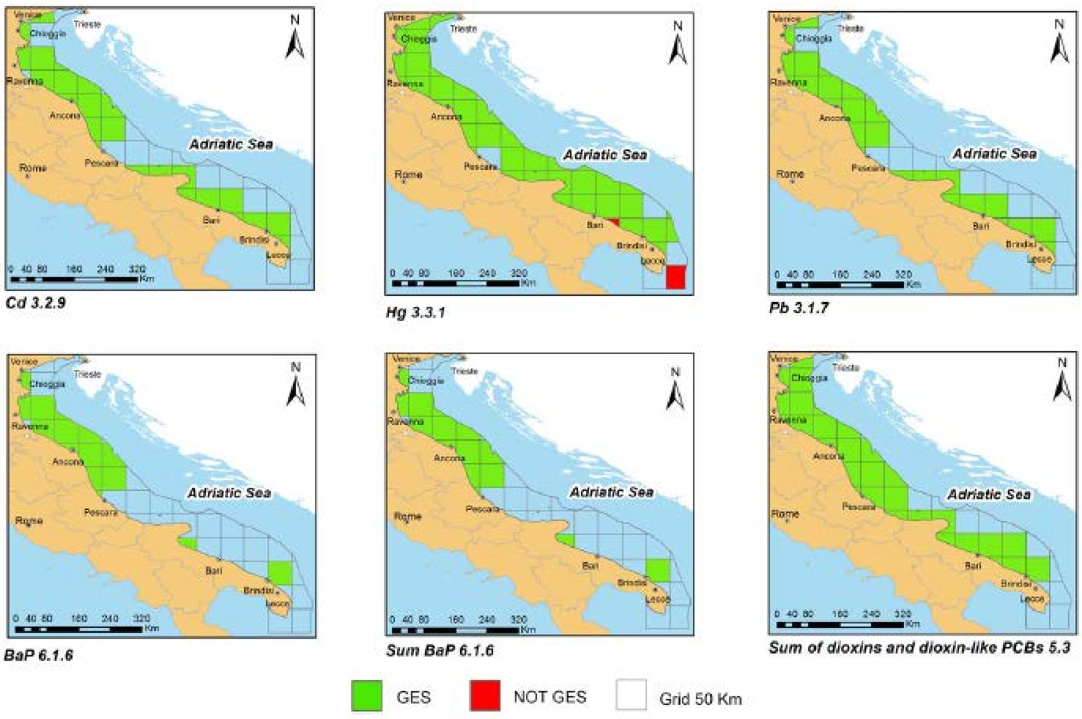

Figure 2: Results on Metals, PAH and Dioxins/Dioxin-like PCBs in Adriatic Sea Subregion (AS), (source: Maggi, C., Lomiri, S., et al., 2014)

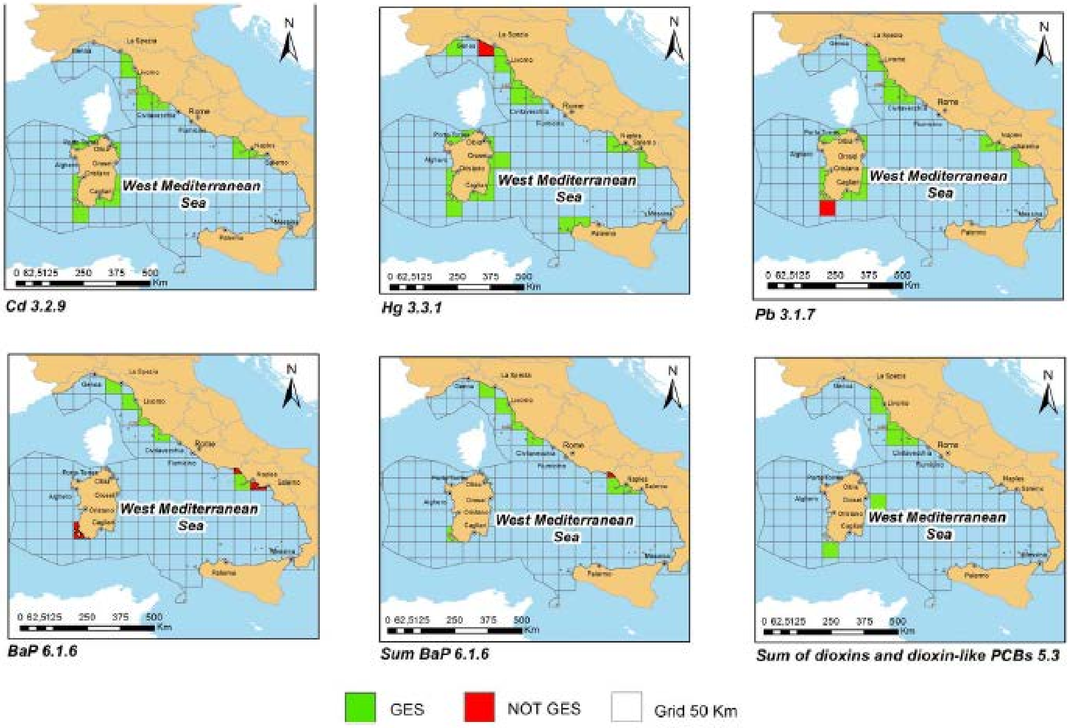

Figure 3: Results on Metals, PAH and Dioxins/Dioxin-like PCBs in Western Mediterranean (WMS), (source: Maggi, C., Lomiri, S., et al., 2014)

CONCLUSIONS

Conclusions (brief)

At present, few research studies and EU policy driven reports (ca. MSFD) in some Mediterranean countries have investigated the occurrence of contaminants in seafood, from an environmental perspective, which are exceeding the maximum regulatory levels established within regulatory standards. Overall, from available studies, no major significant concerns or extreme high levels were on served within these recent research studies by different authors and no confirmation based on temporal trends have been performed yet.

Conclusions (extended)

For future assessments within this CI 20, the GFCM-FAO defined areas in the Mediterranean Sea (Area 37 and their subdivisions), could be selected and assessed under different national strategies, although harmonized at a regional scale, to evaluate contaminants in commercial species to assess CI20 under IMAP. For example, Naccari et al (2015), reported the residual levels of Pb, Cd and Hg in different species, caught from FAO zones around Italy; particularly, small pelagic, benthic and demersal fishes. Whilst in all samples was observed the absence of Pb, small concentrations of Cd and higher Hg levels were found, as well as differences between the two subdivisions. Only Cd concentrations exceeded the EU regulatory limits in different fish species, despite a large number of uncontaminated samples, 67%, 84% and 62% for Cd in mackerel, mullet and seabream, respectively. A recent study with tuna (*Thunnus thynnus*) in Mediterranean FAO areas, shown that residues of PCBs and PBDEs are present. The study concludes that the Mediterranean area show the highest levels for these chemical compounds (Figure 4) compared to other evaluations in FAO areas worldwide (Chiesa et al., 2016).

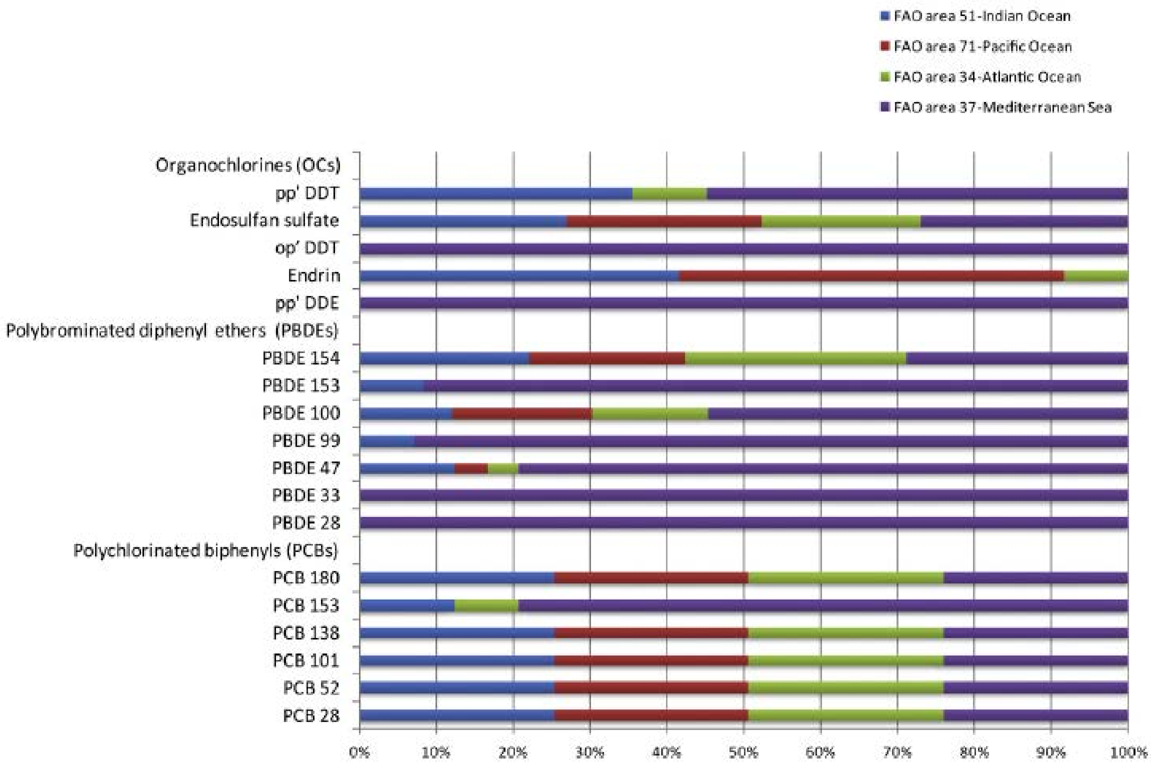

Figure 4: Comparison of POPs levels in different FAO areas worldwide (source: Chiesa et al., 2016)

Key messages

- Regular datasets are unavailable to perform an assessment of the Common Indicator 20.
- Chemical contaminants occurrence in fish and shellfish and the possible intake scenarios for population have been studied in different Mediterranean locations.
- Some of the FAO delimited zones in the Mediterranean Sea have been investigated for a number of legacy and emerging contaminants within research studies.
- Pelagic, demersal and benthic species have been targeted and investigated to assess GES in terms of potential seafood contamination and to reflect the health condition of the marine ecosystem

Knowledge gaps

The regular information required to assess this indicator is clearly lacking on a regional scale (ca. comparable and quality assured data), and at sub regional scale to some extent to be able to perform a complete assessment. Monitoring protocols, risk-based approaches, analytical testing and assessment methodologies would need to be further developed focusing on the harmonization between Contracting Parties. The liason with national food safety authorities, research organisations and/or environmental agencies will be required.

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Ecological Objective 9 (EO9): Chemical pollution

EO9: Common Indicator 21: Percentage of intestinal enterococci concentration measurements within established standards

GENERAL

Reporter:	UNEP/MAP/MED POL
Geographical scale of the assessment:	Regional, Mediterranean Sea
Contributing countries:	Contracting Parties by research studies
Mid-Term Strategy (MTS) Core Theme	1-Land and Sea Based Pollution
Ecological Objective	EO9. Contaminants cause no significant impact on coastal and marine ecosystems and human health
IMAP Common Indicator	CI21. Percentage of intestinal enterococci concentration measurements within established standards
Indicator Assessment Factsheet Code	EO9CI21

RATIONALE/METHODS

Background (short)

The Mediterranean Sea continues to attract every year an ever increasing number of international and local tourists that among their activities use the sea for recreational purposes. Back in 2005, the number of sewage treatment plants were doubled with respect the precedent decade and the water quality with regard to fecal pollution clearly improved (UNEP/MAP MED POL, 2010). The establishment of sewage treatment plants and the construction of submarine outfall structures have decreased the potential for episodes of microbiological pollution; despite few major coastal hotpots still exist. A revision of the Mediterranean guidelines for bathing water quality was formulated in 2007 based on the WHO Guidelines for Safe Recreational Water Environments (WHO, 2003) and on the EC Directive for Bathing Waters (Directive 2006/7/ EU). Later on, a revised UNEP/MAPt proposal was made in an effort to provide updated criteria and standards that could be used in the Mediterranean countries, as well as to harmonize their legislation in order to provide homogenous information and data (UNEP/MAP, 2012a). High levels of enterococci bacteria in recreational marine waters (coasts, beaches, tourism spots, etc) are known to be indicative of human pathogens due to non-treated discharges into the marine environment and cause human infections (Kay et al., 2004; Mansilha et al, 2009). Therefore, these new standards for bathing waters quality in the framework of the implementation of Article 7 of the LBS Protocol should be further used to define GES in bathing and recreational waters. GES for Common Indicator 21 will be accomplished when concentrations of intestinal enterococci would be within the established standards (UNEP/MAP, 2013).

Figure 1: A high bathing water quality in Mediterranean beaches is a key element within safe recreational activities in the coastal environment, Bathingwaterquality_CGuitart.jpg

Background (extended)

Enterococci concentrations are frequently used as a faecal indicator bacteria, or general indicators of faecal contamination. Particularly, *E. faecalis* and *E.faecium* species are related to urinary tract infections, endocarditis, bacteriema, neonatal infections, central nervous system, abdominal and pelvic infections.. It has been suggested and latterly demonstrated that enterococci sp. might be more appropriate than traditional Escherichia coli (E.coli) in marine waters as an index of faecal pollution. Currently, is the only faecal indicator bacteria recommended by the US Environmental Protection Agency (EPA) for brackish and marine waters, since they correlate better than faecal coliforms or *E.coli*. The abundance in human and animal feces and the simplicity of the analytical methods for their measurements has favoured the use of enterococci species as a surrogate of polluted recreational waters, and therefore, as a Common Indicator 21 for GES under EO9. The World Health Organization has been concerned with health aspects of the management of water resources for many years and published various documents concerning the safety of environmental waters and its importance for health, including marine waters. A revision of the Mediterranean guidelines (UNEP/MAP, 2012) for bathing water quality were formulated in 2007 based on the WHO Guidelines for Safe Recreational Water Environments (WHO, 2003) and on the EC Directive for Bathing Waters (Directive 2006/7/ EU). Therefore, these standards for bathing waters quality in the framework of the implementation of Article 7 of the LBS Protocol should be further used to define GES in bathing and recreational waters.

Assessment methods

The present assessment has been undertaken based on reference documents, as no sufficient updated datasets at regional scale are available. The future assessments of Common Indicator 21will be based on the statistics from datasets submitted by local national authorities or/and the corresponding agencies. Standards of application within IMAP Common Indicator 21 compliance by Mediterranean countries will be the proposed criteria adopted by decision IG.20/9, which includes the intestinal enterococci sample criteria (see table below):

Table 1: Microbiological Water Quality Criteria for intestinal enterococci sp., Source: Decision IG. 20/9, UNEP/MAP, 2012.

Microbial Water Quality Assessment Category
(based on Intestinal enterococci (cfu/100 mL)

Category	A	B	C	D
Limit values	<100*	101-200*	185**	>185**(1)
Water quality	Excellent quality	Good quality	Sufficient	Poor quality/ Immediate Action

RESULTS

Results and Status, including trends (brief)

As mentioned, the datasets for the most Eastern and Southern Mediterranean countries are not updated recently, and therefore, the full assessment at regional scale for Common Indicator 21 is not possible. An assessment report from the European Environment Agency (EEA) in 2015 merged with MED POL data for Tunisia (from 2014) shows about a 90% or higher of the sites monitored during the bathing season for some Contracting Parties of the Barcelona Convention classified as good or excellent. Exceptions are Albania and Tunisia were around a 40% and 10%, respectively, show a poor sanitary condition of the bathing and recreational waters. The temporal trends were calculated by the EEA (EEA, 2015) and exhibit an steady-state and conservative trend for almost all the countries with respect the number of acceptable sites were bathing water quality is controlled.

Results and Status, including trends (extended)

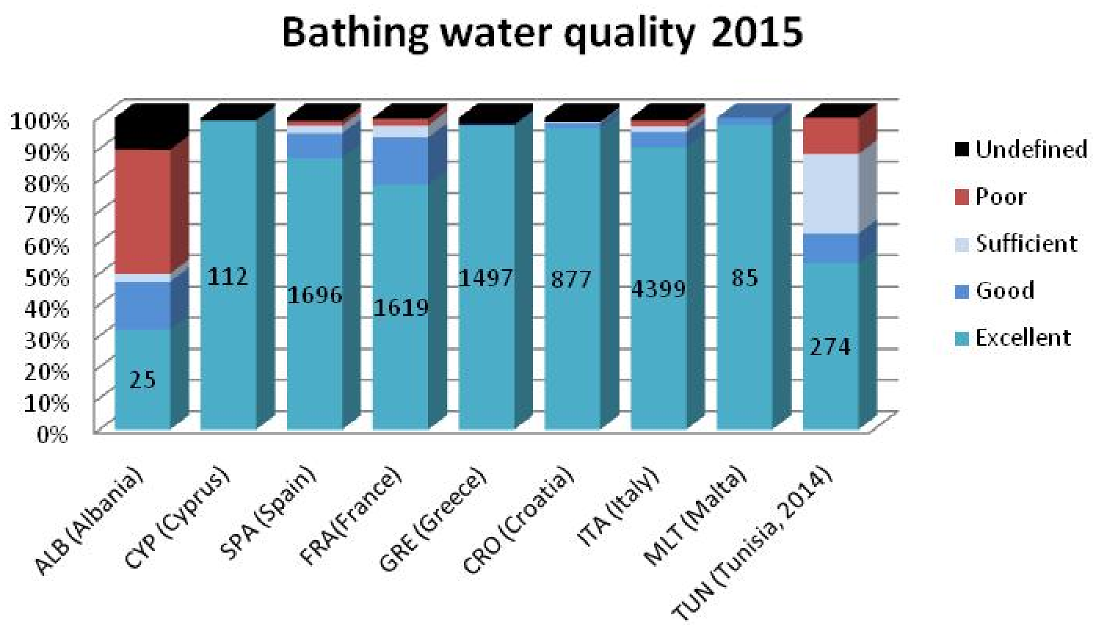

Figure 2: Percentages of the bathing water quality assessment with respect Common Indicator 21 in 2015 for some Contracting Parties of the Barcelona Convention. Please, note France and Spain data includes also the Atlantic coastal sites, in any case, with almost a 100% of sites with good and excellent quality. (Source: EEA, 2015 and MED POL Database for Tunisia).

CONCLUSIONS

Conclusions (brief)

The implementation of measures (e.g. sewage treatment plants) to reduce, among others, the fecal pollution in coastal waters, has been a story-of-success in the Mediterranean Sea through the UN Mediterranean Action Plan. The generalization of the domestic waters depuration in a number of countries the latest decade has demonstrated the benefits of implementing the LBS protocol and environmental measures to reduce pollution, despite some few improvements still need to be taken.

Conclusions (extended)

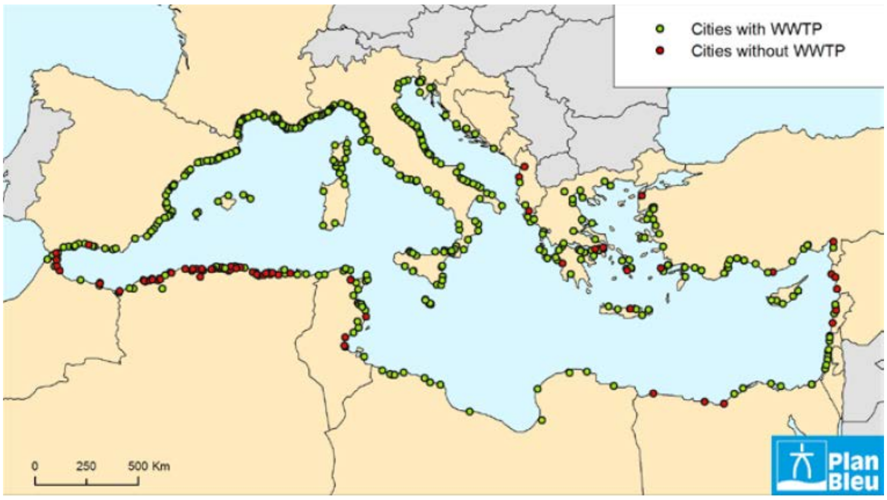

Figure 3: Waste water treatment in the Mediterranean coasts back in 2010 to prevent microbiological pollution of bathing waters (Source: EEA, 2014, based on MAP Technical Report Series No 157, 2004; UNEP/MAP, 2011 and UNEP(DEPI)/MED WG.357/Inf.7).

Key messages

- Initial target of GES under Common Indicator 21 would be an increasing trend in measurements to be able to test that levels of intestinal enterococci comply with established regulation standards

Knowledge gaps

The lack of recent datasets on microbiological pollution in the Mediterranean Sea submitted to the MAP Secretariat is the main current gap and concern, and therefore, to be able to monitor the future progresses under the Common Indicator 21.

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Ecological Objective 10 (EO10): Marine Litter

EO10: Common Indicator 22: Trends in the amount of litter washed ashore and/or deposited on coastlines (including analysis of its composition, spatial distribution and, where possible, source)

GENERAL

Reporter:	UNEP/MAP/MED POL
Geographical scale of the assessment:	Regional, Mediterranean Sea
Contributing countries:	Mediterranean assessment based on existing regional and national surveys, research and publications and as appropriate data from national monitoring programmes of the Contracting Parties.
Mid-Term Strategy (MTS) Core Theme	1-Land and Sea Based Pollution
Ecological Objective	Ecological Objective 10 (EO10): Marine and coastal litter do not adversely affect the coastal and marine environment.
IMAP Common Indicator	Common Indicator 22 (CI22): Trends in the amount of litter washed ashore and/or deposited on coastlines (including analysis of its composition, spatial distribution and, where possible, source).
Indicator Assessment Factsheet Code	EO10CI22

RATIONALE/METHODS

Background (short)

Much of what we know on the presence of marine litter (abundance, distribution, origin) in the marine and coastal environment comes from information collected on marine litter stranded on beaches (Ryan et al., 2009). Beach marine litter has drawn a lot of attention and numerous surveys and corresponding campaigns have been organized. However, a comparison among all these different studies is made difficult as the majority of these studies use different sampling protocols, techniques and methods. As in all marine compartments, plastics are predominant among the collected marine litter items found stranded on beaches. Several NGOs have been very active in tackling the problem, increasing the environmental awareness of the citizens, along with engaging them in marine litter related surveys, events and actions. Most of the available information on beach marine litter for the Mediterranean Sea comes from standing-stock surveys.

Monitoring of marine litter found stranded along the coastline of the Mediterranean still remains a priority. Special attention should be drawn upon the quantification and characterization of litter pollution found on beaches along with providing comparable datasets to support national and regional assessment of beach marine litter (JRC, 2013). This is also the key to introduce and implement effective policy and management measures. An in depth and comprehensive understanding of the level of threat posed by marine litter to biota and ecosystems at regional should be based upon reliable, quality assured, homogenized and comparable datasets and all efforts should target towards that direction.

Background (extended)

Even the most remote parts of the Mediterranean are affected by marine litter. The findings of the "Assessment of the status of marine litter in the Mediterranean" (2009) undertaken by UNEP/MAP MED POL in collaboration with the Mediterranean Information Office for Environment, Culture and Sustainable Development (MIO-ECSDE), the Hellenic Marine Environment Protection Association (HELMEPA), and Clean up Greece Environmental Organization, illustrate that although useful data on types and quantity of marine litter exists in the region, it is inconsistent and geographically restricted mainly to parts of the North Mediterranean.

The economic values from coastal recreation are considerable (Ghermandi and Nunes, 2013). Clean seas and beaches are key to attract local and international tourism and are an integral part of the UN Environment / Mediterranean Action Plan Integrated Monitoring Assessment Programme and related Assessment Criteria (IMAP) and the European Marine Strategy Framework Directive (MSFD), in which marine litter is one of the key indicators to assess Good Environmental Status (GES) and the effectiveness of policy measures (Brouwer et al., 2017; Galgani et al., 2013). Beach marine litter have been argued to pose a significant cost on society, in particular in the way they affect coastal tourism and recreation (UNEP, 2009).

The issue of marine litter and related information on the amounts and types in the Mediterranean is rather complicated; most Contracting Parties have not yet put in place their official monitoring programmes and thus do not submit related data on marine litter. In these cases,   the situation can only be addressed principally by scientific institutions and sub-regional and local authorities in most countries on the one hand, and by competent NGOs on the other hand. Collection of information is a task that requires considerable human resources directly and indirectly related to the subject along with the sophisticated central coordination mechanism. A relatively systematic and reliable source for amounts and types of litter is usually the existing NGO initiatives in the region. NGO efforts are the most significant in terms of surveying and cleaning beaches and the sea and providing information on the volume and types of litter existing in the Mediterranean. However, the role of the Contracting Parties is very important and all national monitoring programmes, when in place, should take into consideration a harmonized approach/methodology applied at regional level.

Furthermore initiatives of varying importance are taken up by NGOs, local authorities and other partners at national and local level in almost all Mediterranean countries. Thousands of volunteers have been gathered in the Mediterranean countries with the purpose not only to clean the coasts, rivers and lakes in their local communities but also to raise awareness amongst students, citizens, and various stakeholders about the serious implications of marine litter and to inspire people to make a difference and improve their daily environmental conduct.

Strandline surveys, cleaning, and regular surveys at sea are gradually being organized in many Mediterranean countries for the aim of providing information on temporal and spatial distribution. Various strategies based on the measurement of quantities or fluxes have been adopted for data collection purposes. However, most surveys are conducted by NGOs with a focus on cleaning. Moreover, small fragments measuring less than 2.5 cm, also referred to as meso-litter(versus macro-litter), are often buried and may not be targeted by clean-up campaigns or monitoring surveys. Stranding fluxes are therefore difficult to assess, and a decrease in litter amounts at sea will only serve to slow stranding rates. They can comprise a large proportion of the debris found on beaches and very high densities have been found in some areas.

Standing stock evaluations of beach litter reflect the long-term balance between inputs, land-based sources or stranding, and outputs from export, burial, degradation and clean-ups. Recording the rate at which litter accumulates on beaches through regular surveys is currently the most commonly-used approach for assessing long-term accumulation patterns and cycles.
One of the major problems that still occur for beach marine litter is due to the fact that each initiative is conducted with different data cards, standards, and measures (litter types are classified differently, if

at all; in some cases litter is measured in items while in others by weight, etc.), while certain crucial information is completely lacking (length of coast cleaned, type of coast, proximity of coast to sources of litter, etc.) (UNEP/MAP, 2015).

Assessment methods

The current assessment has been based on recent key assessments, reports and publications by UNEP/MAP, and other projects and initiatives. The UNEP/MAP (2015) Marine Litter Assessment in the Mediterranean report has been used as the main source for this indicator assessment factsheet.

Strandline surveys, cleaning, and regular surveys at sea are gradually being organized in many Mediterranean countries for the aim of providing information on temporal and spatial distribution. Various strategies based on the measurement of quantities or fluxes have been adopted for data collection purposes. However, most surveys are conducted by NGOs with a focus on cleaning. Moreover, small fragments measuring less than 2.5 cm, also referred to as meso-litter (versus macro-litter), are often buried and may not be targeted by clean-up campaigns or monitoring surveys. Stranding fluxes are therefore difficult to assess, and a decrease in litter amounts at sea will only serve to slow stranding rates. They can comprise a large proportion of marine litter found on beaches and very high densities have been found in some areas.

Moreover, more sophisticated strategies for monitoring beach marine litter can be also applied including the following aspects: selection of survey sites (100m stretch) and number of sites, frequency and timing of surveys, documentation and characterization of sites, selection of sampling unit and unit for quantifying litter, collection and identification of litter items (survey forms, master list of items), size limit and classes of items, and removal and disposal of litter.

The recruitment and training of the corresponding staff and groups of volunteers are a requirement for any long-term marine litter assessment (UNEP, 2009). Staff and volunteers should have a very good level of understanding on the context and purpose of the marine litter assessment programme. Quality assurance and quality control of the collected data should be also ensured, mainly addressed through a consistent way of collecting and characterizing data at regional level.

RESULTS

Results and Status, including trends (brief)

It is currently difficult to assess the impact of marine litter on beaches due to the spatial availability of data and information in the Mediterranean (with most data found on northern shores), and also a lack of comparability between data dues to differing methodologies used. Mediterranean NGOs have significantly contributed in providing data and information on the temporal and spatial distribution of marine litter found stranded on beaches through beach clean-up campaigns and dedicated monitoring surveys but still many of these are not comparable to give a complete picture at regional level. Also, little is known on the accumulation and loading rates and correspondingly stranding fluxes and rates are difficult to assess.

Figure 1: Marine litter stranded along the coastline

Information is available on the main types of beach marine litter comprise of plastic, glass, paper, metal, polystyrene, cloth, rubber, fishing-related items, munitions, wood, smoking-related items, sanitary waste , and other un-identified items (Table 1). According to 2016 International Coastal Cleanup report, the top items for the Mediterranean Sea are: cigarette butts, plastic beverage bottles, food wrappers, plastic bottle caps, straws/stirrers, other plastic bags, glass beverage bottles, plastic grocery bags, metal bottle caps, and plastic lids. Plastics are the predominant type of litter found on beaches accounting for over 80% of the recorded marine litter (UNEP/MAP, 2015). Within these marine litter types, specific items are found more frequently i.e. cigarette butts, food wrappers, plastic bottles, caps, straws and stirrers, grocery plastic bags, glass bottles, other plastic bags and cans. Most of the recorded marine litter items are derived from land-based sources (including poor waste management practices, recreational and tourism activities).

Table 1: Composition/ sources of marine litter in the Mediterranean

Source (Literature)	Items/Consistency (beaches; top five)	Type of material	Sources
IPA Adriatic DeFishGear (2016)	Items (top 5): -Plastic pieces 2.5 cm > < 50 cm : 19.89% -Polystyrene pieces 2.5 cm > < 50 cm: 11.93% -Cotton bud sticks: 9.17% -Plastic caps/lids from drinks: 6.67% -Cigarette butts and filters: 6.60%	Plastics: 91%	Recreational & tourism:40% Households(combined):40 % Coastal tourism: 32,3% Toilet/sanitary: 26,2% Household: 11,2% Waste collection: 6% Recreational: 5,6%

Marine Litter Watch (MLW) / European Environment Agency (EEA)	- Other types: 32% - Cigarette butts: 18% - Plastic pieces 2.5><50 cm: 11% - Shopping bags (incl. pieces): 7% - Cotton butt sticks: 6% - Plastic caps/lids drinks: 6% - Polystyrene pieces 2.5><50 cm: 6% - Glass/ceramic fragments <2.5 cm: 4% - String and cord (less than 1cm): 4% - Crisps packet/sweets wrappers: 3% Drink bottles <=0.5lt: 3%	Plastics: 64% Glass: 4%	
Öko-Institut (2012; figures mainly from UNEP, 2009)	-Cigarette butts: 29,1% - Caps/lids: 6,7% - Beverage cans: 6,3% - Beverage bottles (glass): 5,5% - Cigarette lighters: 5,2%	Beaches: 37-80% plastics Floating: 60-83% plastics Sea-floor: 36-90% plastics	Recreational/shoreline activities: >50%, Increase in tourism season
Ocean Conservancy/ ICC 2002-2006			Beach litter: recreational activities: 52% Smoking-related activities: 40% waterways activities: 5%
JRC IES (2011)		Beach:83% plastics/polystyrene	

Shoreline activities (including poor waste management practices, tourism and recreation), along with sea/waterway activities, smoking-related activities, dumping and improper disposal of medical/personal hygiene items are among the main beach marine litter sources (Table 1). Tourism has a significant share in the generation of beach marine litter. During the summer period population is almost doubled in the coastal areas of the Mediterranean Sea being directly linked with the increased waste generation reaching up to 75% of the annual waste production for some areas. In the same extent marine litter concentration has been found to double during summer.
Public and awareness, citizen engagement and participation are effectively contributing in tackling the problem of marine litter along the shorelines of the Mediterranean Sea.

Results and Status, including trends (extended)

Strandline surveys, cleaning, and regular surveys at sea are gradually being organized in many Mediterranean countries for the aim of providing information on temporal and spatial distribution. Various strategies based on the measurement of quantities or fluxes have been adopted for data collection purposes. However, most surveys are conducted by NGOs with a focus on cleaning. Moreover, small fragments measuring less than 2.5 cm, also referred to as mesolitter (versus macro litter), are often buried and may not be targeted by clean-up campaigns or monitoring surveys. Stranding fluxes are therefore difficult to assess, and a decrease in litter amounts at sea will only serve to slow stranding rates. They can comprise a large proportion of the litter found on beaches and very high densities have been found in some areas.

Based on data provided by the Ocean Conservancy and processed and analyzed by HELMEPA from beach clean-ups in Mediterranean countries within the framework of the International Coastal Cleanup (ICC) campaign, the main types of litter found on Mediterranean beaches, are listed in Table 2, 3 and 4 hereunder.

Table 2: Main types of beach marine litter in the Mediterranean (ICC after UNEP, 2011)

Plastics: bags, balloons, beverage bottles, caps/lids, food wrappers/ containers, six-pack holders, straws/stirrers, sheeting/tarps, tobacco packaging and lighters
Glass: beverage bottles, light bulbs
Paper and cardboard of all types
Metals: aluminium beverage cans, pull tabs, oil drums, aerosol containers, tin cans, scrap, household appliances, car parts
Polystyrene: cups/plates/cutlery, packaging, buoys
Cloth: clothing, furniture, shoes
Rubber: gloves, boots/soles, tires
Fishing related waste: abandoned/lost fishing nets/line and other gear
Munitions: shotgun shells/wadding
Wood: construction timber, crates and pallets, furniture, fragments of all the previous
Cigarette filters and cigar tips
Sanitary or sewage related litter: condoms, diapers, syringes, tampons
Other: rope, toys, strapping bands

Table 3: Top ten items in the Mediterranean Sea (International Coastal Clean-up, ICC, 2016). Total number is the number of items collected on 94.4 km of beaches from 11 different countries (Albania, Algeria, Bosnia/Herzegovina, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, Libya, Malta, Morocco, Slovenia, Spain, and Turkey)

	cigarette butts	**plastic beverage bottles**	**food wrappers**	**plastic bottle caps**	**straws/ stirrers**	**other plastic bags**	**glass beverage bottles**	**plastic grocery**	**metal bottle caps**	**plastic lids**
Total collected number	68561	17652	8429	16809	16061	4026	2914	3908	2918	6833
number /100m	73	19	9	18	17	4	3	4	3	7

Table 4: Top fifteen beach litter items for the Mediterranean Sea and their share and average frequency per 100m coast line, based OSPAR screening (after JRC 2016)

Description	**Average # / 100m**	**Share**
Cutlery/trays/straws (total)	131	17%
Cigarette butts	112	14%
Caps/lids (total)	110	14%
Drink bottles (total)	91	12%
Bags (e.g. shopping)	43	5%
Cotton bud sticks	37	5%
Bags	35	4%
Plastic/polystyrene pieces 2.5 cm > < 50 cm (total)	30	4%
Bottles	28	4%
Crisp/sweet packets and lolly sticks (total)	26	3%
Food incl. fast food containers	15	2%
Cigarette packets	12	2%
Cigarette lighters	11	1%
Drink cans	11	1%
Other sanitary items	9	1%
TOTAL	**701**	**89%**

By far the most predominant type of marine litter in the Mediterranean is cigarette filters (closely followed by cigar tips), which constitute a concern to the region and can be found even in the most remote coastal areas. Thus, 4822 volunteers collected 68,561 cigarette filters in 2015, which corresponds to almost 14.2 cigarette filters per volunteer, while the corresponding average in 2013 was 19.6 and the global average in 2006 was only 3.66 cigarette filters per volunteer. The degradation time for each type of litter is an important factor, as some may degrade fast, in the range of months or years, indicating more concern. It is also important to note that in the ICC Campaign, the small fragments do not appear in the corresponding list of recorded beach marine litter items.

Table 5: Composition/ sources of marine litter in the Mediterranean

Source (Literature)	Items/Consistency (beaches; top five)	Type of material	Sources
IPA Adriatic DeFishGear (2016)	Items (top 5): -Plastic pieces 2.5 cm > < 50 cm : 19.89% -Polystyrene pieces 2.5 cm > < 50 cm: 11.93% -Cotton bud sticks: 9.17% -Plastic caps/lids from drinks: 6.67% -Cigarette butts and filters: 6.60%	Plastics: 91%	Recreational & tourism:40% Households(combined):40% Coastal tourism: 32,3% Toilet/sanitary: 26,2% Household: 11,2% Waste collection: 6% Recreational: 5,6%
Marine Litter Watch (MLW) / European Environment Agency (EEA)	- Other types: 32% - Cigarette butts: 18% - Plastic pieces 2.5><50 cm: 11% - Shopping bags (incl. pieces): 7% - Cotton butt sticks: 6% - Plastic caps/lids drinks: 6% - Polystyrene pieces 2.5><50 cm: 6% - Glass/ceramic fragments <2.5 cm: 4% - String and cord (less than 1cm): 4% - Crisps packet/sweets wrappers: 3% - Drink bottles <=0.5lt: 3%	Plastics: 64% Glass: 4%	
Öko-Institut (2012; figures mainly from UNEP, 2009)	-Cigarette butts: 29,1% - Caps/lids: 6,7% - Beverage cans: 6,3% - Beverage bottles (glass): 5,5% - Cigarette lighters: 5,2%	Beaches: 37-80% plastics Floating: 60-83% plastics Sea-floor: 36-90% plastics	Recreational/shoreline activities: >50%, Increase in tourism season
Ocean Conservancy/ ICC 2002-2006			Beach litter: recreational activities: 52% Smoking-related activities: 40% waterways activities: 5%
JRC IES (2011)		Beach:83% plastics/polystyrene	

Marine litter items cannot always be linked to a specific source as several marine litter items can be attributed to more than one sources, means of release, geographic origin, pathways and transport mechanism (Veiga et al., 2016). We often categorize the origin of marine litter into land-based and sea-based sources. Similarly, riverine litter is sometimes considered to be land-based, even though some of the littering can occur by boats and ships navigating rivers. Possible riverine sources include the following: public littering on riverbanks or directly in the river, and waste from cities and harbours; poor waste management practices, fly tipping; improper disposal or loss of products from industrial and agricultural activities; debris from the discharge of untreated sewage, either through lack of waste - treatment facilities or from sewer overflows; and storm water discharges (González et al., 2016).

Marine litter from smoking related activities accounts for 40% of total marine litter in the same period and 53.5% of the top ten items counted in 2013. Although the number of litter items from smokers dropped significantly between 2004 and 2005, since 2005 it has been on the rise again. The figure in the Mediterranean is considerably higher than the global average, and constitutes a serious problem that has to be given priority in a Regional Strategy to address the issue.

Many studies dedicated to the local beaches surveys and litter collection provide information on litter and tourism. During summer season, the populations of seaside towns are sometimes double what they are in wintertime. In some tourist areas, more than 75% of the annual waste production is generated in summer season. According to statistics from holiday destinations in the Mediterranean (Bibione-Italy and Kos-Greece), tourists generate an average of 10% to 15% more waste than inhabitants. In the example of Kos Island, the tourism period is from April to October, with 70% of the total annual waste produced during this period (UNEP 2011).

Malta, where over 20% of the Global Net Production is generated from tourism, realized an increase of packaging (37% of municipal solid waste) in 2004 and introduced “bring-in sites” with 400 stations installed by 2006 (State of the Environment Report Malta, 2005, in UNEP 2011). Unfortunately, no new data regarding the results of the introduction is yet available, and the latest report from 2005 still shows an increasing waste production per capita and tourism.

Research funded by the Balearic Government in 2005 (Martinez-Ribes *et al.*, 2007) focused on the origin and abundance of beach litter in the Balearic Islands, including Mallorca, Menorca, and Ibiza, which are all main tourist destinations. This fundamental study shows similarities to other tourism areas and is therefore very helpful regarding the sources of littering, which are highly connected to tourism. Litter found in summertime is twice as much as in winter (Figure 1).

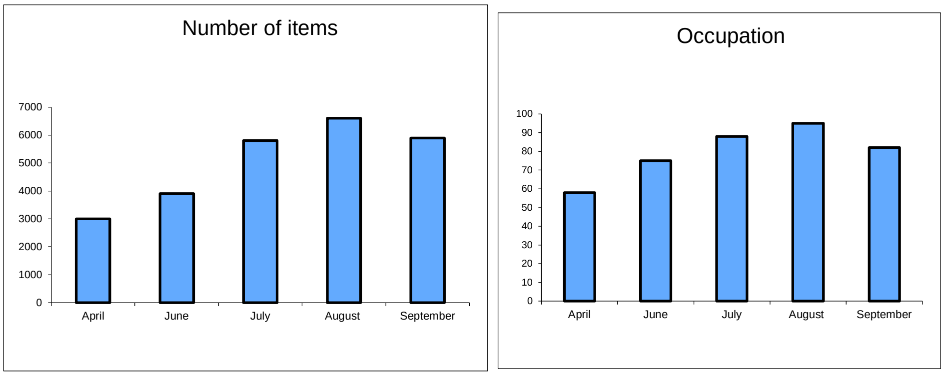

Figure 2: Monthly variation of litter items (A) and percentage of hotel occupation for the corresponding date (B) in the Balearic Islands (Source Martinez-Ribes et al., 2007)

In another example, Israel achieved good results with their pollution abatement Clean Coast Index, involving Municipalities and NGOs in beach clean-ups (Ministry of Environmental Protection, 2008). Although there is no data about the types and quantities of litter pollution in the coastal areas, the published index shows a 30% reduction of littered beaches. Raising public awareness with leaflets and competitions in tourism and public areas supported the strategy, and the ongoing efforts will be continued on a yearly basis to continue to tackle the litter problem on the shorelines of Israel. Moreover, data from a monitoring experiment on a sample of 52 beaches in France (Mer-terre.org) confirmed the existence of tourism and fishing related activities as main sources of litter.

The IPA-Adriatic DeFishGear provides valuable data on beach litter from its one-year long surveys carried on beaches in the seven countries of the Adriatic-Ionian macroregion, namely Albania, Bosnia and Herzegovina, Croatia, Italy, Greece, Montenegro and Slovenia. More specifically 180 beach transects were surveyed in 31 locations, covering 32,200 m2 and extending over 18 km of coastline. The majority of litter items were artificial polymer materials accounting for 91.1% of all beach litter. Shoreline sources -including poor waste management practices, tourism and recreational activities-accounted for 33.4% of total litter items collected on beaches. When looking at the sea-based sources of litter (fisheries and aquaculture, shipping) these ranged from 1.54% to 14.84% between countries, with an average of 6.30% at regional level for beach litter.

Standing stock evaluations of beach litter reflect the long-term balance between inputs, land-based sources or stranding, and outputs from export, burial, degradation and clean-ups. Recording the rate at which litter accumulates on beaches through regular surveys is currently the most commonly-used approach for assessing long-term accumulation patterns and cycles. The majority of studies performed to date have demonstrated densities in the 1 item/m^2 range but show a high variability in the density of litter depending the use or characteristics of each beach (UNEP/MAP, 2015). Plastic accounts for a large proportion of the litter found on beaches in many areas, although other specific types of plastic are widely-found in certain areas, according to type (Styrofoam, etc.) or use (fishing gear). For ICC (Table 6), cigarette butts, plastic bags, fishing equipment, and food and beverage packaging are the most commonly-found items, accounting for over 80% of litter stranded on beaches.

Table 6: Top ten items by country (International Coastal Clean-up, ICC 2016) expressed as number of items/100m of beach

	Number of items per 100 m									
COUNTRY	cigarette butts	Plastic beverage bottles	Food wrappers	Plastic bottle caps	Straws, stirrers	Other plastic bags	Glass beverage bottles	Plastic grocery bags	Metal bottle caps	Plastic lids
Albania	535	39	55	26	35	27	5	25	8	1
Cyprus	30	7	8	3	4	1	1	3	2	2
Egypt	1	1	1	4		1	1	1		
France	34	3	3	2	1	3	1	4	1	1
Greece	71	16	5	15	14	2	2	4	3	10
Italy[1]							5			
Malta		2					1			
Morocco	7	13	1	23	5	7	10	5	13	3
Slovenia	63	2	5	6	2	6	0	1	1	
Spain	83	21	20	36	39	9	5	6	5	7
Turkey	613	811	14				137	12		

Data from *Clean up Greece* between 2004 and 2008 indicated however the importance plastic and paper abandoned and wind born on island beaches. On isolated beaches, other visible and larger sized litter items (metal, rubber, glass, and textile) have increased due to illegal dumping. The abundance, nature, and possible sources of litter on 32 beaches on the Balearic Islands (Mediterranean Sea) were investigated in 2005 (Figure 2). Mean summer abundance in the Balearics reached approximately 36 items per linear meter, with a corresponding weight of 32±25 g per m^{-1}, which is comparable to the results of other studies in the Mediterranean. Strong similarities between islands and a statistically significant seasonal evolution of litter composition and abundance were demonstrated. In summer (the high tourist season), litter contamination was double that in the low season and showed a heterogeneous nature associated with beach use. Again, cigarette butts were the most abundant item, accounting for up to 46% of the objects observed in the high tourist season. In contrast, plastics related to personal hygiene/medical items were predominant in wintertime (67%)In both seasons, litter characteristics suggested a strong relationship with local land-based origins. While beach users were the main source of summer litter, low tourist season litter was primarily attributed to drainage and outfall systems.

[1] The participation of Italy to ICC was limited to only 16 volunteers in a very small portion of coastline, so data reported in table 6 are not representative of the Italian situation.

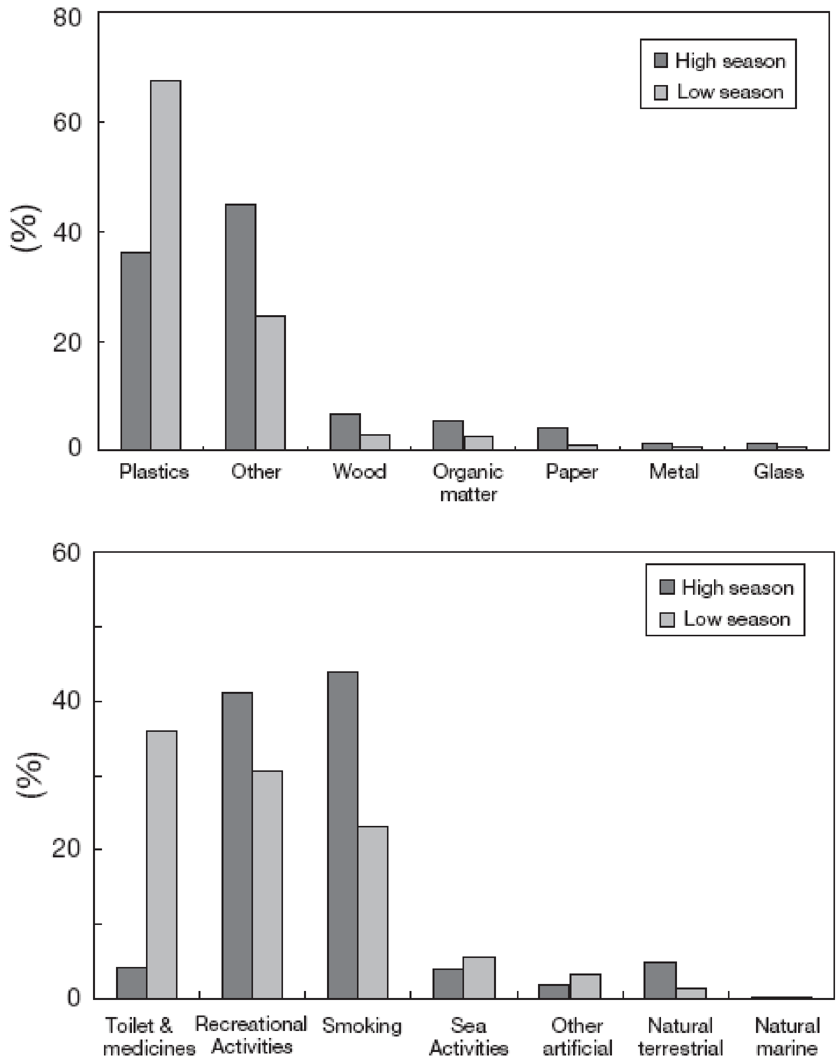

Figure 3: Litter composition (A) and estimated origin (B) of the litter collected in low and high tourist season in Balearic Islands (source Martinez-ribes et al., 2007)

CONCLUSIONS

Conclusions (brief)

Knowing the amounts of marine litter found stranded on beaches can help us assess the potential harm to the environment and would also increase our knowledge on sources (JRC, 2013), as currently there is limited data and great spatial variability on the amounts and composition of marine litter reflecting the different characteristics of the shorelines along the Mediterranean.

Existing studies however indicate the main types of beach litter are of land-based origin, coming from poor waste management practices, recreational and tourism activities, household items and smoking related waste (Table 4). Moreover, it is difficult to draw conclusions regarding the overall increase or decrease of marine litter in the Mediterranean (UNEP/MAP, 2015). Assessments of the composition of beach litter in different regions of the Mediterranean Sea show that synthetic polymer materials (bottles, bags, caps/lids, fishing nets, and small pieces of unidentifiable plastic and polystyrene) make up the largest proportion of overall litter pollution.

Conclusions (extended)

The amount of litter originating from recreational/tourism activities greatly increases during and after the tourism season. Smoking related wastes in general also seems to be a significant problem in the Mediterranean, as several surveys suggest (UNEP 2009). According to the analysis of data collected, shoreline and recreational activities were the main source every year of the last decade, until it was surpassed by smoking-related waste (UNEP, 2011). Moreover, the fishing industry is of significance (UNEP, 2013), as well as the shipping industry, especially off the African coast.

National Case Studies may provide more detailed information on local constraints and effective factors on the distribution of litter. Moreover national data coming from national monitoring programmes on marine litter will improve a lot the picture for beach marine litter. It is important to note, however, that volunteer groups should be informed about the necessity to submit standardized research data for statistical purposes. Clean up actions by NGOs are usually organized to raise awareness and not so much for data collection, and cleanup programmes should increase public knowledge of the scientific relevance of information and information sharing.

There are certain limitations to the results on beach marine litter in the Mediterranean. As it has been already stated for the moment the Contracting Parties are not submitting official marine litter data to the Secretariat as a result of the national monitoring programmes. Moreover, the smaller sized items are not included in most of the case among the cleanup campaigns items list and thus these results are not at all representative for the presence of smaller fragments i.e. micro-litter along the beaches in the Mediterranean.

However, interesting observations have been made on the proliferation of lighter marine litter items in the Mediterranean (plastics, aluminum and smoking-related litter), as opposed to heavier items from basic use (bottles, cans, see Figure 3) or litter from dumping activities (household appliances, construction materials, tires, etc.) This could be related to the efficiency of preventive action (easier collection, recycling, adoption and/or implementation of stricter legislation with regards to dumping activities, etc.) for larger items and the difficulty to manage inputs from sources such as the general public.

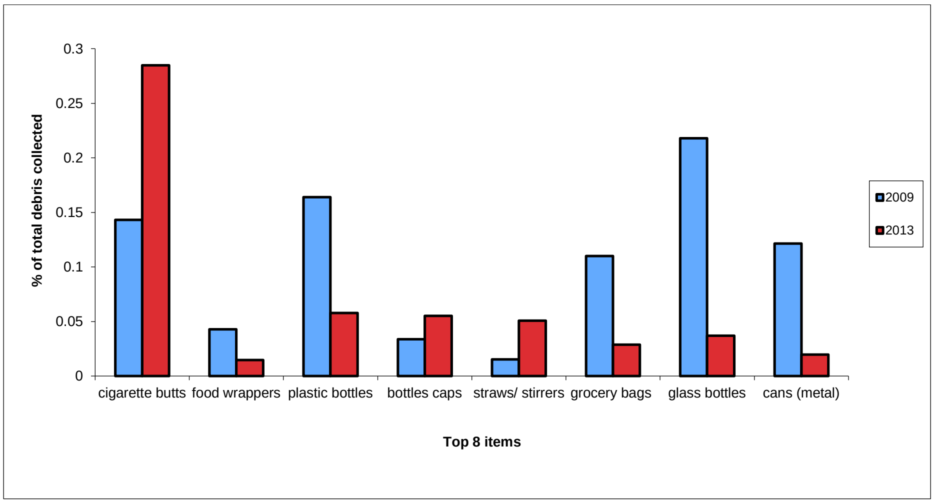

Figure 4: Changes in percentages of the top 8 items in the Mediterranean Sea between 2009 and 2013. Data from Ocean Coastal Cleanup on types of litter of 303522 items and 110698 items collected in 2009 and 2013 respectively on beaches from Greece, Turkey, Egypt and Spain (data from http://www.oceanconservancy.org/)

Environmental awareness is also observed when this general public, conscious of the impact of their actions, do not use beaches as disposal sites for heavy garbage items as lightheartedly as they did in the past. The removal of these heavier items, combined with the persistent nature of plastics and other lighter marine litter items that can still be found in considerable numbers in the Mediterranean, has led to the changing nature of marine litter in the region.

Key messages

Information on beach marine litter exist but the picture is still fragmented and is geographically restricted to the northern part of the Mediterranean. Plastics are the major components with cigarette butts, food wrappers and plastic being the top marine litter items. Land-based sources are predominant but they have to be further specified. Tourism is directly affecting marine litter generation on beaches. There is an urgent need to develop and implement the Integrated Monitoring and Assessment Programme (IMAP) protocol for Common Indicator 22, and submit corresponding data to the Secretariat at national level.

Knowledge gaps

Information on the distribution, quantities and identification of litter sources for beach marine litter needs to be further advanced. For the moment information and data are inconsistent for the Mediterranean. In that aspect, monitoring strategies should be encouraged at regional level based on harmonized and standardized monitoring and assessment methods. Mapping of the shorelines and coasts at basin scale where marine litter accumulates needs to be implemented. Accumulation and stranding fluxes needs to be evaluated along with information on corresponding loads and linkage with specific sources. Efforts should be enhanced towards engaging citizens, informing them about certain aspects and effects of marine litter found stranded on beaches, along with make responsible citizens (responsible consumption and littering behavior).. Harmonized beach clean-up campaign organized at basin scale should be organized based on a science-based protocol which will enable the collection of relevant scientific information.

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Ecological Objective 10 (EO10): Marine Litter

EO10: Common Indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor

GENERAL

Reporter:	UNEP/MAP/MED POL
Geographical scale of the assessment:	Mediterranean Sea
Contributing countries:	Mediterranean assessment based on existing regional and national surveys, research and publications and as appropriate data from national monitoring programmes of the Contracting Parties.
Mid-Term Strategty (MTS) Core Theme:	1-Land and Sea Based Pollution
Ecological Objective	Ecological Objective 10 (EO10): Marine and coastal litter do not adversely affect the coastal and marine environment
IMAP Common Indicator	Common Indicator 23 (CI23): Trends in the amount of litter in the water column including microplastics and on the seafloor
Indicator Assessment Factsheet Code	EO10CI23

RATIONALE/METHODS

Background (short)

The marine environment is directly linked to human life. Nowadays, marine litter is found widespread in the environment, from shallow water till the deep abyssal plains, posing one of the major threats for the marine environment.

The Mediterranean Sea has been described as one of the areas most affected by marine litter in the world. Human activities generate considerable amounts of waste, and quantities are increasing, although they vary between countries. In addition, some of the largest amounts of Municipal Solid Waste (MSW), generated annually per person occur in the Mediterranean Sea (208 – 760 kg/year, http://atlas.d-waste.com/). Plastic, which is the main marine litter component, has now become ubiquitous and may comprise up to 90% for seafloor litter.

Surveys conducted to date in the Mediterranean Sea, show considerable spatial variability. Accumulation rates vary widely and are influenced by many factors, such as the presence of large cities, shore use, hydrodynamics, and maritime activities. Marine litter is even more abundant in enclosed areas, which has some of the highest densities of marine litter stranded on the sea floor, sometimes reaching over 100,000 items/km2 (Galgani et al., 2000). Moreover, the estimated plastic densities found floating in the Mediterranean Sea seems to be of the same range as in the five sub-tropical gyres. To date, the fate of this litter is still questionable and the identification of areas where litter permanently accumulate is a major challenge.

Plastic densities on the deep sea floor did not change over the years (1994 – 2009) in the Gulf of Lion, but conversely the abundance of marine litter in deep waters was found to increase over the years in the Central Mediterranean (Koutsodendris et al., 2008; Ioakeimidis et al., 2014).

Background extended

The global amount of litter entering into the oceans has been calculated at between 4.8 and 12.7 million tons, only for plastics (Jambeck et al., 2015). Moreover, the deep-sea floor is probably the final global sink for marine litter mostly comprising of plastic.

The Mediterranean Sea has been described as one of the areas most affected by marine litter in the world geographical distribution of marine litter and plastic in particular, is highly impacted by hydrodynamics, geomorphology, and human factors. The Mediterranean geomorphology is very peculiar with not extensive shelves and deep-sea environments that can be influenced by the presence of coastal canyons. Continental shelves are proven accumulation zones, but they often gather smaller concentrations of marine litter than canyons; as litter is washed offshore by currents associated with offshore winds and river plumes.

Most litter is comprised of high-density materials and hence sinks. Even low-density synthetic polymers such as polyethylene and polypropylene, may sink under the weight of fouling or additives. The fouling of litter by a wide variety of bacteria, algae, animals and fine-grained accumulated sediments, increases their weight and litter can sink to the seafloor. In the Mediterranean, plastic which is the main marine litter component, is ubiquitous in the marine environment and may comprise up to 90% of the recorded seafloor marine litter. Human activities generate considerable amounts of waste, and quantities are increasing, although they vary between countries. Some of the largest amounts of Municipal Solid Waste (MSW), generated annually per person occur in the Mediterranean Sea (208 – 760 kg/year, http://atlas.d-waste.com/)

Important policy achievements have been expanded at regional level in the Mediterranean. United Nations Environment / Mediterranean Action Plan has adopted the Strategic Framework for Marine Litter Management in 2012 (Decision IG.20/10 - 17th Meeting of the Contracting Parties of the Barcelona Convention). Following, the Regional Plan on Marine Litter Management in the Mediterranean in the Framework of Article 15 of the Land Based Sources Protocol was adopted in 2013 (Decision IG.21/7 – 18th Meeting of the Contracting Parties of the Barcelona Convention), together with a decision (IG.22/10) in 2016 to support the implementation of the Marine Litter Regional Plan including Fishing-for-Litter Guidelines, an Assessment Report, Baselines Values, and Reduction Targets (19th Meeting of the Contracting Parties of the Barcelona Convention). In addition the Integrated Monitoring and Assessment Programme of the Mediterranean Sea Coast and Related Assessment Criteria adopted in 2016 (Decision IG.22/7 – 19th Meeting of the Contracting Parties of the Barcelona Convention) two common and one candidate indicators on marine litter along with an Integrated Monitoring and Assessment Guidance document (UNEP(DEPI)/MED IG.22/Inf7 - 19th Meeting of the Contracting Parties of the Barcelona Convention).

Floating litter comprises the mobile fraction of litter in the marine environment, as it is less dense than seawater. However, the buoyancy and density of plastics may change during their stay in the sea due to weathering and biofouling (Barnes et al., 2009). Polymers comprise the majority of floating marine litter, with figures reaching up to 100%. Although synthetic polymers are resistant to biological or chemical degradation processes, they can be physically degraded into smaller fragments and hence turn into micro litter, measuring less than 5 mm.

The Mediterranean Sea is often referred to as one of the places with the highest concentrations of litter in the world. For floating litter, very high levels of plastic pollution are found, but densities are generally comparable to those being reported from many coastal areas worldwide (UNEP/MAP, 2015). A 30-year circulation model using various input scenarios showed the accumulation of floating litter in ocean gyres and closed seas, such as the Mediterranean Sea, made up 7-8% of the total litter expected to accumulate (Lebreton et al., 2012).

There are several studies investigating the abundance of marine litter in the Mediterranean Sea. The abundance of floating microplastic fragments was investigated in the Mediterranean Sea by Kornilios et al., 1998; Collignon et al., 2012; Fossi et al., 2012; Collignon et al., 2014; de Lucia et al., 2014; Pedrotti et al., 2014; Cozar et al., 2015; Panti et al., 2015; Fossi et al., 2016 ; Ruiz-Orejón 2016 and Suaria et al., 2016. Few studies have been also published on the abundance of floating macro and mega litter in Mediterranean waters (Aliani et al., 2003; UNEP, 2009; Topcu et al., 2010, Gerigny et al., 2011, Suaria and Aliani, 2015). Information also exist on the abundance of seafloor marine litter for the Mediterranean Sea (Galil et al., 1995; Galgani et al., 1996, 2000; Ioakeimidis et al., 2014; Pham et al., 2014; Ramirez-Llodra et al., 2013).

Floating litter can be transported by currents until they sink to the sea floor, are deposited on the shore, or are degraded over time. Litter that reaches the seafloor may have already been transported considerable distance, only sinking when weighted down by entanglement and fouling. The consequence is an accumulation of litter on specific seafloor locations in response to local sources and oceanographic conditions (Galgani et al., 2000; Keller et al., 2010; Watters et al., 2010; Ramirez-L lodra et al., 2013; Pham et al., 2013). Moreover, seafloor litter tends to become trapped in areas of low circulation. Once litter reaches the seafloor, it lies on the seafloor and it may even partly buried in areas of very high sedimentation rate (Ye and Andrady, 1991).

In terms of data availability on marine litter lying on the seafloor of the Mediterranean, there are several studies investigating the abundance of marine litter (Galil et al., 1995; Galgani et al., 1996, 2000; Ioakeimidis et al., 2014; Pham et al., 2014; Ramirez-Llodra et al., 2013, Vlachogianni et al., 2017) but the information is still fragmented and geographically restricted to the northern Mediterranean. Litter that reaches the seafloor may have already been transported considerable distance, only sinking when weighted down by entanglement and fouling. The consequence is an accumulation of litter on specific seafloor locations in response to local sources and oceanographic conditions (Galgani et al., 2000; Keller et al., 2010; Watters et al., 2010; Ramirez-Llodra et al., 2013; Pham et al., 2013). Moreover, seafloor litter tends to become trapped in areas of low circulation like the enclosed and semi-enclosed gulfs. Once litter reaches the seafloor, it lies on the seafloor and it may even partly buried in areas of very high sedimentation rate (Ye and Andrady, 1991).

Marine litter and plastics in particular it was believed to last in the marine environment for decades or even hundreds of years when in surface (Gregory and Andrady, 2003), likely far longer when in deep sea (Barnes et al., 2009). However, recent studies (Ioakeimidis et al., 2016) have found that the degradation of plastics in the marine environment may occur much faster than it was expected. Surveys conducted to date show considerable spatial variability on marine litter abundance. Accumulation rates vary widely and are influenced by many factors, such as the presence of large cities, shore use, hydrodynamics, and maritime activities. They are higher in enclosed seas such as the Mediterranean basin, which has some of the highest densities of marine litter stranded on the sea floor, sometimes reaching over 100,000 items / km² (Galgani et al., 2000). Plastic densities on the deep sea floor did not change between 1994 and 2009 in the Gulf of Lion (Galgani et al., 2011). Conversely, the abundance of litter in deep waters, such as the central Mediterranean, was found to increase over the years (Koutsodendris et al., 2008; Ioakeimidis et al., 2014).

In the Mediterranean, reports from Greece (Koutsodendris et al., 2008; Ioakeimidis et al., 2014) classify land-based sources (up to 69% of litter) and vessel-based sources (up to 26%) as the two predominant litter sources. In addition, litter items have variable floatability and hence variable dispersal potential.

Assessment methods

The current assessment has been based on recent key assessments, reports and publications by UNEP/MAP, and other projects and initiatives. The UNEP/MAP (2015) Marine Litter Assessment in the Mediterranean report has been used as the main source for this indicator assessment factsheet.

For the moment there is no reporting on UN Environment / Mediterranean Action Plan on floating and seafloor marine litter and the assessment is based on the available data and information from reports and scientific publications.

Several approaches, protocols and units (items/km, items/km^2, kg/km^2, kg/h) have been used. However the expression of the abundance of marine litter found float at sea or lying on the seafloor in items per surface are (m2, km^2, ha2) coupled with information on weight seems to be the most appropriate. Nowadays the harmonization of all the sampling methodologies is among the top-priorities of the marine litter agenda.

A. Floating Marine Litter

Visual assessment of floating macro-litter particles include the use of research vessels, marine mammal surveys, commercial shipping carriers, and dedicated litter observations (UNEP/MAP, 2015). Aerial surveys have also being employed for larger items. For floating micro-litter particles the manta-trawl net system is used for sampling the surface layers of the seas. The net it pulls is made of thin mesh (normally with mesh size of 333μm) and the whole trawl is towed behind a vessel. Then laboratory work is required in order to analyze the collected samples.

B. Seafloor Marine Litter

Most of the data and information on seafloor marine litter are coming from general strategies for the investigation of seabed marine litter which are often similar to those used to assess the abundance and type of benthic species. Several approaches are applied in order to assess seafloor litter abundance and distribution: i) visual surveys with SCUBA in shallow waters; ii) opportunistic sampling using otter-trawls; and iii) observation tools (Remote Operated Vehicles - ROV etc.).

The most common approaches to evaluate sea-floor litter distributions is the opportunistic sampling. This type of sampling is usually coupled with regular fisheries surveys and programmes on biodiversity, since methods for determining seafloor litter distributions (e.g. trawling, diving, video) are similar to those used for benthic and biodiversity assessments.

Monitoring programmes for demersal fish stocks, undertaken as part of the Mediterranean International Bottom Trawl Surveys (MEDITS), operate at large regional scale and provide data using a harmonized protocol, which may provide a consistent support for monitoring litter at Regional scale on a regular basis and within the Ecosytem Approach (EcAp) requirements.

The use of observation tools i.e. Remote Operated Vehicles (ROVs) and Submersible Vehicles is a possible approach for deep-sea environments (Galgani et al. 1996; Pham et al., 2014). These methods unfortunately require considerable means but are of great use for areas that cannot be accessed with other ways. The use of observation tools helped scientists assess marine litter far beyond the commonly used fishing grounds (sandy bottoms) and the continental shelf, and extend the assessment of marine litter in bathyal and abyssal environments, reaching in depths up to 4km.

RESULTS

Results and Status, including trends (brief)

A. Floating Marine Litter

The abundance of floating macro and mega litter in Mediterranean waters has been reported at quantities measuring over 2 cm range from 0 to over 600 items per square kilometer (Aliani et al., 2003; UNEP, 2009; Topcu et al., 2010, Gerigny et al., 2011, Suaria and Aliani, 2015) (Figures 1, 2). Plastics are predominant among floating marine macro- and micro-litter items.

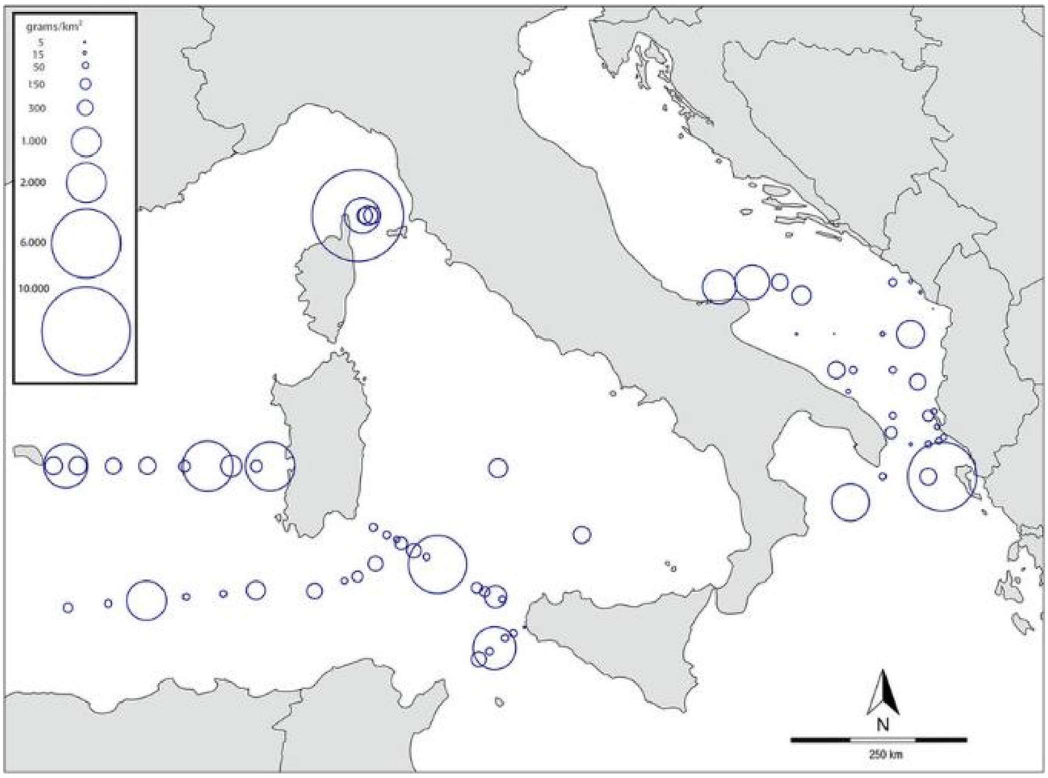

Figure 1: Map of the central-western Mediterranean Sea showing the distribution of plastic densities expressed as grams of plastic per km^2 (after Suaria et al., 2016)

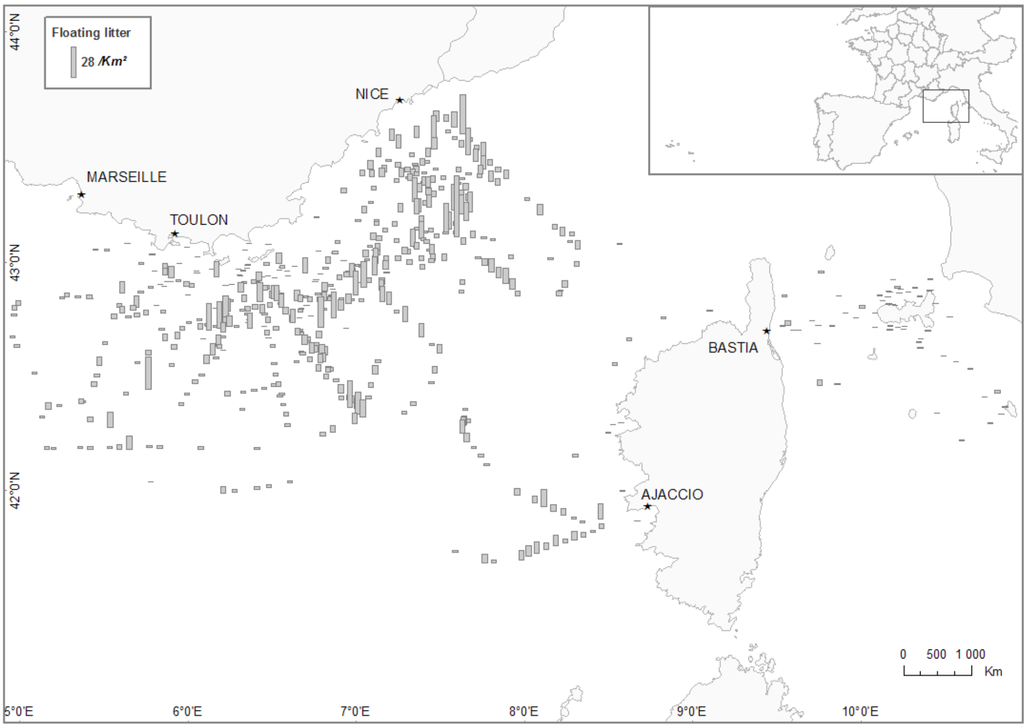

Figure 2: Distribution of floating litter in the northwestern Mediterranean Sea (2006-2008) (visual observations). IFREMER/SHOM map using data from the Ecocean/ParticipeFutur project for initial MSFD assessment (Gerigny et al., 2011)

B. Seafloor Marine Litter

The 2015 UN Environment / Mediterranean Action Plan Marine Litter Assessment report states that approximately 0.5 billion litter items are currently lying on the Mediterranean Seafloor. Moreover, there is great variability in the abundance of seafloor marine litter items ranging from 0 to over 7,700 items per km² depending on the study area. Plastic is the major marine litter component, found widespread in the continental shelf of the Mediterranean, ranging up to 80% and 90% of the recorded marine litter items.

We yet don't have a clear picture on the abundance (number and mass) of marine litter lying on the Mediterranean seafloor, from the shallow water till the deep abyssal plain (Figure 3). The information is only limited and fragmented as only few studies exist investigating marine litter on the Mediterranean seafloor. In addition, the geographical distribution of marine litter items is highly impacted by hydrodynamics, geomorphology, and human factors. Moreover, most of them are geographically restricted to the Northern part of the Mediterranean Sea.

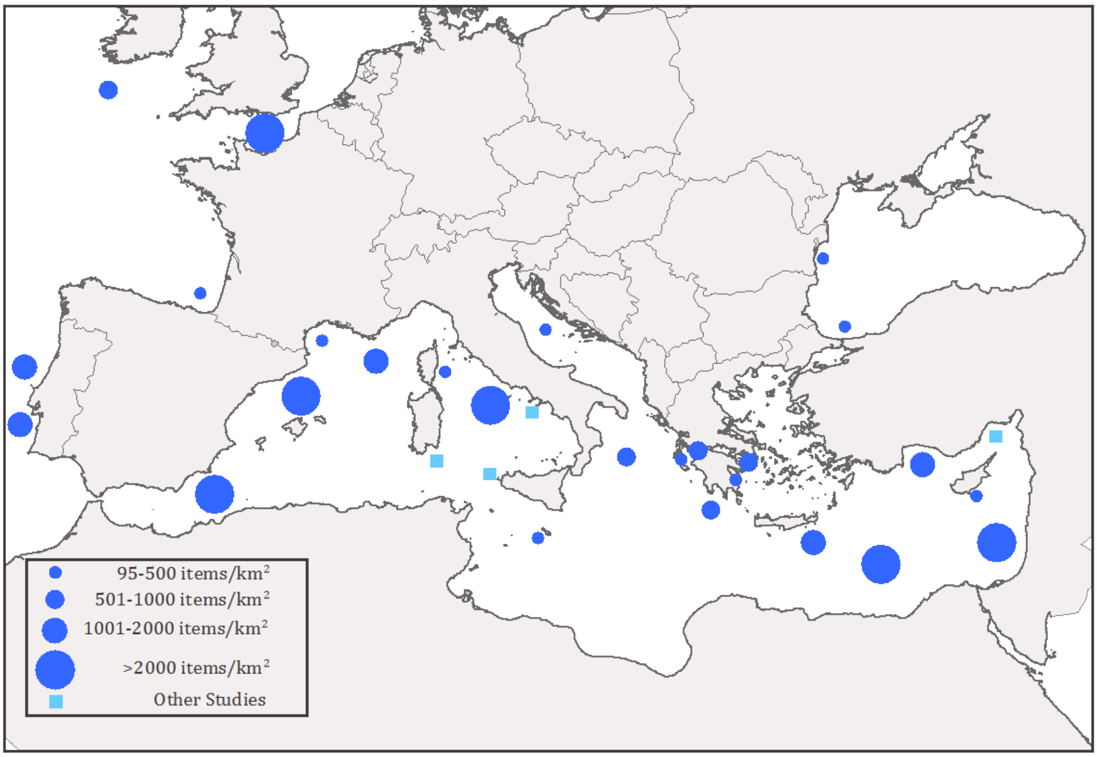

Figure 3: Seafloor marine litter distribution in the Mediterranean and other European Seas (Ioakeimdis, 2015)

Most of the studies have been using traditional fish stock assessment methods i.e. otter trawlers, but recently new, costly and more sophisticated techniques have been also used. In addition to that, little is known on the existence and importance of the corresponding accumulation areas in the Mediterranean.

Results and Status, including trends (extended)

A. Floating Marine Litter

The abundance of floating macro and mega litter in Mediterranean waters has been reported at quantities measuring over 2 cm range from 0 to over 600 items per square kilometer (Aliani et al., 2003; UNEP, 2009; Topcu et al., 2010, Gerigny et al., 2011, Suaria and Aliani, 2015).

In the Ligurian Sea, data was collected through ship-based visual observations in 1997 and 2000; 15-25 items/km² were found in 1997, which decreased to 1.5-3 items in 2000 (Aliani et al., 2003). In the regional assessment conducted by the IPA-Adriatic DeFishGear project (Vlachogianni et al., 2017), the average density of floating macro-litter in coastal Adriatic waters was found 332 ± 749 items/km^2 and in the Adriatic-Ionian waters 4 ± 3 items/km^2. In the Adriatic waters, the highest average abundances were recorded in the coastal waters of Hvar Aquatorium (Croatian coast) (576 ± 650 items/km^2; median 393 items/km^2), followed by the Gulf of Venice (475 ± 1203 items/km^2; median 154 items/km^2) and Cesenatico related area (324 ± 492 items/km^2; median 210 items/km^2). Moreover, during the surveys carried out by observers on ferries on the same areas floating macro-litter abundances were found about two times higher in the Adriatic (5.03 ± 3.86 items/km2) when compared to the Ionian Sea (2.94 ± 2.54 items/km2). Plastic items were dominant (Coastal: 91.4%; Adriatic-Ionian: 91.6%) of total items), followed by paper (Coastal 7.5%; Adriatic-Ionian: 5.1%) and wood items (Coastal: 2.1%; Adriatic-Ionian: 1.4%). The most abundant categories were bags (Coastal: 26.5%; Adriatic-Ionian: 20.4%), plastic pieces (Coastal: 20.3%; Adriatic-Ionian: 21.5%), sheets (Coastal: 13.3%; Adriatic-Ionian: 12.5%), fish polystyrene boxes (Coastal: 11.4%; Adriatic-Ionian: 12.5%), cover/packaging (Coastal: 8.1%), other plastic items (Coastal: 6.0%; Adriatic-Ionian: 2.9%), polystyrene pieces (Coastal: 3.9%; Adriatic-Ionian: 3.6%), and bottles (Coastal: 1.3%; Adriatic-Ionian: 7.7%).

Floating litter was also quantified during marine mammal observation cruises in the northern western basin Mediterranean Sea in a 100 x 200 km offshore area between Marseille and Nice and in the Corsican channel. A maximum density of 55 items/km² was found, with a clearly discernible spatial variability relating to residual circulation and a Liguro-Provencal current vein routing litter to the West (Gerigny et al., 2012 and Figure 4).

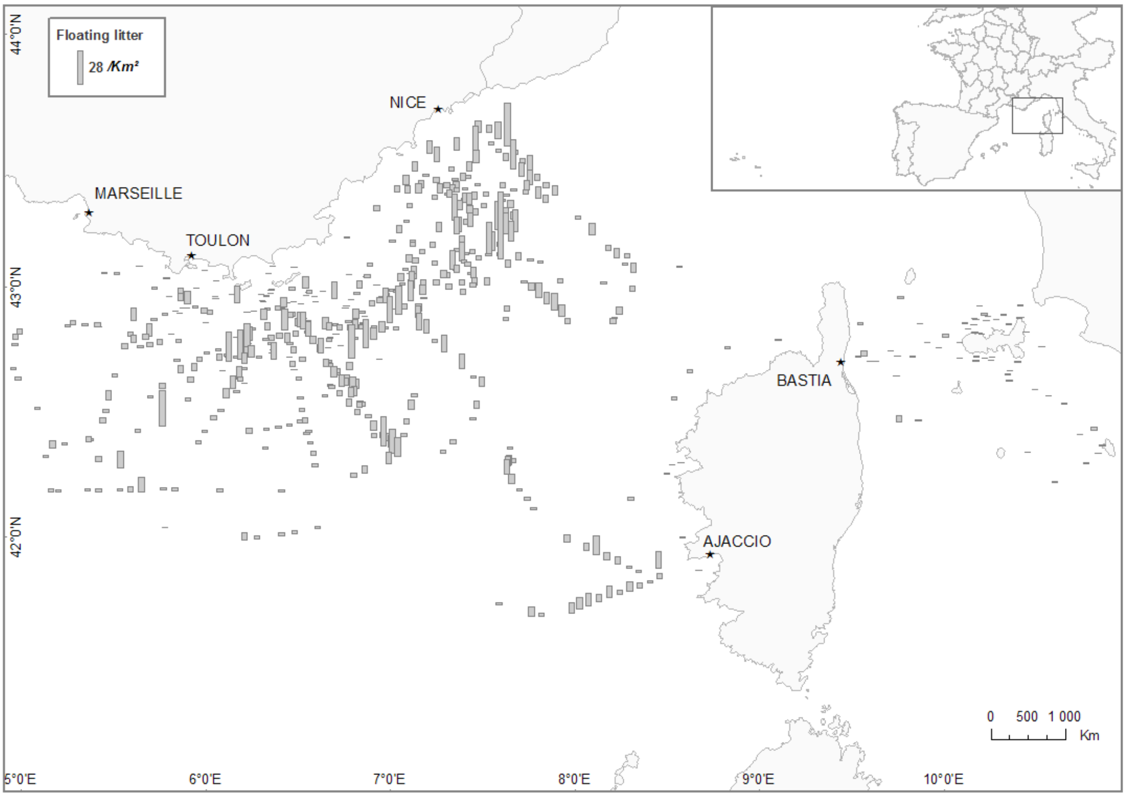

Figure 4: Distribution of floating litter in the northwestern Mediterranean Sea (2006-2008) (visual observations). IFREMER/SHOM map using data from the Ecocean/ParticipeFutur project for initial MSFD assessment (Gerigny et al., 2011)

A subsequent survey made in the Eastern Mediterranean (Topcu et al., 2010) reported densities of less than 2.5 items/ km^2. More recently, results from Suaria and Aliani (2014), dedicated to the first large-scale survey of anthropogenic litter (>2 cm) in the central and western part of the Mediterranean Sea (Figure 5). Throughout the entire study area, densities ranged from 0 to 194.6 items/km^2, with a mean abundance of 24.9 items/km^2. The highest litter densities (>52 items/km^2) were found in the Adriatic Sea and in the Algerian basin, while the lowest densities (<6.3 items/km^2) were observed in the Central Tyrrhenian and in the Sicilian Sea. All of the other areas had mean densities ranging from 10.9 to 30.7 items/km^2.

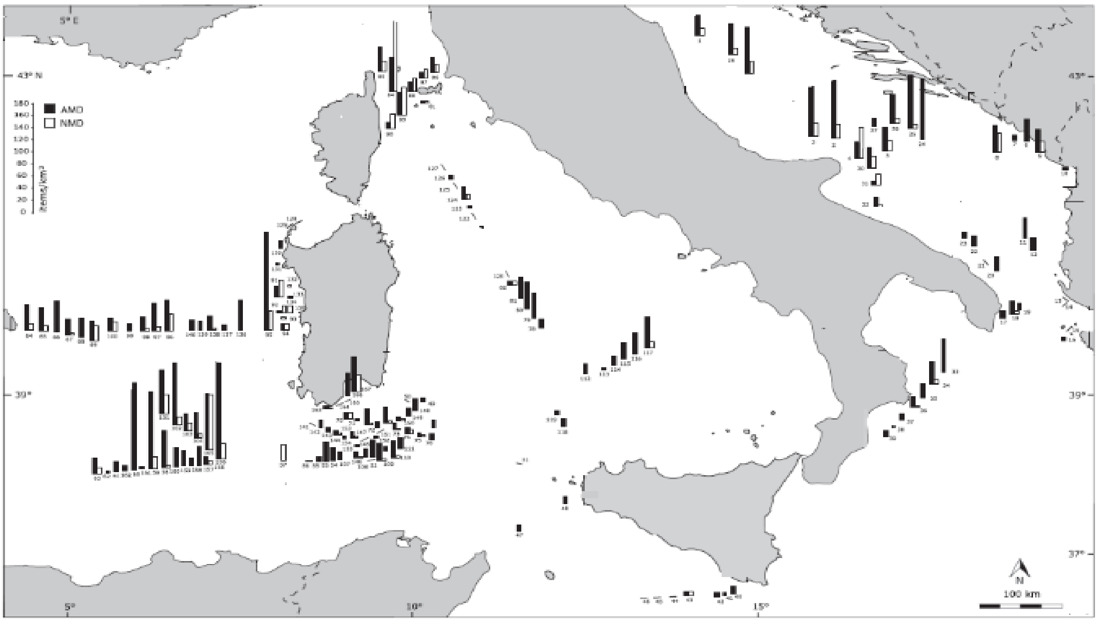

Figure 5: Anthropogenic (black bars) and Natural (white bars) Marine Litter densities (items/km2) in the Western, Adriatic and Northern Ionian basins of the Mediterranean Sea (From Suaria and Aliani, 2014)

Suaria et al. (2016) along with presenting their results (Figure 6) on the distribution of plastic densities in the central Mediterranean Sea, are also providing a detailed comparison table (Table 1) on floating microplastic concentrations based on the available studies performed in the Mediterranean Sea.

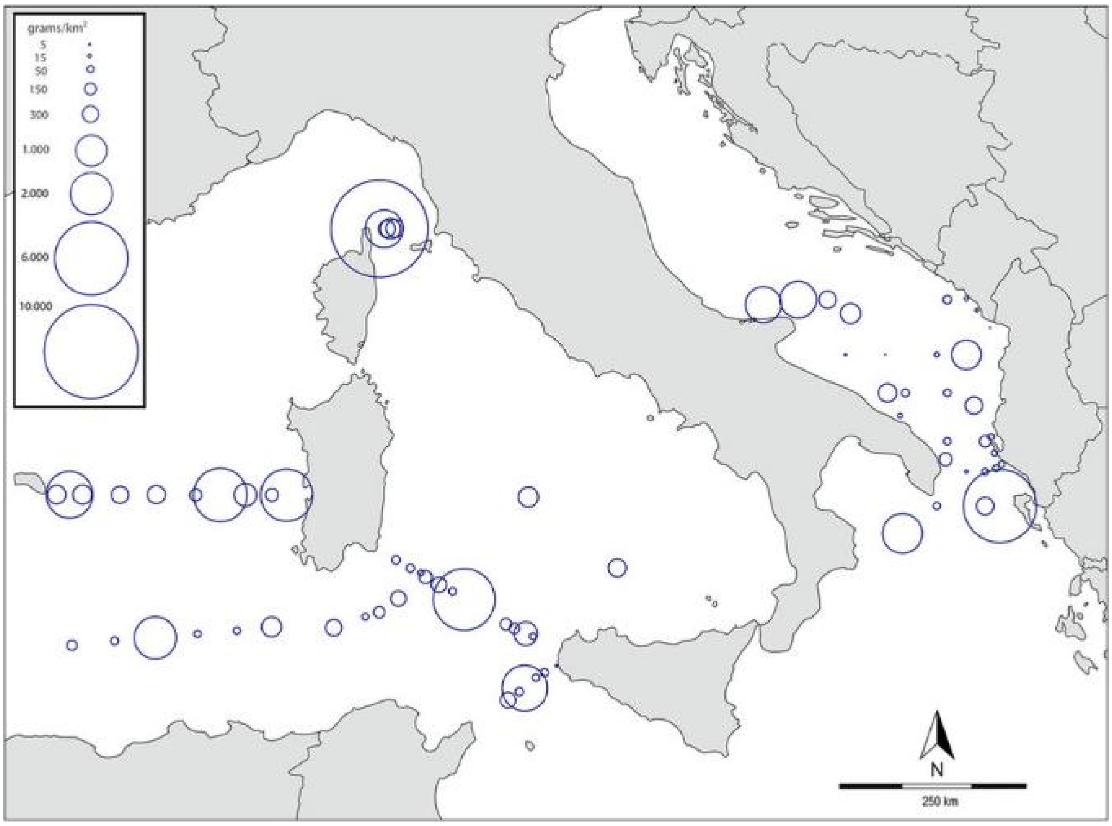

Figure 6: Map of the central-western Mediterranean Sea showing the distribution of plastic densities expressed as grams of plastic per km^2 (after Suaria et al., 2016)

Table 1: Floating microplastic concentrations in the Mediterranean Sea

Study Area	**Year**	**Net mesh**	**Samples**	**Mean Abundance**	**Reference**
Cretan Sea	1997	500 µm	25	119 ± 250 g/km^2	Kornilios et al., 1998
NW Med.	2010	333 µm	40	0.116 items/m^2 2020 g/km^2	Collignon et al., 2012
Ligurian/ Sardinian Sea	2011	200 µm	23	0.31 ± 1.0 items/m^2	Fossi et al., 2012
Bay of Calvi (Corsica)	2011-2012	200 µm	38	0.062 items/m^2	Collignon et al., 2014
W. Med.	2011-2012	333 µm	41	0.135 items/m^2 187 g/km^2	Faure et al., 2015
W. Sardinia	2012-2013	500 µm	30	0.15 items/m^3	de Lucia et al., 2014
Ligurian Sea	2013	333 µm	35	0.103 items/m^2	Pedrotti et al., 2014
NW Sardinia	2012-2013	200 µm	27	0.17 ± 0.32 items/m^3	Panti et al, 2015
Ligurian Sea	2011-2013	200 µm	70	0.31 ± 1.17 items/m^3	Fossi et al., 2016
Med.	2013	200 µm	39	0.243 items/m^2 423 g/km^2	Cózar et al., 2015
Central W Med.	2011-2013	333 µm	71	0.147 items/m^2 579.3 g/km^2	Ruiz-Orejón et al., 2016
W Med/ Adriatic	2013	200 µm	74	0.40 ± 0.74 items/m^2 1.00 ± 1.84 items/m^3 671.91 ± 1544.16 g/km^2	Suaria et al., 2016

Data may also be obtained from NGOs. HELMEPA, a Greek organization of maritime stakeholders, invited its member managing companies with ships traveling in or transiting the Mediterranean to implement a programme for the monitoring and recording of litter floating on the sea surface. During the period February – April 2008, 14 reports were received by HELMEPA member-vessels containing information on litter observations from various sea areas in the Mediterranean. In total, observations of 1,051.8 nautical miles (n.m.) of Mediterranean Sea resulted in the recording of 500.8 Kg of marine litter.

The total length of observation for floating marine litter carried out by HELMEPA member vessels was 1,051.8 nautical miles (1,947 kilometers), corresponding to an observation area of around 172.8 km2. The width of observation depended on the weather conditions, the sea state, the position of the Observer, the use of binoculars, the freeboard and volume of marine litter, etc., and generally fluctuated between 22 and 150 meters. Observations were carried out mainly in the eastern Mediterranean (Aegean Sea, Libyan Sea and Eastern Mediterranean Levantine Sea), in the Alboran Sea between Spain and Morocco, and in the Adriatic Sea. The total of marine litter recorded was 366 items, corresponding to a concentration of one item per 3 n.m., or 2.1 items per km2. The concentration of marine litter ranged from 0.08 to 71 items/n.m. relatively higher concentrations of marine litter were observed along routes close to coastal areas, while there were cases in which lengthy observations (more than 120 n.m.) revealed no existence of marine litter. Plastics accounted for about 83.0% of marine litter items, while all other major categories accounted for about 17%, as the following graph shows. Based on weight extrapolations, the average quantity of marine litter was estimated to be 230.8 kg/km2 ranging from 0.002 to 2,627.0 kg/km2. Relatively heavy items such as steel drums, wooden pallets, and crates observed on the sea surface were responsible for the majority of marine litter in certain routes. In terms of the length of observation, the average weight was 0.47 kg/n.m.

B. Seafloor Marine Litter

In the Mediterranean Sea, no more than 15 studies exist (Fig. 7), dedicated on the assessment and accumulation of marine litter on the seafloor by using otter-trawl, with the corresponding cod-end mess size ranging from 10 mm to 15,000 mm. So far, in the Western Mediterranean Sea, the Gulf o Lions (1993-94: 633-1935 items/km2; 1996: 3900 items/km2; 1996-97: 143 items/km2), the Catalan Coast (2009: 7003±6010 items/km2; 2007-2010: 0.02-3264.6 kg/km2) and the Murcian Coast (4424±3743 items/km2) have been studied (Galgani et al., 1995; Galgani et al., 1996; Galgani et al., 2000; Sanchez et al., 2013; Ramirez-Llodra et al., 2013). In the Central Mediterranean Sea, data on seafloor marine litter exist for the areas of the E. Ionian Sea (2300 items/km2), the Corsica (1993-94: 633-1935 items/km2; 1998: 229 items/km2), the Adriatic Sea (1998: 378 items/km2; 2011-2012: 47.9±23.4-170.6±35.8 kg/km2) Tyrrhenian Sea (2009: 5950 items/km2) (Galgani et al., 1995; Galgani et al., 2000; Sanchez et al., 2013; Misfud et al., 2013; Strafella et al., 2015). The Eastern Mediterranean is the less studied among the three compartments (western, central, eastern Med.). Galil et al. (1995) assessed 200-8,500 items/km2 in several areas in the E. Mediterranean Sea. while more targeted studies have been conducted in the Saronikos Gulf (2013-2014: 1211±594 items/km2) Gulf of Patras (1997-98: 240 items/km2; 2000-2003: 313 items/km2; 2013-2014: 641±579 items/km2), the Gulf of Echinades (1997-98: 89-240 items/km2; 2000-2003: 313 items/km2; 2013-2014: 416±379 items/km2), the Gulfs of Corinth and the Lakonikos Gulf (165 items/km2), the Antalya (115-2,762 items/km2) and the Mersin (0.01-5.85 kg/h) bays (Galil et al., 1995; Stefatos et al., 1999; Koutsodendris et al., 2008; Guven et al., 2013; Eryasar et al., 2014).

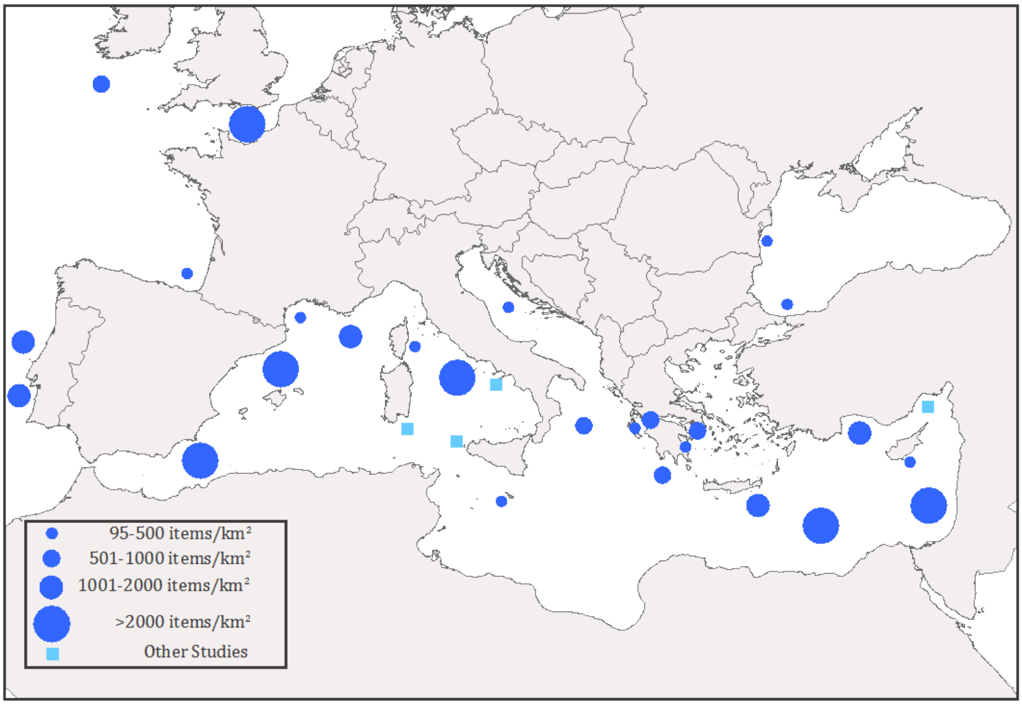

Figure 7: Seafloor marine litter distribution in the Mediterranean and other European Seas (Ioakeimdis, 2015)

Counts from 7 surveys and 295 samples in the Mediterranean Sea and Black Sea (2,500,000 km^2, worldatlas.com) indicate an average density of 179 plastic items/ km^2 for all compartments, including shelves, slopes, canyons, and deep sea plains, in line with trawl data on 3 sites described by Pham et al., 2014. On the basis of this data, we can assume that approximately 0.5 billion litter items are currently lying on the Mediterranean Sea floor (UNEP/MAP, 2015). \

In the Adriatic and Ionian Seas. within 121 transects (hauls) conducted in the framework of the IPA-Adriatic DeFishGear project, 510 ± 517 items/km^2 were recorded on an aggregated basis at regional level, with the a mean weight per haul found at 65 ± 322 kg/km^2. From the 11 locations the highest density of litter items was found in the North Corfu area (Greece) with the average density being at 1,099 ± 589 items/km^2, followed by the South area of the Western Gulf of Venice with 1,023 ± 616 items/km^2. In terms of weight, the highest quantity of litter was found in the South area of the Gulf of Venice (average density 339 ± 910 kg/km2) (Vlachogianni et al., 2017).

Plastics have been found widespread in the continental shelf of the Mediterranean, exceeding in some areas the 80% of the recorded marine (Table 2).

Table 2: Plastic abundance (%) lying on the seafloor of the Mediterranean Sea

Stydy Area	**Plastic (%)**	**Reference**
Gulf of Lions (France)	64-77%	Galgani et al., 1995b; Galgani et al., 2000
Catalanian Provence (Spain)	60%	Sanchez et al.
Murcian Provence (Spain)	84%	Sanchez et al.
Central Med	87%	Sanchez et al., 2013
Corsica (France)	77%	Galgani et al., 1995
Maltese islands	47%	Misfud et al., 2013;
North-Central Adriatic Sea	24-62%	Strafella et al., 2015
Eastern Mediterranean Sea (Italy, Greece, Egypt, Cyprus, Israel).	36%	Galil et al. 1995
Gulf of Patras (Greece)	81%	Stefatos et al. 1999

Echinades Gulf (Greece)	56%,	Koutsodendris et al. 2008
Gulf of Patras (Greece)	60%	Ioakeimidis et al. 2014
Echinades Gulf (Greece)	67%	Ioakeimidis et al. 2014
Antalya (Turhey)	81%	Guven et al., 2013
Mersin (Turkey)	73%	Eryasar et al., 2014
Limassol Gulf (Cyprus)	59%	Ioakeimidis et al. 2014
Saronikos Gulf (Greece)	95%	Ioakeimidis et al. 2014
Argolikos Gulf (Greece)	75%	Ioakeimidis et al., 2015

In a study on 67 sites conducted in the Adriatic Sea using commercial trawl analysis of Marine litter sorted and classified in major categories confirmed that plastic is dominant in terms of concentration by weight, followed by metal (UNEP/MAP, 2015). The highest concentration of litter was found close to the coast, likely as a consequence of high coastal urbanization, river inflow, and extensive navigation. Metals and Glass/Ceramics reached maximum values of 21.9% and of 22.4%, respectively in a study conducted in 4 study areas in the Eastern Mediterranean (Saronikos; Patras and Echinades Gulfs; Limassol Gulf) (Ioakeimidis et al., 2014).

Very limited studies in the Mediterranean have been investigating the presence of seafloor litter in shallow waters. Only one study records marine litter in selected study areas in Greece (Saronikos Gulf, W. Crete, S. Peloponesse, Santorini isl., W. Greece), in depths ranging from the shoreline (0m) till the 25m (Katsanevakis & Katsarou, 2004). In the Saronikos Gulf were recorded 31,660 items/km2 (Plastics: 47%, Metals: 31%), W. Crete 18,944 items/km2 (Plastics: 45%, Metals: 28%), S. Peloponesse 14,025 items/km2 (Plastics: 47%, Metals: 33%), Santorini isl. 9,133 items/km^2 (Plastics: 52%, Metals: 31%).

The first assessment of marine litter in the deep-sea environment of the Mediterranean Sea was conducted back in 1995 by Galgani et al. (1996) in the marine Canyon of Marseille-Nice (1623 items/km2). Nowadays, in the Mediterranean Sea such data exist only for the Western (NW Mediterranean: 1935 items/km^2; French Mediterranean: 3 items/km^2) and the Central Mediterranean Sea (Tyrrhenian Sea: 30,000-120,000 items/km2), while no relevant data exist for the Eastern Mediterranean Sea (Galgani et al., 1996; Galgani et al., 2000; Bo et al., 2014; Fabri et al., 2014; Angiolillo et al., 2015).

The distribution and abundance of large marine litter were investigated on the continental slope and bathyal plain of the northwestern Mediterranean Sea during annual cruises undertaken between 1994 and 2009 (Galgani et al., 2011). Different types of litter were enumerated, particularly pieces of plastic, plastic and glass bottles, metallic objects, glass, and diverse materials including fishing gear. The results showed considerable geographical variation, with concentrations ranging from 0 to 176 pieces of litter/ha. In most stations sampled, plastic bags accounted for a very high percentage (more than 70%) of total litter. In the Gulf of Lions, only small amounts of litter were collected on the continental shelf. Most of the litter was found in canyons descending from the continental slope and in the bathyal plain, with high amounts occurring to a depth of more than 500 m.

Information regarding the abundance of small plastic particles accumulating in the deep-sea sediments is still very limited. However, plastic particles sized in the micrometer range have been found in deep-sea sediments ranging from 1000 to 5000m depth (Van Cauwenberghe et al., 2013; Woodall et al., 2014).

CONCLUSIONS

Conclusions (brief)

Plastic is the main component of floating marine litter and also for those lying on the Mediterranean seafloor, from shallow water, the continental shelf, till the deep abyssal plains. Regarding marine litter (floating and on seafloor) that are accumulating in the Mediterranean basin, no safe conclusion can be drawn for the moment. Probably hydrodynamics and geomorphology favor the constant circulation. More consistent, interconnected and interlinked studies need to be promoted in order to have a better picture at basin scale. The comparability of the existing and future studies seems to be a key point towards an integrated assessment at basin scale. The Mediterranean Sea is heavily impacted by floating marine litter items, giving concentrations comparable to those found in the 5 sub-tropical gyres. Moreover, the seafloor seems to be the final global sink for most marine litter items with densities ranging from 0 to over 7,700 items per km². The deep-sea canyons are of particular concern as they may act as a conduit for the transport of marine litter into the deep sea. As in any other marine litter cases, the human activities (fishing, urban development, and tourism) are primarily responsible for the increased abundance of marine litter items in the Mediterranean Sea.

Conclusions (extended)

Marine litter and mainly plastics are present in the Mediterranean basin from the shallow water, the continental shelf, till the abyssal plains, in all different sea compartments and basins and thus, posing an important problem for the marine environment. Unfortunately so far, we do not have a clear picture regarding the areas in the Mediterranean where the accumulation of marine litter and plastics is significant although several ongoing studies try to give a clearer picture. The Eastern Mediterranean is certainly the least studied of the three compartments (western, central, eastern).

The Mediterranean Sea is very peculiar as there are no areas where marine litter permanently accumulate. Instead, the constant circulation is favored. The picture is fragmented as only through nonrecurring studies information becomes available and this is not enough to drawn safe results or even to partially assess the situation. In addition information on floating and seafloor marine litter is only available for the northern part of the Mediterranean Sea. The combination of the last two points makes the assessment of floating and seafloor marine litter in regional scale almost impossible.

A. Floating Marine Litter

Once floating litter has entered into the marine environment, the hydrographic characteristics of the basin may play an important role in its transport, accumulation, and distribution. Atlantic surface waters enter the Mediterranean Sea through the strait of Gibraltar and circulate anticlockwise in the whole Algero-Provencal Basin, forming the so-called Algerian Current, which flows until the Channel of Sardinia and most often leads to the generation of a series of anticyclonic eddies 50–100 km in diameter wandering in the middle basin (UNEP/MAP, 2015). Despite not being permanent, these mesoscale features could act as retention zones for floating litter and would help explain the high litter densities found in the central Algerian basin at around 80 nautical miles from the nearest shore. For the southern Adriatic Sea, it should be noticed that about one-third of the total mean annual river discharge into the whole Mediterranean basin flows into this basin, particularly from the Po River in the northern basin and the Albanian rivers (UNEP, 2012).

The highest densities found in the Adriatic Sea and along the North-western African coast are related to some of the heaviest densities in coastal population of the entire Mediterranean basin (UNEP/MAP 2015). The Adriatic Sea has more than 3.5 million people along its shores, which along with fisheries and tourism seems to be the most significant sources for floating marine litter in the region. In addition the significant cyclonic gyres which are found in the central and southern Adriatic Sea (Suaria and Aliani, 2014), are favoring the retention of floating marine litter in the middle of the basin. This is also the Case in the Northeastern part of the Aegean Sea, where densities of floating litter are higher due to circulating waters and Black sea/Mediterranean sea water exchanges.

Coastal population is an important aspect also for the North African countries in particular also have the highest rates of growth in coastal population densities, including touristic densities. Algeria, for instance, has a coastal population that has increased by 112% in the last 30 years, and it currently represents one of the most densely populated coastlines in the whole basin (UNEP, 2009). In addition, it should be noted that in some countries appropriate recycling facilities have not been fully implemented yet, and the cost of proper solid waste disposal is still often beyond their financial capacity (UNEP, 2009). Suaria and Aliani (2014), demonstrated that 78% of all sighted objects were of anthropogenic origin, 95.6% of which were petrochemical derivatives (i.e. plastic and Styrofoam). The authors then evaluated the number of macro-litter items currently floating on the surface of the whole Mediterranean basin to be more than 62 million.

As for anthropogenic litter accumulating in oceans gyres and convergence zones, the existence of Floating Marine Litter accumulation zones is a stimulating hypothesis, as their presence was supported recently (Mansui et al., 2015). The existence of one or more ‘‘Mediterranean Garbage Patches’’ should be investigated in more detail, as there are no permanent hydrodynamic structures in the Mediterranean Sea where local drivers may have a greater effect on litter distribution (CIESM, 2014).

B. Seafloor Marine Litter

The deep-sea floor is probably the final global sink for most marine litter and there are several areas in the Mediterranean for which marine litter have been recorded in densities exceeding 1000 items/km^2 (i.e. Gulf of Lions, Catalan Coast, Murcian Coast, Corsica, Saronikos Gulf, Antalya Coast). However, long-term data is scarce for the Mediterranean Sea. Density of litter collected on the sea floor between 1994 and 2014 in the Gulf of Lion (France), does not clearly show any significant trends with regards to variations in marine litter quantities (Galgani, 2015). In another example in Greece (Gulf of Patras, Echinades Gulf) albeit the increase of marine litter abundance plastic percentage seems to remain stable over the years. In much deeper marine environments, Galgani et al. (2000) observed decreasing trends in deep sea pollution over time off the European coast, with extremely variable distribution and litter aggregation in submarine canyons.

The abundance of plastic litter is very location-dependent, with mean values ranging from 0 to over 7,700 items per km^2. Mediterranean sites tend to show the highest densities, due to the combination of a populated coastline, coastal shipping, limited tidal flows, and a closed basin with exchanges limited to Gibraltar. In general, bottom litter tends to become trapped in areas with low circulation, where sediments accumulate.

Only a few studies have focused on litter located at depths of over 500 m in the Mediterranean (Galil, 1995; Galgani et al., 1996, 2000, 2004; Pham et al., 2014; Ramirez-Llodra et al., 2013). Submarine canyons may act as a conduit for the transport of marine litter into the deep sea. Higher bottom densities are also found in particular areas, such as around rocks and wrecks, and in depressions and channels. In some areas, local water movements carry litter away from the coast to accumulate in high sedimentation zones. The distal deltas of rivers may also fan out into deeper waters, creating high accumulation areas.

A wide variety of human activities, such as fishing, urban development, and tourism, contribute to these patterns of seabed litter distribution. Fishing litter, including ghost nets, prevails in commercial fishing zones and can constitute a considerable share of total litter. It has been estimated that 640,000 tons of ghost nets are scattered overall in the world oceans, representing 10% of all marine litter (UNEP, 2009). More generally, accumulation trends in the deep sea are of particular concern, as plastic longevity increases in deep waters and most polymers degrade slowly in areas devoid of light and with lower oxygen content.

Key messages

The abundance of floating litter in Mediterranean waters has been reported at quantities measuring over 2 cm range from 0 to over 600 items per square kilometer (Aliani et al., 2003; UNEP, 2009; Topcu et al., 2010, Gerigny et al., 2011, Suaria and Aliani, 2015). The 2015 UN Environment / Mediterranean Action Plan Marine Litter Assessment report states that approximately 0.5 billion litter items are currently lying on the Mediterranean Seafloor. Moreover, there is great variability in the abundance of seafloor marine litter items ranging from from 0 to over 7,700 items per km² depending on the study area.
However, the information on floating and seafloor marine litter in the Mediterranean is fragmented and is spatially restricted mainly to its northern part. To this extent, no basin-scale conclusions can be exerted and information is only available at local level. However there are many areas with significant marine litter densities, ranging from 0 to over 7,700 items per km² depending on the study area. Plastic is the major marine litter component, found widespread in the continental shelf of the Mediterranean, ranging up to 80% and 90% of the recorded marine litter items.

Knowledge gaps (brief)

Research and monitoring have become critical for the Mediterranean Sea, where information is inconsistent. UNEP/MAP-MED POL (2013), MSFD (Galgani et al., 2011), the European project STAGES (http://www.stagesproject.eu), and CIESM (2014) recently reviewed the gaps and research needs of knowledge, monitoring, and management of marine litter. This requires scientific cooperation among the parties involved prior to reduction measures due to complexity of issues.

Accumulation rates vary widely in the Mediterranean Sea and are subject to factors such as adjacent urban activities, shore and coastal uses, winds, currents, and accumulation areas. Additional basic information is still required before an accurate global litter assessment can be provided. Moreover the available data are geographically restricted in the northern part of the Mediterranean Sea.

For this, more valuable and comparable data could be obtained by standardizing our approaches. In terms of distribution and quantities, identification (size, type, possible impact), evaluation of accumulation areas (closed bays, gyres, canyons, and specific deep sea zones), and detection of litter sources (rivers, diffuse inputs), are the necessary steps that would enable the development of GIS and mapping systems to locate hotspots.

An important aspect of litter research to be established is the evaluation of links between hydrodynamic factors. This will give a better understanding of transport dynamics and accumulation zones. Further development and improvement of modelling tools must be considered for the evaluation and identification of both the sources and fate of litter in the marine environment. Comprehensive models should define source regions of interest and accumulation zones, and backtrack simulations should be initiated at those locations where monitoring data are collected.

For monitoring, there is often a lack of information needed to determine the optimum sampling strategy and required number of replicates in time and space. Moreover, the comparability of available data remains highly restricted, especially with respect to different size class categories, sampling procedures, and reference values.

Data on floating and seafloor marine litter are inconsistent and geographically restricted in only few areas of the Mediterranean Sea. In addition to that, the lack on long-term assessment data makes the assessment of trends of the years extremely difficult. Sources needs also to be further specified and linked to macro- and micro-litter contribution. Moreover, monitoring and assessment of marine litter should be done in a consistent way, based on common protocols and standardized methods, leading to comparable results at basin scale. Effective management practices are also missing, requiring strong policy will and societal engagement. Further work should also be promoted towards identifying marine litter sources more precisely. Cooperation and collaboration between the major marine litter partners in the region with common priority actions is also considered important.

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Annex I
List of Case Studies for the Ecological Objectives 9 (Contaminants), 5 (Eutrophication) and 10 (Marine Litter)

The Annex I provides the list of Case Studies that have been submitted by Contracting Parties and Partners for the Ecological Objectives 9 (Contaminants), 5 (Eutrophication) and 10 (Marine Litter). **The Case Studies are in the process of editing.**

EO5	Title	Contracting Parties, Partners	Authors and Affiliation
1	Long-term variability along a trophic gradient in the North Adriatic Sea	Croatia Italy	M. Chaves Montero, M. Lipizer, A. Giorgetti, Istituto Nazionale di Oceanografia e di Geofisica Sperimentale – OGS (Italy) Robert Precali, Tamara Djakovac, Cener for Marine Research, Rudjer Boskovic Institut (Croatia)
2	Overview of the assessment of pollution related indicators - EO9 Common Indicators with link to the EO5, based on results of CAMP Montenegro assessments and EcAp/MSP Boka Kotorska Bay pilot project	Montenegro	Jelena Knežević, MAP FP, Ministry of Sustainable Development and Tourism, Ivana Stojanović, assistant to MAP FP, Ministry of Sustainable Development and Tourism, Ivana Bulatović, MEDPOL FP, Environmental Protection Agency
3	Eutrophication Status of the Turkish Mediterranean Coastal Waters and Trend Analysis of the Eutrophication-Related Parameters in the Mersin Bay	Turkey	Süleyman Tuğrul, Koray Özhan, İsmail Akçay, Middle East Technical University-Institute of Marine Sciences, Çolpan Polat Beken, TUBITAK Marmara Research Center, Hacer SELAMOĞLU ÇAĞLAYAN, Ministry of Environment and Urbanization of Turkey
EO9	**Title**	**Contracting Parties, Partners**	**Authors and Affiliation**
1	Surveillance de la qualité des eaux de baignade des plages du Marco	Morocco	Laboratoire National des Etudes et de Surveillance de la Pollution relevant du Secrétariat d'Etat chargé du Développement Durable en collaboration avec la Direction des Ports et du Domaine Publics Maritime relevant du Ministère de l'Equipement, du Transport, de la Logistique et de l'Eau ; avec l'appui de la Fondation Mohammed VI pour la Protection de l'Environnement
2	Case Study title: Overview of the assessment of pollution related indicators - EO9 Common Indicators with link to the EO5, based on results of CAMP Montenegro assessments and EcAp/MSP Boka Kotorska Bay pilot project	Montenegro	Jelena Knežević, MAP FP, Ministry of Sustainable Development and Tourism; Ivana Stojanović, assistant to MAP FP, Ministry of Sustainable Development and Tourism; Ivana Bulatović, MEDPOL FP, Environmental Protection Agency
3	Levels and trends of Cd and Zn bioaccumulation in Israeli Mediterranean coastal marine mollusks (Patella sp.)	Israel	Prof. Barak Herut, PhD, Israel Oceanographic and Limnological Research Institute (IOLR) Jack Silverman, PhD, Israel Oceanographic and Limnological Research Institute (IOLR) Shefer Edna, PhD, Israel Oceanographic and Limnological Research Institute (IOLR)

			Dror Zurel, PhD, Marine Monitoring and research Coordinator, Israel Ministry of Environmental Protection, Marine Environment Protection Division
4	Levels and trends of TriButyltin (TBT) in Israeli ports and marinas	Israel	Prof. Barak Herut, PhD, Israel Oceanographic and Limnological Research Institute (IOLR) Dror Zurel, PhD, Marine Monitoring and research Coordinator, Israel Ministry of Environmental Protection, Marine Environment Protection Division.
EO 10	**Title**	**Contracting Parties, Partners**	**Authors and Affiliation**
1	Coordinated and harmonized pilot surveys to assess marine litter along the Adriatic and Ionian coasts	Albania Bosnia and Herzegovina Croatia Greece Italy Montenegro Slovenia MIO-ECSDE	MIO-ECSDE, Agricultural University of Tirana (Albania), Hydro-Engineering Institute of the Faculty of Civil Engineering (Bosnia and Herzegovina), Institute of Oceanography and Fisheries Croatia), Hellenic Centre for Marine Research (Greece), Regional Agency for Environmental Protection in the Emilia-Romagna region (Italy), Italian National Institute for Environmental Protection and Research (Italy), Institute of Marine Biology (Montenegro), Institute for Water of the Republic of Slovenia (Slovenia)
2	Déchets marins benthiques en Mer Méditerranée : quantités à l'échelle régionale et variation temporelle des tendances dans le bassin nord occidental	France Italy	O. Gerigny, Institut Français de Recherche pour l'Exploitation de la Mer, France, M.Spedicato, COISPA Tecnologia & Ricerca, Bari, Italy, MEDITS coordinator, A.Jadaud, Institut Français de Recherche pour l'Exploitation de la Mer, France, C.Ioakeimidis, UN Environment/Mediterranean Action Plan MED POL, Athens, Francois Galgani, Institut Français de Recherche pour l'Exploitation de la Mer, France
3	Marine Litter Fluctuations at the Metu Beach, Mersin Bay (Turkey), the Northeastern Mediterranean during 2013-2017	Turkey	Olgaç Güven, Institute of Marine Sciences, Middle East Technical University, Erdemli, Mersin, Turkey, Ahmet Erkan Kideys, Institute of Marine Sciences, Middle East Technical University, Erdemli, Mersin, Turkey, Kerem Gökdağ, Institute of Marine Sciences, Middle East Technical University, Erdemli, Mersin, Turkey
4	Microplastic Pollution on the Sea Surface, Water Column and Sediment of Mersin Bay (Turkey), in the Northeastern Mediterranean	Turkey	Ahmet Erkan Kideys, Institute of Marine Sciences, Middle East Technical University, Erdemli, Mersin, Turkey, Olgaç Güven, Institute of Marine Sciences, Middle East Technical University, Erdemli, Mersin, Turkey, Kerem Gökdağ, Institute of Marine Sciences, Middle East Technical University, Erdemli, Mersin, Turkey, Çolpan Polat Beken, TUBITAK Marmara Research Center,

			Ebru Olgun Eker, Ministry of Environment and Urbanization of Turkey

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6th Meeting of the Ecosystem Approach Coordination Group

Athens, Greece, 11 September 2017

Agenda item 4: Review of Quality Status Report QSR (Biodiversity and Fisheries)

Quality Status Report (Biodiversity and Fisheries)

For environmental and economic reasons, this document is printed in a limited number. Delegates are kindly requested to bring their copies to meetings and not to request additional copies.

UNEP/MAP
Athens, 2017

Ecological Objective 1 (EO1): Biodiversity

Note: The maps and illustrations are provisional

EO1: Common Indicator 1: Habitat distributional range. Common Indicator 2: Condition of the habitat's typical species and communities.

GENERAL

Reporter: SPA/RAC

Geographical scale of the assessment: Regional, Mediterranean Sea

Contributing countries:

Mid-Term Strategy (MTS) Core Theme 2-Biodiversity and Ecosystems

Ecological Objective EO1: Biological diversity is maintained or enhanced. The quality and occurrence of coastal and marine habitats and the distribution and abundance of coastal and marine species are in line with prevailing physiographic, hydrographic, geographic and climatic conditions.

IMAP Common Indicator Common Indicator 1 (CI1): Habitat distributional range
Common Indicator 2 (CI2): Condition of the habitat's typical species and communities

Indicator Assessment Factsheet Code EO1CI1/EO1CI2

RATIONALE/METHODS

Background (brief)
Background (extended)

Background and rationale for habitats and seafloor integrity, key pressures and drivers

In the list of EcAp Ecological Objectives and Common Indicators, *Habitat distributional range* and *Condition of the habitat's typical species and communities* belong to the Ecological Objective EO1 Biodiversity. The objective *Seafloor Integrity* is also included but, still, the common indicators need further development. "Seafloor" includes the physical and chemical variables of the seabed and the biotic composition of the benthic assemblages. "Integrity", besides covering the physical and biological components of the sea bottom, requires also that habitats are not artificially fragmented. However, there is no single scientific consensus on what constitutes "good environmental status" for Sea Floor Integrity. Baseline information are extremely scant so that also a consensus around the meaning of "integrity" is lacking.

Habitat destruction is one of the most pervasive threats to the diversity, structure, and functioning of Mediterranean marine coastal ecosystems and to the goods and services they provide (1,2,3,4,5,6,7,8,9). The 20% of the entire basin and 60-99% of the territorial waters of EU member states are heavily impacted by multiple interacting threats, less than 20% has low impact and very few areas, less than 1% remain relatively unaffected by human activities (10,11,12). The Alboran Sea, the Gulf of Lyons, the Sicily Channel and Tunisian Plateau, the Adriatic Sea, off the coasts of Egypt and Israel, along the coasts of Turkey, and within the Marmara and Black Sea are highly impacted. Low cumulative human impacts were found in offshore areas, and in several small coastal areas of some countries. These areas represent important opportunities for conservation aimed at preventing future degradation. Pollution, fisheries, urbanisation and invasive alien species (increasing temperature and UV, and acidification) are the most frequently cited pressures in the Red List of European Habitats (https://www.researchgate.net/publication/311772198_European_Red_List_of_Habitats_Part_1_Marine_habitats) affecting the distribution range and the conditions of habitats. Climate change is also affecting some mediolittoral and infralittoral habitats, especially by altering the thermal structure of the water column, with extensive mass mortalities (13).

The proliferation of coastal and marine infrastructures, such as breakwaters, ports, seawalls and offshore installations call for special concern, all being associated with loss of natural habitats and alteration of hydrographic conditions (14). New strategies aimed at elevating the ecological and biological value of coastal infrastructures are urgent. Seabed trawling causes the loss of shallow habitats such as *Posidonia* seagrass meadows and deeper soft bottom habitats. The continuous stirring, mixing, and resuspension of surface sediments by intensive and chronic trawling activities changes sediment dynamics and have permanently smoothed the seafloor morphology of the continental slope over large spatial scales in addition to having induced changes in the water column dynamics and properties. Commercial interest in deep-sea mining is increasing, relating to the future exploitation of seafloor resources and care should be also taken to modifications of water column structures. The environmental impacts of deep-sea mining could be significant, including physical disturbance, the creation of suspended sediment plumes, water mixing effects, and the impacts of mining ships and other infrastructure (15).

Policy Context and Targets

Marine Protected Areas (MPAs) are one of the most important tools for protecting marine-coastal habitats and seafloor integrity. Several institutions (e.g. RAC/SPA, MedPAN, WWF, local NGOs, IUCN, research organisations) are working together to set conservation priorities establishing an ecological network of MPAs to protect at least 10% of the marine and coastal waters (Aichi Target 11), made up of ecologically interconnected and well managed MPAs that are representative of Mediterranean biodiversity, in accordance with the latest guidelines from the Convention on Biological Diversity and the Barcelona Convention (see also the recent document http://www.europarc.org/news/2016/12/tangier-declaration/). MPAs are generally instituted because of the presence of remarkable benthic seascapes and/or interesting hydrological features driven high diversity and/or abundance of pelagic species. Seafloor integrity is also a factor for good larval recruitment (plankton) for many important species (most benthic species having their larval phase in the water column, as well as for demersal fishes)". The Birds Directive and the Habitats Directive (BD and HD) have led to the establishment of the Natura 2000 network of sites where species and habitats (9 marine habitats) of European interest must be maintained or restored at favourable conservation status. The Ramsar Convention includes member states throughout the Mediterranean Basin and focuses on a single threatened habitat, coastal wetlands. Other Eurocentric policies include the Marine Strategy Framework Directive (MSFD), which requires the European States of the Mediterranean to prepare national strategies to manage and monitor their seas to achieve or maintain Good Environmental Status by 2020 in all their national waters. The definition of Good Environmental Status (GES) is based on two pillars: Biodiversity and Ecosystem Functioning (BEF). The conceptual revolution of GES overcomes the limits of both the Habitats Directive and the Landscape Convention, widening conservation not only to structure (biodiversity) but also to function (ecosystem functioning), considering many phenomena that do occur in the water column (16). In this framework, *habitat distribution, extent* and *condition* are included in Descriptor 1, while Descriptor 6 deals directly with *seafloor integrity*. Finally, there are other institutional mandates such as the EU Directive establishing a framework for Maritime Spatial Planning (MSP) and the EU Blue Growth strategy requiring that areas and actions are prioritized to ensure that conservation and management efforts will produce biological and socioeconomic long-term benefits. However, at present, the lack of concrete application of MSP, even at small scale, limits the potential to solve hot spots of conflicts with consequent effects on marine biodiversity and the services it provides. EcAp extends the vision of the MSFD to the whole Mediterranean, while taking into account its peculiarities.

Assessment methods

Assessments of the status and the extension of marine habitats require the adoption of rigorous approaches (in terms of sampling design, selection of appropriate spatial and temporal scales, habitat classification, identification of vulnerable taxa) that can give a good image of the distributional range and the condition of marine systems and of their alteration by pressures from human activities. Following changes in space and time in the occurrence of target species/habitats (e.g. habitat formers) able to indicate the status of the systems, and including the consideration of appropriate control areas should be the way to go.
Habitat mapping is fundamental for the identification of hot spots of habitat diversity. Maps permit to detect changes in habitat cover, and allow boundary demarcation of multiple-use zoning schemes. Large-scale maps visualise the spatial distribution of habitats, thus aiding the planning of networks of MPAs and allowing to monitor the degree of habitat fragmentation.
Habitat mapping should be integrated by the use of several univariate variables such as the number of species, their relative abundance and biomass together with the consideration of whole assemblages (structure and functions) to support the assessment status.
Direct (ROV, scuba diving) and indirect methods (side scan sonar, multibeam, sub bottom profiler) can be integrated to carry out proper assessments.
The monitoring of the pressures is also necessary to the assessment of the ecological status. To this end, data of the distribution of human activities and mapping tools must be collated (eg. Distribution of habitats and changes in the habitat extent).

It has to be stressed that assessments cannot disregard from appropriate sampling designs using replicated samplings in space and time and proper control areas for the identification of the status and the trends of marine systems. In this respect, the spatial identification of the Cells of Ecosystem Functioning can be the precondition to apply the assessment not only of the distribution patterns of some habitats and species, but also the processes that allow for the functioning of ecosystems.

RESULTS

Results and Status, including trends (extended)

A total of 257 benthic marine habitat types were assessed in a recent overview of the degree of endangerment of marine, terrestrial and freshwater habitats in the European Union (EU28) and adjacent regions (EU28+) (The European Red List of Habitats, 2016). In total, 19% (EU28) and 18% (EU28+) of the evaluated habitats were assessed as threatened in categories Critically Endangered, Endangered and Vulnerable. The highest proportion of threatened habitats in the EU28 is in the Mediterranean Sea (32%), followed by the North-East Atlantic (23%), the Black Sea (13%) and then the Baltic Sea (8%). This report provides also an overview of the risk of collapse for 47 benthic habitats in the Mediterranean. Almost half of the Mediterranean habitats (23 habitats, 49%) were Data Deficient in EU28 countries. Of the remainder (24 habitats) 83% were of conservation concern (NT-CR) with 63% threatened to some degree (42% Vulnerable and 21% Endangered). A good proportion of habitats in infralittoral and mediolittoral environments were either Vulnerable or Endangered. They include algal-dominated communities on infralittoral sediments, and circalittoral sediments and rocks together with mussel and oyster beds. The criteria under which habitats were most frequently assessed as threatened in both the EU28 and EU28+ were *decline in extent* and a *decline in quality*.

According to CAMP biodiversity Vulnerability study and “Rapid Assessment Survey of coastal habitats to help prioritize the suitable new areas needing a status of protection for the development of a network of Marine and Coastal Protected Areas in Montenegro” the following 23 benthic assemblages were selected a priori in Montenegro. Detailed habitat mapping was done in 3 areas: Boka Kotorska Bay (Kotorsko-Risan part), Platamuni and Ratac since. List of habitats: 1. Barren = encrusting coralline algae and sea urchins Arbacia lixula and Paracentrotus lividus, 2. Boulders_barren = same as above plus large boulders, 3. Caulerpa racemosa assemblage, 4. Cladocora caespitosa reefs = Cladocora caespitosa assemblage, 5. Coralligenous assemblages = Large boulders and vertical walls with dominance of Halimeda tuna, Parazoanthus axinellae and sponges, 6. Infralittoral algal turf assemblages, 7. Infralittoral gravel assemblages, 8. Infralittoral mud assemblages, 9. Infralittoral mud and gravel assemblages, 10. Infralittoral pebble assemblages, 11. Infralittoral sand assemblages, 12. Large sponge assemblage with Geodia, Aplysina and Petrosia, 13. Mussel bed assemblage, 14. Photophilic algae assemblage with Cystoseira spp. and Halopteris spp., 15. Photophilic algae assemblage with Cystoseira spp., 16. Photophilic algae assemblage with Padina pavonica, 17. Posidonia oceanica, 18. Rubble and turf assemblage with Codium sp., 19. Sciaphilic algae assemblages on hard substrata = Rocky substrates dominated by Codium bursa and Flabellia petiolata, 20. Sciaphilic algae assemblages on hard vertical/subvertical substrata with Flabellia petiolata and Halimeda tuna, 21. Sciaphilic algae assemblages on hard substrata with Flabellia petiolata and Peyssonnelia spp., 22. Submerged canyon, 23. Submerged caves. Data on distribution of all habitats types are missing and detailed maps and data are available for 3 locations.

The brown algae ***Cystoseira* spp**. form dense canopies along rocky intertidal and subtidal rocky coasts. Conspicuous historical declines in extent and quality, for at least a century and especially of species thriving in rock-pools and in the infralittoral zone, are documented in many regions of the Mediterranean Sea (Adriatic Sea, France, Ligurian Sea, Strait of Sicily). Algal turfs replace canopies, with a shift from high- to low-diversity habitats. In many coastal rocky bottoms a shift from canopy-forming algae dominated system to overgrazed sea urchin-dominated barrens (*Paracentrotus lividus* and *Arbacia lixula*) can also occur, mainly in consequence of the illegal destructive fishing of the rock-boring mollusk *Lithophaga lithophaga* and the overfishing of primary sea-urchin predator fishes. Despite the progressive expansion of **barren areas** replacing algal canopies and other rocky bottom assemblages is currently widely acknowledged (Western and Eastern Mediterranean Sea), no published work has been aimed at the assessment of the extension of barren (1).

According to Telesca et al. (2015), “the estimated lost area of ***Posidonia oceanica*** was 124 091 ha over the past 50 years, which corresponds to an average regression of 10.1% of the total known area (Mediterranean basin). If we consider only those areas for which we had historical information (368,837 ha), the estimated loss of *P. oceanica* was 33.6%».

Spatial extent of *Posidonia oceanica* meadows across the Mediterranean Sea (source: Telesca et al., 2015).

	Mediterranean Sea	Western basin	Eastern basin
Coastline length (km)	46000	11.621 25%	34 379 75%
Coastline length with *P. oceanica* (km)	11907	6201 14%	5 706 12%
Coastline length without *P. oceanica* (km)	12622	3925 9%	8 697 19%
Coastline length without data (km)	21471	1494 3%	19 977 43%
Total area of *P. oceanica* (ha)	1224707	510715 41.7%	713 992 58.3%

Kelps such as *Laminaria rodriguezii* are now confined to very deep areas of the Mediterranean Sea (Balearic and Alboran Islands). The few available temporal data from the Adriatic Sea, obtained in surveys undertaken between 1948–1949 and 2002, showed that this species has become exceptionally rare or has completely disappeared from this area. Repeated surveys in 2010 showed no recovery of the species. These losses have been linked to intensive trawling. In other areas of France, Italy and Tunisia the species records date back mainly to the 1960–1970s, while in this work recent accessible information on the status of these populations was not found. Only two habitats were assessed as threatened considering the *area of occupancy*: **biogenic habitats of Mediterranean mediolittoral rock** represented by vermetid molluscs and by red algae such as *Lithophyllum byssoides* and *Neogoniolithon brassica-florida*, and **photophilic communities** dominated by calcareous, habitat forming algae, as they are found at only a few sites on the European side of the Mediterranean Sea.

Our knowledge of the pelagic habitats for the Mediterranean Sea is generally limited to coastal areas for which several long-term monitoring stations exist for both zooplankton (O'Brien et al., 2010) and phytoplankton. Our knowledge for the open-sea is scarcer but satellite data and associated modelling chl a regionalisation (D'Ortenzio et al., 2009) are available, which can be used for the already developed OSPAR pelagic indicator which is adaptable to the Mediterranean (PH2, cf.OSPAR, 2017). It has to be added that these data can be used as well for the descriptor "eutrophisation" (descriptor 5 of the MSFD). Other studies applied to the whole Mediterranean basin considering additional components of the pelagic habitat do exist, such as the work of Berline et al. (2014) considering the larval dispersion. These studies can be used as a baseline for the indicator development related to pelagic habitats (pelagic habitats need to be considered at the ecohydrodynamic scale, cf. Ostle et al., 2017), and notably for the consideration of plankton species distribution. This approach could also be already used for grouping existing MPAs or choosing new MPAs based on their importance in terms of plankton communities, and therefore, for the rest of the marine food-web.

The distribution of **nursery areas (**which will be further developed in the EO3) of 11 important commercial species of demersal fish and shellfish was assessed in the European Union Mediterranean waters using time series of bottom trawl survey data with the aim of identifying the most persistent recruitment areas (17). A high interspecific spatial overlap between nursery areas was mainly found along the shelf break of many sectors of the Northern Mediterranean, indicating a high potential for the implementation of conservation and management measures. The new knowledge on the distribution and persistence of demersal nurseries can further inform the application of spatial conservation measures, such as the designation of new no-take MPAs in EU Mediterranean waters and their inclusion in a conservation network. The establishment of no-take zones has to be consistent with the objectives of the Common Fisheries Policy applying the ecosystem approach to fisheries management and with the requirements of the MSFD to maintain or achieve seafloor integrity and good environmental status.

The first continuous maps of **coralligenous and maërl habitats** across the Mediterranean Sea have been produced across the entire basin, by modelling techniques (5). Important new information was gained from Malta, Italy, France (Corsica), Spain, Croatia, Greece, Albania, Algeria, Tunisia and Morocco, making the present datasets the most comprehensive to date. Still, there were areas of the Mediterranean Sea where data are scarce (Albania, Algeria, Cyprus, Israel, Libya, Montenegro, Morocco, Syria, Tunisia and Turkey) or totally absent (Bosnia and Herzegovina, Egypt, Lebanon and Slovenia). Knowledge on maërl beds was somewhat limited compared to what was available for coralligenous outcrops; a significant update was nevertheless achieved. Previously unknown spatial information on maërl distribution became available for Greece, France (Corsica), Cyprus, Turkey, Spain and Italy. Malta and Corsica, in particular, had significant datasets for this habitat as highlighted by fine-scale surveys in targeted areas.

A fine-scale assessment of (i) the current and historical known distribution of ***P. oceanica***, (ii) the total area of meadows and (iii) the magnitude of regressive phenomena in the last decades is also available (6). The outcomes showed the current spatial distribution of *P. oceanica*, covering a known area of 1,224,707 ha, and highlighted the lack of relevant data in part of the basin (21,471 linear km of coastline). The estimated regression of meadows amounted to 34% in the last 50 years, showing that this generalised phenomenon had to be mainly ascribed to cumulative effects of multiple local stressors.

Our knowledge about the **deep-sea habitats** on the scale of the whole Mediterranean Basin is extremely scant and limited only to sites in the western Mediterranean which received much attention in the last decades (e.g., Cap de Creus Canyon, South Adriatic Sea, Santa Maria di Leuca Coral Province, Alboran Sea). The lack of information about deep-sea habitats in the north African and in the eastern side of the Mediterranean Sea is particularly evident.

CONCLUSIONS

Conclusion (brief)
Conclusions (extended)

● Regional expertise, research and monitoring programmes over the last few decades have tended to concentrate their attention on only a few specific Mediterranean habitats. The exploration of habitats such as bioconstructions from very shallow to the deep-sea should be further supported.

● Despite the scientific importance of time series studies, the funding for many monitoring programmes is in jeopardyand much the Mediterranean Sea remains not just under-sampled but unsampled. Monitoring should be coordinated and standardized so that results can be easily comparable at least for some, decided *a priori*, variables.

● Beside criteria such as reduction in quantity and in quality and the geographical distribution, more research should focus on processes leading to low diversity habitats. Regime shifts are ubiquitous in marine ecosystems, ranging from the collapse of individual populations, such as commercial fish, to the disappearance of entire habitats, such as macroalgal forests and seagrass meadows. Lack of a clear understanding of the feedbacks involved in these processes often limits the possibility of implementing effective restoration practices.

● To make the descriptor Sea Floor Integrity operational 8 attributes of the seabed system have been suggested to provide adequate information to meet requirements of the MSFD: (i) substratum, (ii) bioengineers, (iii) oxygen concentration, (iv) contaminants and hazardous substances, (v) species composition, (vi) size distribution, (vii) trophodynamics and (viii) energy flow and life history traits. An important issue is to select the proper spatial and temporal scales. Some of these attributes such as species composition, energy flow and life history traits are important as well to pelagic habitats conditions.

● Increase the geographical coverage of protection, establishing new arrays of MPAs (and then Networks of MPAs) in the southern and eastern parts of the Mediterranean Sea (most MPAs are concentrated in the north-central Mediterranean Sea) since Descriptors 1, 3, 4 and 6 have been shown to evolve favourably in Mediterranean MPAs. The use of MPA networks as a reference volume where to assess the attainment of GES should be taken into account. The GES should be achieved in all Mediterranean waters by 2020. In addition, Establish Exclusive Economic Zones (EEZ) in EU countries and encourage other non-EU states to do so as well. This will minimize or eliminate the High Seas in the Mediterranean. Outside the EEZs, in fact, the seas are a “no man’s land” and regulations are weak, especially for deep-sea mining and fisheries.

● The coastal states are currently formulating their criteria and the associated monitoring protocols for recognising GES. This is leading to quite wide disparities of the interpretations of the Descriptors/Indicators among coastal states, not least in the ecological terminology used: this is particularly evident in the definition of Sea Floor Integrity (Descriptor 6) largely differing across countries such as Spain, Italy, Slovenia, Croatia, Cyprus and Bulgaria (1). The monitoring programmes also suffer of the same inconsistencies. The consequence is that, in most EU countries, the criteria for implementing GES are still unclear, with lack of harmonization of methods between countries. Significant work has been carried out for the MSFD at the European level, through the OSPAR and HELCOM conventions notably, where monitoring guidelines have been produced. The cohrence with such work and with the guidelines produced should be considered in the EcAp process.

● Large-scale analyses have been critical to expand our knowledge about the *extent* of habitats and threats but are often biased by the extrapolation of either a few small-scale studies or low-resolution large-scale assessments. This limits very much the potential to assess the condition and the trajectories of change in Mediterranean habitats

● Ocean warming, acidification, extreme climate events and biological invasions are expected to increase in the next years. These are difficult to be assessed and managed. More attention should be directed to those threats that can be more easily mitigated such as trawling, maritime traffic and nutrient loading from some land-based activities. In this framework, improve knowledge of the distribution and intensity of threats (e.g. fishery, bioinvasions, marine litter, seabed mining, coastal and non-coastal infrastructures) to reduce uncertainties on their effects should be also increased.

- Promote open access to data is very critical, especially those deriving from EU projects, through institutional databases sustained under rules and protocols endorsed by EU. The data ensuing from EU projects are still much fragmented and are not stored in a single repository where data are available in a standard format with a stated access protocol.
- The process of Maritime Spatial Planning (MSP) across the Mediterranean should be largely supported, considering activities that are expected to increase in the future (e.g. aquaculture, maritime traffic, seabed mining).

Key messages

The shift from Habitat approaches to Biodiversity and Ecosystem Functioning approaches much better reflects the rationale that sustains the management and conservation of marine systems.
This shift calls for holistic, integrative and ecosystem based approaches that are just being developed and that will require a reappraisal of the way we tackle ocean sciences.
The adoption of the concept of Cells of Ecosystem Functioning, and their spatial definition throughout the Mediterranean Sea, is a pre-requisite to design assessment procedures taking care of both patterns and processes.

Knowledge gaps

The analysis of marine systems is mostly compartmentalised, with a series of approaches that should be complementary but that, instead, are developed with little connections with each other. The distinction between benthic systems and pelagic ones, for instance, is based on the patterns of distribution of biodiversity but does not consider processes much.
Examples of gaps:
Role of resting stage banks for plankton dynamics.
Impact of gelatinous macrozooplancton on the functioning of ecosystems.
Links between deep sea systems and coastal ones.
Knowledge of connectivity processes.
Knowledge of temporal dynamics in the functioning of marine systems, with the coupling of seasonal dynamics and multiannual dynamics.
Role of larval mortality driven by predation in fisheries yields (see the example of Mnemiopsis in the Black Sea).
Definition of the Cells of Ecosystem Functioning.There are important gaps concerning knowledge/monitoring of larval stages of fish (ichtyoplancton) but also for plankton (micro-) organisms for the pelagic habitats.

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Ecological Objective 1 (EO1): Biodiversity

Note: The maps and illustrations are provisional

EO1: Common Indicator 3: Species distributional range (related to marine mammals)

GENERAL

Reporter:	SPA/RAC
Geographical scale of the assessment:	Regional, Mediterranean Sea
Contributing countries:	
Mid-Term Strategy (MTS) Core Theme	2-Biodiversity and Ecosystems
Ecological Objective	EO1: Biological diversity is maintained or enhanced. The quality and occurrence of coastal and marine habitats and the distribution and abundance of coastal and marine species are in line with prevailing physiographic, hydrographic, geographic and climatic conditions.
IMAP Common Indicator	Common Indicator 3 (CI3): Species distributional range (related to marine mammals)
Indicator Assessment Factsheet Code	EO1CI3

RATIONALE/METHODS

Background (short)

Robust information on species occurrence, distribution and ranges is the baseline to perform any further in depth investigation and to gain insights on the conservation status of the target populations. These are therefore pivotal to inform conservation and management at the diverse temporal and spatial scale. Cetaceans in the Mediterranean Sea are protected under statutory regulations (e.g. the Habitat Directive and the Marine Strategy Framework Directive) and by several international agreements such as ACCOBAMS among the others, which not only indicates to some extent the priorities in terms of conservation, but also clearly states the details of monitoring activities that should be in place. By consequence, these information and the process to gather them are necessary to abide to national and international regulations.

Background (extended)

Background and rationale for the indicator, key pressures and drivers

The aim of this indicator is to provide information about the geographical area where marine mammal species occur, and to determine the range of cetaceans and seals that are present in the Mediterranean waters. The distribution of a given marine mammal species is usually described by a map, describing the species presence, distribution and occurrence. Geographical Information Systems (GIS) are commonly used to graphically represent monitoring data and species distributional range maps.

Data on distribution of marine mammals are usually collected during dedicated ship and aerial surveys, acoustic surveys, or opportunistically by whale watching operators, ferries, cruise ships, military ships.

Twelve species of marine mammals — one seal and 11 cetaceans — are regularly present in the Mediterranean Sea; all these 12 species belong to populations (or sub-populations, *sensu* IUCN) that are genetically distinct from their North Atlantic conspecifics. The Mediterranean monk seal (*Monachus monachus*) and the 11 cetacean species (fin whale, *Balaenoptera physalus*; sperm whale, *Physeter macrocephalus*; Cuvier's beaked whale, *Ziphius cavi*rostris; short-beaked common dolphin, *Delphinus delphis*; long-finned pilot whale, *Globicephala melas*; Risso's dolphin, *Grampus griseus*; killerwhale, *Orcinus orca*; striped dolphin, *Stenella coeruleoalba*; rough-toothed dolphin, *Steno bredanensis*; common bottlenose dolphin, *Tursiops truncatus*; harbour porpoise, *Phocoena phocoena relicta*) face several threats, due to heavy anthropogenic pressures throughout the entire Mediterranean basin.

The conservation status of marine mammals in the region is jeopardised by many human impacts, such as: (1) deliberate killing (mainly due to interactions with fisheries), naval sonar, ship strikes, epizootics, fisheries bycatch, chemical pollution and ingestion of solid debris; (2) short-term habitat displacement as a consequence of naval exercises using sonars, seismic surveys, vessel disturbance and noise; and (3) long-term relocation caused by food depletion due to over fishing, habitat fragmentation, coastal development and possibly climate change.

Two of these species have very limited ranges: the harbour porpoise, possibly representing a small remnant population in the Aegean Sea, and the killer whale, present only as a small population (less than 50 individuals) in the Strait of Gibraltar.

Out of the 12 marine mammal species listed above, seven are listed under a Threat category on the IUCN's Red List, three are listed as Data Deficient and two need to be assessed.

Policy Context and Targets

The Mediterranean cetaceans' populations are protected under the framework of ACCOBAMS (Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area), under the auspices of the UNEP Convention on the Conservation of Migratory Species of Wild Animals (UNEP/CMS). The Pelagos Sanctuary is a large marine protected area, established by France, Italy and Monaco in the Corso-Ligurian-Provençal Basin and the Tyrrhenian Sea, where most cetacean species are regularly observed and benefit from its conservation regime.

All cetacean species in the Mediterranean Sea are also protected under the Annex II of the SPA-BD Protocol of the Barcelona Convention; under the Appendix I of the Bern Convention; under the Annex II of the Washington Convention (CITES); and under the Appendix II of the Bonn Convention (CMS).

The short-beaked common dolphin, the sperm whale and the Cuvier's beaked whale and the monk seal are also listed under the Appendix I of the Bonn Convention (CMS). The common bottle dolphin, the harbor porpoise and the monk seal are also listed under the Annex II of the EU Habitats Directive.

Assessment methods

Visual and acoustic surveys

Before conducting any type of monitoring of animal populations aimed at assessing the species distribution, it is essential to define the main objectives of the programme, alongside with the collection of relevant information on the target study area and the species presence, occurrence and behaviour. These elements are critical to choose the right data collection methodology, survey design approach and analytical framework.

We can identify are at least five potential approaches to be undertaken when monitoring cetaceans:

1. Visual surveys from ship, aircraft or land observation platforms (LOP).
2. PAM carried out during ship surveys with towed hydrophones.
3. PAM performed by means of static acoustic monitoring, e.g. using T-PODs or EARS.
4. A combination of all or some of the above methodologies.
5. Satellite tagging and tracking.

Visual aerial and both acoustic and visual surveys offer several advantages, but present some limitation depending on the target species. Therefore, when deciding which monitoring method to implement, it is pivotal to consider the limitations of each approach and compare the different methodologies. In general, surveys from ship or aircraft have a low temporal resolution. Ship surveys may have bias due to responsive movements of animals, stationary acoustic systems often have low spatial resolution and are inherently problematic from a logistical point of view in terms of deployment of instruments.

Passive Acoustic Monitoring

Cetaceans, in particular odontocetes, are highly vocal animals that can produce vocalisations for over the 80% of the time (e.g. the sperm whale). The monitoring of these sounds allows, hence, for the collection of information on spatial and temporal habitat use. The collection of acoustic data for cetaceans has some significant advantages over visual methods. In fact, acoustic methods can be automated, data can be collected 24-hrs a day over long period of time, data collection is not dependent on observer's skills, is less sensitive to weather conditions and can detect the presence of diving animals not available for visual observations. The disadvantages of of PAM methods are that they rely on animals making sounds within a useful detection range and are identifiable to the species level.

Satellite tracking

Information on the distribution and movements of individual animals can help to identify critical habitats, migration routes and patterns, to define boundaries between populations, as well as, to identify and quantify potential threats during long distance migrations (i.e. ships strikes). Effective conservation of animal populations is enhanced by this information, which can also be valuable when designing monitoring programmes.

To make inferences about large populations ranging over a wide area, many animals must be tagged, especially in species with high individual variation in behaviour.

Many kinds of tags have been used in studies of cetaceans, including VHF transmitters, satellite tags and GPS data loggers. Satellite telemetry, being based on signal transmission between the tagged animals and the ARGOS satellite network, offers a virtually total coverage of the Earth's oceans and bodies of water and can be used to track animals even in remote location that difficult to reach. Furthermore, being the data downloaded to land-based server stations, they can be accessed, parsed and analysed without the need to physically retrieve the tags.

Each tagged animal can provide a wealth of information but the limitation is that typically only a few animals can be tagged in a study due to limited funding or access to live animals. General conclusions arising from these studies must be carefully evaluated especially if all members of the population are not equally available for tagging.

RESULTS

Results and Status, including trends (brief)

Results and Status, including trends (extended)

Mediterranean monk seal – Regularly present only in the Ionian, Aegean and Levantine Seas, the Mediterranean monk seas breeds in Greece and parts of Turkey and Cyprus. Deliberate killing, habitat loss and degradation, disturbance and potentially by-catch in fishing gear are the main threats.
Fin whale – This species is observed throughout the Mediterranean Sea, mainly in the western Basin. True Mediterranean fin whales range from the Balearic Islands to the Ionian and southern Adriatic seas, while North East North Atlantic (NENA) whales seasonally enter through the Strait of Gibraltar (Fig. 1). The main anthropogenic threats include collisions with ships, disturbance, chemical and acoustical pollution.

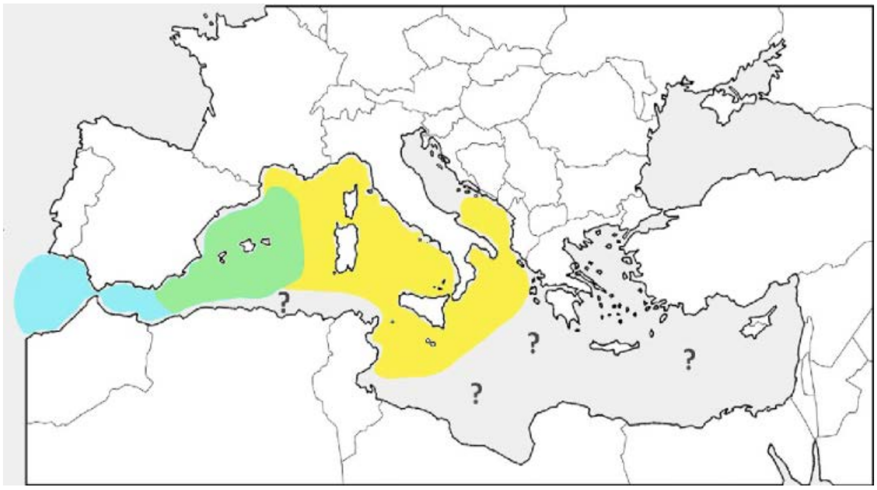

Fig. 1 - Presumed distribution of fin whale (*Balaenoptera physalus*) populations in the Mediterranean Sea. Blue: north-east North Atlantic population (NENA whales). Yellow: Mediterranean population (MED whales). In green the presumed overlap between the two populations (from: Notarbartolo di Sciara, G., Castellote, M., Druon , J.N., Panigada, S. 2016. Fin whales: at home in a changing Mediterranean Sea? Advances in Marine Biology Series, 75:75-101).

Sperm whale – Sperm whales prefer slope and deep waters all over the Basin, with localized hot spots in the Hellenic Trench, the Ligurian Sea, the Balearic area and the Gibraltar Strait. Human threats include ship strikes, occasional entanglement in driftnets, ingestion of plastic debris, anthropogenic noise and chemical contaminants.
Cuvier's beaked whale – This species is distributed throughout the Mediterranean Sea, mainly along the deep continental slope, in presence of underwater canyons. Cuvier's beaked whales are particularly vulnerable to military and industrial sonars, bycatch in fishing gears, ingestion of plastics.
Short-beaked common dolphin – Common dolphins significantly declined in the Mediterranean Sea over the last few decades and are now present in specific locations within the Alborán Sea, the Sardinian Sea, the Strait of Sicily, the eastern Ionian Sea, the Aegean Sea and the Levantine Sea. Prey depletion from overfishing and incidental mortality in fishing gear seem to be the main current threats for this species in the Mediterranean Sea.
Long-finned pilot whale – This species in present only in the western Basin only, mainly in offshore waters. Current threats include bycatch in driftnets, ship strikes, disturbance from military sonar and chemical pollution.
Risso's dolphin – Risso's dolphins are present – in relatively low numbers – throughout the Mediterranean Sea, with a preference for slope waters. Known distributional range includes the Alborán, Ligurian, Tyrrhenian, Adriatic, Ionian, Aegean and Levantine seas and the Strait of Sicily.

Killer whale – This species is seasonally present in the Strait of Gibraltar and adjacent Atlantic waters only and it is very rare in the rest of the Mediterranean Sea. Strong negative interactions with local artisanal bluefin tuna fisheries have been described.
Striped dolphin –The most abundant cetacean species in the Mediterranean Sea, mainly using offshore deep waters, from the Levantine Basin to the Strait of Gibraltar. Subject to a wide range different threats affect the Mediterranean population, such as morbillivirus epizootics and high levels of chemical pollutants.
Rough-toothed dolphin – It is regular in the eastern Mediterranean only, particularly in the Levantine Sea, at very low densities and limited range. Subject to similar human impacts as other dolphins, including bycatch, acoustic and chemical pollution.
Common bottlenose dolphin – One of the most common species all over the Mediterranean Sea, mainly found on the continental shelf. Human threats include mortality in fishing gear, occasional direct killings, habitat loss or degradation including coastal development, overfishing of prey and high levels of contamination.
Harbour porpoise – This cetacean subspecies, typically found in the Black Sea, is occasionally observed in the northern Aegean Sea. Main threats in the Black Sea include severe levels of bycatch in fishing gears, mortality events and habitat degradation.

CONCLUSIONS

Conclusions (brief)

Current knowledge about the presence, distribution, habitat use and preferences of Mediterranean marine mammals is limited and regionally biased, due to an unbalanced distribution of research effort during the last decades, mainly focused on specific areas of the Basin. Throughout the Mediterranean Sea, the areas with less information and data on presence, distribution and occurrence of marine mammals, are the south-eastern portion of the basin, including the Levantine basin and the North Africa coasts. In addition, the summer months are the most representative and very few information have been provided for the winter months in the data pool, when conditions to conduct off-shore research campaigns are particularly hard due to meteorological adversity.

Marine mammals' presence and distribution are mainly related to suitable habitats and availability of food resources; anthropogenic pressures, as well as climate change, may cause changes and shifts in the occurrence of marine mammals, with potential detrimental effects at the population levels. Accordingly, in order to enhance conservation effort and inform management purposes, it is crucial to obtain detailed and robust descriptions of species' range, movements and extent of geographical distribution, together with detailed information on the location of breeding and feeding areas.

Ongoing effort by ACCOBAMS to start a synoptic region-wide survey referred to as the ACCOBAMS Survey Initiative (ASI), to assess the presence distribution and to estimate density and abundance of cetaceans in the summer of 2018. Concurrently, local scientists are working on the identification of Cetacean Critical Habitats (CCHs) and Important Marine Mammal Areas (IMMAs) in the entire Mediterranean Sea. A gap analysis has also been conducted within the Mediterranean Sea, to provide an inventory of available data and to select areas where more information should be collected.

Conclusions (extended)

Key messages

Systematic surveys should be carried out throughout the whole Mediterranean Sea.

More effort should be devoted in poorly monitored areas.

Those species which are listed as Data Deficient under the Red List criteria should be considered as a priority.

Knowledge gaps

Most of the Mediterranean Sea has been surveyed to some extent to evaluate cetaceans occurrence, distribution and ranges. Nonetheless, there is a great disparity in the overall distribution of research effort, with most research that has been and still is carried out in the north-western portion of the basin, where long time series of data, covering up to three decades, exist. In southern Mediterranean countries information on species occurrence and distribution mostly arises from anecdotal information and localized research projects. Systematic surveys in these areas are still in their infancy. Effort should be done to allocate research in those areas to start building baseline information and to eventually obtain long time series of data. The current gap in the availability of data, and by consequence of knowledge, is hampering the identification of protection measures towards the conservation of species at the regional level.

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Ecological Objective 1 (EO1): Biodiversity

Note: The maps and illustrations are provisional

EO1: Common Indicator 3: Species distributional range (marine reptiles)

GENERAL

Reporter:	SPA/RAC
Geographical scale of the assessment:	Regional, Mediterranean Sea
Contributing countries:	No national data were provided for this assessment.
Mid-Term Strategy (MTS) Core Theme	2-Biodiversity and Ecosystems
Ecological Objective	EO1: Biological diversity is maintained or enhanced. The quality and occurrence of coastal and marine habitats and the distribution and abundance of coastal and marine species are in line with prevailing physiographic, hydrographic, geographic and climatic conditions.
IMAP Common Indicator	Common Indicator 3 (CI3): Species distributional range (Marine reptiles)
Indicator Assessment Factsheet Code	EO1CI3

RATIONALE/METHODS

Background (short)

This assessment presents a brief overview of the known distribution range of loggerhead and green sea turtles at breeding, foraging and wintering grounds, based on published data. Sea turtles are an ideal model species to assess the selected indicator, as their populations are dispersed throughout the entire Mediterranean, as discrete breeding, foraging, wintering and developmental habitats (Casale & Margaritoulis 2010), making the two sea turtle species a reliable indicator on the status of biodiversity across this region. Therefore, the objective of this indicator is to determine the species range of sea turtles that are present in Mediterranean waters, especially the species selected by the Parties.

Background (extended)

Background and rationale

In biology, the range of a given species is the geographical area in which that occurs (i.e. the maximum extent). A commonly used visual representation of the total areal extent (i.e. the range) of a species is a range map (with dispersion being shown by variation in local population densities within that range). Species distribution is represented by the spatial arrangement of individuals of a given species within a geographical area. Therefore, the objective of this indicator is to determine the species range of sea turtles that are present in Mediterranean waters, especially the species selected by the Parties.

Sea turtles are an ideal model species to assess the selected indicator, as their populations are dispersed throughout the entire Mediterranean, as discrete breeding, foraging, wintering and developmental habitats (Casale & Margaritoulis 2010), making the two sea turtle species a reliable indicator on the status of biodiversity across this region. Three sea turtle species are found in the Mediterranean (leatherback, *Dermochelys coriacea*; green, *Chelonia mydas*; and loggerhead, *Caretta caretta*), but only green and loggerhead turtles breed in the basin and have limited gene flow with those from the Atlantic, even though, turtles from the Atlantic do enter the western part of the basin (confirmed by genetic analyses: Encalada et al. 1998; Laurent et al. 1998). Green turtles are primarily herbivores, whereas loggerheads are primarily omnivores, resulting in their occupying important components of the food chain; thus, changes to the status in sea turtles, will be reflected at all levels of the food chain. However, the extent of knowledge on the occurrence, distribution, abundance and conservation status of Mediterranean marine species is uneven. In general, the Mediterranean states have lists of species, but knowledge about the locations used by these species is not always complete, with major gaps existing (Groombridge 1990; Margaritoulis et al. 2003; Casale & Margaritoulis 2010; Mazaris et al. 2014; Demography Working Group 2015). Even some of the most important programmes on this topic have significant gaps (e.g. Global databases do not reflect actual current knowledge in the Mediterranean region). It is therefore necessary to establish minimum information standards to reflect the known distribution of the two selected species. Species distribution ranges can be gauged at local (i.e. within a small area like a national park) or regional (i.e. across the entire Mediterranean basin) scales using a variety of approaches.

Given the breadth of the Mediterranean, it is not feasible to obtain adequate information about the entire surface (plus, the marine environment is 3 dimensional, with sea turtles being present only briefly to breathe), so it is necessary to choose sampling methods that allow adequate knowledge of the distribution range of each species. Such sampling involves high effort for areas that have not been fully surveyed to date. Monitoring effort should be long term and should cover all seasons to ensure that the information obtained is as complete as possible.

Key pressures and drivers

Both nesting and foraging areas of marine turtles are vulnerable to anthropogenic pressures in the Mediterranean Sea, including an increase in the exploitation of resources (including fisheries), use and degradation of habitats (including coastal development), pollution and climate change (UNEP/MAP/BLUE PLAN, 2009; Mazaris et al. 2009, 2014; Witt et al. 2011; Katselidis et al. 2012, 2013, 2014). These issues might reduce the resilience of this group of species, negatively impacting the ability of populations to recover (e.g. Mazaris et al. 2009, 2014; Witt et al. 2011; Katselidis et al. 2012, 2013, 2014). The risk of extinction is particularly high in the Mediterranean because the breeding populations of both loggerhead and green turtles in this basin are demographically distinct to other global populations (Laurent et al., 1998; Encalada et al., 1998), and might not be replenished.

The main threats to the survival of loggerhead and green turtles in the Mediterranean have been identified as incidental catch in fishing gear, collision with boats, and intentional killing (Casale & Margaritoulis 2010). Casale (2011) estimated that there are more than 132,000 incidental captures per year in the Mediterranean, of which more than 44,000 are predicted to be fatal, although very little is known about post-release mortality (Álvarez de Quevedo et al. 2013). Wallace et al. (2010, 2011) grouped all species of sea turtles globally into regional management units (RMUs), which are geographically distinct population segments, to determine the population status and threat level. These regional population units are used to assimilate biogeographical information (i.e. genetics, distribution, movement, demography) of sea turtle nesting sites, providing a spatial basis for assessing management challenges. A total of 58 RMUs were originally delineated for the seven sea turtle species. The Mediterranean contains 2 RMUs for loggerheads and 1 RMU for green turtles (Figure 1).

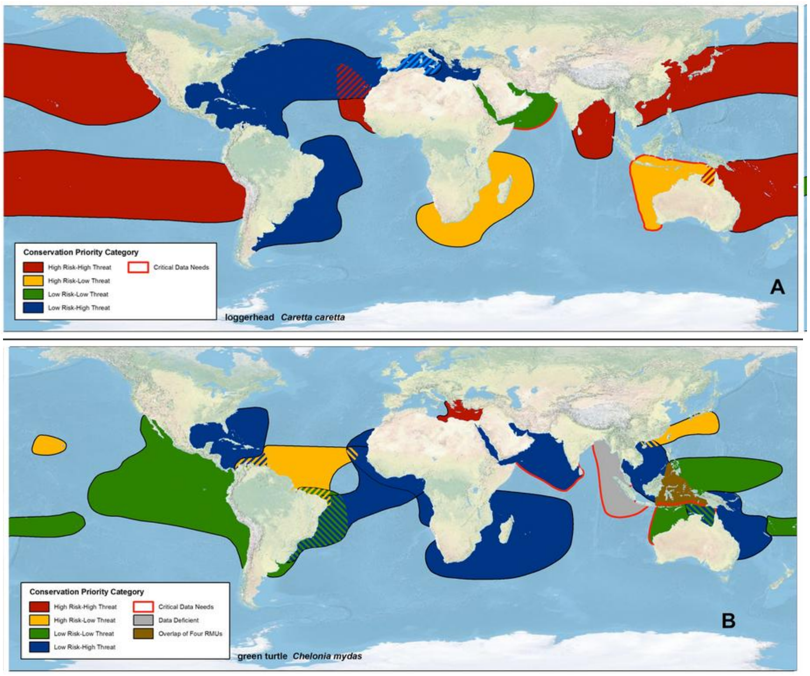

Figure 1: Regional Management Units of sea turtle populations globally (extracted from Wallace et al. 2010, 2011). (A) Showing the 2 loggerhead RMUs in the Mediterranean and (B) showing the 1 green turtle RMU in the Mediterranean.

These analyses showed that the Mediterranean has the highest average threats score out of all ocean basins, particularly for marine turtle bycatch (Wallace et al. 2011). However, compared to all RMUs globally, the Mediterranean also has the lowest average risk score (Wallace et al. 2011).

Other key threats to sea turtles in the Mediterranean include the destruction of nesting habitat for tourism and agriculture, beach erosion and pollution, direct exploitation, nest predation and climate change (Casale & Margaritoulis 2010; Mazaris et al. 2014; Katselidis et al. 2012, 2013 2014). Coll et al. (2011) also identified critical areas of interaction between high biodiversity and threats for marine wildlife in the Mediterranean. Within this analysis, the authors delineated high risk areas to both species, with critical areas extending along most coasts, except the south to east coastline (from Tunisia to Turkey) (Figures 2-4).

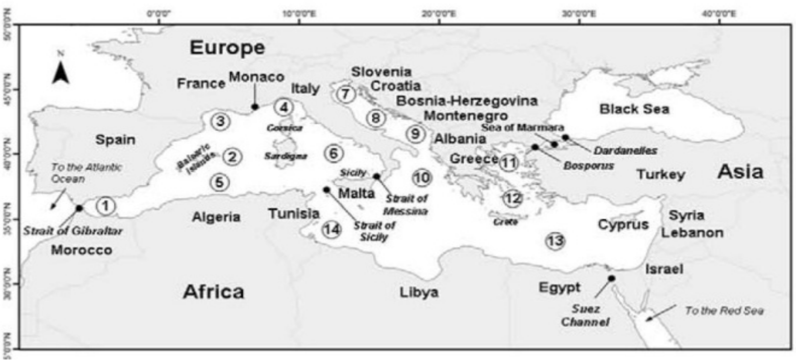

Figure 2: Main biogeographic regions of the Mediterranean Sea (extracted from Coll et al. 2011)

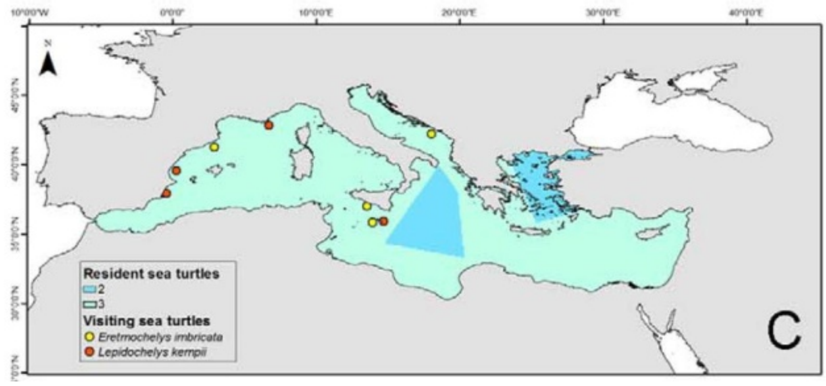

Figure 3: Modelled resident and sea turtle species richness (n = 3 species) in the Mediterranean (extracted from Coll et al. 2011)

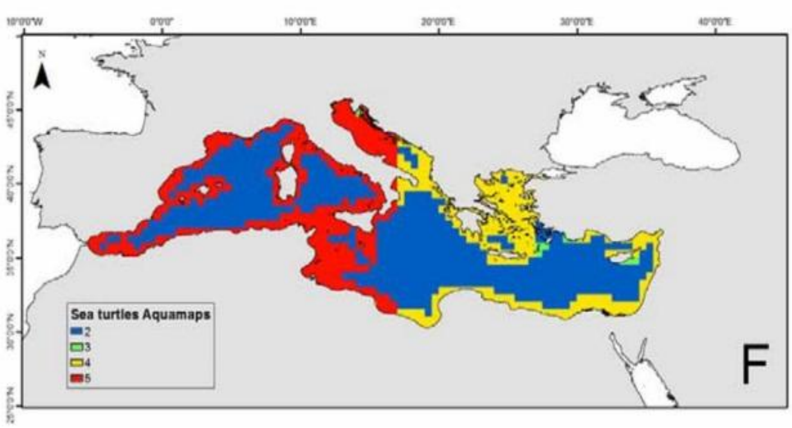

Figure 4: Aqua Map model of sea turtle distribution in the Mediterranean Sea (extracted from Coll et al. 2011). Note, this is primarily based on nesting beach data.

Policy Context and Targets

Similar to the Ecosystem Approach, the EU adopted the European Union Marine Strategy Framework Directive (MSFD) on 17 June 2008, which includes Good Environment Status (GES) definitions, Descriptors, Criteria, Indicators and Targets. In the Mediterranean region, the MSFD applies to EU member states. The aim of the MSFD is to protect more effectively the marine environment across Europe. In order to achieve GES by 2020, each EU Member State is required to develop a strategy for its marine waters (Marine Strategy). In addition, because the Directive follows an adaptive management approach, the Marine Strategies must be kept up-to-date and reviewed every 6 years.

The MSFD includes Descriptor 1: Biodiversity: "The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions." Assessment is required at several ecological levels: ecosystems, habitats and species. Among selected species are marine turtles and within this framework, each Member State that is within a marine turtle range, has submitted GES criteria, indicators, targets and a program to monitor them.

The MSFD will be complementary to, and provide the overarching framework for, a number of other key Directives and legislation at the European level. Also it calls to regional cooperation meaning "cooperation and coordination of activities between Member States and, whenever possible, third countries sharing the same marine region or subregion, for the purpose of developing and implementing marine strategies" […] "thereby facilitating achievement of good environmental status in the marine region or subregion concerned". Commission Decision 2010/477/EU sets out the

MSFD's criteria and methodological standards and under Descriptor 1 includes criteria "1.1. Species distribution" and indicators "Distributional range (1.1.1)", "Distributional pattern within the latter, where appropriate (1.1.2)", and "Area covered by the species (for sessile/benthic species) (1.1.3)". At a country scale, Greece, Italy, and Spain have selected targets for marine turtles (Breeding areas are included as an MSFD target in Greece); Cyprus and Slovenia mention marine turtles in their Initial assessment, but do not set targets (Milieu Ltd Consortium. 2014) See UNEP/MAP 2016 for more details.

Assessment methods

This assessment presents a brief and general overview of the distributional range of two marine turtle species to identify existing knowledge and knowledge gaps for use in elaborating the national monitoring programmes for biodiversity. Published information by regional and national surveys and research projects were used to compile the review, but this overview does not present a comprehensive assessment of existing knowledge.

RESULTS

Results and Status, including trends (brief)

This general overview reconfirms that most nesting sites of loggerheads are located in the eastern and central basins of the Mediterranean, in particular in Greece, Turkey, Cyprus and Libya, while all green turtle nesting sites are located in the eastern basin, primarily Turkey, Syria and Cyprus. The number of nests held at different sites is not just dependent on climate, but other factors, like predation, sand type/structure etc. Most research has been conducted on nesting beaches; consequently, detailed information about marine habitat use at developmental, foraging and wintering grounds and how these areas connect with one another and the overlap in use by multiple populations is still missing.

Results and Status, including trends (extended)

Loggerhead sea turtles

Nesting sites

Over 100 sites around the Mediterranean have scattered to stable (i.e. every year) nesting (Halpin et al., 2009; Kot et al. 2013; SWOT, 2006a, 2006b, 2008, 2009, 2010, 2011, 2012). Most sites are located in the eastern and central basins of the Mediterranean (Figure 5).

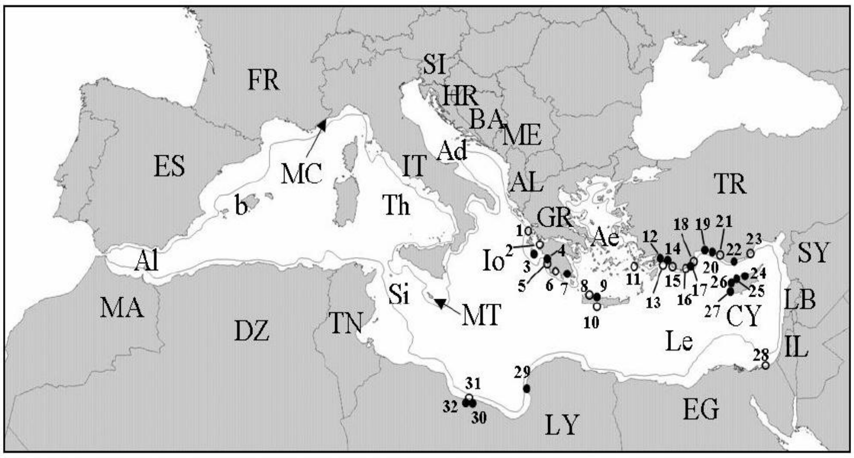

Figure 5: Map of the major loggerhead nesting sites in the Mediterranean (extracted from Casale & Margaritoulis): Major nesting sites (>50 nests/year) of Loggerheads in the Mediterranean. 1 Lefkas;

2 Kotychi; 3 Zakynthos; 4 Kyparissia; 5 beaches adjacent to Kyparissia town; 6 Koroni; 7 Lakonikos Bay; 8 Bay of Chania; 9 Rethymno; 10 Bay of Messara; 11 Kos; 12 Dalyan; 13 Dalaman; 14 Fethiye; 15 Patara; 16 Kale; 17 Finike-Kumluca; 18 Cirali; 19 Belek; 20 Kizilot 21 Demirtas; 22 Anamur; 23 Gosku Delta; 24 Alagadi; 25 Morphou Bay; 26 Chrysochou; 27 Lara/Toxeftra; 28 Areash; 20 Al-Mteafla; 30 Al-Ghbeba; 31 Al-thalateen; 32 Al-Arbaeen. Closed circles >100 nests/year; open circles 50-100 nests/year. Country codes: AL Albania; DZ Algeria; BA Bosnia and Hersegovina; HR Croatia; CY Cyprus; EG Egypt; FR France; GR Greece; IL Israel; IT Italy; LB Lebanon; LY Libya; MT Malta; MC Monaco; ME Montenegro; MA Morocco; SI Slovenia; ES Spain; SY Syria; TN Tunisia; TR Turkey; Ad Adriatic; Ae Aegean; Al Alboran Sea; Io Ionian; Le Levantine basin; Si Sicily Strait; Th Thyrrenian; b Balearic.

Sporadic to regular nesting has been recorded in Cyprus, Egypt, Greece, Israel, Italy, Lebanon, Libya, Malta, Syria, Tunisia and Turkey (Margaritoulis et al. 2003; Casale & Margaritoulis 2010). Surveys have been conducted for tracks in Algeria (last surveyed 1980s), Croatia (last surveyed 1990s), France (last surveyed 1990s), Morocco (last surveyed 1980s), Spain (last surveyed 1990s) (Margaritoulis et al. 2003; Casale & Margaritoulis 2010). Information on nesting has not been gathered for Albania, Montenegro, Monaco, Slovenia or Bosnia (Margaritoulis et al. 2003; Casale & Margaritoulis 2010). A recent IUCN analysissuggests that, when all Loggerhead nesting sites in the Mediterranean are considered together, the geographic distribution of loggerheads in the Mediterranean is broad, and is considered of Least Concern though conservation dependent, under current IUCN Red List criteria (Casale 2015).

Most nests are laid in Greece, Turkey, Cyprus and Libya (Margaritoulis 2003; Casale & Margaritoulis 2010; Almpanidou et al. 2016). An average of 7200 nests are made per year across all sites (Casale & Margaritoulis 2010), which are estimated to represent 2,280–2,787 females based on clutch frequency assumptions (Broderick et al. 2002). Greece and Turkey alone have more than 75% of the nesting in the Mediterranean; however, the smaller populations at other sites such as Libya and Cyprus are also of regional significance being at the edges of the species range (Demography Working Group, 2015). Of note, the beaches of the countries of North Africa have not been extensively surveyed, particularly Libya, so gaps on the numbers and distribution of nests still remain. Genetic analyses suggest low gene flow among groups of rookeries; thus, it is essential to preserve distinct genetic units (Carreras et al. 2006).

The number of nests held at different sites is not just dependent on climate, but other factors, like predation, sand type/structure etc. (Almpanidou et al. 2016). Thus, a recent study of all Mediterranean nesting sites showed that the climatic suitability of current stable sites will remain suitable in the future (Almpanidou et al. 2016). However, other factors may lead to the loss of these sites, such as sea level rise (e.g. Katselidis 2014). Furthermore, Almpanidou et al. (2016) showed that sites with sporadic nesting might be increasingly used, i.e. such sites might not be past sites that are infrequently used, but may reflect the exploratory nature of turtles to locate new alternative sites (Schofield et al. 2010a). Thus, it is worth ensuring that all current stable nesting sites are fully protected (with their use into the future being likely); however, it is also important to follow how the use of sporadic nesting sites changes over time, to detect new sites of importance in need of protection (Katselidis 2014; Almpanidou et al. 2016).

Foraging (adult and developmental) and wintering sites

Most research has been conducted on nesting beaches; consequently, detailed information about marine habitat use at developmental, foraging and wintering grounds is still missing (Figure 6).

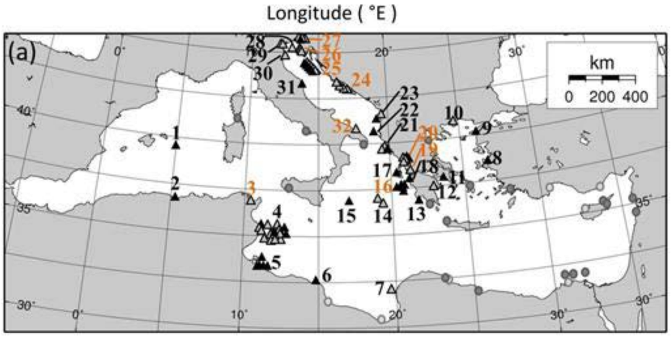

Figure 6: Foraging sites identified across the Mediterranean based on published papers (extracted from Schofield et al. 2013)

Discrete foraging sites frequented by male (black triangles) and female (grey triangles) loggerheads from Zakynthos (with some turtles frequenting more than one site). The foraging sites are indicated and numbered by open circles; orange circles = foraging sites overlapping or in close proximity to existing marine protected areas and/or national parks. Discrete foraging sites are arbitrary, and defined as a single site or group of overlapping sites that are separated from adjacent sites by a minimum distance of 36 km, which reflects the mean migration speed of loggerhead turtles (1.5 km h^{-1}; Schofield *et al.*, 2010) over a 24 h period. In addition, other known loggerhead (filled dark grey circles) and green turtle (filled light grey circles) foraging sites based on published datasets (Bentivegna, 2002; Margaritoulis *et al.*, 2003; Broderick *et al.*, 2007; Hochscheid *et al.*, 2007; Casale *et al.*, 2008). Note: solely juvenile foraging sites of the West Mediterranean have not been included here. The table below lists the different foraging sites, including the species, size class and genetic populations detected at these sites in various papers.

The way in which adult and newly hatched turtles disperse from breeding sites has been explored using a range of techniques in the Mediterranean, including genetics, stable isotope, satellite tracking, particle tracking and stable isotopes (e.g. Zbinden et al 2008, 2011; UNEP(DEPI)/MED. 2011; Schofield et al. 2013; Patel 2013; Luschi & Casale 2014; Casale & Patrizio 2014; Hays et al. 2014; Snape et al. 2016). These studies indicate that loggerheads probably forage throughout all oceanic and neritic marine areas of the west and east basins of the Mediterranean (Hays et al. 2014; Casale & Marianni 2014). Most satellite tracking studies have been conducted in Spain (of juvenile turtles), Italy (a mix of juvenile and adult turtles) and Greece (adult males and females) and Cyprus (adult females) (UNEP(DEPI)/MED. 2011; Casale & Patrizio 2014). Due to these biases, the results of tracking studies alone should be treated with caution.

Through combining studies using various techniques, loggerheads do not appea to be uniformly distributed (Clusa et al. 2014), with foraging in different sub basins affecting remigration rates, body size and fecundity (Zbinden et al. 2011; Cardona et al. 2014; Hays et al 2014). While most turtles that breed in the eastern basin tend to forage in the eastern and central areas, increasing numbers of satellite studies are showing that some individuals do disperse to and use the western basin too (Bentivegna 2002; Schofield et al. 2013; Patel 2013). The west Mediterranean primarily supports individuals from the Atlantic (Laurent et al. 1998; Carreras et al. 2006; Casale et al. 2008). Tracking studies of juvenile loggerheads in the western Mediterrnaean show that they are widely distributed throughout the entire region (UNEP(DEPI)/MED. 2011). As information on the distribution is not available on juvenile loggerheads in the central and east Mediterranean, it is likely that similarly ubiquitous distribution exists, but needs confirming (UNEP(DEPI)/MED. 2011).

The two most important neritic loggerhead foraging grounds for adults and juveniles appear to be the Adriatic Sea and the Tunisian Continental Shelf (including Gulf of Gabés) (Zbinden et al. 2010;

Casale et al. 2012; Schofield et al. 2013; Snape et al. 2016). Important oceanic areas include the Alboran Sea, the Balearic Sea and different parts of the North African coasts, as well as the Sicily Channel. Large numbers of juvenile loggerheads have been documented in the south Adriatic too (Casale et al. 2010; Snape et al. 2016). Aerial and fishery bycatch data indicate that the highest density of turtles occur in the western basin Alboran Sea and Balearic islands, the Sicily Strait, the Ionian Sea, the north Adriatic, off Tunisia, Libya, Egypt and parts of the Aegean (Gómez de Segura et al. 2003, 2006; Cardona et al. 2005; Lauriano et al. 2011; Casale & Margaritoulis 2010). In Egypt, Bardawil Lake has been identified as an important foraging area for adult and juvenile loggerheads based on stranding records and tracking studies of turtles from Cyprus (Nada et al. 2013, Snape et al. 2016).

However, establishing the distribution of, even coastal, foraging sites has yet to be achieved. Certain sites, where high numbers of turtles of all size classes from different populations aggregate in confined areas, have been identified, such as Amvrakikos Bay, Greece (Rees & Margaritoulis 2008) and Drini Bay, Albania (White et al 2011). However, tracking studies also show that the foraging areas of individual turtles may extend from <10 km2 up to 1000 km2 in the open waters of the Adriatic and Gulf of Gabés (Schofield et al. 2013). Furthermore, knowledge of how foraging habitat differs between adult males and females, as well as how these sites overlap with juvenile developmental habitat remains limited across the various populations (Snape et al. in submission). Particle tracking has suggested that, within the Mediterranean, adults exhibit high fidelity to sites where they established use as juveniles (Hays et al. 2014).

Furthermore, various studies have shown that, while turtles exhibit high fidelity to certain sites (Schofield et al. 2010b), both juvenile and adult loggerheads use more than one foraging site (sometimes up to 5), spanning both neritic and oceanic sites, particularly in the Ionian and Adriatic (Casale et al. 2007, 2012; Schofield et al. 2013). Adults that forage in the Adriatic, tend to use sites seasonally, shifting to alternative sites in winter (Zbinden et al. 2011: Schofield et al. 2013), although some hibernate (Hoscheid et al. 2007). However, juveniles have also been documented shifting into the Adriatic in winter, suggesting that some sites may be used year-round by different components of loggerhead populations (Snape et al. in submission). The use of multiple sites and seasonal shifts in site use need to be documented to understand how different foraging, developmental and wintering sites are connected. In this way, groups of areas should be protected where connections are known to exist.

Green turtles

Nesting sites

Most green turtle nests (99%) are laid in Turkey, Cyprus and Syria, with the remainder being found in Lebanon, Israel and Egypt (Figure 7; Kasparek et al. 2001; Casale & Margaritoulis 2010). An average of 1500 nests are documented each year (range 350 to 1750 nests), from which an annual nesting population of around 339–360 females has been estimated (Broderick et al. 2002), ranging from 115 to 580 females (Kasparek et al. 2001). The five key nesting beaches include: Akyatan, Samadağ, Kazanli (Turkey), Latakia (Syria) and Alagadi (northern Cyprus), with Ronnas Bay also being a priority area (Stokes et al. 2015). This allows the conservation effort of the nesting beaches for this species to be highly focused.

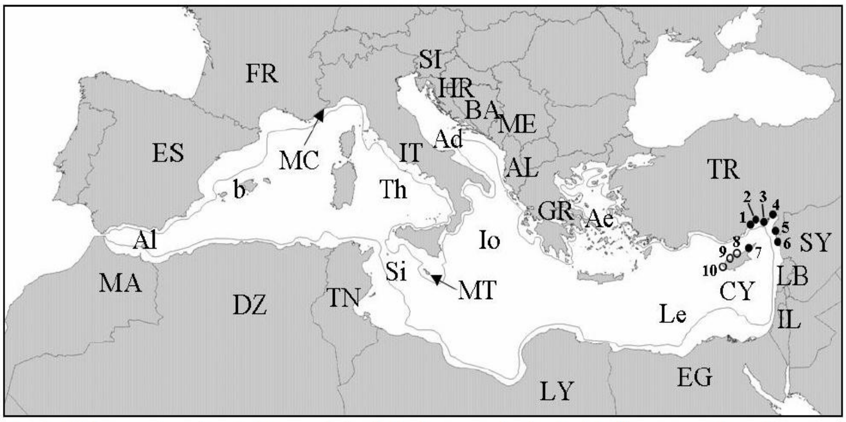

Figure 7: Map of the major green turtle nesting sites in the Mediterranean (extracted from Casale & Margaritoulis): Major nesting sites (>40 nests/year) of green turtles in the Mediterranean. 1 Alata; 2 Kazanli; 3 Akyatan; 4 Sugozu; 5 Samandag; 6 Latakia; 7 North Karpaz; 8 Alagadi; 9 Morphou Bay; 10 Lara/Toxeftra. Closed circles >100 nests/year; open circles 40-100 nests/year. Country symbols, see previous map.

Foraging (adult and developmental) and wintering sites

As with loggerheads, most information about green turtles is restricted to the nesting habitats, rather than developmental, foraging, and wintering habitats. Green turtles have been primarily documented foraging and wintering along the Levantine basin (Figure 8 and Table 1; Turkey, Syria, Cyprus, Lebanon, Israel, Egypt) (Broderick et al. 2007; Stokes et al. 2015). However, foraging areas have also been documented in Greece (particularly, Lakonikos Bay and Amvrakikos Bay; Margaritoulis & Teneketzis 2003) and along the north coast of Africa, primarily Libya and some sites in Tunisia (see Figure 8 and Table for published sources). Some turtles have been documented in the Adriatic Sea (Lazar et al. 2004) and around Italian waters (Bentivegna et al. 2011), with some records occurring in the western basin (see Figure 8 and Table for published sources). In addition, Broderick et al (2007) detected wintering behaviour for greens off of Libya, with high fidelity to the same sites across years; however, further documentation has not been recorded for the other populations or other areas of the Mediterranean. These wintering sites were detected based on a shift in location to deeper water from early November to March/April and reduced area use compared to summer months, which were assumed to be indicative of reduced activity during the colder months. Lakonikos Bay in Greece and Chrysochou Bay in southern Cyprus represent well documented foraging grounds of juvenile green turtles based on strandings and bycatch databases. Within Egypt, Bardawill Lake has been identified as an important foraging area for adult and juvenile green turtles based on stranding records and tracking studies of turtles from Cyprus (Nada et al. 2013). In Turkey, green turtles have been documented stranded in the Gulf of Iskenderun, and might represent foraging habitat, while juvenile green turtles have been confirmed inhabiting the coast along the Cukurova, with Samandag and Fethiye Bay also representing possible juvenile foraging grounds (see Casale & Margaritoulis 2010 for overview). Overall, the way in which the foraging grounds are distributed and the numbers and size classes that they support, or how frequently green turtles move among sites (i.e. connectivity), remains limited.

Table 1 (extracted from Schofield et al. 2013a). *Published literature used to identify overlap in foraging sites (A) based on tracking datasets and (B) based on genetic data. Foraging category, NO = neritic open sea; NC = neritic coastal. Thermal state, Avail = availability; Use = recorded use; Y-R = year round; S (Wi) = Seasonal (Winter); S (Su) = Seasonal (Summer); Unconf. = unconfirmed. Species, Log = loggerhead; Gre = Green; Gender/Ageclass, M = adult male; F = adult female; Juv = juveniles, with gender not differentiated. Breeding populations, ? = unconfirmed; Zak = Zakynthos, Greece; Kyp = Kyparissia, Greece; Cyp = Cyprus; Syr = Syria; T = Turkey; Lib = Libya; Tunis =*

Tunisia; Mess = Messina; Cal = Calabria; Is = Israel; It = Italy. Sources: 1 = current study; 2 = Casale et al., (2007, 2010); 3 = Zbinden et al., (2008, 2011); 4 = Margaritoulis et al., (2003); 5 = Bentivegna (2002); 6 = Broderick et al., (2007); 7 = Hochscheid et al., (2007); 8 = Echwikhi et al., (2010); 9 = Chaeib et al., (in press); 10 = Houghton et al., (2000); 11 = Rees et al. (2008), Rees & Margaritoulis (2008); 12 = Lazar et al., (2004a,b); 13 = Vallini et al., (2006); 14 = Carreras et al., (2006); 15 = Casale et al., (in press); 16 = Casale et al., 2012 ; 17 = Saied et al., 2012.

Foraging site	Basin	Sea/ gulf	Country	Foraging category	Thermal Avail.	Protection available	Species	Gender /Age class Loggerhead	Green	Breeding (Log only) No.	Populations	Sources
1	West	Balearic	Majorca	O	S (Su)	No	Log	M / Juv		1	Zak	1,2
2	West	Algerian coast	Algeria	NC	Y-R	No	Log	M		1	Zak	1
3	West	Gulf of Tunis	Tunisia	NC	Y-R	**Yes**	Log	F		1	Zak	1,3
4	Central	Gulf of Gabes	Tunisia	NC/NO	Y-R	No	Log	M /F / Juv		~10	Zak; Kyp; Cyp; Turk, Mess Tunis; Lib; ?Cal; ?Is; ?It	1, 2, 3, 4, 5, 6 7,8,9,15,16
5	Central	Gulf of Gabes	Tunisia	NC/NO	Y-R	No	Log	M /F / Juv		~6	Zak; Kyp; Cyp; Turk; Tunis Tunis; Lib	1,2,3,5, 6 7,8,17
6	Central	Gulf of Sindra	Libya	NC	Y-R	No	Log	F		2	Zak; Cyp	1, 4, 6
7	Central	Gulf of Sindra	Libya	NC	Y-R	No	Log	M /F		1	Zak	
8	East	Gulf of Izmir	Turkey	NC	S (Su)	**Yes**	Log	M		2	Zak; ?Kyp	1, 4
9	East	Straits of Dardanelles	Turkey	NC	S (Su)	No	Log	M		1	Zak	
10	East	Aegean	Greece	NC	S (Su)	No	Log	F		2	Zak; ?Kyp	1, 4
11	East	Aegean	Greece	NC	Y-R	No	Log	M		1	Zak	
12	East	Aegean	Greece	NC	Y-R	No	Log	F		2	Zak; ?Kyp	1, 4
13	Central	Ionian	Greece	NC	Y-R	No	Log	M		1	Zak	
14	Central	Ionian	Greece	NC	Y-R	No	Log	F		1	Zak	1,3
15	Central	Ionian	Greece	O	Y-R	No	Log	M		1	Zak	
16	Central	Ionian	Greece	O	Y-R	**Yes**	Log	M		1	Zak	
17	Central	Ionian	Greece	NC	Y-R	No	Log	M		~3	Zak; Kef, Unkown	1,5,10
18	Central	Ionian	Greece	NC	Y-R	No	Log	M / F		2	Zak; ?Kyp	1, 4
19	Central	Ionian	Greece	NC	Y-R	**Yes**	Log	F		1	Zak	
20	Central	Amvrakikos	Greece	NC	Y-R	**Yes**	Log / Gre	M /F /Juv	Juv	~3	Zak;? Kyp; Syr, Unknown	1, 3, 4, 5,1 1
21	Central	Adriatic	Greece	NC	Y-R	No	Log	M / F /Juv		1	Zak	1,2
22	Central	Adriatic	Albania	O	Y-R	No	Log	M / Juv		1	Zak	1,2
23	Central	Adriatic	Albania	NC	Y-R	No	Log	M / F / Juv		~2	Zak; Unknown	1,2,7
24	Central	Adriatic	Croatia	NC/NO	Y-R	**Yes**	Log / ?Gre	F / Juv	Juv	2	Zak; Kyp	1,2,3,4,12
25	Central	Adriatic	Croatia	NO	S (Su)	**Yes**	Log	M / F / Juv		2	Zak; Kyp	1,2,3,4,14
26	Central	Adriatic	Croatia	NC	S (Su)	**Yes**	Log	F / Juv		3	Zak; Kyp; Lak, Cyp; Turk	1,2,3,4 ,12,14
27	Central	Adriatic	Slovenia	NO	S (Su)	**Yes**	Log	M / F / Juv		1	Zak	1,2,3, 14
28	Central	Adriatic	Italy	NO	S (Su)	No	Log	F / Juv		1	Zak	1,2,3,4
29	Central	Adriatic	Italy	NC	S (Su)	No	Log /? Gre	F / Juv	Juv	1	Zak	1,2,3,12,13
30	Central	Adriatic	Italy	NC	S (Su)	No	Log / ?Gre	F / Juv	Juv	1	Zak	1,2,3,12
31	Central	Adriatic	Italy	NC	S (Su)	No	Log / ?Gre	F / Juv	Juv	1	Zak	1,2,12
32	Central	Adriatic	Italy	NC	Y-R	**Yes**	Log / ?Gre	F / Juv	Juv	1	Zak	1,2,3,12

CONCLUSIONS

Conclusions (brief)

This general overview stresses the importance of assimilating all available information on the distribution of sea turtles at breeding, foraging, developmental sites and how these areas are connected to understand the distribution patterns of sea turtles at the size class, population and species level to select key areas for protection. Parallel mitigation strategies are required to build the resilience of existing populations.

Conclusions (extended)

Due to the importance of both breeding and foraging grounds, parallel mitigation strategies are required to build the resilience of existing populations; such as regulating coastal development at nesting areas and fishery bycatch at foraging areas. However, foraging grounds tend to be broadly dispersed over a range of 0 to 2000 km from the breeding areas, complicating the identification of key foraging grounds for protection. As a starting point, it is essential to assimilate all research material on sea turtles (e.g. satellite tracking, stable isotope, genetic, strandings aerial surveys) to make a comprehensive overview of the distribution of different species, populations and size classes (Figure 8, represents a starting point).

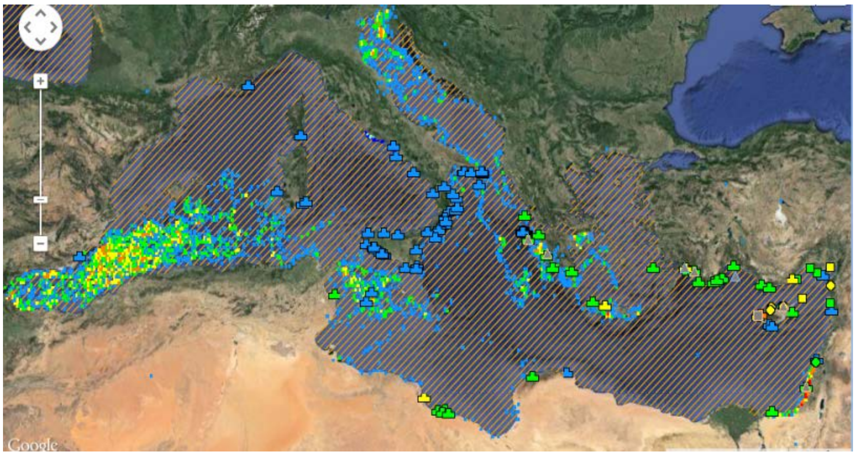

Figure 8: Image from OBIS-SEAMAP: State of the World's Sea Turtle (SWOT). The image presents an example for sea turtles, showing satellite tracking data (dots), nesting sites and genetic sampling sites (shapes) that have been voluntarily submitted to the platform by data holders. Many datasets are missing, including several known nesting sites and a considerable amount of satellite tracking from the eastern, central and western Mediterranean (over 195 routes have been published, and many remain unpublished; Luschi & Casale 2014, Italian Journal of Zoology 81(4): 478-495). The distribution range (lines) of the three sea turtles species present in the Mediterranean encompasses the entire basin. Big gaps exist; yet, this is the only information currently available in the form of an online database and mapping application.

Nesting sites

In general, knowledge about currently used nesting sites of both loggerhead and green turtles in the Mediterranean is good. However, all potential nesting beaches need to be surveyed throughout the Mediterranean to fill gaps in current knowledge (e.g. nesting in north Africa, particularly Libya). This could be done via traditional survey methods, but also by aerial surveys (plane or drone) at the peak period of nesting (July), or even by high resolution satellite imagery, which is becoming commercially available.

Existing stable nesting beaches should be afforded full protection, in parallel to collecting key information on why turtles use them, including geographic location, beach structure, sand composition, sand temperature ranges, coastal sea temperatures etc. In parallel, sporadically used beaches should be monitored at regular intervals (i.e. every 5 years or so), to identify changes in use over time, and pinpoint sites where use changes from sporadic to stable. Again, all these sites should be assessed with respect to geographic location, beach structure, sand composition, sand temperature ranges, coastal sea temperatures etc. on the ground, which will help with identifying future viable beaches for nesting. Ideally, all sandy beaches, whether used or not should be subject to the same analyses, to identify any beaches that might be used in the future by turtles, due to range shifts under climate change, which will alter sand temperatures on beaches and in the water, as well as causing sea level rise, which will alter the viability of current beaches, forcing turtles to shift to alternative sites. In this way, future beaches of importance can be detected and protected from certain human activities.

Foraging (adult and developmental) and wintering sites

It is necessary to determine how to focus protection effort of foraging (adult and developmental) habitats, i.e.

Protect easy-to-define areas where high numbers of turtles aggregate from different populations and size classes

Protect protracted areas of coastline where 10-20 individuals may aggregate at intervals from different populations and size classes, but amounting to representative numbers over a large expanse.

The former is easier to design and protect, but the latter may be more representative of sea turtle habitat use in the Mediterranean. The latter is more at risk of loss too, as management studies for the development of e.g. marinas and hotels would assume that the presence of just 10-20 turtles was insignificant; however, if this action was repeated independently across multiple sites, one or more turtle populations could become impacted.

Thus, it is essential to determine how developmental, foraging and wintering grounds are distributed throughout the Mediterranean, as well as the numbers of turtles of different size classes and from different populations that frequent these sites, including the seasonality of use and connectivity across sites. Only with this information can we make informed decisions about which sites/coastal tracts to protect that incorporate the greatest size class and genetic diversity.

Thus, aerial (plane or drone) surveys are recommended to delineate areas used by sea turtles in marine coastal areas, along with seasonal changes in use, by monitoring these sites at 2-4 month intervals. Following this initial assessment, representative sites should be selected and sampled on the ground (i.e. boat based surveys) to delineate species, size classes and collect genetic samples to determine the extent of population mixing. Where possible, stable isotope and tracking studies should be conducted (including PIT tagging) to establish the connectivity among sites.

Key messages

This general overview stresses the importance of assimilating all information on the distribution of green and loggerhead sea turtles in the Mediterranean at breeding, foraging, developmental and wintering grounds to understand how these areas are connected when considering different size classes, populations and species for effective conservation management. Parallel mitigation strategies are required to build the resilience of existing populations.

Knowledge gaps

- Location of all breeding/nesting sites
- Location of all wintering, feeding, developmental sites of adult males, females, juveniles
- Connectivity among the various sites in the Mediterranean
- Vulnerability/resilience of these sites in relation to physical pressures
- Analysis of pressure/impact relationships for these sites and definition of qualitative GES
- Identification of ex -tent (area) baselines for each site and the habitats they encompass
- Appropriate assessment scales
- Monitor and assess the impacts of climate change
- Assimilation of all research material on sea turtles (e.g. satellite tracking, stable isotope, genetic, strandings aerial surveys) in a single database

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Ecological Objective 1 (EO1): Biodiversity

Note: The maps and illustrations are provisional

EO1: Common Indicator 3: Species distributional range (Related to Seabirds)

GENERAL

Reporter:	SPA/RAC
Geographical scale of the assessment:	Regional, Mediterranean Sea
Contributing countries:	
Mid-Term Strategy (MTS) Core Theme	2-Biodiversity and Ecosystems
Ecological Objective	EO1: Biological diversity is maintained or enhanced. The quality and occurrence of coastal and marine habitats and the distribution and abundance of coastal and marine species are in line with prevailing physiographic, hydrographic, geographic and climatic conditions.
IMAP Common Indicator	Common Indicator 3 (CI3): Species distributional range (related to seabirds)
Indicator Assessment Factsheet Code	EO1CI3

RATIONALE/METHODS

Background (short)

The distribution range of a species is the first step to assess its status and potential changes over time. It is also the simplest indicator, but that does not mean that reliable information is available for the whole region. Overall, Mediterranean seabirds have reduced their distribution range across historical times, although there are few reliable sources of data to make a proper assessment of trends. The following factors are considered the main responsible for the changes in distribution range: (1) the introduction of terrestrial predators in islands; (2) human coastal development; (3) human persecution and harvesting (not relevant anymore in most countries). Other relevant pressures to consider are overfishing and climate change, particularly from now on.

Processes driving changes in distribution range can work both at local and regional level. For a local level approach, the protection of breeding sites is a first step to ensure the maintenance of the breeding range of seabirds. However, it is important to complement these efforts on land with the protection of the corresponding key habitats at sea. However, local measures might not suffice to fight pressures at sub-regional, regional or global level. Ensuring a healthy marine ecosystem requires sectorial policies adopting an ecosystem-based approach.

Background (extended)

Background and rationale for the indicator, key pressures and drivers

Understanding the distribution range of a species is the first step to assess its status and potential changes over time. It is also the simplest indicator, but that does not mean that reliable information is available for the whole region.

Overall, Mediterranean seabirds have reduced their distribution range across historical times, although there are few reliable sources of data to make a proper assessment of trends. The following factors are considered the main responsible for the changes in distribution range:

- The introduction of terrestrial predators in islands has likely shaped the current distribution of many seabirds, particularly the shearwaters and the storm-petrel, restricting those to inaccessible areas of the main islands and to remote islets. Even so, in many cases these seabirds coexist with terrestrial predators (Ruffino et al. 2009), often resulting in population declining trends.
- Human development has led to the degradation and destruction of coastal habitats across the Mediterranean basin. Birds breeding in wetlands have been likely the most affected, due to the systematic drying of these habitats. Likewise, birds breeding in beaches and dunes have also experienced a severe decline of available habitat in good condition and free of disturbances, particularly with the boom of tourism in the last century. The latter are more acute in the northern side of the region, but the whole basin is affected.
- Human persecution and harvesting. This is a threat that has been largely reduced in the last century, particularly in the north, but might have been a major source of change in past centuries, and can be still a threat in some areas.

Other relevant pressures to consider are overfishing and climate change, but these might have a major influence on the distribution patterns of seabirds at sea, while their role at shaping breeding distributions is not clear within the Mediterranean region. Species with limited foraging ranges, such as the Mediterranean shag and the terns are the most prone to suffer from these alterations, as they cannot buffer the effects of local alterations of their (breeding) foraging grounds by switching to other (more distant) areas. On this regard, terns (and Audouin’s gull) are adapted to cope with fluctuations on prey availability by changing their breeding location between years, if necessary.

Even if there are no proven changes in seabirds breeding distribution ranges due to food depletion and/or climate change (or, more widely, environmental change), they are likely to occur in the near future if the levels of fish overexploitation and environment degradation are maintained through time. Nevertheless, lacks of accurate data make it difficult to assess this type of changes, and it is necessary to set in place adequate monitoring programmes across the basin to make possible a proper assessment in the future.

Policy Context and Targets

Processes driving changes in distribution range can work both at local and regional level. For a local level approach, the protection of breeding sites is a first step to ensure the maintenance of the breeding range of seabirds. However, it is important to complement these efforts on land with the protection of the corresponding key habitats at sea. On this regard, the Mediterranean is in the process of building a representative and coherent network of Marine Protected Areas (e.g. Gabrié *et al*. 2012), that under proper management strategies will surely benefit the maintenance of the remaining seabird breeding populations, plus other visiting species. Moreover, promoting the protection of former/potential breeding sites, or even their restoration, could help recovering part of the lost distribution range for some species, through re-colonisation processes.

However, local measures might not suffice to fight pressures at sub-regional, regional or global level. Ensuring a healthy marine ecosystem requires sectorial policies adopting an ecosystem-based approach. Fisheries deserve particular attention, given the level of overexploitation of Mediterranean fish stocks. Current commitments by the General Fisheries Commission for the Mediterranean are a promising perspective, as well as the efforts of the EU Common Fisheries Policy in the European countries, but there is a long way ahead. Other issues to address are pollution (UNEP/MAP 2015), river discharges (to ensure marine productivity), and climate/environmental change, which require an even wider approach (UNEP/MAP 2016).

Assessment methods

The breeding distribution range of a seabird species may be assessed using a wide diversity of methodological approaches, most of them quite simple. For the most visible species, such as gulls and terns, simple visual inspection of the most suitable habitat might suffice, as these birds use open nests and have daily activity at the colony. Shags might be more difficult to confirm as breeders, as they often breed sparsely along coastal cliffs and islets and use crevices or caves that may be difficult to detect. In such cases, specific surveys from coastal vantage points or (even better) boats might be useful to confirm their breeding in some sites. For the secretive shearwaters, that breed in crevices and burrows and attend the nest at night, a combination of methods may be useful: vocalizations in suitable areas and the formation of rafts near the coast are indicators of breeding nearby, although other proofs are required to confirm breeding by direct prospection of the area and the location of occupied nests.

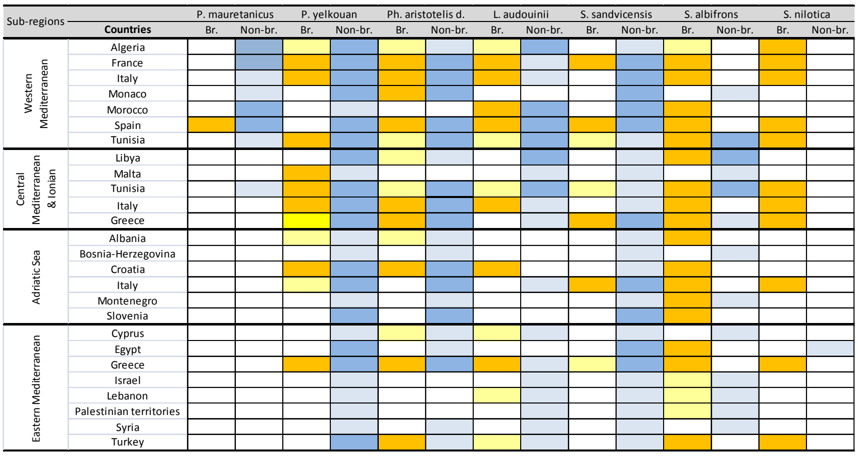
Assessing the distribution range of a species at sea may be trickier, as many areas remain largely un-prospected. A combination of coastal based counts at sea and boat surveys (e.g. using ferry lines or oceanographic cruises) might provide useful information. On the other hand, tracking technologies nowadays represent a highly valuable tool to understand the patterns of distribution of seabirds across their annual cycle. The latter are only limited by the type of device used (revealing different information for different time periods and at different precision), as well as by the age-groups tracked (most often adults) and the colonies of origin. Finally, citizen-science platforms are increasing and might provide very valuable, opportunistic information to refine seabird distribution patterns.

RESULTS

Results and Status, including trends (brief)

A summary of the presence/absence of the species selected for monitoring is shown in Table 1, per sub-region and country. As with other biodiversity components, seabirds show a higher diversity to the west and north of the Mediterranean basin (cf. Coll et al. 2008). This general pattern is in agreement with the marine productivity patterns in the region, but might also be related to other factors, such as better knowledge/monitoring programmes in the north and west. Species that breed in open nests, such as gulls and terns, seem to be more widely distributed, particularly the little tern. On the other hand, burrowing/crevice breeding species such as the shearwaters tend to concentrate in the north and west. These species might find more suitable habitat in these areas, but also the difficulty of finding their nests and their secretive behaviour near the colonies might have left them overlooked in some low-prospected areas.

Table: *Presence of the different seabird species selected for monitoring per sub-region and country. Orange represents breeding and blue non-breeding (mainly winter, but this can also reflect the presence of birds during the breeding season and/or migration in countries where they do not breed). Dark colour is for regular and well established species, while light colour is for scarce species. Question marks are introduced when the information deserves further corroboration or refinement.*



Results and Status, including trends (extended)

CONCLUSIONS

Conclusions (brief)

As insinuated above, the southeast to northwest increasing diversity gradient might be partly influenced by prospection/monitoring effort. For many eastern and southern countries, as well as some Adriatic countries, the information on seabird breeding populations or occurrence at sea is patchy or completely lacking. This might be partly because the birds are actually rare or absent there, but could also be related with lack of data. Particularly little information is available for Algeria, Egypt, Israel, Lebanon, Syria, Cyprus and Turkey, as well as Albania. There is no information from Bosnia-Herzegovina, but this country has extremely limited coastal area, and most likely has no relevant seabird breeding populations. Information from Libya is also patchy, and focuses on terns.

The lack of information is not limited to the above countries, however. Most of the remaining countries have some important gaps, particularly at assessing population sizes, but also at properly inventorying all breeding colonies present in their territories, particularly in the case of the the shearwaters. For instance, a colony of over 1,500 Yelkouan shearwaters was recently found in Greece, near Athens, although this area is reasonably well prospected. Likewise, the breeding of the storm-petrel in the Aegean Sea was not confirmed until a few years ago.

Conclusions (extended)

Key messages

Despite breeding distribution patterns are relatively easy to assess, information is patchy and often lacking. A southeast to northwest increasing diversity gradient has been observed, in agreement with productivity patterns in the region, but this might be confounded by larger data gaps in the southernmost and easternmost countries.

Knowledge gaps

Information on gulls and terns seems reasonable good, although some southern and eastern countries might need updating their surveys. For the shearwaters it is more difficult to find information for these same countries, which might be a combination of both small/inexistent breeding populations and lack of prospection.

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Ecological Objective 1 (EO1): Biodiversity

Note: The maps and illustrations are provisional

EO1: Common Indicator 4: Population abundance of selected species (related to marine mammals)

GENERAL

Reporter: SPA/RAC

Geographical scale of the assessment: Regional, Mediterranean Sea

Contributing countries:

Mid-Term Strategy (MTS) Core Theme 2-Biodiversity and Ecosystems

Ecological Objective	EO1: Biological diversity is maintained or enhanced. The quality and occurrence of coastal and marine habitats and the distribution and abundance of coastal and marine species are in line with prevailing physiographic, hydrographic, geographic and climatic conditions.
IMAP Common Indicator	Common Indicator 4 (CI4): Population abundance of selected species (related to marine mammals)

Indicator Assessment Factsheet Code EO1CI4

RATIONALE/METHODS

Background (short)

Robust information on population parameters such as abundance and density is pivotal to inform conservation and management at the diverse temporal and spatial scale. They are also relevant to ensure that conservation measures, mitigation actions and management measures that are already in place are effective by providing a meter to evaluate their effectiveness (e.g. by evaluating population trends). Cetaceans in the Mediterranean Sea are protected under statutory regulations (e.g. the Habitat Directive and the Marine Strategy Framework Directive) and by several international agreements such as ACCOBAMS among the others, which not only dictate to some extent the priorities in terms of conservation but also clearly state the details of monitoring activities that should be in place. By consequence, this information and the process to gather it are necessary to abide national and international regulations.

Background (extended)

Background and rationale for the indicator, key pressures and drivers

Population parameters such as abundance and density are essential components of the provision of science-based advice on conservation and management issues, both in terms of determining priorities for action and evaluating the success or otherwise of those actions. Such information is also often necessary to guarantee compliance with regulations at the national and international level.

By definition, population abundance refers to the total number of individuals of a selected species in a specific area in a given timeframe; while with density we refer to the number of animals per surface unit (e.g. number of animals per km^2). Monitoring density and abundance of cetaceans is particularly challenging and expensive. Cetaceans generally occur in low densities and are highly mobile; they are difficult to spot and to follow at sea, even during good survey conditions, because they typically only show part of their head, back and dorsal fin while surfacing and spend the majority of their time underwater.

In order to be able to assess potential trends over time, it is crucial to plan systematic monitoring programs, which are crucial components of any conservation strategy; unfortunately such approach is neglected in many regions, including much of the Mediterranean. Monitoring at the regional level may require data collection throughout the year, to better understand seasonal patterns in distribution, whereas monitoring at the population level would mainly address inter-annual changes.

Changes in density and abundance in time and space - known as population trends – are usually caused by anthropogenic pressures and/or natural fluctuations, environmental dynamics and climate changes. It is strongly suggested that marine mammals' abundance is monitored systematically at regular intervals to suggest and apply effective conservation measures and assess /review the effectiveness of measures already in place.

This indicator aims at providing robust and quantitative indications on population abundance and density estimates for marine mammal species living in the Mediterranean Sea.

Policy Context and Targets

The Mediterranean cetaceans' populations are protected under the framework of ACCOBAMS (Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area), under the auspices of the UNEP Convention on the Conservation of Migratory Species of Wild Animals (UNEP/CMS). The Pelagos Sanctuary is a large marine protected area established by France, Italy and Monaco in the Corso-Ligurian-Provençal Basin and the Tyrrhenian Sea, where most cetacean species are regularly observed and benefit from its conservation regime.

All cetacean species in the Mediterranean Sea are also protected under the Annex II of the SPA-BD Protocol of the Barcelona Convention; under the Appendix I of the Bern Convention; under the Annex II of the Washington Convention (CITES); and under the Appendix II of the Bonn Convention (CMS).

The short-beaked common dolphin, the sperm whale and the Cuvier's beaked whale and the monk seal are also listed under the Appendix I of the Bonn Convention (CMS). The common bottle dolphin, the harbor porpoise and the monk seal are also listed under the Annex II of the EU Habitats Directive.

Assessment methods

Visual aerial and vessel surveys

Before conducting any type of monitoring of animal populations aimed at assessing the species abundance and density, it is essential to define the

main objectives of the programme, alongside with the collection of relevant information on the target study area and the species presence and occurrence. These elements are critical to choose the right data collection methodology, survey design approach and analytical framework. Visual aerial- and vessel-based surveys, as well as acoustic surveys from both static platforms and vessels, have proven to be successful to assess the density and abundance of many species, providing robust estimates. Monitoring at the regional level may require data collection throughout the year, to better understand seasonal patterns in distribution, whereas monitoring at the population level would mainly address inter-annual fluctuations.

We can identify are at least five potential approaches to be undertaken when monitoring cetaceans:

1. Visual surveys from ship, aircraft or land observation platforms (LOP).
2. PAM carried out during ship surveys with towed hydrophones.
3. PAM performed by means of static acoustic monitoring, e.g. using T-PODs or EARS.
4. Photo-identification and mark-recapture analysis.
5. A combination of all or some of the above methodologies.

Visual aerial and both acoustic and visual surveys offer several advantages, but present some limitation depending on the target species. Therefore, when deciding which monitoring method to implement, it is pivotal to consider the limitations of each approach and compare the different methodologies. In general, surveys from ship or aircraft have a low temporal resolution. Ship surveys may have bias due to responsive movements of animals, stationary acoustic systems often have low spatial resolution and are inherently problematic from a logistical point of view in terms of deployment of instruments. Photographic identification relies on visual differences between individuals and generally span over large time windows to obtain robust results. Finally, telemetry studies typically only allows small samples resulting in much inter-individual variation.

Line transect distance sampling, from both aircraft and ships, is a well-established approach used to estimate abundance and assess density for several species of cetaceans and mega-vertebrates. In line transect distance sampling, a survey area is defined and surveyed along pre-determined transects. The distance to each detected animal is measured and consequently used to obtain a detection function, from which an estimate of the effective width of the strip that has been searched can be calculated. Abundance is then calculated by extrapolating estimated density in the sampled strips to the entire survey area. This approach, despite being relatively easy to implement, relays on strong assumptions, of which one of the most significant is the assumption that all animals on the track line are detected, ie. probability to detect an animal or a group of animals is maximum ($g(0)=1$). This assumption is often invalidated by the so called perception and availability biases where the former implies that animals are not available to be seen during the period it is within visual range (e.g. the animal is underwater), and the latter implies that an observer misses an animal that is available at the surface. Both biases negatively affect abundance estimates. Therefore, estimates that do not take into account possible correction factors for these biases, represent underestimates of the real abundance. Both availability and perception biases vary with species, being generally small for large animals and larger for small sized species. Both biases can be overcome, and estimates corrected using a double platform approach, where the use of two independent platforms or sets of observers would allow for the estimation of the proportion of animals missed on the transect line, in conjunction with information on diving behaviour of the tagged species.

Relative abundance uncorrected for availability and/or perception biases may be sufficient for detecting population trends, reducing surveys cost considerably and may be used to monitoring the status of the target population between large-scale absolute abundance surveys based on larger budgets. It is important to underline that for these surveys correction factors for the availability and perception biases can be used *a posteriori* when available to obtain absolute estimates.

Passive Acoustic Monitoring

Cetaceans, in particular odontocetes, are highly vocal animals that can produce vocalisations for over the 80% of the time (e.g. the sperm whale). The monitoring of these sounds allows, hence, for the collection of information on spatial and temporal habitat use, as well as estimation of relative density. The collection of acoustic data for cetaceans has some significant advantages over visual methods. In fact, acoustic methods can be automated, data can be collected 24-hrs a day over long period of time, data collection is not dependent on observer's skills, is less sensitive to weather conditions and can detect the presence of diving animals not available for visual observations. The disadvantages of PAM methods are that they rely on animals making sounds within a useful detection range and are identifiable to the species level.

Furthermore, with exception of some species such as the sperm whale and some Ziphiidae, methods to estimate abundance are not well established yet.

Photo-identification

Photo-identification is a widely used technique in cetacean research. It can be used to obtain estimates of abundance and population parameters e.g. survival and calving rate for virtually oll the species of cetaceans and it has been in use since the early 170s to monitor common bottlenose dolphins and killer whales since the 1970s. The technique uses good quality photos of animals' body parts that constitute unique recognizable and permanent markings.

Using photo-identification, it is sometimes possible to census the whole population when all individuals can be encountered at any given time in an area, all are well marked and no individuals seem to be moving in or out of the population. This is however unusual and has only been accomplished for a few populations of bottlenose dolphin, e.g. Sado Estuary, Portugal and Doubtful

Sound, New Zealand, and for killer whales off Vancouver Island. More commonly, mark-recapture models must be applied to photo-identification data to estimate abundance (rather than a census the whole population) for specific areas that populations or part of populations occupy during one or more seasons of the year. Information on the proportion of the population possessing recognisable markings is also required to allow estimation of population size.

RESULTS

Results and Status, including trends (brief)

Results and Status, including trends (extended)

Mediterranean monk seal – Currently there are no population estimates for monk seals at the Mediterranean level; genetic analysis suggests that there may be two separate populations – genetically isolated – within the Basin, one in the Ionian Sea and one in the Aegean Sea. Previously listed as Critically Endangered by the IUCN Red List, the Mediterranean monk seal has been recently reassessed as Endangered, following an observed increase in individuals at localized breeding sites.

Fin whale – Comprehensive basin-wide estimates of density and abundance are lacking for all the species of cetaceans across the Mediterranean Region. Nonetheless, these parameters have been previously obtained for fin whales over large portions of the Central and Western Mediterranean Basin, highlighting seasonal, annual and geographical patterns. Line-transect surveys in 1991 yielded fin whale estimates in excess of 3,500 individuals over a large portion of the western Mediterranean (Forcada et al., 1996), where most of the basin's fin whales are known to live. Panigada et al. (2011, 2017) reviewed the existing density and abundance estimates in the Central and Western parts of the Basin and reported on a series of aerial surveys conducted in the Pelagos Sanctuary and in the seas around Italy, providing evidence of declining numbers in density and abundance since the 1990's surveys. These recent estimates provided values of 330 fin whales in July 2010 in the Pelagos Sanctuary area. Panigada and colleagues also reported on density and abundance estimates on a wider area, including the Pelagos Sanctuary, the Central Tyrrhenian Sea and portion of the sea west of Sardinia, with an estimated abundance of 665 fin whales in summer 2010.

Sperm whale – There are no robust information on sperm whale population estimates for the entire Mediterranean Sea, while there are estimates obtained through photo-identification, line transect acoustic studies in localized specific areas. Given the values obtained in some Mediterranean areas (e.g. the Hellenic Trench, the Balearic islands, the Central Tyrrhenian Sea and the Ionian Sea), it has been suggested that the entire population may be around a few thousand animals, with possibly less than 2500 animals sexually mature and in a reproductive status.

Cuvier's beaked whale – No density or abundance estimates for this species are available for the whole Mediterranean Sea. The only available robust sub-regional estimates come from line-transect surveys in the Alborán Sea and from photo-identification studies in the Ligurian Sea. The most recent corrected estimates number 429 individuals (CV=0.22) from the Alborán Sea and around 100 individuals (CV=0.10) in the Ligurian Sea. The lack of other estimates throughout the whole Mediterranean Sea precludes any inference on the numerical consistency of the entire population.

Short-beaked common dolphin – Common dolphins used to be very common in the Mediterranean Sea, and during the 20th century the species was subject to a large decline, drastically reducing its population levels. No population abundance estimates are available for the Mediterranean Sea, apart from localized areas, such as for example the Gulf of Corinth and the Alborán Sea, thus making it difficult to assess the entire population.

Long-finned pilot whale – Two populations have been described in the Mediterranean Sea, one living in the Strait of Gibraltar and one in the area between the Alborán and the Ligurian Seas. The Gibraltar population has been estimated at less than 250 individuals, while there are no estimated for the other population, which seems to be declining.

Risso's dolphin – There are no population estimates for Risso's dolphin in the whole Mediterranean Sea, with information coming only from localized areas. Distance sampling was used to estimate winter and summer abundance of Risso's dolphins in the north-western Mediterranean (N=2550 (95% CI: 849–7658) in winter and N=1783 (95% CI: 849–7658) in summer). Systematic photo-identification studies allowed to estimate, through mark-recapture methods, an average population of about 100 individuals (95% CI: 60–220) summering in the Ligurian Sea.

Killer whale – The most recent abundance estimate for this species is 39 individuals in 2011, representing one of the lowest levels compared to other killer whales population elsewhere in the world.

Striped dolphin – Comprehensive basin-wide estimates of density and abundance are lacking for this species across the Mediterranean Region; nonetheless, ship and aerial surveys have provided abundance and density values for striped dolphins over large portions of the Central and Western Mediterranean Basin, highlighting seasonal, annual and geographical patterns. The overall higher density, and hence abundance, was observed in the North-Western Mediterranean Sea and estimated at

95,000 individuals (CV=0.11), with values clearly decreasing during the winter months and towards the Southern and Eastern sectors, reflects the general knowledge on the ecology of these species, described as the most abundant one in the Basin. Several estimates of abundance and density for this species have been provided for many areas of the Mediterranean, especially in the west, but no baseline data are available for the whole basin.

Rough-toothed dolphin – The very small number of authenticated records over the last 20 years (12 sightings and 11 strandings/bycatch) render any population estimate impossible and statistically unacceptable.

Common bottlenose dolphin – There are no density and abundance estimates for the entire Mediterranean Sea, with the only statistically robust estimates obtained from localized, regional research programmes in the Alborán Sea, the Balearic area, the Ligurian Sea, the Tunisian Plateau, the Northern Adriatic, Western Greece and Israel in the Levantine Basin. The IUCN assessment for the Mediterranean population implies that less than 10,000 common bottlenose dolphins are present in the Basin.

Harbour porpoise – This cetacean is not regularly present in the Mediterranean basin except in the Aegean Sea, where individuals from the Black Sea subspecies are occasionally observed and in the Alborán Sea, where individuals from the North Atlantic Ocean are rarely seen. No density and abundance estimates are available.

CONCLUSIONS

Conclusions (brief)

The Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS) has been working for several years on defining an exhaustive program for estimating abundance of cetaceans and assessing their distribution and habitat preferences in the Black Sea, Mediterranean Sea and the adjacent waters of the Atlantic (the "ACCOBAMS Survey Initiative"). This initiative consists in a synoptic survey to be carried out in a short period of time across the whole Agreement area and it will combine visual survey methods (boat- and ship-based surveys) and passive acoustic monitoring (PAM).
Some of the cetaceans species present in the Mediterranean Sea are migratory species, whit habitat ranges extending over wide areas; it is therefore highly recommended to monitor these species at regional or sub-regional scales for the assessment of their population abundance. Priority should be given to the less known areas, using online data sources, such as Obis Sea Map and published data and reports as sources of information.
There is also general consensus among the scientific community that long-term systematic monitoring programmes, using techniques such as the photo-identification, provide robust and crucial data that can be used in assessing abundance at sub-regional levels and inform local conservation and mitigation measures. Establishing international collaborations between different research groups, merging existing data-sets allows performing robust analysis and estimating population parameters at larger scales.

Conclusions (extended)

Key messages

Effort should be dedicated to provide density and abundance estimates at the Mediterranean level, with synoptic surveys, such as that currently ongoing with ACCOBAMS.

The conservation priorities listed by the European Directives and the Ecosystem Approach should be implemented.

Knowledge gaps

Gaps still exist on baseline information such as abundance and density for many species of cetaceans occurring in the Mediterranean Sea, especially in those sectors where research is carried out on limited resources and not systematically. Even though for some species such as the striped dolphin and the fin whale estimates have been obtained for a large portion of the Basin, for none of the species there are available estimates at the regional scale. The lack of these baseline critical information is therefore detrimental for conservation, slowing down the identification of potential and actual threats, the assessment of their effect on populations and eventually the evaluation of trends and the triggering of mitigation and conservation measures.

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Ecological Objective 1 (EO1): Biodiversity

Note: The maps and illustrations are provisional

EO1: Common Indicator 4: Population abundance of selected species (related to marine turtles)

GENERAL

Reporter: SPA/RAC

Geographical scale of the assessment: Regional, Mediterranean Sea

Contributing countries:

Mid-Term Strategy (MTS) Core Theme 2-Biodiversity and Ecosystems

Ecological Objective EO1: Biological diversity is maintained or enhanced. The quality and occurrence of coastal and marine habitats and the distribution and abundance of coastal and marine species are in line with prevailing physiographic, hydrographic, geographic and climatic conditions.

IMAP Common Indicator Common Indicator 4 (CI4): Population abundance of selected species (related to marine turtles)

Indicator Assessment Factsheet Code EO1CI4

RATIONALE/METHODS

Background (short)

This assessment presents a brief overview of the known abundance of loggerhead and green sea turtles at breeding, foraging and wintering grounds, based on published data, to determine what knowledge gaps need to be filled to realise the objective of this indicator. The objective of this indicator is to determine the population status of selected species by medium-long term monitoring to obtain population trends for these species. This objective requires a census to be conducted in breeding, migratory, wintering, developmental and feeding areas.

Background (extended)

Background and rationale

Measurements of biological diversity are often used as indicators of ecosystem functioning, as several components of biological diversity define ecosystem functioning, including richness and variety, distribution and abundance. Abundance is a parameter of population demographics, and is critical for determining the growth or decline of a population. The objective of this indicator is to determine the population status of selected species by medium-long term monitoring to obtain population trends for these species. This objective requires a census to be conducted in breeding, migratory, wintering, developmental and feeding areas.

Effective conservation planning requires reliable data on wildlife population dynamics or demography (e.g. population size and growth, recruitment and mortality rates, reproductive success and longevity) to guide management effectively (Dulvy et al. 2003; Crick 2004). However, it is not possible to obtain such data for many species, especially in the marine environment, limiting our ability to infer and mitigate actual risks through targeted management. For sea turtles, nest numbers and/or counts of females are often used to infer population trends and associated extinction risk, because counts of individuals in the sea or when nesting on (often) remote beaches is tricky. Estimates of sea turtle abundance are obtained from foot patrols on nesting beaches counting either the number of females (usually during the peak 2-3 weeks of nesting) and/or their nests (Limpus 2005; Katselidis et al. 2013; Whiting et al. 2013, 2014; Pfaller et al. 2013; Hays et al. 2014). However, females may not be detected by foot patrols because they do not all initiate and end nesting at the same time and might not nest on the same beach or section of beach within or across seasons; consequently monitoring effort could fail to detect turtles or miss them altogether on unpatrolled beaches. Consequently, it is assumed that females lay two (Broderick et al. 2001), three (Zbinden et al. 2007; Schofield et al 2013) or possibly as many as 5 or more clutches (Zbinden et al. 2007), depending on the beach being assessed in the Mediterranean. High environmental variability leads to overestimates of female population size in warmer years and under-estimates in cooler years (Hays et al. 2002). This is because sea turtles are ectotherms, with environmental conditions, such as sea temperature and forage resource availability, influencing the seasonality and timing of reproduction (Hays et al. 2002; Broderick et al. 2001, 2003; Fuentes et al. 2011; Schofield et al. 2009; Hamann et al. 2010; Limpus 2005). As a result, concerns have been raised about the reliability of using nest counts of females alone to infer sea turtle population trends (Pfaller et al 2013; Whiting et al. 2013, 2014).

Furthermore, nest counts cannot inform us about the number of adult males, the number of juveniles being recruited into the adult population, the longevity of nesting by individuals or mortality rates. Information is lacking on these components of sea turtle populations because males and juveniles remain in the water. Because turtles do not surface regularly, along with detection being difficult in low sea visibility of great sea depth conditions, a number of individuals are always missed from population surveys, requiring the use of certain statistical tools (such as distance sampling, Buckland et al. 1993) to be implemented to make up for the shortfall. Furthermore, for most populations the areas used by males and juveniles remain unknown (see Indicator 1). Yet, it is important to quantify the number of juveniles and males to guarantee successful recruitment into a population, as well as successful breeding activity to ensure population viability and health (i.e. genetic diversity, within Indicator 3) (Limpus 1993; Schofield et al. 2010; Demography Working Group 2015). This is because sea turtles exhibit temperature dependent sex determination, with the warming climate leading to heavily biased female production (Poloczanska et al., 2009; Katselidis et al. 2012; Saba et al., 2012). Therefore, we must quantify all of these parameters to understand sea turtle abundance trends and survival. Furthermore, factors impacting turtle population dynamics in the coming decades will not be detected from nest counts for another 30 to 50 years (Scott et al. 2011), because this is the generation time of this group and nest counts cannot predict how many juveniles are recruiting into the populations until they begin nesting themselves. This timeframe will likely be far too late to save many populations.

Gaps remain in assessing population abundance because it is not possible to survey all individuals in a turtle population either through in-water or beach-based surveys. It is therefore necessary to establish minimum information standards at key geographical sites to obtain reliable measures of population abundance of two selected species, taking into account all components of the population. To achieve this, first adequate knowledge about the distribution range of each species is required (Indicator 1). Monitoring effort should be long term and should cover all seasons to ensure that the information obtained is as complete as possible.

Key pressures and drivers

Both nesting and foraging areas of marine turtles are vulnerable to anthropogenic pressures in the Mediterranean Sea, including an increase in the exploitation of resources (including fisheries), use and degradation of habitats (including coastal development), pollution and climate change (UNEP/MAP/BLUE PLAN, 2009; Mazaris et al. 2009, 2014; Witt et al. 2011; Katselidis et al. 2012, 2013, 2014). These issues might reduce the resilience of this group of species, negatively impacting the ability of populations to recover (e.g. Mazaris et al. 2009, 2014; Witt et al. 2011; Katselidis et al. 2012, 2013, 2014). The risk of extinction is particularly high in the Mediterranean because the breeding populations of both loggerhead and green turtles in this basin are demographically distinct to other global populations (Laurent et al., 1998; Encalada et al., 1998), and might not be replenished.

The main threats to the survival of loggerhead and green turtles in the Mediterranean have been identified as incidental catch in fishing gear, collision with boats, and intentional killing (Casale & Margaritoulis 2010). Casale (2011) estimated that there are more than 132,000 incidental captures per year in the Mediterranean, of which more than 44,000 are predicted to be fatal, although very little is known about post-release mortality (Álvarez de Quevedo et al. 2013). Wallace et al. (2010, 2011) grouped all species of sea turtles globally into regional management units (RMUs), which are geographically distinct population segments, to determine the population status and threat level. These regional population units are used to assimilate biogeographical information (i.e. genetics, distribution, movement, demography) of sea turtle nesting sites, providing a spatial basis for assessing management challenges. A total of 58 RMUs were originally delineated for the seven sea turtle species. The Mediterranean contains 2 RMUs for loggerheads and 1 RMU for green turtles. These analyses showed that the Mediterranean has the highest average threats score out of all ocean basins, particularly for marine turtle bycatch (Wallace et al. 2011). However, compared to all RMUs globally, the Mediterranean also has the lowest average risk score (Wallace et al. 2011).

Other key threats to sea turtles in the Mediterranean include the destruction of nesting habitat for tourism and agriculture, beach erosion and pollution, direct exploitation, nest predation and climate change (Casale & Margaritoulis 2010; Mazaris et al. 2014; Katselidis et al. 2012, 2013, 2014). Coll et al. (2011) also identified critical areas of interaction between high biodiversity and threats for marine wildlife in the Mediterranean. Within this analysis, the authors delineated high risk areas to both species, with critical areas extending along most coasts, except the south to east coastline (from Tunisia to Turkey).

Policy Context and Targets

Similar to the Ecosystem Approach, the EU adopted the European Union Marine Strategy Framework Directive (MSFD) on 17 June 2008, which includes Good Environment Status (GES) definitions, Descriptors, Criteria, Indicators and Targets. In the Mediterranean region, the MSFD applies to EU member states. The aim of the MSFD is to protect more effectively the marine environment across Europe. In order to achieve GES by 2020, each EU Member State is required to develop a strategy for its marine waters (Marine Strategy). In addition, because the Directive follows an adaptive management approach, the Marine Strategies must be kept up-to-date and reviewed every 6 years.

The MSFD includes Descriptor 1: Biodiversity: “The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.” Assessment is required at several ecological levels: ecosystems, habitats and species. Among selected species are marine turtles and within this framework, each Member State that is within a marine turtle range, has submitted GES criteria, indicators, targets and a program to monitor them.

The MSFD will be complementary to, and provide the overarching framework for, a number of other key Directives and legislation at the European level. Also it calls to regional cooperation meaning "cooperation and coordination of activities between Member States and, whenever possible, third countries sharing the same marine region or sub-region, for the purpose of developing and implementing marine strategies" […] "thereby facilitating achievement of good environmental status in the marine region or sub-region concerned". Commission Decision 2010/477/EU sets out the MSFD's criteria and methodological standards and under Descriptor 1 includes criteria "1.1. Species distribution" and indicators "Distributional range (1.1.1)", "Distributional pattern within the latter, where appropriate (1.1.2)", and" Area covered by the species (for sessile/benthic species) (1.1.3)". At a country scale, Greece, Italy, Spain have selected targets for marine turtles; Cyprus and Slovenia mention marine turtles in their Initial assessment, but do not set targets (Milieu Ltd Consortium. 2014). Italy has an MSFD target to define the spatial distribution of loggerheads and their aggregation areas by assessing temporal and seasonal distribution differences for each aggregation area. Spain has an MSFD target to promote international cooperation on studies and monitoring of populations of groups with broad geographic distribution, contributing to a second target of maintaining positive or stable trends for the populations of key species, like marine turtles, and maintain commercially exploited species within safe biological limits. Obtaining census data on nesting beaches is included as an MSFD target in Greece. See UNEP/MAP 2016 for more details.

Assessment methods

This assessment presents a brief and general overview of the distributional range of two marine turtle species to identify existing knowledge and knowledge gaps for use in elaborating the national monitoring programmes for biodiversity. Published information by regional and national surveys and research projects were used to compile the review, but this overview does not present a comprehensive assessment of existing knowledge.

RESULTS

Results and Status, including trends (brief)

This general overview indicates that over 100 sites around the Mediterranean have scattered to stable (i.e. every year) nesting of loggerhead turtles. Greece and Turkey alone represent more than 75% of the nesting effort in the Mediterranean. Information on the size structure and abundance of individuals at oceanic and neritic marine areas has proven difficult. Most green turtle nests are laid in Turkey, Cyprus and Syria, with the remainder being found in Lebanon, Israel and Egypt. Information about the numbers of green turtles in various developmental, foraging and wintering habitats is limited.

Results and Status, including trends (extended)

Loggerhead sea turtles

Adult females at breeding areas

Over 100 sites around the Mediterranean have scattered to stable (i.e. every year) nesting (Halpin et al., 2009; Kot et al. 2013; SWOT, 2006a, 2006b, 2008, 2009, 2010, 2011, 2012), of which just 13 sites support more than 100 nests each (Casale & Margaritoulis 2010). Greece and Turkey alone represent more than 75% of the nesting effort in the Mediterranean; for details on nest numbers at the different sites in the Mediterranean see Casale & Margaritoulis (2010) and Figure 1. An average of 7200 nests are made per year across all sites (Casale & Margaritoulis 2010), which are estimated to be made by 2,280–2,787 females assuming 2 or 3 clutches per female (Broderick et al. 2002).

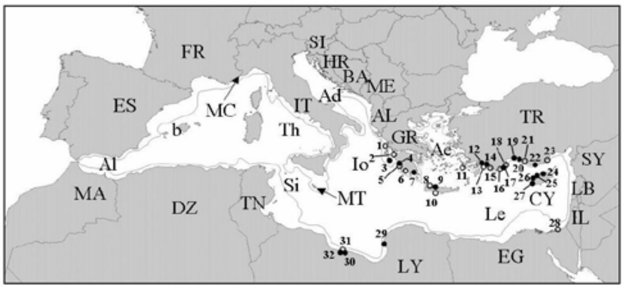


Figure 1. Map of the major loggerhead nesting sites in the Mediterranean (extracted from Casale & Margaritoulis); Major nesting sites (>50 nests/year) of Loggerheads in the Mediterranean. 1 Lefkas; 2 Kotychi; 3 Zakynthos; 4 Kyparissia; 5 beaches adjacent to Kyparissia town; 6 Koroni; 7 Lakonikos Bay; 8 Bay of Chania; 9 Rethymno; 10 Bay of Messara; 11 Kos; 12 Dalyan; 13 Dalaman; 14 Fethiye; 15 Patara; 16 Kale; 17 Finike-Kumluca; 18 Cirali; 19 Belek; 20 Kizilot 21 Demirtas; 22 Anamur; 23 Gosku Delta; 24 Alagadi; 25 Morphou Bay; 26 Chrysochou; 27 Lara/Toxeftra; 28 Areash; 20 Al-Mteafla; 30 Al-Ghbeba; 31 Al-thalateen; 32 Al-Arbaeen. Closed circles >100 nests/year; open circles 50-100 nests/year. Country codes: AL Albania; DZ Algeria; BA Bosnia and Hersegovina; HR Croatia; CY Cyprus; EG Egypt; FR France; GR Greece; IL Israel; IT Italy; LB Lebanon; LY Libya; MT Malta; MC Monaco; ME Montenegro; MA Morocco; SI Slovenia; ES Spain; SY Syria; TN Tunisia; TR Turkey; Ad Adriatic; Ae Aegean; Al Alboran Sea; Io Ionian; Le Levantine basin; Si Sicily Strait; Th Thyrrenian; b Balearic.

A recent IUCN analysis (Casale 2015) suggests that, when all Loggerhead nesting sites in the Mediterranean are considered together, the Mediterranean population size is relatively large, and is considered of Least Concern but conservation dependent under current IUCN Red List criteria. However, refer back to limitations of population analyses in the introductory section.

While tagging programs exist at some of the main nesting sites in the Mediterranean on nesting beaches, the loss of external flipper tags has proven problematic in maintaining long-term records of individuals (but see Stokes et al. 2014). However, these estimates of female numbers should be treated with caution because the Mediterranean represents one of the most temperate breeding regions of the world. Consequently, clutch frequency will vary from season to season depending on the prevailing weather conditions. For instance, in years with prevailing north winds, sea temperatures remain cooler, resulting in longer inter-nesting periods (Hays et al. 2002), and fewer clutches per individual, with the opposite trend being obtained in years with prevailing south winds. Even in tropical nesting sites, with relatively stable temperatures during breeding, clutch frequency can vary by as much as 3-12 clutches (Tucker 2010). Furthermore, the trophic status of foraging sites influences remigration frequency; thus, more turtles may return to breed in some years, again causing nest numbers to fluctuate (Broderick et al. 2001, 2002). Therefore, for programs that elucidate female numbers based on nest counts, the mean clutch frequency and breeding periodicity should be assessed at regular intervals by means of high resolution satellite tracking of individuals across years with different climatic conditions. Of note, knowledge about the numbers of females that nest on the beaches of the countries of North Africa remains limited and requires resolution.

Adult males at breeding areas

To date, no study globally has obtained an estimate of the number of males in a breeding population. This is because males remain in the marine area, making counts difficult to obtain. Within the Mediterranean, only Schofield et al. (2010) have attempted to estimate the numbers of males within a loggerhead rookery (Zakynthos) using photo-identification. Intensive capture-recapture over a three month period indicated a 1:3.5 ratio of males to females (based on a sample size of 154 individuals). Furthermore, Hays et al. (2014) showed that most males in this population breed annually (although some of those that forage off Tunisia/Libya and in western Greece return biannually; Hays et al. 2014; Casale et al. 2013), using a combination of long-term satellite tracking (over 1 year) and multi-year photo-identification records, with similar return rates being recorded in other populations globally (Limpus 1993). Based on this information, just 100 males might breed annually, with the same males breeding every year, in contrast to an estimated 600-800 females for this population (based on nest counts; Casale and Margaritoulis 2010). Therefore, it is imperative to ascertain the rate of recruitment and mortality of males in the population. If we assume 2,280–2,787 adult females loggerheads in the Mediterranean (Broderick et al. 2002), then there may be just 580 to 696 adult loggerhead males in total, with some populations potentially supporting very small numbers of males, especially when considering that Zakynthos is considered one of the largest breeding populations in the Mediterranean (Casale & Margaritoulis 2010; Katselidis et al. 2013; Almpanidou et al. 2016). Thus, counts of males across all breeding populations are required to ascertain the importance of protecting this component of sea turtle populations.

Developmental and adult foraging/wintering habitats

Because loggerheads probably forage throughout all oceanic and neritic marine areas of the west and east basins of the Mediterranean (Hays et al. 2014; Casale & Mariani 2014), combined with the fact that both adults and juveniles may frequent multiple habitats, counts of individuals in specific areas prove difficult.

Juvenile and immature turtles represent the greatest component of the population; thus information on the size structure and abundance at foraging grounds is essential to understand changes in nest counts, based on changes in mortality and recruitment into adult breeding populations (Demography Working Group, 2015). However, because the juveniles of each nesting population may be dispersed across multiple habitats, and appear to use different sites across seasons, obtaining such counts is difficult requiring the complementary use of genetic sampling (Casale & Margaritoulis 2010).

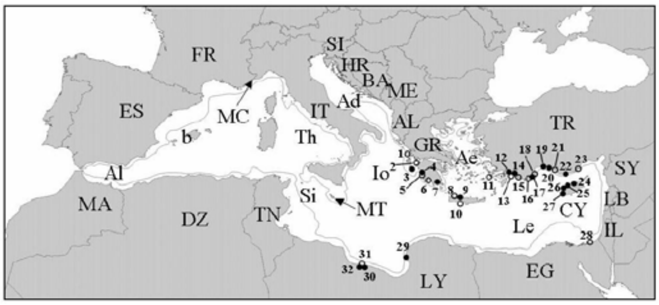
Aerial and fishery bycatch data provide some information on turtle abundance in the western basin Alboran Sea and Balearic islands, the Sicily Strait, the Ionian Sea, the north Adriatic, off Tunisia-Libya, Egypt and parts of the Aegean (Gómez de Segura et al. 2003, 2006; Cardona et al. 2005; Lauriano et al. 2011; Casale & Margaritoulis 2010; Fortuna et al. 2015), with unpublished information existing for the Balearic Sea, the Gulf of Lions, the Tyrrhenian Sea, the Ionian Sea, and the Adriatic Sea (Demography Working Group 2015). There are also bycatch data available providing evidence of turtle numbers (e.g. Casale & Margaritoulis 2010; Casale 2011, 2012). Another source of information is in-water capture at focal sites such as Amvrakikos, Greece (Rees et al. 2013) and Drini Bay, Albania (White et al. 2013). At Drini Bay, Albania, 476 turtles of size class 20 cm to 80 cm were captured primarily May to October (Casale & Margaritoulis 2010). Furthermore, long-term studies (2002-present) have shown the presence of large juvenile to adult loggerheads (46-92 cm) in Amvrakikos Bay, Greece (Rees et al. 2013).

Thus, the data from existing sites needs to be assimilated and assessed for representativeness in providing abundance information on juvenile and adult turtles, so as to determine how to focus effort effectively across foraging and developmental sites across the Mediterranean. In parallel, techniques to obtain counts on a regular basis across a wide range of habitats need to be developed.

Green turtles

Adult male and females in breeding habitats

Most green turtle nests (99%) are laid in Turkey, Cyprus and Syria, with the remainder being found in Lebanon, Israel and Egypt (Figure 2; Kasparek et al. 2001; Casale & Margaritoulis 2010). Out of 30 documented sites, just six host more than 100 nests per season (Stokes et al. 2014), with a maximum of just over 200 nests at two sites (both in Turkey). For details on nest numbers at the different sites in the Mediterranean see Stokes et al (2015) and Figure 2. An average of 1500 nests are documented each year (range 350 to 1750 nests), from which an annual nesting population of around 339–360 females has been estimated assuming two to three clutches (Broderick et al. 2002). Unlike loggerheads, green turtles globally strong exhibit interannual fluctuations in the number of nests, which has been associated with annual changes in forage resource availability (Broderick et al. 2001). Consequently, our knowledge about the population dynamics of green turtles in the Mediterranean remains insufficient.



Map of the major green turtle nesting sites in the Mediterranean (extracted from Casale & Margaritoulis), Major nesting sites (>40 nests/year) of green turtles in the Mediterranean. 1 Alata; 2 Kazanli; 3 Akyatan; 4 Sugozu; 5 Samandag; 6 Latakia; 7 North Karpaz; 8 Alagadi; 9 Morphou Bay; 10 Lara/Toxeftra. Closed circles >100 nests/year; open circles 40-100 nests/year. Country symbols, see previous map.

Developmental and adult foraging/wintering habitats

Information about the numbers of green turtles in various developmental, foraging and wintering habitats is limited. While the greatest numbers of green turtles have been documented in the Levantine basin (Demography Working Group 2015), there are records of individuals using habitat in the Adriatic Sea (Lazar et al. 2004) and around Italian waters (Bentivegna et al. 2011), with some records occurring in the western basin; however, actual numbers, have not been obtained. It is essential to document the numbers of adults and juveniles that frequent developmental, foraging and wintering habitats in order to isolate key sites for management protection.

CONCLUSIONS

Conclusions (brief)

This general overview indicates that overall, programs at nesting sites need to place a strong focus on ensuring long-term recognition of unique female individuals and incorporate counts of males. The realisation of Indicator 1, will help with delineating developmental, foraging and wintering sites to make counts of adult vs. juvenile turtles and fluctuations in numbers over time. Information obtained through Indicator 2 will be intrinsically linked with Indicator 3 (see this section).

Conclusions (extended)

Major gaps exist in estimating the population abundance of sea turtles. First, the use of nest counts as a proxy for female numbers must be treated with caution, and variation in climatic factors at the nesting site and trophic factors at foraging sites taken into account. Counts of males at breeding grounds must be incorporated into programs at nesting sites. If just a total of 100 males frequent Zakynthos, which has around 1000 nests/season, then most sites throughout the Mediterranean (of which most have <100 nests) are likely to support very low numbers of males, making the protection of these individuals essential. Finally, with the delineation of developmental, foraging and wintering habitats (Indicator 1), it will be necessary to obtain counts of the number of individuals, particularly juveniles, that frequent these various habitats seasonally and across years. While information on the number of juveniles alone at given habitats does not reflect on any given nesting population, the relative numbers of immature to mature animals will provide baseline information about key juvenile developmental habitats and actual numbers relative to those obtained to adults.

Overall, programs at nesting sites need to place a strong focus on ensuring long-term recognition of female individuals and incorporate counts of males. The realisation of Indicator 1, will help with delineating developmental, foraging and wintering sites to make counts of adult vs. juvenile turtles and fluctuations in numbers over time. Information obtained through Indicator 2 will be intrinsically linked with Indicator 3 (see this section).

Key messages

This general overview indicates that major gaps exist in estimating the population abundance of sea turtles. Programs at nesting sites need to place a strong focus on ensuring long-term recognition of female individuals and incorporate counts of males. Programs need to be developed at foraging, wintering and developmental grounds, providing counts of individuals and linking them to their source breeding populations.

Knowledge gaps

- Seasonal and total numbers of adult females frequenting breeding sites
- Seasonal and total numbers of adult males frequenting breeding sites
- Numbers of adult males and females frequenting foraging and wintering sites, including seasonal variation in numbers
- Numbers of adult males and females frequenting foraging and wintering sites, including seasonal variation in numbers
- Vulnerability/resilience of documented populations and subpopulations in relation to physical and anthropogenic pressures;
- Analysis of pressure/impact relationships for these populations and subpopulations, and definition of qualitative GES;
- Identification of extent (area) baselines for each population and subpopulation with respect to adult females, adult males and juveniles to maintain the viability and health of these populations
- Appropriate assessment scales;
- Monitor and assess the impacts of climate change on nest numbers (clutch frequency) and breeding periodicity (remigration intervals) of females, as these paramaters are used as proxies for inferring female numbers.
- Monitor and assess the impacts of climate change on the breeding periodicity (remigration intervals) of males, as this provides an indication of total male numbers
- Assimilation of all research material on sea turtles (e.g. satellite tracking, stable isotope, genetic, strandings aerial surveys) in a single database

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Ecological Objective 1 (EO1): Biodiversity

Note: The maps and illustrations are provisional

EO1: Common Indicator 4: Population abundance of selected species (related to Seabirds)

GENERAL

Reporter: SPA/RAC

Geographical scale of the assessment: Regional, Mediterranean Sea

Contributing countries:

Mid-Term Strategy (MTS) Core Theme 2-Biodiversity and Ecosystems

Ecological Objective EO1: Biological diversity is maintained or enhanced. The quality and occurrence of coastal and marine habitats and the distribution and abundance of coastal and marine species are in line with prevailing physiographic, hydrographic, geographic and climatic conditions.

IMAP Common Indicator Common Indicator 4 (CI4): Population abundance of selected species (related to seabirds)

Indicator Assessment Factsheet Code EO1CI4

RATIONALE/METHODS

Background (short)

Background and rationale for the indicator, key pressures and drivers

Population size is the most straightforward indicator to assess the status and trends of seabirds. However, this information is subject to strong biases, particularly for species that attend colonies at night and/or breed in caves and crevices underground. Thus, for the gulls and terns there are often good count series in some regions, at least for some relevant local areas (particularly for protected sites). On the other hand, count data for “secretive” species such as shearwaters are often unreliable, even if prospection efforts have been reasonable. In the latter case it is particularly important to take this type of data with extreme caution, and avoid drawing out trends except if there is a careful monitoring programme behind. Demographic information may result far more reliable in this type of situations (e.g. Genovart *et al.* 2016).

Background (extended)

Assessment methods

Estimating breeding seabird populations might seem straightforward, but is often an extremely complex task, particularly with the nocturnal and burrowing species such as the shearwaters (e.g. Sutherland *et al*. 1994).

For gulls and terns, they tend to breed in aggregated colonies and their direct count may be relatively easy. Ideally a nest count is recommended, by visiting the colony and prospect systematically all the area occupied by the seabirds. Transects are the most used approach, dividing the colony in bands of a given width (which may depend on the visibility of the nests and the difficulty of the terrain) and counting every nest within each band. A slight modification consists of walking along transect lines and recording all nests detected, indicating the distance of each nest to the line; then a mathematical function of detectability allows to correct for the decreasing detectability of nests with distance and to get a whole estimate (distance-sampling) (Barbraud *et al*. 2014).

For shags, the direct count of nests often require of boat-based counts following the rocky and cliff areas where the birds breed.

For the shearwaters the direct count of nests is extremely complicated, although it may be attempted in accessible areas; call-playback may be of help in these cases (Perrins *et al*. 2012). However, it is often necessary to rely on indirect methods, as several areas remain inaccessible (e.g. Arcos et al. 2012b, Borg *et al*. 2016). These indirect methods are subject to potentially strong biases, and results must be taken with caution. Among them: counts of rafts and setting abundance out of vocalization rates. Capture-recapture methods may also be used, although the necessary assumption that populations are “closed” is often violated.

RESULTS

Results and Status, including trends (brief)

Results and Status, including trends (extended)

Information on seabird population sizes in the Mediterranean is patchy and often old, with some figures being repeated work after work while no real progress has been made. The different groups and species deserve different considerations.

Balearic and Yelkouan shearwaters. For the shearwaters, information on population size is particularly hard to get from the colonies, and most figures rely on indirect estimates subject to strong biases, and in occasions they just come from wild guesses. Comments on the trends of these species are therefore considered under common indicator 5 (demography).

However, the upsurge of tracking technologies in the last decade and the increasing attention paid to marine protected areas for seabirds has led to an increase of monitoring work at the colonies, and the finding of new breeding sites. At the same time, the efforts of monitoring at sea (both direct counts from the coast or boats, and tracking studies) have led to an unprecedented knowledge of the patterns of distribution of these seabirds, which is essential to deal with the threats that occur at sea.

The Balearic shearwater is restricted to the Balearic Islands in the western Mediterranean as a breeder (Figure 1). There have been no proper counts of the breeding population at regional scale since 2001 (Ruiz & Martí 2004), although some colonies have been counted afterwards, and assumptions to infer estimates have changed for other colonies (Arcos 2011, 2016). All in all, the official estimate for the breeding population is of 3,200 breeding pairs. However, counts at sea suggest a larger population, with a global estimate of ca. 25,000 individuals (Arcos *et al*. 2012b, Arroyo *et al*. 2014), which could imply a breeding population of about 7,000 breeding pairs (Genovart *et al*. 2016). Trends based on this type of data should be considered as unreliable and therefore demographic data should be taken as the best reference (see common indicator 5).

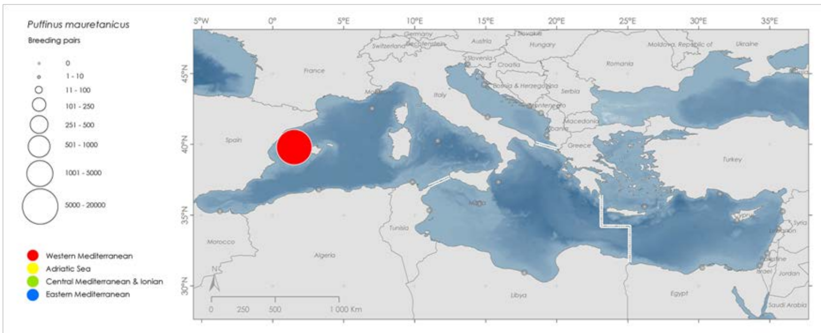

Figure 1. Distribution and relative size of the Balearic shearwater *Puffinus mauretanicus* breeding population, sorted by sub-region and country. In this case the species is limited as a breeder to the Balearic Islands (Spain), in the Western Mediterranean.

The Yelkouan shearwater keeps a wider distribution, with the bulk of birds breeding in Italy (mainly in Corsica), Greece and Malta, plus scattered colonies all across the Mediterranean, being scarcer in the south and east (Figure 2). Overall the breeding population is estimated at around 21,000-33,000 pairs (Bourgueois & Vidal 2008, Derhé 2012, García-Robles *et al*. 2016, Gaudard *in prep*.). It is also important to highlight the relevance of some congregation areas at sea, and particularly the flyway of the Bosphorus, where up to 90,000 individuals have been counted in a single day (Sahin 2016).

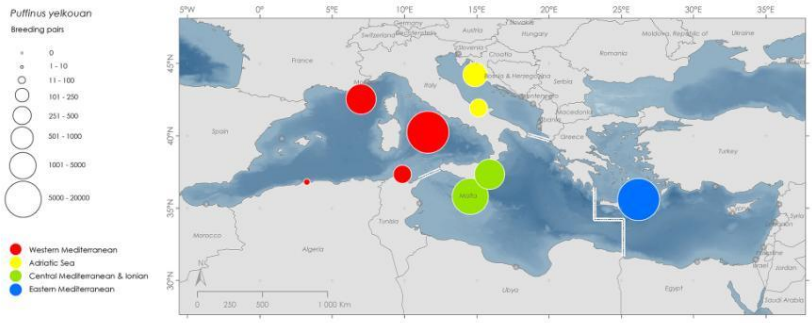

Figure 2. Distribution and relative size of the Yelkouan shearwater *Puffinus yelkouan* breeding population, sorted by sub-region (each colour corresponds to a given sub-region, see map legend) and country.

The information from the Bosphorus, coupled with the discovery of a few new breeding sites, and an inferred positive trend from colony estimates in Italy and Malta has led to infer a positive population trend in recent years, but this is most likely a misinterpretation of the available information, since: (1) the population of the Bosphorus has not increased, simply was not exhaustively counted before; (2) the discovery of new colonies should be related to increased effort of prospection, not to a real colonisation of new breeding sites; and (3) the perceived positive trend in some colonies is either limited to a few sites were rat control has permitted a real recovery at local level or the result of inferring trends out of unreliable figures. Demographic data suggest precisely the opposite, as explained under common indicator 5.

Mediterranean shag. This species is easier to detect and count than the shearwaters, but maybe harder than the gulls and terns. Compared to the shearwaters, it is a diurnal species and it’s easier to detect the nests. However, shags tend to breed in coastal cliffs, most often in inaccessible nests speared across long stretches of coastline, so counting them requires time and, most often, a boat to cover all areas. In comparison, gulls and terns tend (with exceptions) to nest in aggregated colonies in flat areas, easier to count.
According to the available information, the breeding population of this shag is spread across the Mediterranean basin, occupying the four sub-regions considered here, with the bulk of it in the north (Figure 3). The largest populations occur in the Balearic Islands and Corsica-Sardinia, Croatia and the Aegean (both Greece and Turkey), with only a few small colonies in the north African coast, usually

lacking reliable numerical data (Algeria, Tunisia, Lybia and Egypt). The global population of this subspecies endemic to the Mediterranean is estimated at below 10,000 breeding pairs, although proper prospection is lacking for some areas. Available data for Turkey and Cyprus is particularly old. Trends are unclear, with differences between countries, but either slight declines or stability seem the norm for those countries with most reliable data.

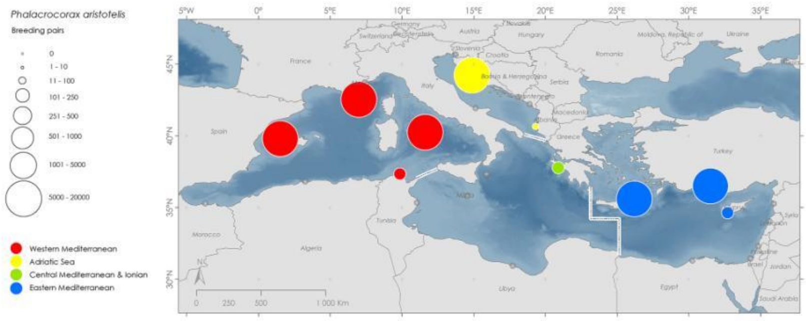

Figure 3. Distribution and relative size of the Mediterranean shag *Phalacrocorax aristotelis* breeding population, sorted by sub-region (each colour corresponds to a given sub-region, see map legend) and country.

Audouin's gull. It is also a Mediterranean endemic species, spread across the basin with about 22,000 breeding pairs. The bulk of the population breeds in Spain, which concentrates over 90% of the total, although colonies extend eastwards to Turkey and southwards down to Morocco and Algeria (Figure 4). The species is adapted to changing the location of breeding colonies from year to year, if necessary (Oro 2003), but overall the eastern population seems to have decreased significantly in recent years, particularly in Greece (where the estimates moved from 700-900 breeding pairs in 1995 to 350-500 in 2010, coupled with a decrease in breeding productivity; Saravia-Mullin *et al*. 2012) (see common indicator 5). On the other hand, the western population seems to be in better shape. However, recent declines of the major western colonies (such as the Ebro Delta), coupled with the colonisation of new breeding sites in areas of highly degraded habitat (e.g. ports), make it recommendable to keep alert to a potential decline in the near future. All in all, the recent uplisting of the species in the IUCN global list, from Near Threatened to Not Threatened might require further review in the near future.

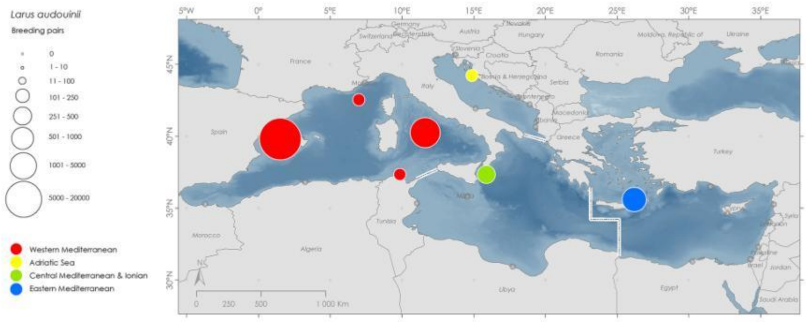

Figure 4. Distribution and relative size of Audouin's gull *Larus audouinii* breeding population, sorted by sub-region (each colour corresponds to a given sub-region, see map legend) and country.

Sandwich tern. The bulk of the Mediterranean population is concentrated in the Western sub-region, where a few colonies sum up over 6000 breeding pairs between France and Spain. Italy also holds an important population in the Adriatic Sea, with about 800 breeding pairs, and Greece holds smaller colonies in the Central and Eastern sub-regions (Figure 5).

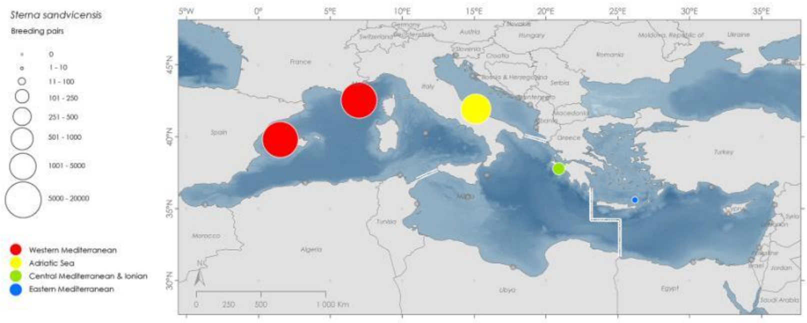

Figure 5. Distribution and relative size of Sandwich tern *Sterna sandvicensis* breeding population, sorted by sub-region (each colour corresponds to a given sub-region, see map legend) and country.

Little tern. This is a widespread species across the region, breeding in wetlands and beaches in the four sub-regions considered (Figure 6). Numbers are lacking for Morocco, Libya and the easternmost countries. Turkey populations appear to be the largest ones, but the available information is poor, with 5,000-8,000 breeding pairs estimated (BirdLife International 2017b). Population trends vary between countries, with no clear trend at regional level.

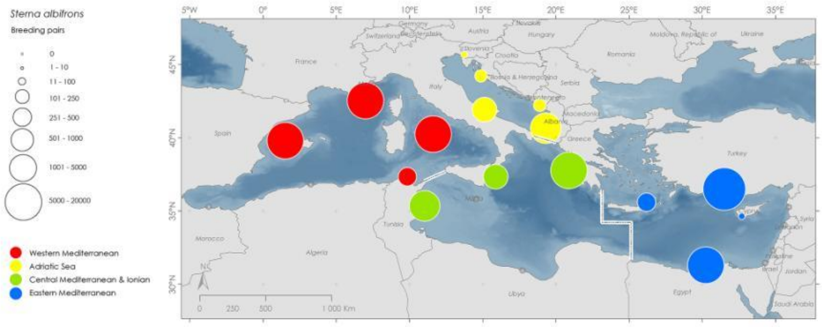

Figure 6. Distribution and relative size of the little tern *Sternula albifrons* breeding population, sorted by sub-region (each colour corresponds to a given sub-region, see map legend) and country.

Gull-billed tern. The species is widespread across the whole Mediterranean, occupying the four sub-regions considered (Figure 7) and totalling over 4,000 breeding pairs. It is important to recall that most of the population inhabits in wetlands and makes little use of the sea.

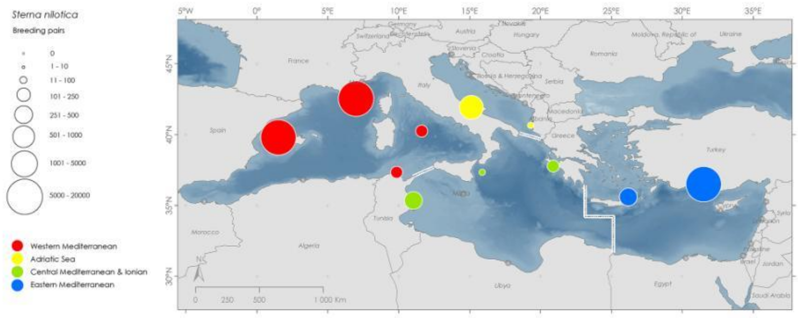

Figure 7. Distribution and relative size of the gull-billed tern *Sterna nilotica* breeding population, sorted by sub-region (each colour corresponds to a given sub-region, see map legend) and country.

CONCLUSIONS

Conclusions (brief)

The overall pattern of seabird abundance in the Mediterranean region is consistent with the results of common indicator 3 (distribution): seabirds tend to be more abundant in the north and west of the

Mediterranean basin. This is particularly so in the case of the most marine species (shearwaters, Mediterranean shag and Audouin's gull). As in the case of the distribution patterns, it remains to elucidate to which extent this pattern, that makes sense in terms of productivity and maybe also of suitable breeding habitat availability, is not confounded by prospection effort/data quality.
Getting reliable estimates of population size is harder than just confirming presence/absence (which is the basis for assessing distribution patterns), so there are more gaps regarding this common indicator. Information for some countries and species is old and just repeated from one publication to another, so it is important to break with this tradition and ensure that the different countries start implementing proper monitoring programmes. Information will be easier to collect and more reliable for the diurnal species breeding in open habitats, such as Audouin's gull and the terns, whereas for the most "secretive" species (shearwaters) it might be important to rely on demographic studies of representative colonies to properly assess population trends (see common indicator 5).

Conclusions (extended)

Key messages

Patterns of abundance roughly match those of distribution for seabirds, with a southeast to northwest increase.

Information is patchy, often old and subject to potentially high biases, particularly in the case of the shearwaters. Establishing population trends for the latter is complicated out of censuses.

Knowledge gaps

The geographic gaps are similar to those described for common indicator 3. For many eastern and southern countries, as well as some Adriatic countries, the information on seabird breeding populations is patchy or completely lacking. Particularly little information is available for Algeria, Libya, Egypt, Israel, Lebanon, Syria, Cyprus and Turkey, as well as Montenegro, Bosnia-Herzegovina and Albania.

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Ecological Objective 1 (EO1): Biodiversity

Note: The maps and illustrations are provisional

EO1: Common Indicator 5: Population demographic characteristics (e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates related to marine mammals)

GENERAL

Reporter:	SPA/RAC
Geographical scale of the assessment:	Regional, Mediterranean Sea
Contributing countries:	
Mid-Term Strategy (MTS) Core Theme	2-Biodiversity and Ecosystems
Ecological Objective	EO1: Biological diversity is maintained or enhanced. The quality and occurrence of coastal and marine habitats and the distribution and abundance of coastal and marine species are in line with prevailing physiographic, hydrographic, geographic and climatic conditions.
IMAP Common Indicator	Common Indicator 5 (CI5): Population demographic characteristics (e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates related to marine mammals)
Indicator Assessment Factsheet Code	EO1CI5

RATIONALE/METHODS

Background (short)

The objective of this indicator is to focus on the population demographic characteristics of marine mammals within the Mediterranean waters. Demographic characteristics of a given population may be used to assess its conservation status by analysing demographic parameters as the age structure, age at sexual maturity, sex ratio and rates of birth (fecundity) and of death (mortality). These data are particularly difficult to obtain for marine mammals, thus relying on demographic models, which imply several assumptions which may be violated.

The populations of long-lived and slow reproducing cetaceans are among the most critical conservation units; a demographic approach can be therefore very useful for their management and conservation.

While some demographic studies have been conducted using industrial whaling data on Northeast Atlantic populations, little is known about the demography of their counterparts in the Mediterranean, where industrial whaling has never occurred.

Background (extended)

Assessment methods

Monitoring effort should be directed to collect long-term data series covering the various life stages of the selected species. This would involve the participation of several teams using standard methodologies and covering sites of particular importance for the key life stages of the target species.

The preliminary classical tools for demographic analyses are life tables, accounting for the birth rates and probabilities of death for each vital stage or age class in the population. A life table can be set out in different ways:

1) following an initial age class (i.e. cohort) from birth to the death of the last individual; this approach allows to set out a cohort life table and is generally applied on sessile and short-lived populations;

2) counting population individuals grouped by age or by stages in a given time period; this approach allows to obtain a static life table, that is appropriate with long-lived or mobile species;

3) analysing the age or stage distribution of individuals at death; this approach allows to develop a mortality table, using carcasses from stranding data.

Photo-identification is one of the most powerful techniques to investigate cetacean populations. Information on group composition, area distribution, inter-individual behavior and short and long-term movement patterns can be obtained by the recognition of individual animals. Long-term datasets on photo-identified individuals can provide information on basic life-history traits, such as age at sexual maturity, calving interval, reproductive and total life span. Nevertheless, estimating age and length from free-ranging individuals may be rather difficult and increase the uncertainties in the models. Long-term data sets on known individuals through photo-identification may overcome some of the potential biases.

RESULTS

Results and Status, including trends (brief)

Fin whale - Demographic models - commonly used in animal and plant populations - have been applied to marine mammals and cetaceans only in the recent years. Usually, two different approaches are used when dealing with demographic studies, based on static or cohort life-tables. A third approach refers to the use of mortality tables and provides detailed information about size⁄age and sex of dead individuals. This approach, based on stranding data, has for the first time been applied to cetaceans in the Mediterranean Sea, developing a demographic model for the Mediterranean fin whale population based on a life-history table (mortality table) using stranding records. Dealing with stranded data implies several assumptions; the main one being that stranding data represent a faithful description of the real mortality by different life stages. This assumption, however, is true only if the probability of stranding is equal in all life stages.

This preliminary study described the structure of the Mediterranean sub-population by analyzing stranding records from the period 1986–2007, showing a strong impact, natural and anthropogenic, on calves and immature animals. These results, while confirm a common pattern to several mammals – characterized by high mortality in the youngest age classes - may prevent reaching sexual maturity, thus severely impacting the species at the population level. Proper conservation plans should therefore consider the discovery of breeding grounds, where calves may benefit from greater protection, to increase survival rates. Similarly, appropriate naval traffic regulations, aimed at reducing mortality rates from ship collisions, could enhance the survival of mature females and calves. In addition, mitigating other sources of mortality and stress, such as chemical and acoustic pollution, whale-watching activities and habitat loss and degradation, could further improve the population's chances of survival.

Common bottlenose dolphin - The only Mediterranean area with quantitative historical information that can be used to infer population trends over time scales of more than a couple of decades is the northern Adriatic Sea. There, bottlenose dolphin numbers likely declined by at least 50% in the second half of the 20th century, largely as a consequence of deliberate killing initially, followed by habitat degradation and overfishing of prey species. For some other parts of the northern Mediterranean, e.g. Italy and southern France, the available information is less precise but suggests similar trends. In an area off southern Spain where the species has been studied intensively, abundance estimates have shown variability but no trend since the early 1990s.

Since there are no historical data on the density and abundance of bottlenose dolphins in the Pelagos Sanctuary, it is not possible to infer possible increase or decrease over time. The Groupe d'Etudes des Cétacés de Méditerranée has estimated – through direct counting and photo-identification - around 198–242 dolphins around the island of Corsica in 2000, and 130–173 in 2003. These estimates appear to be lower than those assessed through mark recapture analysis in the same area in 2006, but any inference on potential trends is purely speculative, as a different approach has been used to for these estimated and this may lead to significant biases

Results and Status, including trends (extended)

CONCLUSIONS

Conclusions (brief)

Available data on demography for Mediterranean marine mammals are rather scarce and fragmented and at present it is rather difficult to provide strong and robust evidence on trends.

Data are available for localized regions only, where more effort has been devoted over the years allowing to estimate survival rates for specific species and time intervals.

Demographic studies can supply useful tools to the management and the conservation of threatened and overexploited species. Population models, based on life-history tables and transition matrices, allow to assess population performance, to project population trends overtime and thus to foster the conservation of the studied populations, suggesting specific measures for their protection.

Conclusions (extended)

Key messages

Systematic and long-term photo-identification programs, jointly to the use of appropriate instruments to measure observed animals, would be essential tools to supply basic knowledge on population structure needed for conservation plans.

Knowledge gaps

There is a strong need for systematic monitoring programmes over time, to collect time series and allow the assessment of trends over time and space.

Monitoring programmes should be replicated at regular intervals, i.e. 5-6 years, following international regulations (e.g.: Habitat and Marine Strategy Directives, Ecosystem Approach).

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Ecological Objective 1 (EO1): Biodiversity

Note: The maps and illustrations are provisional

EO1: Common Indicator 5: Population demographic characteristics (e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates related to marine reptiles)

GENERAL

Reporter:	SPA/RAC
Geographical scale of the assessment:	Regional, Mediterranean Sea
Contributing countries:	
Mid-Term Strategy (MTS) Core Theme	2-Biodiversity and Ecosystems
Ecological Objective	EO1: Biological diversity is maintained or enhanced. The quality and occurrence of coastal and marine habitats and the distribution and abundance of coastal and marine species are in line with prevailing physiographic, hydrographic, geographic and climatic conditions.
IMAP Common Indicator	Common Indicator 5 (CI5): Population demographic characteristics (e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates related to marine reptiles)
Indicator Assessment Factsheet Code	EO1CI5

RATIONALE/METHODS

Background (short)

This assessment presents a brief overview of demographical parameters that are used to monitor loggerhead and green sea turtles at breeding, foraging and wintering grounds in the Mediterranean, based on published data, to determine what knowledge gaps need to be filled to realise the objective of this indicator. Demographic information helps to identify the stage(s) in the life cycle that affect(s) most population growth, and may be applied to (1) quantify the effectiveness of conservation measures or extent of exploitation (e.g. fisheries management), (2) understand the evolution of life history traits and (3) indicate fitness with respect to the surrounding environment. For sea turtle populations, some measures of demography are well documented, such as nest and/or female numbers (see Indicator 2), from which population trends are currently applied to infer population growth (or recovery) and, hence, threat status. Yet, without information about the number of juveniles recruiting into the population (e.g. Dutton et al. 2005; Stokes et al. 2014), or reliable estimates of mortality rates of both juveniles and adults, it is very difficult to predict future trends.

Background (extended)

Background and rationale

Effective conservation planning requires reliable data on wildlife population dynamics or demography (e.g. population size and growth, recruitment and mortality rates, reproductive success and longevity) to guide management effectively (Dulvy et al. 2003; Crick 2004). However, it is not possible to obtain such data for many species, especially in the marine environment, limiting our ability to infer and mitigate actual risks through targeted management. Yet, demographic information helps to identify the stage(s) in the life cycle that affect(s) most population growth, and may be applied to (1) quantify the effectiveness of conservation measures or extent of exploitation (e.g. fisheries management), (2) understand the evolution of life history traits and (3) indicate fitness with respect to the surrounding environment.

For sea turtle populations, some measures of demography are well documented, such as nest and/or female numbers (see Indicator 2), from which population trends are currently applied to infer population growth (or recovery) and, hence, threat status. Yet, without information about the number of juveniles recruiting into the population (e.g. Dutton et al. 2005; Stokes et al. 2014), or reliable estimates of mortality rates of both juveniles and adults, it is very difficult to predict future trends. For instance, factors impacting turtle population dynamics in the coming decades will not be detected from nest counts for another 30 to 50 years (Scott et al. 2011), because this is the generation time of this group and nest counts cannot predict how many juveniles are recruiting into the populations until they begin nesting themselves.

Another parameter that is well established is the emergence success rate of hatchlings from the nests, along with offspring sex ratios at hatching. Globally, highly female-biased offspring sex ratios have been predicted (Witt et al. 2010; Hays et al. 2014). This high female bias is of concern because sea turtles exhibit temperature dependent sex determination, with the warming climate ultimately leading to even more biased female production (Poloczanska et al., 2009; Saba et al., 2012; Katselidis et al. 2012). Thus, it is essential to determine how the offspring sex ratio transforms into the adult sex ratio, to determine the minimum number of males needed to keep a population viable and genetically healthy, which are not necessarily the same. Because males tend to breed more frequently than females (i.e. every 1-2 years versus 2 or more years by females; Casale et al. 2013; Hays et al. 2014), fewer males might be needed in the population to mate with all females. However, biased sex ratios can induce deleterious genetic effects within populations with a decline in the effective population size and increasing the odds of inbreeding and random genetic drift (Bowen & Karl 2007; Girondot et al. 2004; Mitchell et al. 2010). However, most sea turtle populations exhibit high multiple paternity (i.e. the eggs of individual females are fathered by multiple males; for review see Lee et al. in submission). This behaviour is considered to be a strategy to enhance genetic diversity; thus, if male numbers further declined, this could have deleterious effects on the population (Girondot et al. 2004). Furthermore, differences in survival between the sexes might occur in different age classes (Sprogis et al. 2016); thus, it is essential to quantify sex ratios and sex-specific mortality across the different size/age classes. Strandings provide a useful source of information on the causes of mortality, but do not necessarily reflect the actual numbers of animals that are dying (Epperly et al. 1996; Hart et al. 2006). Bycatch data have also been used to estimate mortality rates (for overview see, Casale 2011), which are predicted to be around 44000 turtles/year in the Mediterranean. However, these values need confirmation.

Consequently, these knowledge gaps hinder our ability to generate representative demographic models to provide accurate assessments of the conservation status of loggerhead and green turtles in the Mediterranean. Yet, such information is vital to implement the most appropriate measures to conserve sea turtles.

Key pressures and drivers

Both the nesting and foraging areas of marine turtles are vulnerable to anthropogenic pressures in the Mediterranean Sea, including an increase in the exploitation of resources (including fisheries), use and degradation of habitats (including coastal development), pollution and climate change (UNEP/MAP/BLUE PLAN, 2009; Mazaris et al. 2009, 2014; Witt et al. 2011; Katselidis et al. 2012, 2013, 2014). These issues might reduce the resilience of this group of species, negatively impacting the ability of populations to recover (e.g. Mazaris et al. 2009, 2014; Witt et al. 2011; Katselidis et al. 2012, 2013, 2014). The risk of extinction is particularly high in the Mediterranean because the breeding populations of both loggerhead and green turtles in this basin are demographically distinct to other global populations (Laurent et al., 1998; Encalada et al., 1998), and might not be replenished.

The main threats to the survival of loggerhead and green turtles in the Mediterranean have been identified as incidental catch in fishing gear, collision with boats, and intentional killing (Casale & Margaritoulis 2010). Casale (2011) estimated that there are more than 132,000 incidental captures per year in the Mediterranean, of which more than 44,000 are predicted to be fatal, although very little is known about post-release mortality (Álvarez de Quevedo et al. 2013). Wallace et al. (2010, 2011) grouped all species of sea turtles globally into regional management units (RMUs), which are geographically distinct population segments, to determine the population status and threat level. These regional population units are used to assimilate biogeographical information (i.e. genetics, distribution, movement, demography) of sea turtle nesting sites, providing a spatial basis for assessing management challenges. A total of 58 RMUs were originally delineated for the seven sea turtle species. The Mediterranean contains 2 RMUs for loggerheads and 1 RMU for green turtles. These analyses showed that the Mediterranean has the highest average threats score out of all ocean basins, particularly for marine turtle bycatch (Wallace et al. 2011). However, compared to all RMUs globally, the Mediterranean also has the lowest average risk score (Wallace et al. 2011).

Other key threats to sea turtles in the Mediterranean include the destruction of nesting habitat for tourism and agriculture, beach erosion and pollution, direct exploitation, nest predation and climate change (Casale & Margaritoulis 2010; Mazaris et al. 2014; Katselidis et al. 2012, 2013, 2014). Coll et al. (2011) also identified critical areas of interaction between high biodiversity and threats for marine wildlife in the Mediterranean. Within this analysis, the authors delineated high risk areas to both species, with critical areas extending along most coasts, except the south to east coastline (from Tunisia to Turkey).

Policy Context and Targets

Similar to the Ecosystem Approach, the EU adopted the European Union Marine Strategy Framework Directive (MSFD) on 17 June 2008, which includes Good Environment Status (GES) definitions, Descriptors, Criteria, Indicators and Targets. In the Mediterranean region, the MSFD applies to EU member states. The aim of the MSFD is to protect more effectively the marine environment across Europe. In order to achieve GES by 2020, each EU Member State is required to develop a strategy for its marine waters (Marine Strategy). In addition, because the Directive follows an adaptive management approach, the Marine Strategies must be kept up-to-date and reviewed every 6 years.

The MSFD includes Descriptor 1: Biodiversity: “The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.” Assessment is required at several ecological levels: ecosystems, habitats and species. Among selected species are marine turtles and within this framework, each Member State that is within a marine turtle range, has submitted GES criteria, indicators, targets and a program to monitor them.

The MSFD will be complementary to, and provide the overarching framework for, a number of other key Directives and legislation at the European level. Also it calls to regional cooperation meaning “cooperation and coordination of activities between Member States and, whenever possible, third countries sharing the same marine region or sub-region, for the purpose of developing and implementing marine strategies" […] "thereby facilitating achievement of good environmental status in the marine region or sub-region concerned". Commission Decision 2010/477/EU sets out the MSFD's criteria and methodological standards and under Descriptor 1 includes criteria "1.1.Species distribution" and indicators "Distributional range (1.1.1)", "Distributional pattern within the latter, where appropriate (1.1.2)", and "Area covered by the species (for sessile/benthic species) (1.1.3)". At a country scale, Greece, Italy, and Spain have selected targets for marine turtles; Cyprus and Slovenia mention marine turtles in their Initial assessment, but do not set targets (Milieu Ltd Consortium. 2014; UNEP/MAP 2016). Italy has an MSFD target of reducing fishing pressure by decreasing accidental mortalities by regulating fishing practices, along with by-catch reduction in areas where loggerhead sea turtles aggregate and delineating the spatial distribution of turtles in areas with highest use of pelagic long line (southern Tyrrhenian and southern Ionian sea) and trawling (northern Adriatic). One of the MSFD targets of Spain is to reduce the main causes of mortality and reduction of turtle populations, such as accidental capture, collisions with vessels, intaking of litter at sea, introduced terrestrial predators, pollution, habitat destruction, overfishing.

Assessment methods

This assessment presents a brief and general overview of the distributional range of two marine turtle species to identify existing knowledge and knowledge gaps for use in elaborating the national monitoring programmes for biodiversity. Published information by regional and national surveys and research projects were used to compile the review, but this overview does not present a comprehensive assessment of existing knowledge.

RESULTS

Results and Status, including trends (brief)

Knowledge about the various demographic parameters of sea turtles remains patchy throughout the Mediterranean, with detailed information being available at some sites and no information at other sites. To develop comprehensive models, knowledge about all aspects of demography across a range of representative populations of different sizes is required.

Results and Status, including trends (extended)

Loggerhead and green sea turtles

For this indicator, both species have been combined as the same gaps exist for both. Specific details for green turtles on Cyprus are provided by Broderick et al. (2002) and Stokes et al. (2014), with published data lacking for most other sites in the Mediterranean.

Population size and growth (breeding grounds)

See Indicator 2 for details on this topic.

Internesting intervals of adult females (breeding grounds)

It is essential to quantify the internesting interval within and across years because this influences clutch frequency and will influence estimates of population size (see Indicator 2). The nesting interval is regulated by sea temperature (Hays et al. 2002), being longer when the sea temperature is cooler. Ranges from 12 to over 20 days have been detected within and across nesting sites in the Mediterranean (see Demography Working Group 2015 and Casale & Margaritoulis 2010 for ranges across Mediterranean populations).

Remigration intervals of adult males and females (breeding grounds)

Knowledge on remigration rates (breeding periodicity) of known females and how this changes with time (i.e. maturation of younger nesters or aging of older nesters) is essential as this will affect our ability to predict the total adult sex ratio of populations. Knowledge on female remigration intervals is again limited to Greece, Turkey and Cyprus. Females in Greece and Cyprus tend to have remigration intervals of approximately 2 years (Demography Working Group 2015 and Casale & Margaritoulis 2010), but can be 1-3, or more years (Schofield et al. 2009). For males, remigration intervals have only been documented for males on Zakynthos, which are primarily 1 year, but with some individuals that forage near Tunisia/Libya and the western basin returning every 2 years (Hays et al. 2014; Casale et al. 2013). To determine the total number of adults in the population, clear knowledge about remigration frequency is required.

Clutch frequency (breeding grounds)

This parameter is difficult to quantify due to difficulty in detection rates. Clutch frequencies of 1.2-2.2 have been suggested for green and loggerhead turtles on Cyprus (Broderick et al. 2002). However, on Zakynthos, loggerhead turtles have mean clutch frequencies of 2-3 nests, with up to 5 occurring, based on satellite tracking studies (Zbinden et al. 2011; Schofield et al. 2013a). As this parameter is critical for inferring the numbers of females at breeding sites, as most estimates of females are estimated from nest counts divided by the assumed clutch frequency, it is essential to understand this parameter. Furthermore, clutch frequency will vary with internesting period; i.e. in warmer years, a female could lay more clutches due to shorter internesting periods and vice versa. Again, this information will influence population estimates.

Sex ratios of adult male and females (breeding grounds)

Once information on clutch frequency and remigration interval is robust, then estimates of the numbers of females can be obtained. However, to quantify adult sex ratios at the breeding grounds and overall for the adult component of sea turtle populations, counts of males in the marine environment during breeding must be made. Thus, at present, knowledge about the number of males that frequent breeding areas is non-existent. Therefore, we do not know how many males are currently breeding with females or what the sex ratios are for adults. Only on Zakynthos has a prediction been made of 1:3.3 males to females based on in-water photo-id surveys of a portion of the breeding population (Schofield et al. 2009). Thus, efforts are needed to quantify the number of males (See indicator 2 for more on this issue) in order to understand adult sex ratios and their potential implications on the conservation and persistence of the species.

Offspring sex ratios at breeding sites, including incubation (breeding grounds)

Estimated hatchling sex ratios exist for a number of nesting sites in Greece, Turkey and North Cyprus, as well as Tunisia (Hays et al. 2014) (Figure 1), with all being strongly female biased. For all the other nations there are no published accounts of estimated sex ratios (see Demography Working Group 2015). It is possible to infer offspring sex ratio from sand temperatures and incubation duration (e.g. Godley et al. 2001; Katselidis et al. 2012), which is relatively straight forward. Incubation duration has been recorded in most countries (see Demography Working Group 2015 and Casale & Margaritoulis 2010 for details).

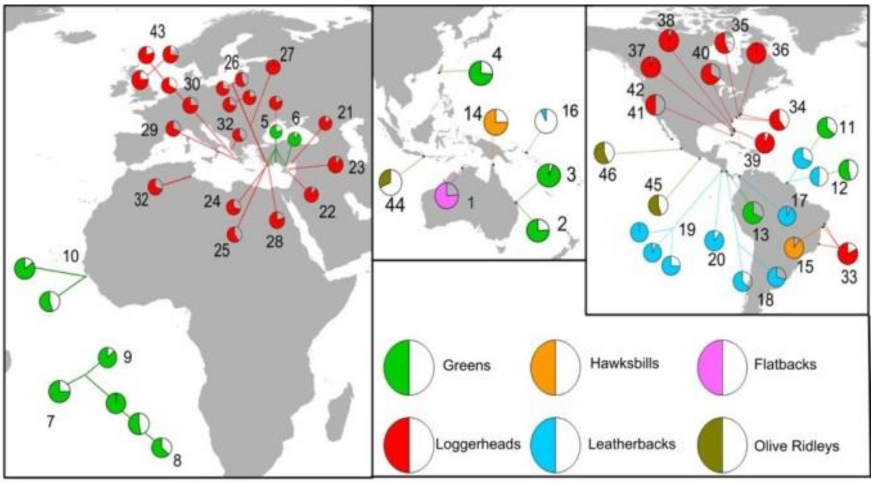

Figure 1 Offspring sex ratios globally, including the Mediterranean (extracted from Hays et al. 2014)

Breeding success of adult males and females (breeding grounds)

Less is known regarding the breeding success of individual females and males. For females, breeding success should be measured generally and for individuals. General measures include the total number of female emergences versus successful nests. This information is generally collected by established beach-based monitoring programs in Greece, Turkey and North Cyprus. Furthermore, breeding success by females is reflected in fecundity (birth rates), i.e. the number of offspring an individual in a population produces. While information on emergence and hatching success is available for established beach-based monitoring programs in Greece, Turkey and North Cyprus, it is not linked to individual turtles in these programs. This is due to issues with tags falling off, knowledge about the successful production of offspring within and across years by individuals is not known, but could help towards indicating the fitness of individuals which could be used to infer the general health of the population.

With respect to males, just one study on multiple paternity has been conducted (Zbinden et al. 2007) on Zakynthos, showing higher than expected multiple paternity levels. Thus, some males might be more successful at mating with females than other males. Therefore, baseline data on the reproductive activity and success of individual males needs to be documented, again to ascertain their reproductive health and how this transforms to their contribution to the clutch (i.e. number of eggs represented by each male).

Hatchling success and emergence success (breeding grounds)

Hatchling success (i.e. number of eggs that hatch; 60-80%) and hatchling emergence success (the number of hatchlings that make it out of the nest; 60-70%) has been documented for the major nesting countries of Greece, Turkey and Cyprus, but more information is required from the other countries (for more details see, Demography Working Group 2015 and Casale & Margaritoulis 2010).

Recruitment, mortality, longevity of breeding (breeding grounds)

With the use of reliable tagging methods (i.e. use of 2 or more complementary techniques to ensure information on individuals is not lost; see Indicator 2), this information should be available for some nesting populations with long-term tagging programs (for example see, Dutton et al. 2005 and Stokes et al. 2014). At present recruitment is inferred by most tagging programs (i.e. in Greece, Turkey and Cyprus) from the absence of scars on flippers; however, this technique is not reliable. However, it is essential for existing and new programs to ensure continuous records of individual females, so that these key parameters can be assessed, which will help improve predictions of population recovery or decline.

Growth rates

A study of juvenile loggerheads sampled along the coast of Italy showed that growth rates differ between individuals of Atlantic and Mediterranean origin (Piovano et al. 2011). Casale et al. (2009, 2011) has assessed growth rates using skeletochronology and length-frequency analyses around Italian waters in the Adriatic. Studies of the growth rates of juveniles from different areas of the Mediterranean, however, are required, as these rates will vary depending on forage type. For instance, the size ranges of adult turtles tracked to the Adriatic, Ionian and Gulf of Gabes showed that those that migrated to the Adriatic were the largest, while those from the Ionian were intermediate in size and those from the Gulf of Gabes were the smallest (Schofield et al. 2013, supplementary literature); thus, the location of foraging sites likely influences the growth rates of juveniles. Because there is strong overlap in foraging site used by different populations, genetics analyses should be made in parallel to studies on growth rates. Genetic sampling is required to distinguish origin, with skeletochronology being the advised method to assess growth rates (Demography Working Group 2015); although, this can only be done on dead individuals at present. Studies of growth rate and age at first maturity of loggerhead sea turtles of Mediterranean origin are needed in the Adriatic Sea, the Aegean Sea, the Libyan Sea, the Levantine Sea, the Tyrrhenian Sea and the Balearic Sea (Demography Working Group 2015).

Sex ratios of juveniles and adults (developmental and foraging grounds)

Estimates of juvenile and adult sex ratios at foraging grounds have been completed by only a few studies in the Mediterranean using capture-recapture or bycatch. Different adult sex ratios might be associated with different neritic areas; thus estimates should be made at the level first, then at regional level. Generally balanced adult sex ratios have been documented for adults, ranging from 40-60% female bias, while 52-60% female bias has been documented for females (for overview see Casale et al. 2014). Studies on adults have been limited to the central Mediterranean, Italy, Greece (north-west section of Amvrakikos Gulf) and the southeast Tyrrhenian Sea to date (Casale et al. 2005, 2014; Rees et al. 2013). For juveniles, studies have been conducted at sites in the northwest Mediterranean, southwest Adriatic, north-east Adriatic and southeast Tyrrhenian (Casale et al. 1998, 2006; Maffucci et al. 2013). Of note, satellite tracking studies indicate that male loggerheads that breed on Zakynthos (Greece) forage along the entire Peloponnese mainland, whereas most females migrate at least 100 km away from the site (up to 1000 km) (Schofield et al. 2013b); thus, the Peloponnese might exhibit a strong male bias in terms of foraging habitat use. Furthermore, within the breeding area of Zakynthos, resident males occupied distinctly different foraging sites compared to breeding females (Schofield et al. 2013a), showing that sex specific differences might even occur on very small scales.

Therefore, existing values on sex ratios should be treated with caution. For instance, satellite tracking studies of turtles from Zakynthos (Greece) to Amvrakikos Gulf (Greece) (Zbinden et al. 2011; Schofield et al. 2013b) showed that males and females forage in all parts of the gulf, with females particularly using the southern and south-western areas. However, the study by Rees et al. (2013) was focused in a north-west section of the gulf, and so is not necessarily representative of the male:female ratios of this foraging ground. Thus, extensive surveys are required in most areas of the Mediterranean, with clarification on the area sampled related to the region and justification of its representativeness.

Physical parameters (breeding and foraging grounds)

The carapace dimensions (curved [(CCL)] and straight [(SCL)] length and width [(CCW and SCW)]) tend to be measured in all programs that tag females on nesting beaches, as well as capture-recapture and bycatch studies of juveniles and adults in the marine environment. This information has shown that female loggerheads nesting in the Mediterranean are the smallest in the world, with those nesting on Cyprus being the smallest (Broderick and Godley 1996; Margaritoulis et al. 2003). However, variation in body size within populations has also been documented, and might be associated to foraging site use (Zbinden et al. 2011; Schofield et al. 2013b; Patel et al. 2015). For morphometric measurements across the different breeding sites see Casale & Margaritoulis (2010). Furthermore, capture-recapture studies of juvenile and adult turtles have shown that turtles in the Mediterranean mature at >70 cm CCL, respectively (Casale et al. 2005, 2013, Rees et al. 2013), with visual differentiation at <75-80 cm CCL (for smaller turtles, other techniques must be used to distinguish between males and females). However, White et al. (2013) found that in the Drini Bay population (Albania), tail elongation began at 60cm CCL. In Amvrakikos Gulf, which hosts loggerheads of similar demographic groups that also originate in Greek rookeries, tail elongation was considered to begin at 64.6 to 69.8cm CCL (Rees et al. 2013), with nesting females of 70 cm CCL regularly nest on beaches in Greece and Cyprus (Margaritoulis et al. 2003).

However, measures of biomass are less common, but are of importance. Furthermore, documenting the frequency of carapace injury to known individuals could provide an important means of inferring their exposure to boats. Indices of body fat status are rare (Heithaus et al. 2007). Furthermore, blood and tissue samples are only collected under certain conditions; thus, information on the actual health of individuals remains sparse. This information could be used for genetic analysis to determine the source population of individuals and stable isotope analyses to indicate general foraging areas used by the individuals.

Genetic parameters (breeding and foraging grounds)

A large quantity of genetic information has been collected on sea turtles in the Mediterranean; however, information at specific foraging and breeding grounds is required. This information could be applied towards distinguishing the breeding site origin of mixed foraging and developmental stocks.

At present, genetic studies indicate the existence of six distinct loggerhead populations in the Mediterranean: Libya, Dalyan, Dalaman, Calabria, Western Greece and Crete and the Levant (central and eastern Turkey, Cyprus, Israel and Lebanon, and possibly Egypt) (Carreras et al. 2014; Saied et al. 2012; Yilmaz et al. 2012; Clusa et al. 2013; Demography Working Group 2015). In contrast, turtles nesting in Tunisia are not genetically distinct (Chaieb et al. 2010). No major genetic structuring has been detected for green turtles in the Mediterranean to date; however, as analyses evolve, updates may arise (Tikochinski et al. 2012).

Genetic analyses (e.g. mixed stock analysis and microsatellites) has shown the origin of turtles recorded at several Mediterranean foraging grounds (Maffucci et al. 2013; Giovannotti et al. 2010; Carreras et al. 2014; Yilmaz et al. 2012; Garofalo et al. 2013; Clusa et al. 2013). When combined with tracking datasets, these data reinforce the fact that turtles from different populations mix in the same foraging grounds (see Schofield et al. 2013b for overview; and details in Indicator 1).

However, at present it is difficult to assign individuals of unknown origin to distinct nesting populations using current genetic markers. Future studies need to build on this issue.

Furthermore, it is important to establish the genetic diversity within breeding populations, for both males and females, to evaluate health and potential changes in status. It is generally assumed that females and males return to breed at natal sites (Bowen et al. 2004). However, males have been shown to frequent multiple sites during the breeding period (Schofield et al. 2013; Casale et al. 2013). Moreover, genetic studies indicate high levels of multiple paternity on Zakynthos, which might be a mechanism to help enhance the genetic diversity of the population (Lee et al. in submission); although further examination of this phenomenon across different populations with different ratios of males and females and encounter rates (linked to how aggregated populations are) is needed.

Mortality including bycatch (breeding and foraging grounds)

Several countries in the Mediterranean have stranding networks and rescue centres (MEDASSET 2016). Gaps exist in the Middle East and North Africa. Within this framework, genetic, blood and tissue samples are collected, as well as information on animal morphometrics, including skeletochronology, and cause of trauma. However, strandings represent a minimum estimate of mortality because carcasses decompose rapidly while drifting in currents and eddies and eventually sink (Epperly et al., 1996; Hart et al. 2006); consequently, many dead turtles probably never reach shore. By-catch information from different regions of the Mediterranean has been assimilated (for details see Demography Working Group 2015). Casale (2011) suggesting more than 132,000 incidental captures per year in the Mediterranean, of which more than 44,000 are predicted to be fatal; however, current knowledge on post-release mortality is restricted and needs further quantification (Álvarez de Quevedo et al. 2013). Of note, at least, 50% of small scale fisheries fleets are concentrated in the Aegean Sea, Gulf of Gabès, Adriatic and Eastern Ionian Sea, which represent the four major foraging grounds for loggerhead and green turtles in the region (for details see Demography Working Group 2015).

CONCLUSIONS

Conclusions (brief)

At present our knowledge on sea turtle demography is patchy at best for each component, with certain information being more widely available than other information. To understand the demography of loggerhead and green turtle populations in the Mediterranean, greater effort needs to be placed on filling existing gaps. Only then can we predict with any certainty the future viability of sea turtle populations in the Mediterranean.

Conclusions (extended)

Key messages

This general overview, indicates that at present our knowledge on sea turtle demography is patchy at best for each component and that effort needs to be placed on filling existing gaps in order to predict with any certainty the future viability of sea turtle populations in the Mediterranean.

Knowledge gaps

- Knowledge on the sex ratios within different components (breeding, foraging, wintering, developmental habitats), age classes and overall within and across populations.
- Knowledge about recruitment and mortality into different components of the population
- Knowledge about the physical and genetic health status of these groups.
- Vulnerability/resilience of these populations/sub-populations in relation to physical pressures;
- Analysis of pressure/impact relationships for populations/sub-populations and definition of qualitative GES;
- Identification of extent (area) baselines for each population/subpopulation and the habitats they encompass;
- Monitor and assess the impacts of climate change on offspring sex ratios.

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Ecological Objective 1 (EO1): Biodiversity

Note: The maps and illustrations are provisional

EO1: Common Indicator 5: Population demographic characteristics (e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates related to Seabirds)

GENERAL

Reporter:	SPA/RAC
Geographical scale of the assessment:	Regional, Mediterranean Sea
Contributing countries:	
Mid-Term Strategy (MTS) Core Theme	2-Biodiversity and Ecosystems
Ecological Objective	EO1: Biological diversity is maintained or enhanced. The quality and occurrence of coastal and marine habitats and the distribution and abundance of coastal and marine species are in line with prevailing physiographic, hydrographic, geographic and climatic conditions.
IMAP Common Indicator	Common Indicator 5 (CI5): Population demographic characteristics (EO1, e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates related to seabirds)
Indicator Assessment Factsheet Code	EO1CI5

RATIONALE/METHODS

Background (short)

A proper knowledge of the demography of seabirds is important to understand their population dynamics and trends, and to put any threat in context. This is particularly relevant for the most “secretive species”, particularly the shearwaters, for which reliable information on population size is most often either unavailable or unreliable, and the only way to assess trends is through demographic studies. These are also species with particularly low flexibility on breeding performance, as they only lay one egg (compared to the shag, gulls and terns, which usually lay 2-3+ eggs), and are highly philopatric (so they cannot change their breeding location from one year to the other). Therefore they have limited buffer mechanisms to face adverse conditions, particularly to compensate increases of mortality, which is their most sensitive demographic parameter. On the other hand, their large foraging ranges do provide some buffering ability to react against local food shortages, as they can search a huge area in search of food.

Background (extended)

Assessment methods

The basic methodology to gain information on seabird demography consists on the regular monitoring of nests at their colonies, coupled with ringing schemes and capture-recapture studies. In this case it is easier to monitor shearwaters, as they often breed in well-defined nests where it is easy to capture and ring both the adults and their chick, and adults are highly faithful to the same colony (and usually also the same nest) year after year. This allows to easily get information on breeding success (as the chicks remain at the nest until fledging) and, after a few years, other demographic parameters such as adult survival, age of recruitment, rate of sabbatical years, etc. These demographic parameters can be then used to model population trends, and to identify the most sensitive parameters influencing such trends. A similar approach may be used with shags, although nests tend to be even less accessible, and adults are difficult to capture. For a proper monitoring scheme, at least 2 visits per year should be conducted (incubation + chick-rearing periods) to ensure the assessment of breeding success, the ringing of chicks and the ringing/control of adults.

The gulls and terns present more difficulties, as they tend to nest in densely aggregated colonies and it is difficult to associate any nest with their adults and chicks. Moreover, adult birds can change their breeding location from one year to another. However, with some dedicated effort it is possible to assess breeding success (e.g. by fencing some areas and counting how many chicks fledge relative to the number of nests), and ringing schemes may allow to estimate other demographic parameters, particularly when using darvic rings that can be read at some distance.

Information from colonies may be complemented with data from other sources, particularly from ringed birds: sightings outside the colony, corpses collected by recovery centers (providing information on causes of mortality), bycatch information, etc.

RESULTS

Results and Status, including trends (brief)

Results and Status, including trends (extended)

Information on seabird demographic parameters is scarce and very sparse in the Mediterranean region. For most species there is some available information on productivity (breeding success and average number of chicks fledged per pair), whereas there is far less information for demographic parameters that require quality data and elaborate analysis (e.g. survival). Results provided here focus on the two shearwater species, as this type of information is essential to understand their population dynamics. In both cases adult survival is the most sensitive parameter, and current estimates are well below the expected rates. Ongoing threats causing adult mortality, such as predation by introduced species and fishing bycatch, thus deserve urgent attention to ensure the long-term viability of these populations. Of the remaining species, the best studied case is that of Audouin’s gull, where the regular census of most colonies and the establishment of a long term colour-ringing scheme in the region have facilitate high quality studies, particularly in the western sub-region.

Balearic shearwater. This species poses a good example of how demographic data can help understanding the population dynamics of certain seabird species with more reliability than census data. Indeed, as nests are difficult to locate, and many of them remain inaccessible, estimating the breeding population of such a species requires the use of indirect methods, often subject to high potential biases, such as raft counts at sea, habitat mapping and vocalisation rates at the colonies. Using a combination of these approaches, the estimate for the breeding population of Balearic shearwaters has ranged from about 1,700 to 4,500 breeding pairs in the last 30 years, with no clear trends (Ruiz & Martí 2004, Arcos 2011). Moreover, recent estimates at sea suggest that the global population might approach 25,000 individuals (Arcos *et al*. 2012b, Arroyo *et al*. 2014), which suggests an even larger breeding population, up to possibly 7,000 breeding pairs (Genovart *et al*. 2016). These last figures led to criticize the global status of the species, which was based on a population viability analysis conducted in 2004 under the assumption that the breeding population was of 2,000 breeding pairs. However, a review of the demographic analysis, with updated information and improved analytical tools, showed an even sharper decline than previously expected, of 13% per year, and set the average extinction time of the species in 60 years (Genovart *et al*. 2016). Such an assessment would have been not possible without a demographic approach, and the species might still be regarded as in good shape if it were for population counts alone.

The available demographic information for the species is very limited, however, and efforts should be directed to ensure the establishment of breeding monitoring programmes in a few representative colonies. Current work in Ibiza, Cabrera and Formentera might make help attaining this objective in the near future. So far information on breeding success is available for several colonies, ranging from 0.33 to 1.00 chicks fledged/year, with average values around 0.60-0.70 (out of a unique egg laid, as occurs with all shearwaters). On the other hand, other parameters more difficult to estimate come from a unique colony in Mallorca, Sa Cella, where adult survival is estimated at 0.81, immature survival at 0.43, the rate of sabbaticals is of 0.26, and age of breeding recruitment is concentrated between 3 and 6 years. This colony is free of predators, so demographic estimates out of there should be taken as “optimistic”, as some colonies do have predators (rats, cats and others). This also suggests that the main mortality occurs at sea, where bycatch is the main concern (ICES 2013, Genovart *et al*. 2016).

Yelkouan shearwater. For this species there is very limited information on demography, mainly from Malta and France (Oppel *et al*. 2011, Borg *et al*. 2016, Gaudard 2017). Adult survival for Malta has been estimated at 0.74, whereas in France there are interesting differences between breeding birds (0.82) and non-breeding adult birds (0.95), suggesting that breeding represents a burden (which could be related with predation, but also with added foraging effort at sea and/or segregation leading to differential bycatch risk). Breeding success has been reported to be influenced by rats throughout; in Italy, this parameter ranged from 0.09 to 0.41 in islands with rats, and 0.75-0.90 in islands where rats had been eradicated (Gaudard 2017).

Audouin’s gull. For this species, demographic studies conducted in the Mediterranean region, particularly in the western sub-region, have allowed to study in depth several aspects of seabird ecology, including the relative influence of different factors on the breeding performance, survival and dispersal rates of birds (e.g. Oro *et al*. 1999, Oro & Pradel 2000, Oro & Ruxton 2001, Oro *et al*. 2004). Current work is being directed at understanding the recent disaggregation of the Spanish colonies, resulting in the colonisation of sub-optimal areas such as ports. On the other hand, the species is undergoing a steady decline in the eastern sub-region, including low breeding success, which has declined from 0.9 cicks per pair in 1997 to 0.3-0.4 chicks per pair afterwards (Saravia-Mullin *et al*. 2012).

CONCLUSIONS

Conclusions (brief)

Information for this common indicator is far scarcer than that for common indicators 3 (distribution) and 4 (population size). However, for some species this type of information is essential to properly understand population trends, as well as to assess the relevance of different threats in context. This is particularly so for the Procellariiformes, represented here by the Balearic and Yelkouan shearwaters. The good news is that collecting this type of information might be quite simple and less resource-consuming than conducting exhaustive population counts. It only requires of the selection of a few, representative colonies where breeding monitoring schemes could be conducted on a year-basis. These schemes would require the follow-up of standard protocols that might be simple enough, with 2-3

visits per year to ensure the assessment of breeding success, the ringing of chicks and the ringing/control of adults. The very limited schemes in place suggest that both shearwaters are undergoing a severe decline.
For the remaining species, although population counts already provide relevant information, it is important to systematically collect demographic data as to better understand their population dynamics, and to put the different threats that they face in context. Colour-ringing schemes such as that of Audouin's gull, coupled with the detailed monitoring of a few, representative breeding colonies might provide high quality data on this regard. In addition, a systematic compilation of information from dead birds, particularly from wildlife recovery centres, might greatly help to understand the impact of different threats.

Conclusions (extended)

Key messages

Demographic information is essential to properly assess the trends of certain seabirds, particularly shearwaters.

The limited information available for Balearic and Yelkouan shearwaters suggests that both species are undergoing a severe decline, which threatens them with extinction. Introduced predators and fishing bycatch deserve particular attention on this regard.

Knowledge gaps

Information on seabird demographic parameters is extremely scarce in the Mediterranean region, with the exception of Audouin's gull. It is essential to set in place breeding monitoring programmes, particularly for the Balearic and Yelkuoan shearwaters, as well as ensure the continuity of the few already existing. Special attention must also be paid to their main threats, particularly predation by introduced mammals in the colonies and fishing bycatc at sea.

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Ecological Objective 2 (EO2): Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystem.

Note: The maps and illustrations are provisional

EO2: Common Indicator 6: Trends in abundance, temporal occurrence, and spatial distribution of non-indigenous species, particularly invasive, non-indigenous species, notably in risk areas (EO2, in relation to the main vectors and pathways of spreading of such species

GENERAL

Reporter: SPA/RAC

Geographical scale of the assessment: Regional, Mediterranean Sea

Contributing countries:

Mid-Term Strategy (MTS) Core Theme 2-Biodiversity and Ecosystems

Ecological Objective EO2: Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystem.

IMAP Common Indicator Common Indicator 6 (CI6): Trends in abundance, temporal occurrence, and spatial distribution of non-indigenous species, particularly invasive, non-indigenous species, notably in risk areas (in relation to the main vectors and pathways of spreading of such species)

Indicator Assessment Factsheet Code EO2CI6

RATIONALE/METHODS

Background (short)

Work undertaken to define indicators, key pressures and drivers

The February 2014 Integrated Correspondence Group on GES and Targets (Integrated CorGest) of the EcAp process of the Barcelona Convention selected the Common Indicator 6 “Trends in the abundance, temporal occurrence and spatial distribution of non-indigenous species particularly invasive non-indigenous species, notably in risk areas in relation to the main vectors and pathways of spreading of such species” from the integrated list of indicators adopted in the 18th Conference of the Parties (COP 18), as a basis of a common monitoring program for the Mediterranean in relation to non-indigenous species. The Integrated Monitoring and Assessment Programme (IMAP), adopted at the 19th Conference of the Parties to the Barcelona Convention (COP 19) in Athens, included definitions of ecological objectives, operational objectives and related indicators for the implementation of the EcAp, as well as guidelines for monitoring to address Common Indicator 6.

Four main pathways, i.e. the Suez Canal, shipping, aquaculture, and aquarium trade, were identified as the main drivers of species introduction in the Mediterranean.

Policy context and targets

The CBD's Aichi Biodiversity Target 9 is that "by 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment". This is also reflected in Target 5 of the EU Biodiversity Strategy (EU 2011). The new EU Regulation 1143/2014 on the management of invasive alien species seeks to address the problem of IAS in a comprehensive manner so as to protect native biodiversity and ecosystem services, as well as to minimize and mitigate the human health or economic impacts that these species can have. The Regulation foresees three types of interventions: prevention, early detection and rapid eradication, and management.

The Marine Strategy Framework Directive (MSFD) specifically recognizes the introduction of marine alien species as a major threat to European biodiversity and ecosystem health, requiring EU Member States to include alien species in the definition of GES and to set environmental targets to reach it. Hence, one of the 11 qualitative descriptors of GES defined in the MSFD is that "non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystem" (Descriptor 2). Among the indicators adopted to assess this descriptor are "trends in abundance, temporal occurrence and spatial distribution in the wild of non-indigenous species, particularly invasive non-indigenous species, notably in risk areas, in relation to the main vectors and pathways of spreading of such species". Ecological Objective 2 and the Common Indicator 6 are in agreement with the MSFD objectives and targets.

Background (extended)

Assessment methods

To estimate Common Indicator 6, a trend analysis (time series analysis) of the available monitoring data needs to be performed, aiming to extract the underlying pattern, which may be hidden by noise. A formal regression analysis is the recommended approach to estimate such trends. This can be done by a simple linear regression analysis or by more complicated modelling tools (when rich datasets are available), such as generalized linear or additive models.

To monitor trends in temporal occurrence, two indicators are estimated on a yearly basis. The first is about the number of non-indigenous species at the current year that were not present at the previous year. To calculate this indicator the non-indigenous species lists of both years are compared to check which species were recorded in year n, but were not recorded in year n-1 regardless of whether or not these species were present in earlier years. The second indicator is estimated as the total number of known non-indigenous species at Tn minus the corresponding number of non-indigenous species at Tn-1, where Tn stands for the year of reporting.

It is recommended to use standard monitoring methods traditionally being used for marine biological surveys, including, but not limited to plankton, benthic and fouling studies described in relevant guidelines and manuals. Standard methods for monitoring marine populations include plot sampling, distance sampling, mark-recapture, removal methods, and repetitive surveys for occupancy estimation. As a complimentary measure and in the absence of an overall IAS NIS targeted monitoring programme, rapid assessment studies may be undertaken, usually but not exclusively at marinas, jetties, and fish farms. The compilation of citizen scientists input, validated by taxonomic experts, can be useful to assess the geographical ranges of established species or to early record new species.

RESULTS

Results and Status, including trends (brief)

Results and Status, including trends (extended)

Two basin-wide inventories of the marine alien species of the Mediterranean have been published the last years, by Zenetos et al. (2010, 2012) and Galil (2012). Furthermore, many national lists of marine alien species have been published in the scientific literature, most of them the last decade, including Croatia, Cyprus, Greece, Israel, Italy, Libya, Malta, Slovenia, and Turkey.

All known alien species introductions have been compiled in the Marine Mediterranean Invasive Alien Species online database (MAMIAS; www.mamias.org), developed by RAC/SPA in collaboration with the Hellenic Centre for Marine Research (HCMR). According to MAMIAS, 1057 non-indigenous species have been reported in the Mediterranean Sea (excluding vagrant species and species that have expanded their range without human assistance through the Straits of Gibraltar), of which 618 are considered as established. Of those established species, 106 have been flagged as invasive. Among the four Mediterranean sub-regions, the highest number of established alien species has been reported in the eastern Mediterranean, whereas the lowest number in the Adriatic Sea (Table 1).

In terms of alien species richness, the dominant group is Mollusca, followed by Crustacea, Polychaeta, Macrophyta, and Fish (Fig. 1). The taxonomic identity of alien species differs among the four sub-basins, with macrophytes being the dominant group in the western and central Mediterranean and in the Adriatic Sea (Table 1).

Table 1: Summarized information for each Mediterranean sub-region about the status of alien invasions. Sources: MAMIAS, Zenetos et al. (2012)

	Eastern Mediterranean	**Central Mediterranean**	**Adriatic**	**Western Mediterranean**
number of established alien species	468	183	135	215
most important pathway of introduction	Suez Canal	shipping	shipping	shipping
2nd most important pathway	shipping	Suez Canal	aquaculture	aquaculture
richest taxons in alien biota	Mollusca, Crustacea	Macrophyta, Polychaeta	Macrophyta, Mollusca	Macrophyta, Crustacea
trend in the rate of new introductions (based on the last 3 decades)	increasing	decreasing	decreasing	decreasing

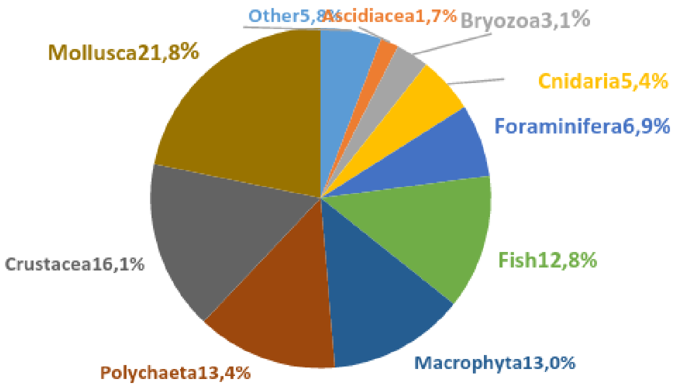

Figure 1: Contribution of the major taxa in the alien marine biota of the Mediterranean Sea. Modified from Zenetos et al. (2012).

Alien species in the Mediterranean Sea are linked to four main pathways of introduction: the Suez Canal, shipping (ballast waters and hull fouling), aquaculture, and aquarium trade. Overall in the Mediterranean, the Suez Canal is the most important pathway, contrary to the situation in Europe, where shipping is the most important (Fig. 2). Nevertheless, the importance of pathways varies among the four Mediterranean sub-regions, with shipping being the most important pathway in the western and central Mediterranean and the Adriatic (Table 1). An assessment of the 'gateways' (i.e. countries of initial introduction) to alien invasions in the European Seas (Nunes et al. 2014) revealed marked geographic patterns depending on the pathway of introduction. The Suez Canal was the predominant pathway of first introductions in Egypt, Lebanon, Israel, Syria and the Palestine Authority (all in the eastern Mediterranean), representing more than 70% of each country's first introduction events. For the other Mediterranean countries, shipping was the predominant pathway of initial introduction.

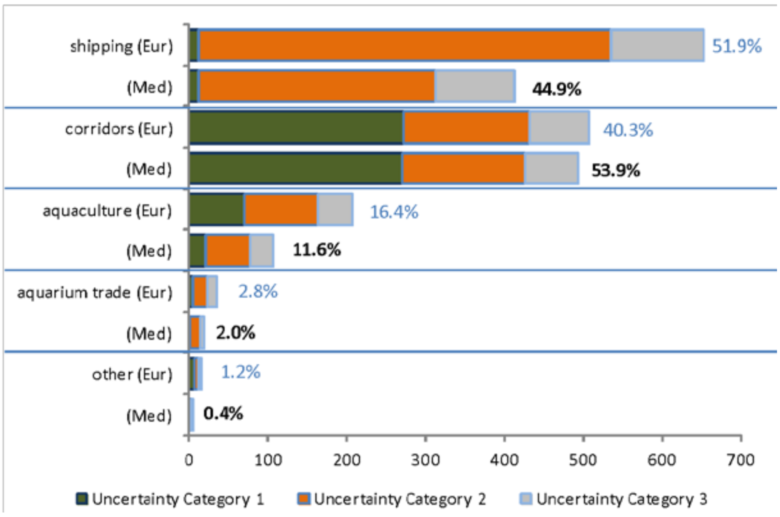

Figure 2: Number of marine alien species known or likely to have been introduced by each of the main pathways, in Europe (Eur) and the Mediterranean (Med). Percentages add to more than 100% as some species are linked to more than one pathway (blue percentages refer to the European total, while black percentages to the Mediterranean total). Uncertainty categories: (1) there is direct evidence of a pathway/vector; (2) a most likely pathway/vector can be inferred; (3) one or more possible pathways/vectors can be inferred; (4) unknown (not shown in the graph). Modified from Katsanevakis et al. (2013), Zenetos et al. (2012).

New introductions of alien species in the Mediterranean Sea have an increasing trend in the rate of new introductions by 30.7 species per decade, and the current (as of the 2000s) rate of new introductions exceeds 200 new species per decade (Fig. 3).

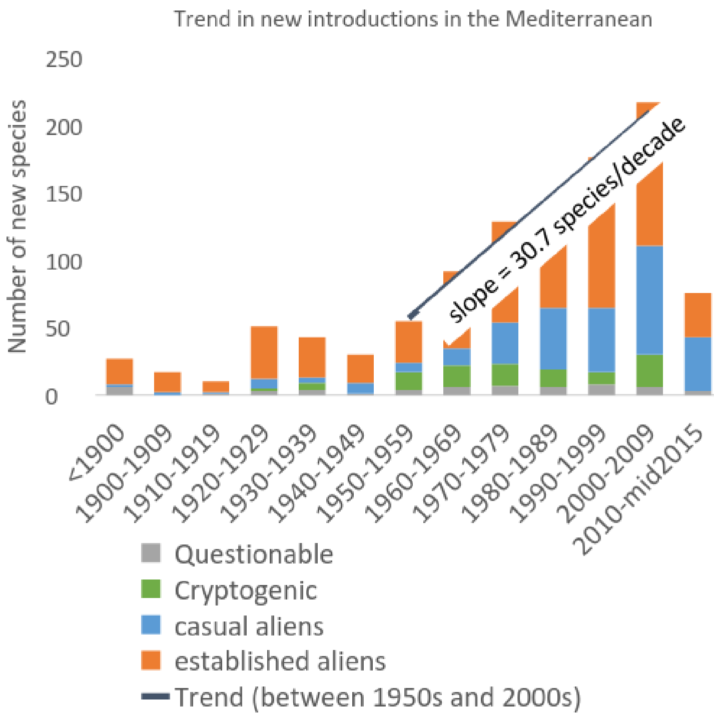

Figure 3: Trend in new introductions of alien marine species per decade in the Mediterranean Sea. Source: MAMIAS

However, this increasing trend in the rate of new introductions mainly reflects new introductions in the eastern Mediterranean, while in the other sub-regions the rate of new introductions is decreasing (Fig. 4).

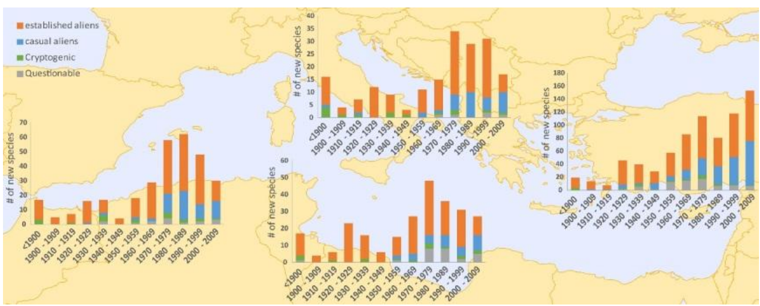

Figure 4: Trend in new introductions of alien marine species per decade in the Mediterranean sub-regions (eastern, central, western Mediterranean, and Adriatic Sea). Source: MAMIAS

The cumulative impact of alien species on the Mediterranean marine habitats was recently assessed and mapped, using the CIMPAL index, a conservative additive model, based on the distributions of alien species and habitats, as well as the reported magnitude of ecological impacts and the strength of such evidence (Katsanevakis et al. 2016). The CIMPAL index showed strong spatial heterogeneity, and impact was largely restricted to coastal areas (Fig. 5).

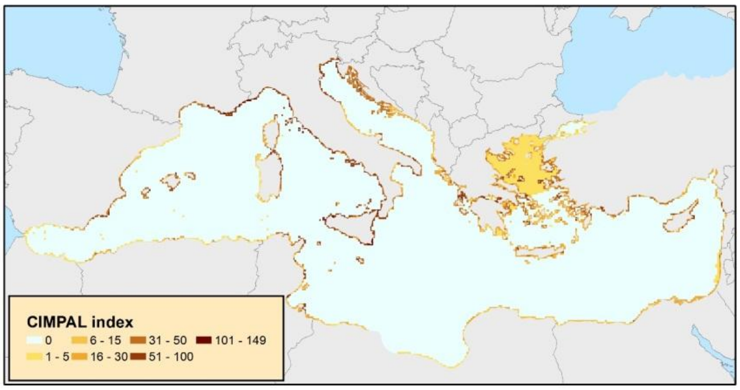

Figure 5: Map of the cumulative impact score (CIMPAL) of invasive alien species to marine habitats. Modified from Katsanevakis et al (2016).

CONCLUSIONS

Conclusions (brief)

Important progress has been made the last decade in creating inventories of non-indigenous species (NIS), and on assessing pathways of introduction and the impacts of invasive alien species on a regional scale. The development and regular updating of MAMIAS substantially contributes to address Common Indicator 6.

Nevertheless, research effort currently greatly varies among Mediterranean countries and thus on a regional basis current assessments and comparisons may be biased.

Conclusions (extended)

Key messages

- Progress has been made in creating national and regional inventories of alien species and assessing their pathways and impacts
- There is an increasing trend in the rate of new alien species introductions in the Mediterranean Sea, in particular in the eastern basin.
- The Suez Canal is the most important pathway of new introductions in the Mediterranean, followed by shipping and aquaculture

Knowledge gaps

Evidence for most of the reported impacts of alien species is weak, mostly based on expert judgement; a need for stronger inference is needed based on experiments or ecological modelling. The assessment of trends in abundance and spatial distribution is largely lacking. Regular dedicated monitoring and long time series will be needed so that estimation of such trends is possible in the future. NIS identification is of crucial importance, and the lack of taxonomical expertise has already resulted in several NIS having been overlooked for certain time periods. The use of molecular approaches including bar-coding are often needed to confirm traditional species identification.

List of references

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Zenetos A, Gofas S, Morri C, Rosso A, Violanti D, *et al*, 2012. Alien species in the Mediterranean Sea by 2012. A contribution to the application of European Union's Marine Strategy Framework Directive (MSFD). Part 2. Introduction trends and pathways. *Mediterranean Marine Science* 13(2): 328–352.

Annex I
List of Case Studies for the Ecological Objectives 1 (Biodiversity), and 2 (Non-Indigenous Species)

The Annex I provides the list of Case Studies that have been submitted by Contracting Parties and Partners for the Ecological Objectives 1 (Biodiversity), and 2 (Non-Indigenous Species). **The Case Studies are in the process of editing.**

EO1	**Title**	**Contracting Parties, Partners**	**Authors and Affiliation**
1	Case study of bottlenose dolphins of the Gulf of Ambracia, Western Greece: high dolphin density not a synonymous of good conservation status	Greece and SPA/RAC	Author: Joan Gonzalvo; Director Ionian Dolphin Project, TETHYS RESEARCH INSTITUTE, Italy
2	Cuvier's Beaked whale, Ziphius cavirostris, distribution and occurrence in the Italian waters of the Pelagos Sanctuary (NW Mediterranean sea), a key area for the species in the Mediterranean sea	Italy	Massimiliano Rosso (PhD), Paola Tepsich (PhD) and Aurelie Moulins (PhD) CIMA Research Foundation, Via Magliotto 2 - 17100 Savona, Italy. www.cimafoundation.org
3	Overview of the assessment of the Common Indicator 1: Habitat distributional range (EO1), based on CAMP assessments results for Montenegro and EcAp/MSP Boka Kotorska Bay pilot project	Montenegro	Jelena Knezević, MAP Focal Point, Ministry of Sustanible Development and Tourism; Milena Bataković, SPA/RAC FP, Environmental Protection Agency of Montenegro; Ivana Stojanović, assistant to MAP FP, Ministry of Sustainable Development and Tourism
4	Population demographic characteristics (EO1, e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates related to marine mammals, seabirds, marine reptiles)	Tunisia and SPA/RAC	SPA/RAC
EO2	**Title**	**Contracting Parties, Partners**	**Authors and Affiliation**
1	Invasive versus native bottom-trawl fish species diversity and population dynamic at the soft-bottom habitats of the Southeastern Mediterranean coast of Israel.	Israel	Nir Stern, PhD, Israel Oceanographic and Limnological Research (IOLR) Hadas Lubinevsky, PhD, Israel Oceanographic and Limnological Research Dror Zurel, PhD, Marine Monitoring and research Coordinator, Israel Ministry of Environmental Protection, Marine Environment Protection Division. Prof' Barak Herut, PhD, Israel Oceanographic and Limnological Research

UNITED NATIONS

EP

UNEP(DEPI)/MED WG.444/10

UNITED NATIONS ENVIRONMENT PROGRAMME MEDITERRANEAN ACTION PLAN

11 July 2017
Original: English

6th Meeting of the Ecosystem Approach Coordination Group

Athens, Greece, 11 September 2017

Agenda item 4: Review of Quality Status Report (QSR)

Quality Status Report (QSR) Fact Sheet Assessment (Coast and Hydrography)

UNEP/MAP
Athens, 2017

Ecological Objective 7 (EO7): Hydrography

Note: The maps and illustrations are provisional.

EO7: Location and extent of the habitats impacted directly by hydrographic alterations

GENERAL

Reporter:	PAP/RAC
Geographical scale of the assessment:	
Contributing countries:	
Mid-Term Strategy (MTS) Core Theme	3-Land and Sea Interaction and Processes
Ecological Objective	Ecological Objective 7(EO7): Alteration of hydrographical conditions
IMAP Common Indicator	Common Indicator 15 (CI15): Location and extent of the habitats impacted directly by hydrographic alterations
Indicator Assessment Factsheet Code	EO7CI15

RATIONALE/METHODS

Background (short)

Large-scale coastal and off-shore developments have the potential to alter the hydrographical regime of currents, waves and sediments in marine environment (UNEP/MAP/PAP, 2015).

To address these issues, UN Environment/MAP has included the Ecological Objective 7 ("Alteration of hydrographical conditions") into the Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Sea and Coast (UNEP(DEPI)/MED IG.22/Inf.7, 2016) . EO7's Common Indicator 15 - 'Location and extent of habitats impacted directly by hydrographic alterations' considers marine habitats which may be affected or disturbed by changes in hydrographic conditions due to new developments. The main target of this indicator is to ensure that all possible mitigation measures are taken into account when planning the construction of new structures, in order to minimize the impact on coastal and marine ecosystem and its services, integrity, and cultural/historic assets. The Good Environmental State (GES) regarding EO7 Hydrography is achieved when negative impacts due to new structures are minimal with no influence on the larger scale coastal and marine systems.

There are clear links between EO7 and other ecological objectives, especially EO1 (Biodiversity), and these need to be determined on a case-by-case basis.

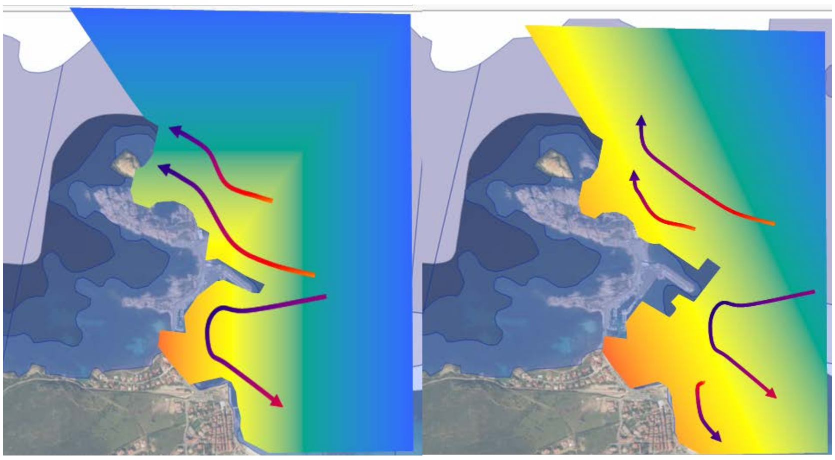

Figure 1. Illustration of hydrodynamic conditions without and with structure (image developed and provided by O. Brivois)

Background (extended)

Ecological Objective 7 is dedicated to assess permanent alterations in the hydrographic conditions due to new developments. By definition the term ‘hydrography’ is meant to include depth, tidal currents and wave characteristics of marine waters, including the topography and morphology of the seabed.

EO7 Common Indicator 15 considers only new developments, since existing structures have already changed the hydrographic conditions and potentially impacted the habitats. Since the baseline conditions before the construction of existing structures are unknown, the monitoring of CI15 for existing structures is not possible.
There is a clear link between EO7 and other ecological objectives, especially EO1 (Biodiversity). By definition of functional habitats under EO1, the priority benthic habitats for consideration in EO7 are to be selected. Ultimately, the assessment of impacts, including cumulative impacts, is a cross-cutting issue for EO1 and EO7.

The guidance document on how to reflect changes in hydrographical conditions in relevant assessments was prepared in 2015, aiming to define a methodological approach for assessing alterations of hydrographical conditions and the impact this may have on habitats due to permanent constructions and activities on the coast or at sea (UNEP/MAP/PAP, 2015).

As for Protocols of the Barcelona Convention relevant for the EO7, the Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean (UNEP/MAP/PAP, 1999) calls to Contracting Parties of the Barcelona Convection for continuous monitoring of ecological processes, population dynamics, landscapes, as well as the impacts of human activities (Article 7b). In addition, it calls to Parties to evaluate and take into consideration the possible direct or indirect, immediate or long-term impacts, including the cumulative impact of the projects and activities, on protected areas, species and their habitats (Article 17).

Another Protocol of the Barcelona Convention, the Protocol on the Integrated Coastal Zone Management in the Mediterranean (UNEP/MAP/PAP, 2008), in its Article 9, calls for Parties to minimize negative impacts on coastal ecosystems, landscapes and geomorphology, coming from infrastructure, energy facilities, ports and maritime works and structures; or where appropriate to compensate these impacts by non-financial measures. In addition, the Article 9 demands maritime activities to be conducted “in such a manner as to ensure the preservation of coastal ecosystems in conformity with the rules, standards and procedures of the relevant international conventions“.

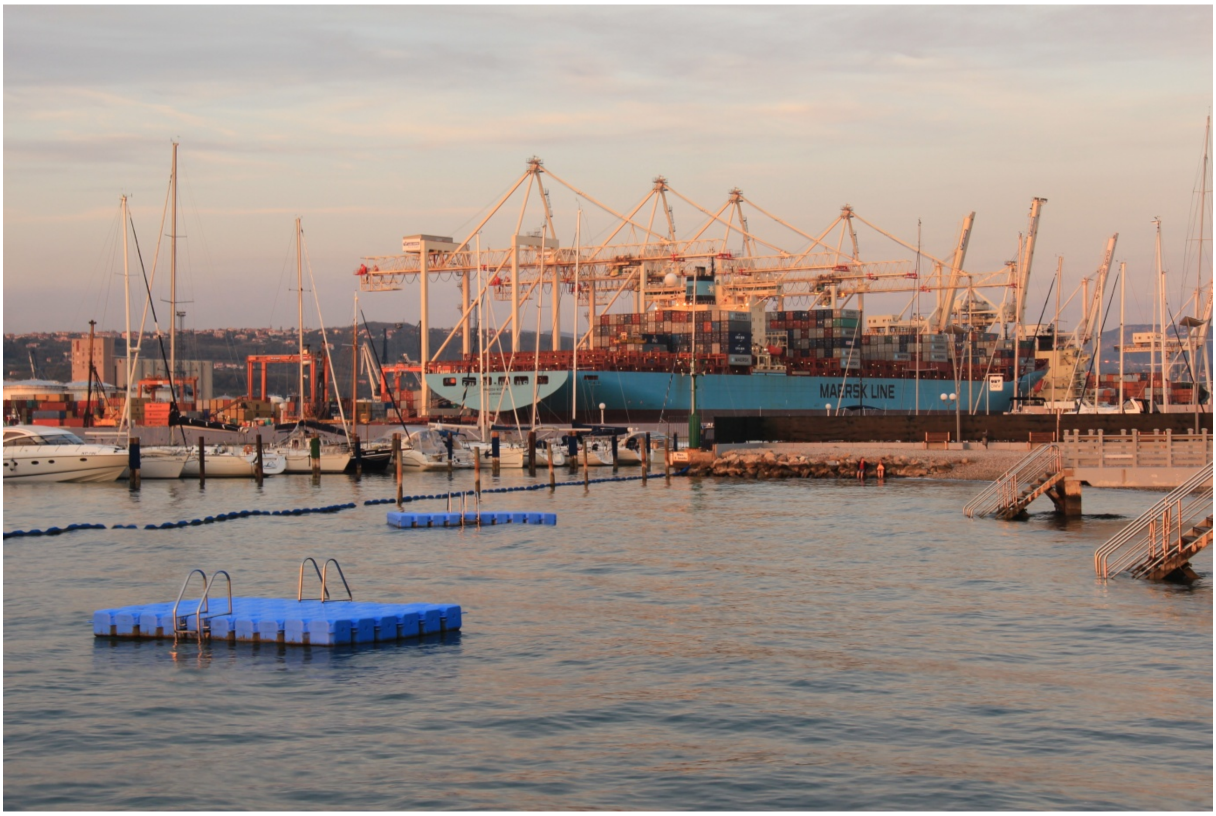

Photo by Marko Prem

Assessment methods

In brief, the methodology to assess the indicator can be divided in three main steps:

(i) Baseline hydrographical conditions characterisation (Monitoring and modelling of actual conditions without structure);

(ii) Assessment of hydrographical alterations induced by new structure (comparing baseline conditions and with structure conditions, using modelling tools); and

(iii) Assessment of habitats impacted directly by hydrographic alterations (by crossing hydrographical alterations and habitat maps).

Among hydrographical conditions, at least waves and currents changes should be assessed, with changes in sediment transport processes and turbidity in case of sandy sites, and salinity and/or temperature changes in case of structures that involve water discharge, water extraction or changes in fresh water movements.

The monitoring should focus on habitats of interest around new permanent constructions (lasting more than 10 years). At first, the spatial scale (in cross-shore and long-shore directions) to be used should be about 10 to 50 times the characteristic length of the structure, and should be enlarged depending on the first results obtained for this area.

To correctly assess changes in time on habitats induced by constructions, the monitoring should be performed: before construction (baseline conditions); during construction; and after construction - short term changes 0 to 5 years after (at least yearly up to 5 years), midterm changes 5 to 10 years after (at least biennium to 10 years), and long-term changes (10 to15 years after construction).

RESULTS

Results and Status, including trends (brief)

Since there was no systematic monitoring on this particular indicator on regional level until now, examples of intersection of modeled area of hydrographic alterations with habitat area were not found. The methodology applied in some partial examples consisted mostly in measurement of trends for certain hydrographic parameters (temperature, salinity, waves, currents, marine acidification etc.) and limited, mostly qualitative, analysis on impacts on habitats at a national level.

The data presented in the Extended section are mainly from the EU countries. It needs to be highlighted that the information presented here is extracted from technical assessment of the European Commission of submissions on Descriptor 7 by the EU countries. This information end up with 2012 and are not fully in line with the Indicator Guidance Fact Sheet for the CI15.

There are some partial information which are more in line with CI15 Guidelines fact sheets, but these surveys were done on much local scale and are presented as case studies (namely, LNG terminal in Monfalcone Port, Italy; and container terminal Haifa Bay in Israel)

Results and Status, including trends (extended)

A brief overview of initial assessments of the current environmental status of marine waters belonging to Mediterranean-based EU countries has been summarized here. It needs to be highlighted that the information presented here is extracted from technical assessment of the European Commission of submissions on Descriptor 7 by the EU countries. This information end up with 2012 and are not fully in line with the Indicator Guidance Fact Sheet for the CI15.

Nearly all of the EU Member States focused on coastal zones in their report, with most Member States (e.g. France, Greece, Italy Spain) expressed the readiness to address the existing knowledge gaps.

Many countries have focused on specific hydrographic parameteres, most of them on temperature and salinity (e.g. Croatia, Cyprus, Italy), while some countries also assessed other parameters such as wave/current regime (e.g. Malta, France) and marine acidification (e.g. Cyprus, Greece)

The proportion of the assessment area affected by hydrological processes was reported for some countries (Cyprus, Greece, Italy, Slovenia, Spain) although numbers quite varied due to the different methodologies used.

Some countries indicated different drivers behind pressures on hydrographic conditions (France, Greece, Malta, Slovenia). Some countries also estimated the impact of hydrographic alterations on marine habitats, such as Cyprus (impacts on macroalgae), Greece (impacts on seabed habitats), and Malta (impacts on algae and seagrass).

Photo by Marko Prem

CONCLUSIONS

Conclusions (brief)

The EO7 Common Indicator 15 reflects location and extent of the habitats impacted directly by hydrographic alterations due to new coastal structures. The big issue on deriving concluding remarks for this indicator on regional level is that the national monitoring programmes are currently being developed for most Mediterranean countries. Therefore, assessment results on this indicator (as proposed in indicator guidance fact sheet) were not found on national, nor regional level.

The findings here were mostly based on literature review of technical assessments on EU countries' reports on hydrographic alterations. However, these reports mainly focus on measurement of trends for certain hydrographic parameters, which is not completely in line with requirement for common Indicator 15. However, measurement of baseline hydrographic conditions can serve as a baseline for more detailed assessments in the future. Two local scale projects are presented as case studies namely, LNG terminal in Monfalcone Port, Italy; and container terminal Haifa Bay in Israel.

Conclusions (extended)

Key messages

- The EO7 Common Indicator 15 considers marine habitats which may be affected or disturbed by changes in hydrographic conditions (currents, waves, suspended sediment loads) due to new coastal structures;
- The national monitoring in Mediterranean countries regarding EO7 has not been initiated yet, or it is just being initiated;

- There is no sufficient data to derive conclusions/observe trends on Common Indicator 15 on regional, sub-regional or even national level.

Photo by Marko Prem

Knowledge gaps

There is a significant knowledge gaps on implementation of the Common Indicator 15. It is a complex and only introduced indicator. The knowledge gaps are mainly related to insufficient surveys and monitoring of this indicator on all geographical levels. Assessments that estimate the extent of hydrographic alterations (knowing conditions before and after construction) and its intersection with marine habitats are currently rare in the Mediterranean, except for some local studies of EIA/SEA.

Like everywhere, there is certainly a lack of hydrographic data in the Mediterranean Sea (bathymetric data, seafloor topography, current velocity, wave exposure, turbidity, salinity, temperature, etc.), which is one of the main problems to implement this indicator, in particular to define the base-line conditions. To identify these gaps, a clear inventory of existing and available data in Mediterranean Sea should be done.

Other difficulties come from the use of numerical model to assess hydrographic alterations before the structure is built. These tools need many data (bathymetry, offshore hydrodynamics data, field data); can be costly and time-consuming; and their use requiers experience and knowledge about the processes and theories involved.

The link to EO1 is so essential, as map of benthic habitats in the zone of interest (broad habitat types and/or particular sensitive habitats) is required. Therefore, identifying the priority benthic habitats for consideration in EO7 together assessment of impacts, including cumulative impacts, is a cross-cutting issue of high priority for EO1 and EO7. In addition, effort needs to be given to detect the cause-consequence relationship between hydrographic alterations due to new structures and habitat deterioration.

To conclude, such an integrated assessment of impacts calls for additional research efforts on habitat modeling, pressure mapping and cumulative impacts, along with monitoring of potentially affected areas.

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UNEP/MAP/PAP (2008) Protocol on the ICZM in the Mediterranean, Split, Priority Actions Programme, 2008. http://www.pap-thecoastcentre.org/pdfs/Protocol_publikacija_May09.pdf

UNEP/MAP/PAP (2015). Guidance document on how to reflect changes in hydrographical conditions in relevant assessment (prepared by Spiteri, C.). Priority Actions Programme. Split, 2015.

UNEP(DEPI)/MED IG.22/Inf.7 (2016). Draft Integrated Monitoring and Assessment Guidance

UNEP(DEPI)/MED WG.433/1 (2017) PAP/RAC Meeting of the Ecosystem Approach Correspondence Group on Monitoring (CORMON) on Coast and Hydrography – Working Document

Information used in "Key assessment" chapter:

For Cyprus, France , Greece, Italy, Slovenia and Spain: Article 12 Technical Assessments of the MSFD 2012 obligations (2014)

For Croatia: Institute for Oceanography and Fisgeries (2014) Skup značajki dobrog stanja okoliša za morske vode pod suverenitetom republike hrvatske i skup ciljeva u zaštiti morskog okoliša i s njima povezanih pokazatelja (in Croatian)

For Malta: Interference with Hydrological Processes (2013), retreived from http://rod.eionet.europa.eu, on 22 February, 2017

Ecological Objective 8 (EO8): Coastal Ecosystems and Landscapes

Note: The maps and illustrations are provisional.

EO8: Common Indicator 16: Length of coastline subject to physical disturbance due to the influence of manmade structures

GENERAL

Reporter: PAP/RAC

Geographical scale of the assessment: National: France, Italy, Montenegro

Contributing countries: France, Italy, Montenegro

Mid-Term Strategty (MTS) Core Theme: 3-Land and Sea Interaction and Processes

Ecological Objective Ecological Objective 8 (EO8): Coastal Ecosystems and Landscapes

IMAP Common Indicator Common Indicator 16 (CI16): Length of coastline subject to physical disturbance due to the influence of manmade structures

Indicator Assessment Factsheet Code EO8CI16

RATIONALE/METHODS

Background (short)

The Mediterranean coastline is approximately 46000 km long, with around 40% of the coastal zone being under some form of artificial land cover (Plan Bleu, 2005). Mediterranean coastal areas are threatened by development that modifies the coastline through the construction of buildings and infrastructure needed to sustain residential, tourism, commercial, transport and other activities. This kind of development can cause irreversible damage to landscapes; habitats and biodiversity; and shoreline configuration.
This EO does not have a precedent in other regional ecosystem approach initiatives, such as Helcom or OSPAR, neither in Marine Strategy Framework Directive.

The MAP emphasizes the integrated nature of the coastal zone, particularly through consideration of marine and terrestrial parts as its constituent elements required by the ICZM Protocol. The aim of monitoring the EO8 common indicator 16 “Length of coastline subject to physical disturbance due to the influence of manmade structures**”** is twofold: to quantify the rate and the spatial distribution of the Mediterranean coastline artificialisation; and to provide a better understanding of the impact of those structures to the shoreline dynamics.

GES for Common Indicator 16 can be achieved by minimizing physical disturbance to coastal areas close to the shoreline induced by human activities. Definition of targets, measures and interpretation of results regarding this common indicator is left to the countries, due to strong socio-economic, historic and cultural dimensions in addition to specific geomorphological and geographical conditions.

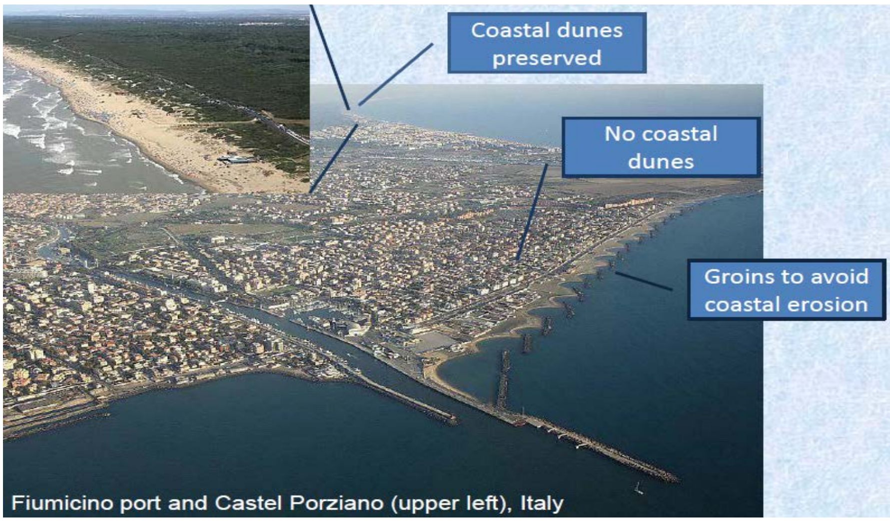

Figure 1. Example of urbanized coastline (photo provided by G.Giorgi)

Background extended

The land, inter-tidal zone and near-shore estuarine and marine waters in Mediterranean are increasingly altered by the loss and fragmentation of natural habitats and by the proliferation of a variety of built structures, such as ports, marinas, breakwaters, seawalls, jetties and pilings. These coastal manmade infrastructures cause irreversible damage to landscapes, losses in habitat and biodiversity, and strongly influence the configuration of the shoreline. Indeed, physical disturbance in particular in sandy coasts due to the development of artificial structures in the coastal fringe can disrupt the sediment transport, reduce the ability of the shoreline to respond to natural forcing factors, and fragment the coastal space. The modification of emerged beach and elimination of dune system contribute to coastal erosion phenomena by lessening the beach resilience to sea storms. Coastal defence infrastructures have been implemented to solve the problem together with beach nourishment, but preserving the natural shoreline system with adequate sediment transport from river has proved to be the best solution.

Around 40% of Mediterranean coastal zone is already under some form of artificial land cover. This share is expected to grow, especially since urban population in Mediterranean coasts is expected to grow to 90 million in 2025, compared to 70 million in 2000 (Plan Bleu, 2005). In addition, importance of tourism in these areas should be considered as well, since tourists can double the number of permanent dwellers in peak periods in some areas. That is why construction of holiday homes is one of the important drivers of land consumption.

In Mediterranean, the linear nature of coastal urbanization and the speed of the phenomenon is significant (Plan Bleu, 2005). The consequence of the growth in population growth, infrastructure and facilities results in increase in artificial land cover in the coastal zone. Monitoring the length of coastline subject to physical disturbance due to the influence of manmade structures and its trend is therefore of paramount importance, in order to preserve habitat, biodiversity and prevent coastal erosion phenomena. Also, access to the coast, beaches, visual qualities of coastal landscapes, decreasing potentials for other users to develop, such as tourism etc. are important elements to take into account.

The EO8 also reflects the aim of the Barcelona Convention to include coastal areas in the assessment, which became a legal obligation upon the entry into force of its Protocol on Integrated Coastal Zone in the Mediterranean (ICZM Protocol). In the Article 16 of the Protocol, the Contracting Parties are required to “set out an agreed reference format and process to collect appropriate data in national inventories“regarding the state and evolution of coastal zones.

Photo by Marko Prem

Assessment methods

Monitoring of the EO8 Common Indicator 16 focuses on measuring the length of artificial coastline and its share in total country's coastline, on a proper geographical scale. An example of artificial vs. natural coastline can be seen in example on breakwaters in Figure 2.

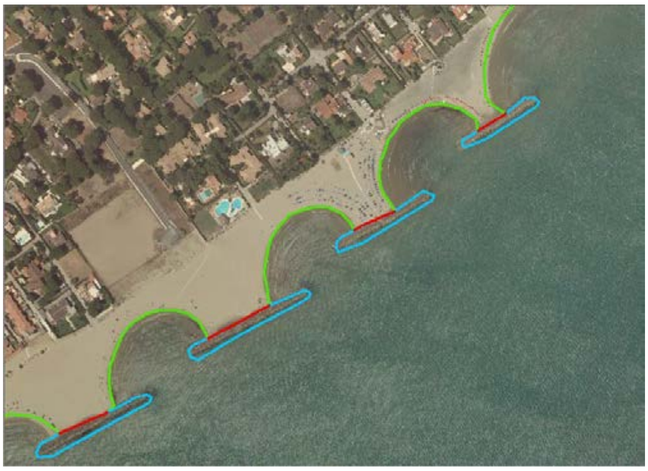

Figure 2. Image showing coastal defence structure (blue), artificial coastline (red) and natural coastline (green) (image developed by G.Giorgi)

The monitoring of this Common Indicator entails an inventory of:
(i) the length and location of manmade coastline (hard coastal defence structures, ports, marinas. Soft techniques e.g. beach nourishment are not included.
(ii) land claim, i.e. the surface area reclaimed from the 1980's onward (ha); and
(iii) the Impervious surface in the coastal fringe (100m from the coastline).

With regard to the coastline to be considered: the fixed reference official coastline as defined by responsible Contracting Party should be available throughout monitoring (initial, and all consequent monitoring should use the same official coastline). The optimal resolution should be 5 m or 1: 2000 spatial scale. The monitoring should be done every 6 years, and so every CP should fix a reference year in the time interval 2000-2012 in order to eliminate the bias due to old or past manmade infrastructures and coastal processes such as coastal erosion.

The length of artificial coastline should be calculated as the sum of segments on reference coastline identified as the intersection of polylines representing manmade structures with reference coastline ignoring polylines representing manmade structures with no intersection with reference coastline. The minimum distance between coastal defence structures should be set to 10 m in order to classify such segments as natural, i.e. if the distance between two adjacent coastal defence structures is less than 10 m, all the segment including both coastal defence structures is classified as artificial.

RESULTS

Results and Status, including trends (brief)

Until now there has been no systematic monitoring in Mediterranean regarding the EO8 Common Indicator. The only country that has implemented the monitoring of this indicator on a national level, at the moment, is Italy. There were also assessments on national level in France and Montenegro, but these assessments, although quite similar, do not fully resemble the implementation of the EO8 indicator, since they pre-date it. However, they still provide a deep insight on the state of Montenegrin and French coastlines regarding length of artificialized coastline.

Italy, for now, is the only country to implement the monitoring of the EO8 common indicator 16 on a national level. Almost 16 % of the coastline was classified as built-up in 2006, with strong regional (sub-national) differences, for example between Continental Italy (20.5%) and Sardinia (4.5%). The share of built-up coastline slightly increased in 2012 in the whole country (+0.36%), again with higher increase in Continental Italy (+0.51%) than in Sardinia (0.06%).

In Montenegro, the assessment in 2013 showed around 32% of built-up coastline on national level with notable differences between coastal counties (e.g. 11.6% in Ulcinj County and 40.4% in Tivat County).

The rate of artificalization of the whole of the French Mediterranean coast is around 11 %, with differences apparent from region to region: from the 19.5% for the coast of Languedoc-Roussillon to around 2 % for the coast of Region of Corsica (MEDAM Project).

It is important to note that in Montenegro and France the inventories of length of built-up coastline took place before the implementation of national Integrated Monitoring Assessment Programmes. However, methodology for delineating built-up coastline is quite similar to IMAP’s monitoring guidelines.

Results and Status, including trends (extended)

The assessment results for Italy on the length of artificialized coastline are summarized in Table 1.

Table 1. Length of built-up coastline in Italy in 2006 (provided by Project EcAp-ICZM Italian Ministry of Environment/ISPRA)

	LENGTH (KM) *2006*			**PERCENTAGE** *2006*		**PERCENTAGE** *2012*		***TREND*** *2006-2012*
	total	natural	artificial	natural	artificial	natural	artificial	artificial
ITALY – continental	3844.985	3058.103	786.882	79.53	20.47	79.02	20.98	+0.51%
SICILIY	1177.769	1003.140	174.629	85.17	14.83	85.01	14.99	+0.16%
SARDINIA	1512.145	1444.395	67.749	95.52	4.48	95.46	4.54	+0.06%
TOTAL	6535.899	5505.638	1029.261	**84.25**	**15.75**	**83.89**	**16.11**	**+0.36%**

The total length in Table 1 is referred to a reference coastline for year 2006, and does not include islands except Sardinia and Sicily. Built-up coastline includes coastal defense structures, ports and marinas. The spatial extension of impervious surfaces on land side has not been considered in the calculation of the length of built-up coastline. The above results show that meaningful trends as for ex. 2012 over 2006 or 2018 over 2012, have to be calculated considering Sardinia and Sicily separated by the continental part of Italy as they both have share percentage completely different from each other and from the continental part. The high level of artificialisation in Sicily is mainly due to little ports and marinas for touristic and fishery activities that have been built or expanded in the last 30-20 years.

In Montenegro, the built-up assessment of coastal zone was carried out within the frame of Coastal Area Management Program (CAMP), which served as a basis for Spatial plan for six coastal counties and latter National strategy for integrated coastal zone management for Montenegro. The length of built-up coastline in Montenegro was assessed for each of the six coastal counties (Table 2). The indicator was calculated by overlapping the built-up areas with generalized coastline to get the share of the built-up coastline in the whole coastline. The coastline was generalized in order to avoid unrealistic length of anthropogenic coastline (e.g. to avoid undulations by marinas, ports, were groins, etc.). The built-up coastline is shown in Figure 3.

Table 2. Length of built-up coastline in Montenegro (provided by G. Berlengi)

County	**Natural coastline (km)**	**Built-up coastline (km)**	**Total (km)**	**Share (built-up/total) (%)**
Bar	23.615	12.549	36.164	**34.7**
Budva	24.505	7.305	31.810	**23.0**
Herceg Novi	32.883	19.715	52.597	**37.5**
Kotor	39.596	23.819	63.415	**37.6**
Tivat	19.008	12.885	31.893	**40.4**
Ulcinj	32.158	4.236	36.393	**11.6**
Total	**171.764**	**80.509**	**252.273**	**31.9**

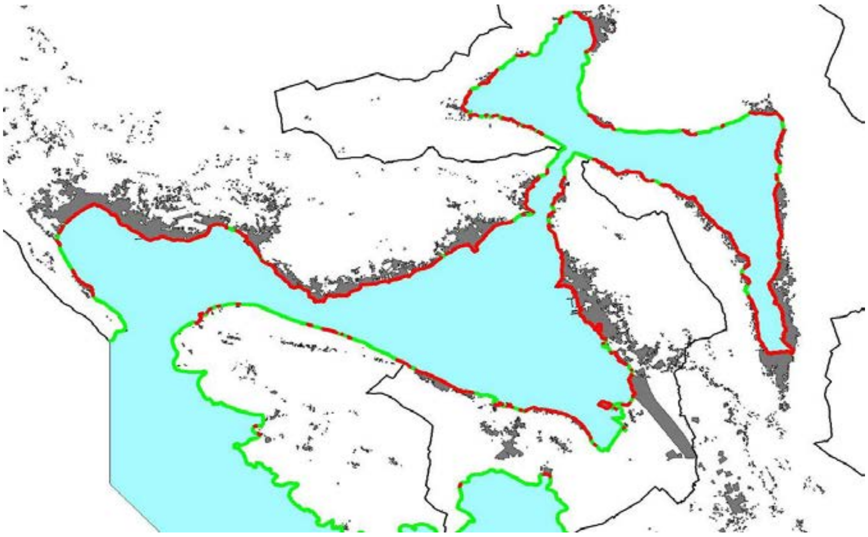

Figure 3. Map showing built-up coastline (in red) and natural coastline (in green) in Montenegro (provided by G. Berlengi)

In France, the MEDAM inventory (i.e. database) was established as a project that monitors the sources of artificial and development pressure on the French Mediterranean Coast, entailing features such as: the total length of coastline; coastline 'artificialised' by reclamation; rate of 'artificialisation' of coastline (linear), etc.

The rate of artificalisation of the whole of the French Mediterranean coast, according to MEDAM, is 11.1 %, with differences apparent from region to region: from the from the 19.5% for the coast of Languedoc-Roussillon to around 2 % for the coast of Region of Corsica (MEDAM Project).

In 1960-1985 period, the number of reclamations from the sea tripled along the French Mediterranean, followed by a distinct slow-down of these redevelopments between 1985 and 2010. The slowing down was to a large extent the result of enforcement of an Act (arrêté) that banned the destruction of marine phanerogams (*Posidonia oceanica* and *Cymodocea nodosa*) (Arrêté of 19 July 1988).

CONCLUSIONS

Conclusions (brief)

The inclusion of the EO8 Common Indicator aims to fill the gap of not having systematic monitoring in Mediterranean regarding the physical disturbance of coastline due to the influence of manmade structures. On the other hand, it offers very few examples to follow, especially since this indicator has no precedents in regional ecosystem approach initiatives, such as Helcom or OSPAR, neither in Marine Strategy Framework Directive.

Some countries, such as Italy, France and Montenegro, have developed the inventories of the share of their urbanized coastline, while some countries of South and East Mediterranean are starting to do so in frame of the EcAp MED II project.

Conclusions (extended)

Key messages

- Mediterranean coastal areas are threatened by intensive construction of buildings and other infrastructure that can impact landscapes, habitats and biodiversity. The national reporting on state and evolution of coastal zones is required by the ICZM Protocol

- There was no systematic monitoring in Mediterranean regarding coastal artificialization by now. The only country that has implemented the monitoring of the EO8 common indicator on a national level by this moment is Italy, with Montenegro and France performing similar inventories;
- Targets, GES thresholds, measures and interpretation of results regarding this indicator should be left to the countries due to strong nation-specific socio-economic, historic and cultural dimensions and geographical conditions.

Photo by Marko Prem

Knowledge gaps

It is difficult to point out the knowledge gaps in this phase since there are so few examples of implementation of the EO8 Common Indicator. However, there are some “known” knowledge gaps that could hinder successful implementation of this indicator.

First, it is a choice of a fixed reference coastline that each CP should select in order to assure comparability of results between successive reporting exercises. Unfortunately, it is not unusual to find out that more than one ‘official’ coastline exists for the same CP produced with different technological techniques. Plus, coastlines change due to coastal erosion, sea level rise and morphological modifications. In addition, if spatial resolution is too low or time period is too long, manmade structures could be poorly identified or completely missed with heavy consequences on the calculation of length of artificial coastline.

The availability of satellite imagery of high resolution could also be a challenge, since these images could be costly. In addition, interpretation of these images requires certain knowledge and experience. In this case, some training and capacity building of national experts is essential.

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Annex I
List of Case Studies for the Ecological Objectives 7 (Hydrography) and 8 (Coastal Ecosystems and Landscapes)

The Annex I provides the list of Case Studies that have been submitted by Contracting Parties and Partners for the Ecological Objectives **7 (Hydrography) and 8 (Coastal Ecosystems and Landscapes). The Case Studies are in the process of editing.**

EO7	**Title**	**Contracting Parties, Partners**	**Authors and Affiliation**
1	Assessment of Environmental Aspects Related to a New Container Terminal (Haifa Bay Port)	Israel	CAMERI – Coastal and Marine Engineering Research Institute, Technion City, Haifa, Israel
2	Hydrological alterations and prediction on habitats impacted by the planned storage, regasification and distribution terminal of LNG in port of Monfalcone – Northern Adriatic	Italy	Giordano Giorgi[1], Federico Rampazzo[2], Daniela Berto[1] Project EcAp-ICZM founded by Italian Ministry of Environment. [1]ISPRA - Italian National Institute for Environmental Protection and Research, Via Vitaliano Brancati, 48 – 00144 – Roma, Italy
EO8	**Title**	**Contracting Parties, Partners**	**Authors and Affiliation**
1	Implementation of indicator on length of artificialized coastline for Italy: continental part, Sardinia and Sicily	Italy	Giordano Giorgi[1], Tania Luti[1], Luca Parlagreco[1], Tiziana Cillari[1], Patrizia Perzia[1] Saverio Devoti[1] Project EcAp-ICZM founded by Italian Ministry of Environment. [1]ISPRA - Italian National Institute for Environmental Protection and Research, Via Vitaliano Brancati, 48 – 00144 – Roma, Italy

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UNITED NATIONS
ENVIRONMENT PROGRAMME
MEDITERRANEAN ACTION PLAN

11 July 2017
Original: English

6th Meeting of the Ecosystem Approach Coordination Group

Athens, Greece, 11 September 2017

Agenda item 4: Review of Quality Status Report (QSR)

Quality Status Report (QSR) Cross-cutting and horizontal issues

UNEP/MAP
Athens, 2017

Quality Status Report (QSR) Cross-cutting and horizontal issues

(Plan Bleu, Version 10/07/2017)

Note: The maps and illustrations are provisional

2. Environmental characteristics

2.1. The Mediterranean Marine and Coastal Environment

Introduction

As the Ecosystem Approach is a strategy for integrated management of land, water and living resources, the assessment recognizes interactions not only between organisms and their environment, but also takes into account humans as in integral component of ecosystems. Indeed, humans are unquestionably dependent on the status and future of ecosystems and of what these may provide them. In turn, it can be said that the ecosystem's conditions are affected by human actions and influences.

In the case of marine and coastal ecosystems, resources face a well-known and growing list of pressures and demands – *from long-standing activities such as fisheries and extraction of fossil fuels, to newer uses such as wind and wave energy.*

The Integrated Ecosystem Assessment identifies socio-economic and biophysical attributes that maintain ecosystem structure and function assess human activities and their independence with the natural ecosystem. This assessment also evaluates management alternatives that will maintain or improve the coupled social-ecological system.

Before introducing the socio-economic elements and their interactions with the marine and coastal ecosystems, environmental characteristics of the Mediterranean Sea are essential to be included in order to have a clearer overview of the unique marine and coastal ecosystem.

Description of the Mediterranean Sea (area, depth, water cycle, streams ...)

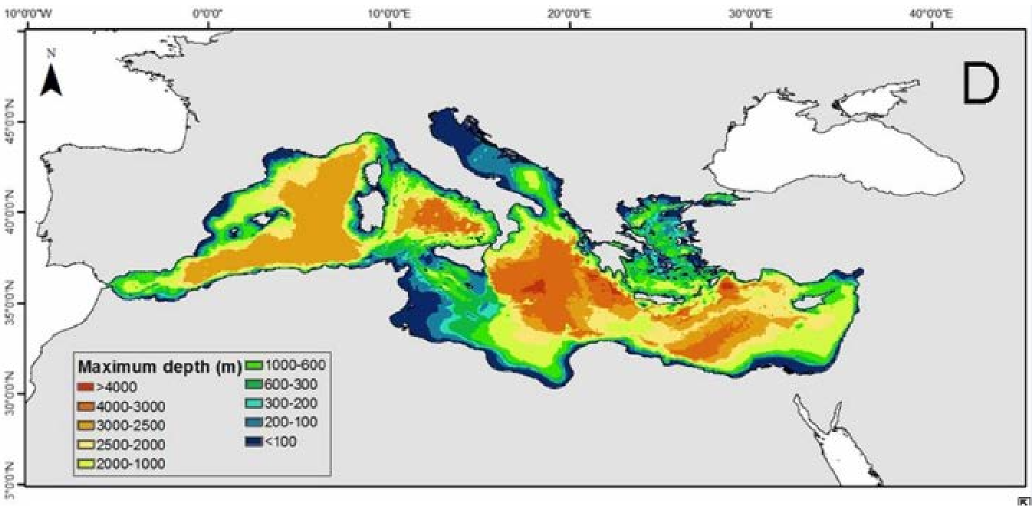
Among its 22 riparian countries and territories, the basin shares a unique climate and natural cultural heritage where environmental and development issues are notably severe. The Mediterranean Sea is a marine biodiversity hot spot.

1. Alboran Sea, 2. Balearic Sea, 3. Gulf of Lions, 4. Ligurian Sea, 5. Algeria and Tunisian waters, 6. Tyrrhenian Sea, 7. North Adriatic Sea, 8. Central Adriatic Sea, 9. South Adriatic Sea, 10. Ionian Sea, 11. North Aegean Sea, 12. South Aegean Sea, 13. Levant Sea, 14. Gulf of Gabès.

Main biogeographic regions, basins, and administrative divisions of the Mediterranean Sea (Source: Coll et al., 2010)

The intercontinental sea stretches from the Atlantic Ocean on the west to the Asian continent on the east, and separates Europe from Africa. Also named the incubator of Western civilization, the ancient “sea between the lands” occupies a deep, elongated, and almost landlocked irregular depression lying between latitudes 30° and 46° N and longitudes 5°50W and 36°E. This basin is the largest (2.969.000 square kilometers) and deepest (average 1.460 meters, maximum 5.267 meters) enclosed sea on Earth.

The Mediterranean has narrow continental shelves and a large area of open sea. Therefore, a large part of the Mediterranean basin can be classified as deep sea and includes some unusual features such as variation of temperatures from 12.8°C–13.5°C in the western basin to 13.5°C–15.5°C in the eastern and high salinity of 37.5–39.5 psu.



Bathymetry map (Source: Coll et al., 2010)

Mediterranean hydrodynamics are driven by three layers of water masses: a surface layer, an intermediate layer, and a deep layer that sinks to the bottom. The Mediterranean Sea receives from the rivers that flow into it only about one-third of the amount of water that it loses by evaporation. In consequence, there is a continuous inflow of surface water from the Atlantic Ocean. After passing through the Strait of Gibraltar, the main body of the incoming surface water flows eastward along the north coast of Africa. This current is the most constant component of the circulation of the Mediterranean. It is most powerful in summer, when evaporation in the Mediterranean is at a maximum. This inflow of Atlantic water loses its strength as it proceeds eastward, but it is still recognizable as a surface movement in the Sicilian channel and even off the Levant coast. A small amount of water also enters the Mediterranean from the Black Sea as a surface current through the Bosporus, the Sea of Marmara, and the Dardanelles.

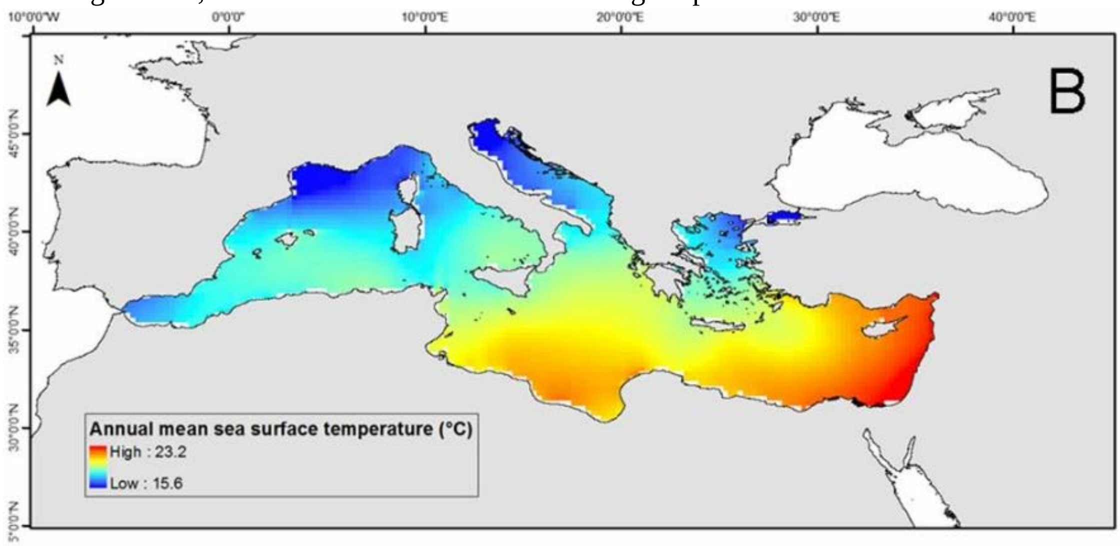
Distribution of the coastline per type

The coasts of the western Mediterranean, just as those of the eastern basin, have been subjected in recent geologic times to the uneven action of deposition and erosion. This action, together with the movements of the sea and the emergence and submergence of the land, resulted in a rich variety of types of coasts. The Italian Adriatic coast, revealing the Apennines, is typical of an emerged coast. The granite coast of northeastern Sardinia and the Dalmatian coast where the eroded land surface has sunk, producing elongated islands parallel to the coast, are typical submerged coasts. The deltas of the Rhône, Po, Ebro, and Nile rivers are good examples of coasts resulting from silt deposition.

Climate: Temperature and precipitations

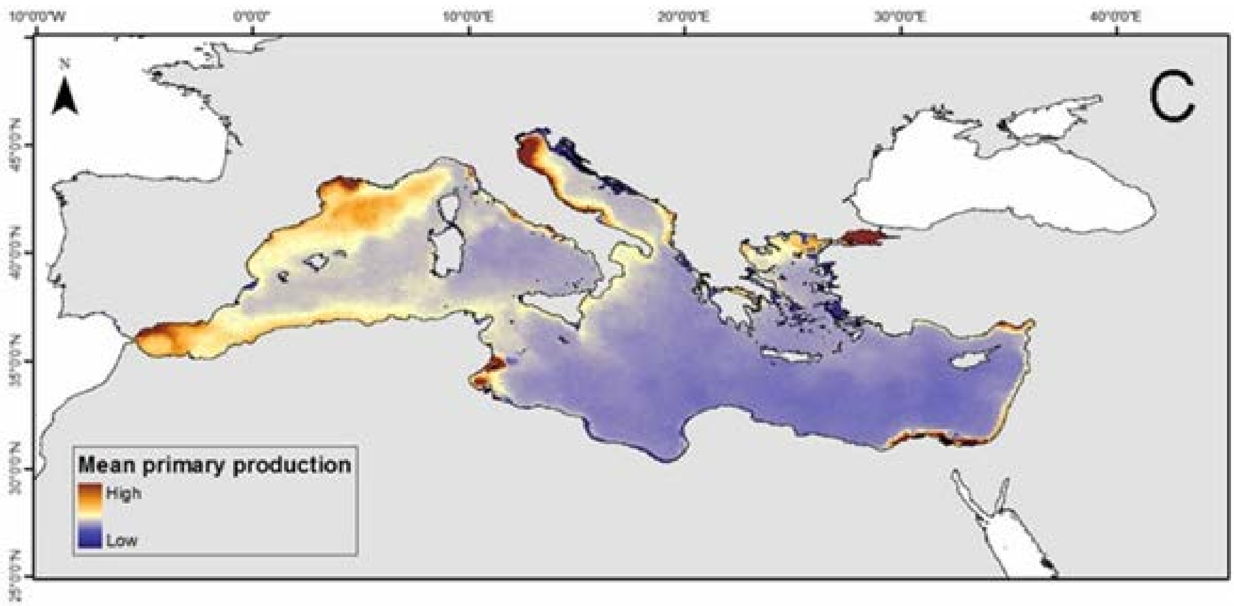
The amount and distribution of rainfall in Mediterranean localities is variable and unpredictable. Along the North African coast from Gabès in Tunisia to Egypt, more than 10 inches (250 mm) of rainfall per year is rare, whereas on the Dalmatian coast of Croatia there are places that receive 100 inches (2,500 mm). Maximum precipitation is found in mountainous coastal areas. The climate in the region is characterized by hot, dry summers and cool, humid winters. The annual mean sea surface temperature shows a high seasonality and important gradients from west to east and north to south

The basin is generally oligotrophic, but regional features enrich coastal areas through changing wind conditions, temporal thermoclines, currents and river discharges. The basin is characterized by strong environmental gradients, in which the eastern end is more oligotrophic than the western. The



biological production decreases from north to south and west to east, and is inversely related to the increase in temperature and salinity.

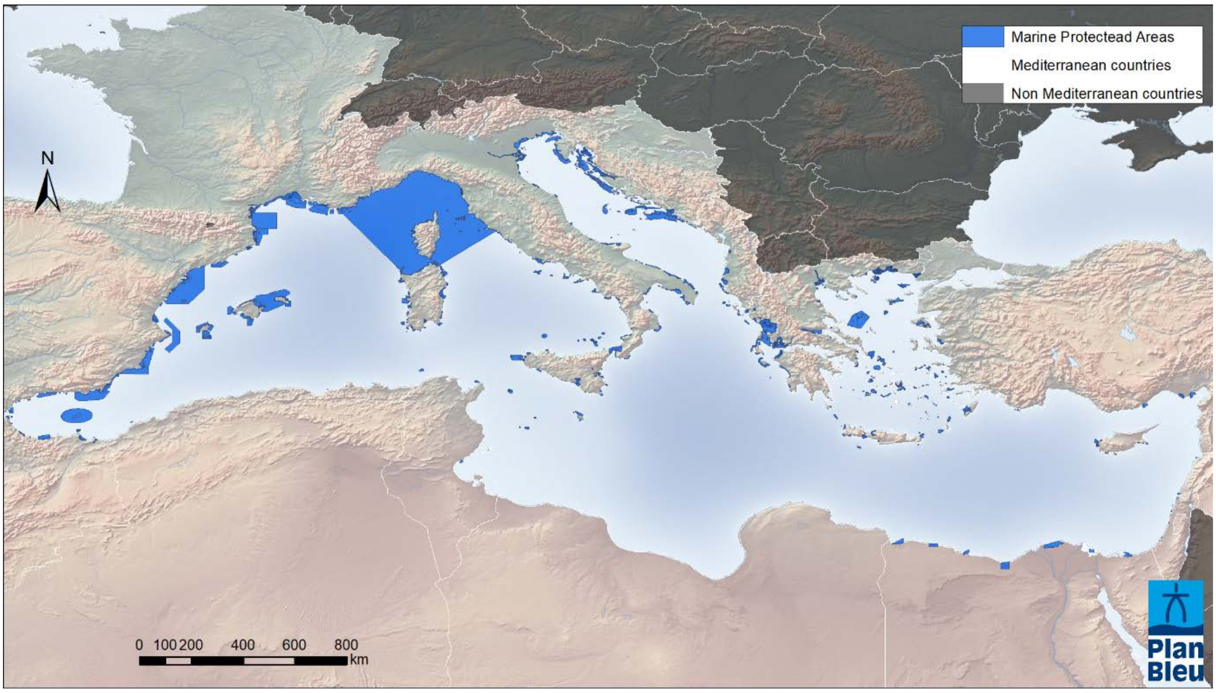
Annual mean sea surface temperature (Source: Coll et al., 2010)



Annual mean net primary production (Source: Coll et al., 2010)
(*The map was generated from SeaWiFS chlorophyll distributions according to the Vertically Generalized Production Model - VGPM, Behrenfeld and Falkowski, 1997)*

iodiversity (Key species, habitats, MPA)

The Mediterranean is one of the world’s 25 hot spots for biodiversity. Its highly diverse marine ecosystem hosts around 4 to 18% of the world’s marine biodiversity. It is defined as “under siege” due to historical and current impacts of multiple stressors. Among them, fishing practices, habitat loss and degradation, eutrophication, and more recently, the introduction of alien species and climate change effects. Since the intensity of these stressors is increasing throughout most of the Mediterranean basin, temporal analyses are increasingly needed to inform effective current and future marine policies and management actions.



Marine protected Areas (Source WDPA)

Almost 86 000 km² of the Mediterranean is classified Marine Protected Areas (MPAs) or Natura 2000 site. In 2016, only 3 % of the Mediterranean Sea is protected. The target of 10% protection of the CBD convention is far from being achieved. New Marine Protected Areas must be created in high and deep sea which are not represented in the current network.

Water flows in the Mediterranean: Watersheds/Water resources

The Mediterranean region is characterized by winter dominated rainfall and hot dry summers. Even though large spatial climate variability and diversity exist within the Mediterranean basins, many areas can be classified as arid or semiarid. The Mediterranean is an area of transition between a temperate Europe with relatively abundant and consistent water resources, and the arid African and Arabian deserts that are very short of water.

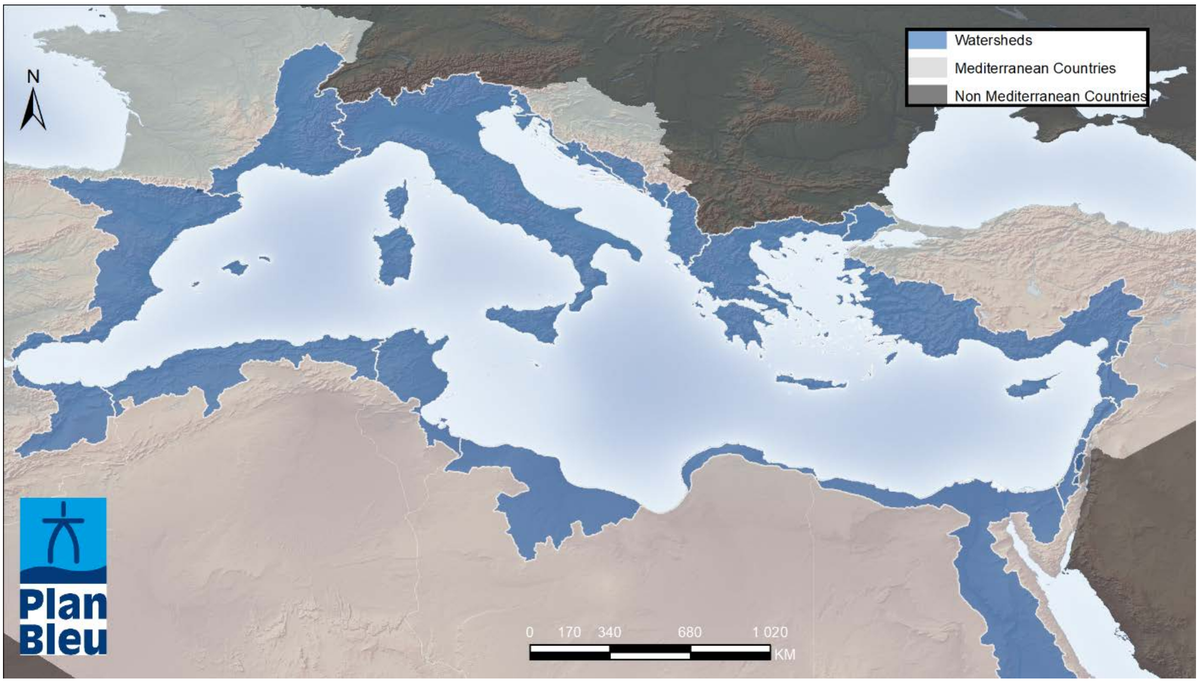
The Mediterranean region is experiencing a large stress on its water resources due to a combination of effects ranging from climate change to anthropogenic pressures due to an increasing water demand for domestic and industrial use, expansion of irrigated areas, and tourism activities.

More than half of the water-poor population of the world is concentrated in the Mediterranean basin, which holds only 3% of the world's fresh water resources.

Drastic actions have already been taken to mitigate water shortage such as large scale water transfers within and between countries. Holding structures are being built to conserve as much water as possible to sustain the domestic, industrial, and agricultural demand. However, these measures are severely affecting the freshwater input and associated sediment and nutrients in the Mediterranean Sea, endangering ecosystems including coastal wetlands, by increased coastal erosion and aquifer salinization.

Of particular interest is the riverine input of freshwater into the Sea, which is with precipitation the unique source of fresh water entering the Mediterranean Sea. In fact, the riverine water inflow is estimated to be half the precipitation amount falling onto the Sea. Surface runoff is thus one of the critical components for computing the hydrological water budget for the Mediterranean Sea. Estimates for all of the components of the water cycle are available however with great uncertainties leading to net water losses from the Sea varying from 470 to 1310 mm yr-1.

The region is characterized by its link to the Mediterranean, with many islands of various sizes and peninsulas dividing the Mediterranean Sea into many sub basins connected by narrow straits and the presence of steep mountain ridges close to the coast. This complex land-sea pattern helps to explain the spatial heterogeneity of climate in the Mediterranean region and provides a better understanding to face the issues of its current and future climate change.



Watersheds in the Mediterranean region (Plan Bleu)

2.2. Climate Change.

The Mediterranean region: a climate change Hot-spot

The Mediterranean region has been referenced as one of the most responsive regions to climate change and was defined as a primary "Hot-spot" by Giorgi (2006), based on the results from global climate change projection scenarios. The last report from the International Panel on Climate Change (IPPC, 2013) highlights the Mediterranean as one of the most vulnerable regions in the world to the impacts of global warming. The context of global warming stresses the necessity to assess the possible consequences of climate change on this sensitive region which would become warmer and drier (IPCC 2007, 2013).

In the Mediterranean, the far distant past has witnessed some major climatic changes (with temperatures which could on average be 8°C below current ones (20, 000 years ago) or 1 - 3°C higher (6,000 years ago). Landscape, fauna and flora and coastal layout were very different depending on the period (due to variations in sea level of several tens of meters). These developments took hundreds if not thousands of years.

The current situation, however, and the one expected to prevail over coming years is marked by the speed of the changes coming about. This factor amplifies the expected impact since relatively rapid developments give ecosystems or societies no chance to acclimatize and gradually adapt.

During the 20th century, air temperature in the Mediterranean basin was observed to have risen by 1.5-4°C depending on the sub-region. Over the same period and with clear acceleration since 1970, temperatures in south-western Europe (Iberian Peninsula, south of France) rose by almost 2°C. The same warming effect can also be seen in North Africa, albeit more difficult to quantify given the more patchy nature of the observation system.

Major climate change impacts in the Mediterranean region

The conclusions drawn by climate specialists converge on several points of general consensus:

- Even if the European Union's objective of not exceeding a global average temperature increase of 2°C is met, temperature increases in the Mediterranean are likely to be above 2°C and, because of the ecological and socioeconomic characteristics of the areas, the impact will be more marked than in many other regions of the world; The Mediterranean has thus been qualified as the « hot spot for climate change» (Giorgi, 2007).
- A general decrease in average rainfall is expected throughout the Mediterranean basin.
- The most vulnerable areas of the Mediterranean are the north African ones bordering on the desert areas, the major deltas (Nile, Po and Rhone, for example), the coastal zones (both Northern and Southern shores) as well as socially vulnerable areas and those with rapid demographic growth (southern and eastern banks, dense towns and suburbs) (IPCC AR4, 2007).
- The impact of climate change on the environment is already noticeable in the Mediterranean, and is already producing observable effects on human activity.
- Given the uncertainty previously referred to, more optimistic or more pessimistic scenarios (breakdown scenarios with abrupt and rapid change) around the central ones presented here are not to be ruled out. Thus a consensus has been reached on temperature increase and precipitation decrease in the Mediterranean Basin as a whole.
- According the 4th IPCC Report under the scenario A1B, air temperature will increase between 2.2°C and 5.1°C in the Southern Europe and Mediterranean region if the 2080-2099 period is compared to that of 1980-1999 (with some sub regions differences).
- The same projections assume a decrease for the precipitations between 4 and 27% in the Southern Europe and Mediterranean region (while the Northern Europe region will record an increase between 0 and 16%). An increase of drought periods (associated to land degradation) being declined by a high number of days recording more than 30°C is also expected (Giannakopoulos and al. 2005).
- Extreme event such as heat waves, drought or floods could be more frequent and stronger.
- As for the sea level trend/change there is still a need for longer time-series from satellite altimetry and for an improved in-situ tide-gauge network to attain robust conclusions. Only a few climatological studies estimate that a mean 35 cm sea level increase could occur during the 21st century.

Water at the heart of the main expected impacts of climate change on the natural environment in the Mediterranean, which are:

- Water: A rapid change in the water cycle due to increased evaporation and less rainfall;

- Soil: A drop in water storage capacity (because of changes in porosity as a result of temperature change, making it drier), accelerated desertification which is already underway (soil over-use and depletion);
- Land and marine biodiversity (animal and plant): A northwards and altitude shift of certain species, extinction of the most climate-sensitive or less mobile species and the appearance of new ones;

Sea level rise

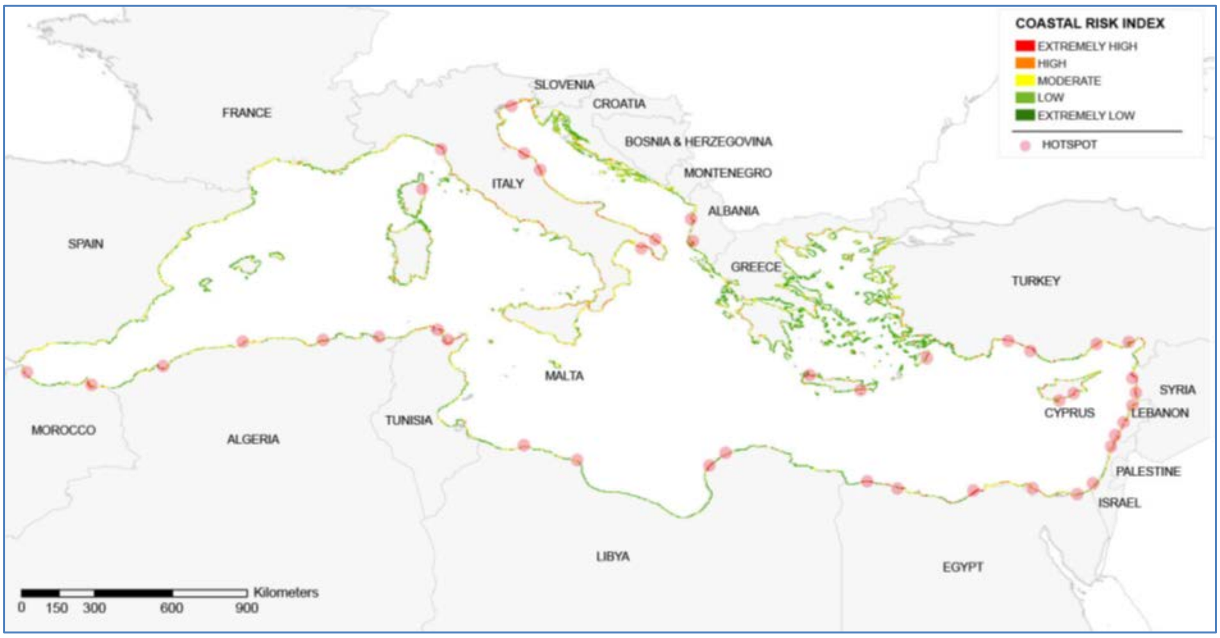
Based on the existing models available for assessment, the central values for projections of sea level rise by 2100 range from about 30 to 40 cm, and about 60% of this increase would be due to the thermal expansion of sea water.

The Mediterranean Sea displays rugged coastlines indented into several smaller seas: Adriatic, Aegean, Alboran, and Ionian that require high-resolution observations for complete analyses. Altimetry from space (i.e., the TOPEX/Poseidon program launched in December 2001) has supplied scientists with time-series of exceptional quality for the study of global sea level variations. For example, it has been found that most of the temperature variations cause most of the overall steric sea level change in the upper 400 m of the Mediterranean Sea (MEDAR13 datasets). Between 1960 and the 1990s, cooling of the upper waters of the Eastern Mediterranean caused a reduction in the steric heights, while after 1993 warming caused the sea level to rise. The steric sea level changes in the upper waters of the Adriatic and the Aegean Sea seem also to be correlated with the NAO.

Climate Change related risks

Climate change is arguably one of the most critical challenges that the Mediterranean region is facing. The Mediterranean basin has been identified as one of the two most responsive regions to climate change globally. The IPCC Fifth Assessment Report considers the Region as “highly vulnerable to climate change”, also mentioning that it “will suffer multiple stresses and systemic failures due to climate changes”. The overall risks of climate change impacts can be reduced through mitigation, i.e. by limiting the rate and magnitude of climate change. However, even under the most ambitious mitigation scenarios, risks from adverse climate impacts remain, due to already locked-in climate change. Therefore, adaptation policies and measures anticipating a wide range of potential climate-related risks are essential.

Climate change impacts put coastal communities and assets at risk. Relevant authorities are encouraged to undertake adaptation measures that are compliant with the Protocol on Integrated Coastal Zone Management in the Mediterranean (Barcelona Convention) and national Integrated Coastal Zones Management strategies.



Coastal Risk Index (Source: MedSea Foundation, 2016)
Source http://planbleu.org/sites/default/files/publications/notes28_en_revisee.pdf

The Regional Risk Assessment Map of coastal risk to climate and non-climate forcing, displays the result in terms of qualitative risk classes in the coastal zones investigated. The map shows the values of risk assumed by each location (cell) by applying the equation defined for the method CRIMED. Sites that assume "extremely high risk" values are indicated in red and in the context of the study these are defined as "hot-spots".

Beyond the north-south gradient in the Mediterranean, particularly vulnerable landscapes include deltas and coastal zones (vulnerable to sea-level rise), as well as rapidly growing cities without adequate infrastructure and institutions. In the Mediterranean regions, about 50% of the urban population lives less than 10m above sea level. Tourist destinations (concentrated along the coast) are vulnerable not only to sea-level rise but also to higher summer temperatures, which may turn tourists away toward more northern and cooler locations.

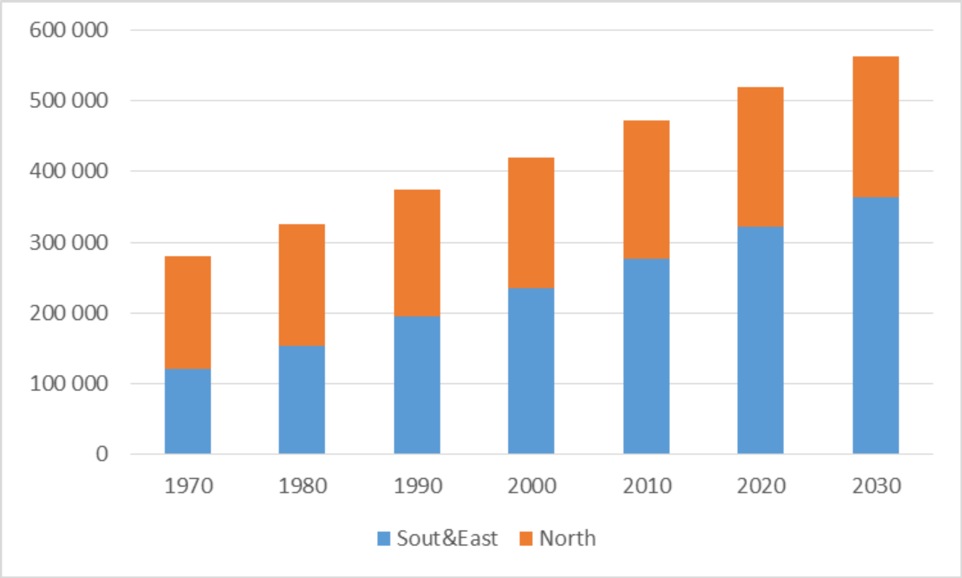
3. Socioeconomic characteristics of the Mediterranean

National level

The Mediterranean basin is characterized by strong socioeconomic disparities, in particular between the northern countries and the southern and eastern countries of the region.

Population

While population development in the north is almost stagnant, strong population growth in the southeast (in combination with a lack of effective policies) results in overexploitation of water, land, and other resources, driven by land clearing, cultivation of marginal land, overgrazing, and firewood harvesting. Land productivity is decreasing accordingly.

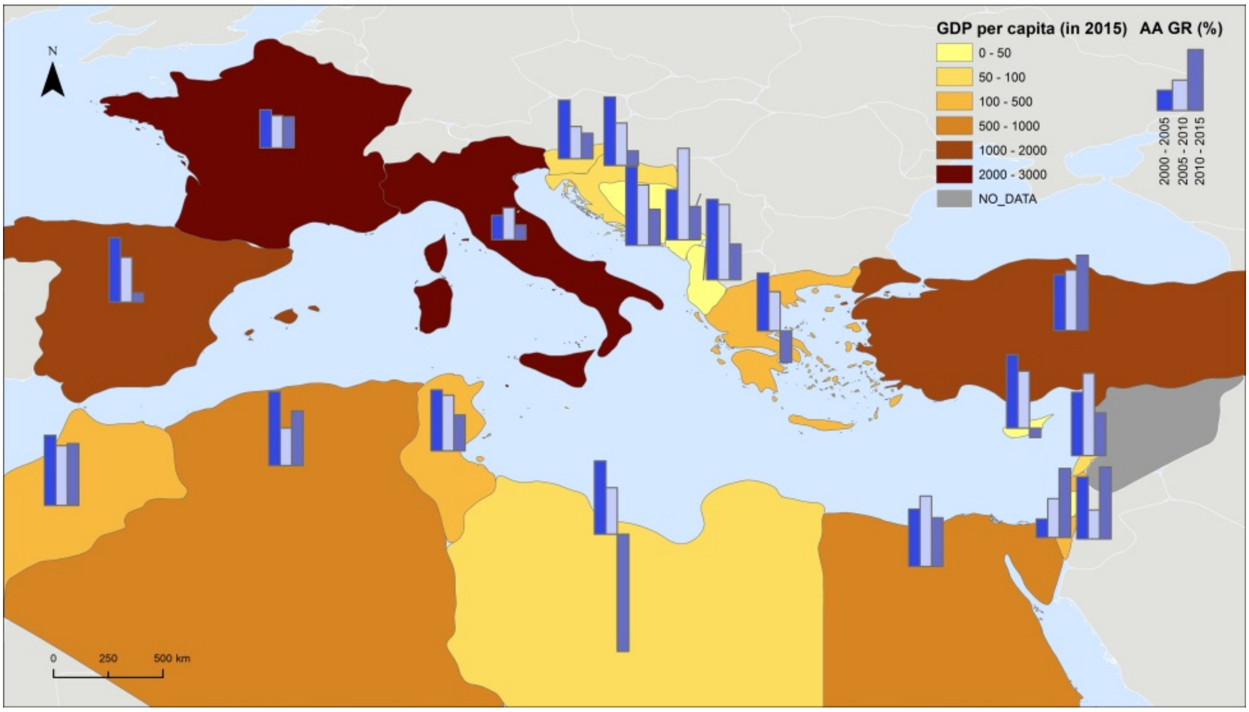


Population in the Mediterranean countries (100 inhabitants) (Source UN WPP 2015)

In contrast, many rural areas in the northern countries experience abandonment of agricultural land, with subsequent encroachment of shrubs and trees and a greening of the land. The southern and eastern countries of the Mediterranean are rapidly urbanizing – with almost all of the future population growth projected to be in the cities – while urbanization rates in the north are more or less stable.

Economic disparity in the Mediterranean region

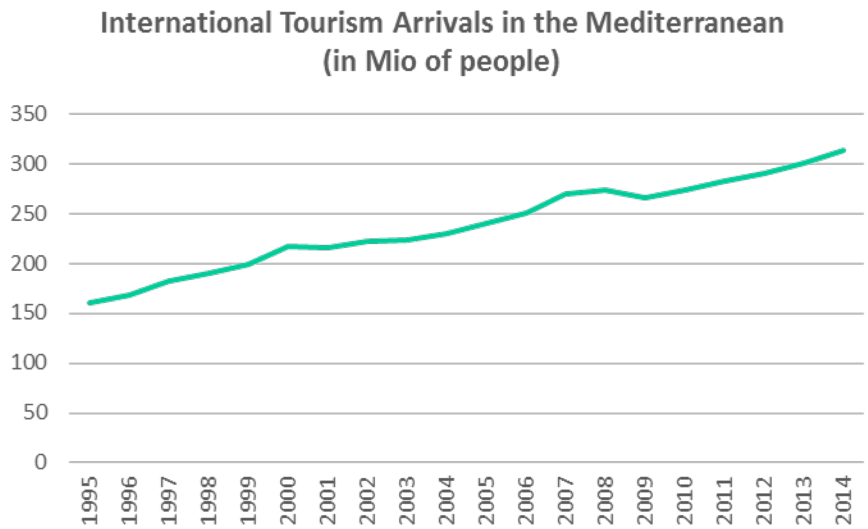
In 2015, the average income per capita in the South and East Mediterranean countries is 2.5 times lower than the average income in the EU Mediterranean countries. The GDP growth rate in the south and east Mediterranean countries are much higher than those of the EU Mediterranean countries. However, they are considered low when compared to the population growth rates, as the demographic growth is still high in the southern Mediterranean countries. The share of the Mediterranean GDP in the world GDP is decreasing: from more than 13.5% in 1990 to 11.5% in 2010 and 9.7% in 2015. Meanwhile, the share of the Mediterranean population remains constant in the world population (about 7%).

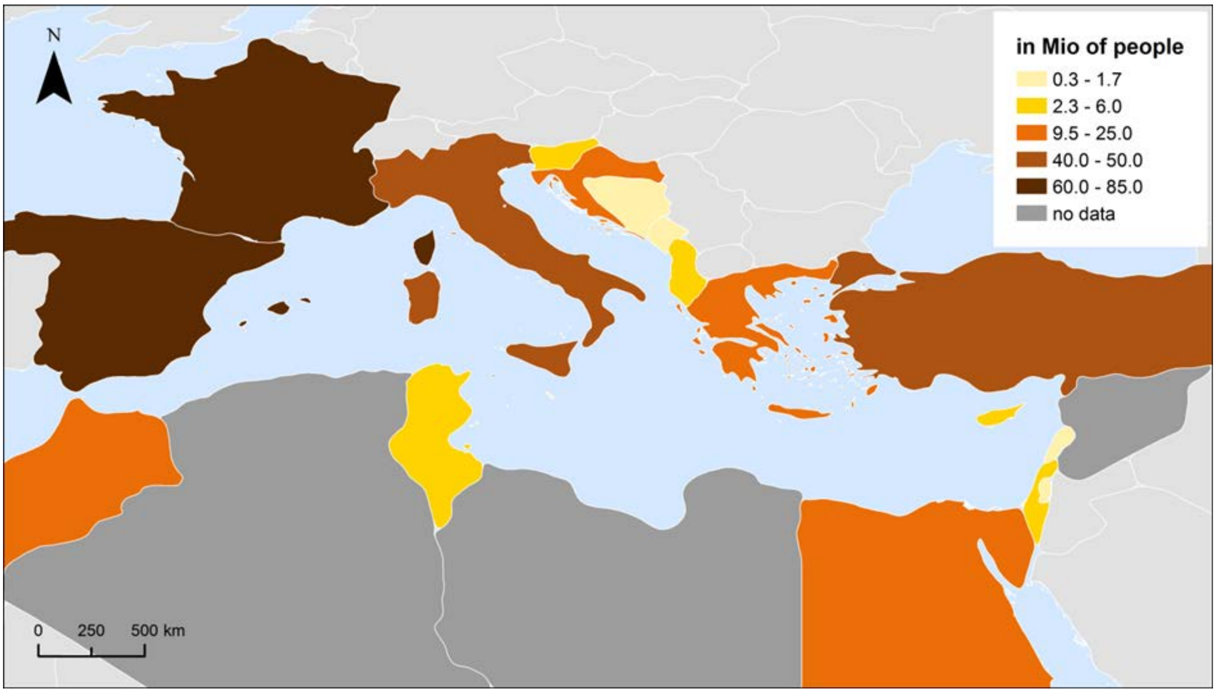


Gross Domestic Product (World Bank)

Tourism

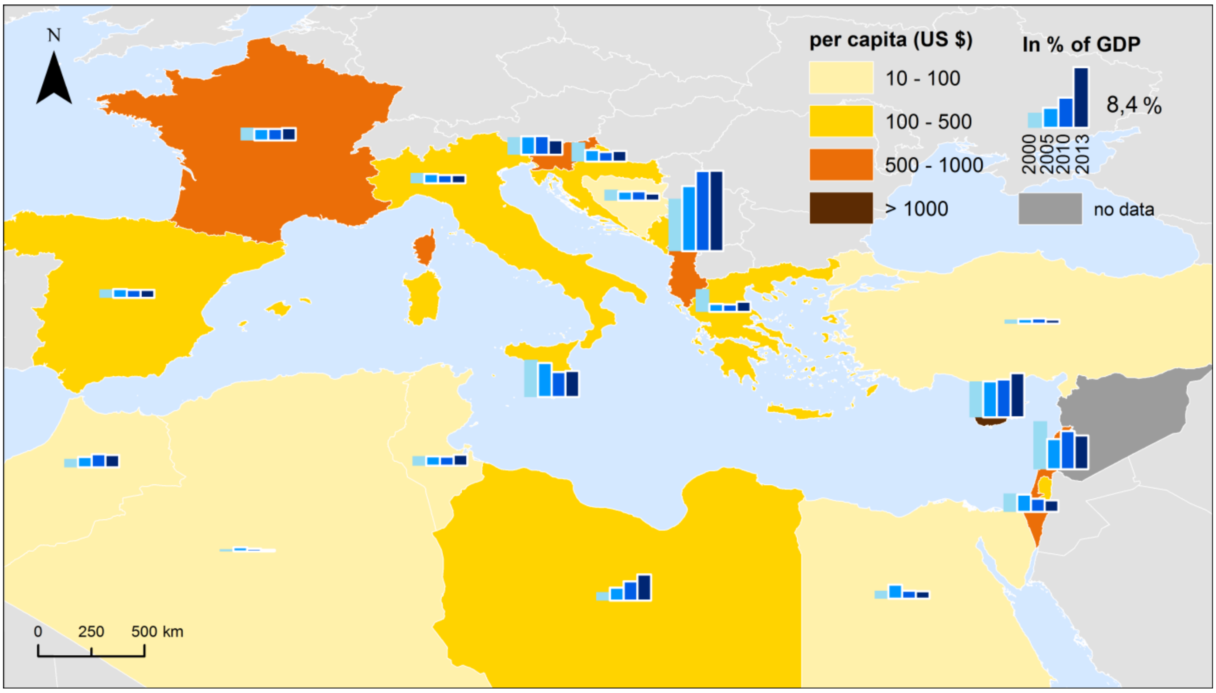
Mediterranean is the world's leading tourism destination in terms of both international and domestic tourism with more than 300 million international tourist arrivals representing 30% of total world tourists for 2014. International tourist arrivals have grown from 58 million in 1970 to nearly 314 million in 2014, with a forecast of 500 million by 2030. About 50% of these arrivals are in coastal areas.





International Tourism Arrivals in the Mediterranean countries in 2014
(Source UN-WTO)

In 2016, Tourism contributed to create 333.2 billion US$ in the Mediterranean countries. During the last 20 years, the direct contribution of tourism to GDP in the Mediterranean region has increased by 53%. Tourism is a major pillar of Mediterranean economies, offering consistent employment (11.5% of total employment in 2014) and economic growth (11.3% of regional GDP). In the Mediterranean basin, tourism is vital for many countries: considering exclusively coastal areas economy, tourism represents over 70% in terms of Production Value and Gross Value Added.

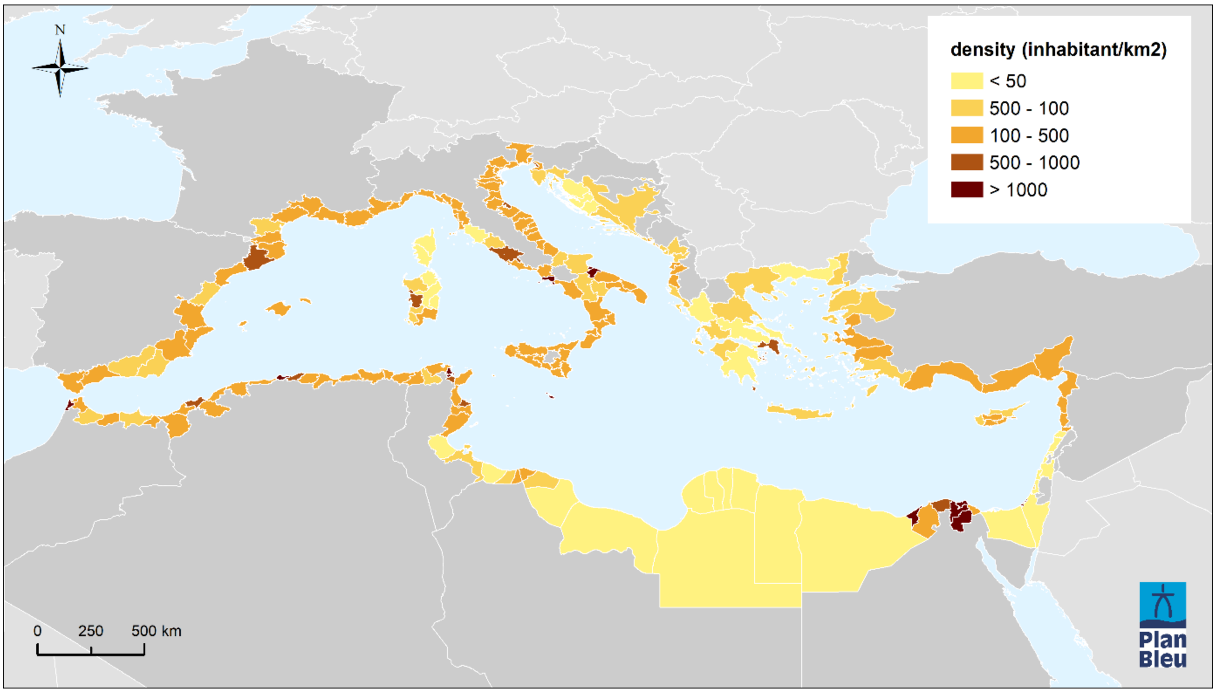


International Tourism Receipts (Source UN-WTO)

Coastal level

Population on the coast.

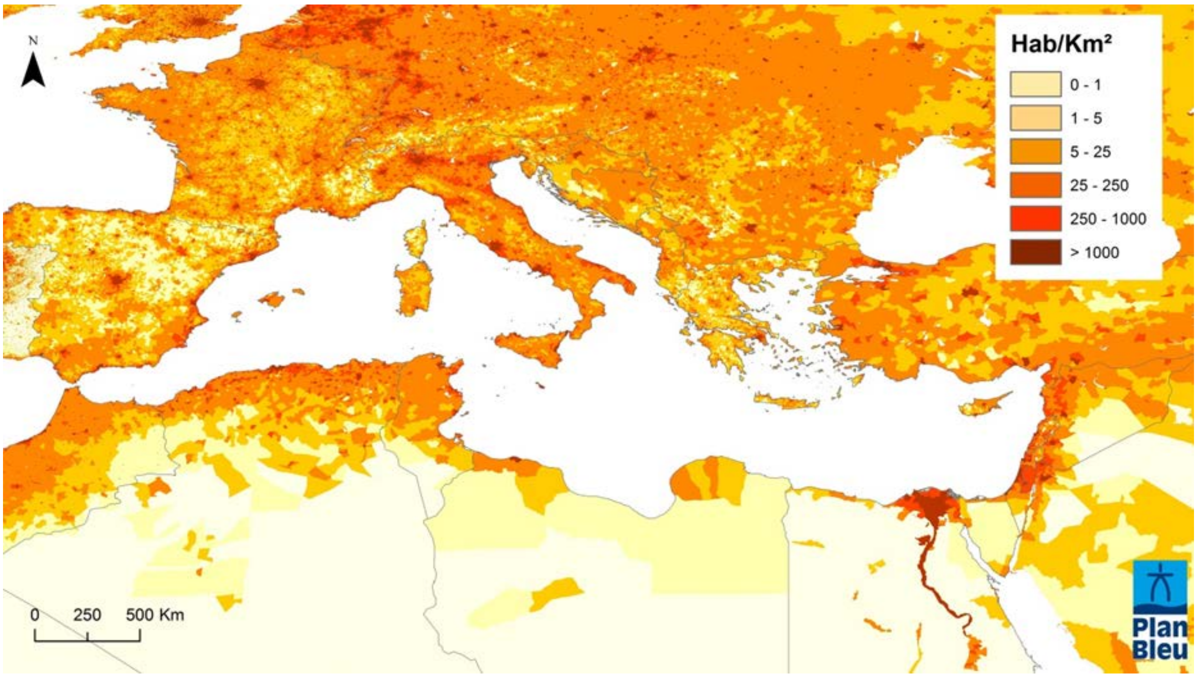
Coastal areas are usually rich in their natural resources that provide great opportunities for economic activities, especially resource-based economic activities such as agriculture, fisheries, tourism, oil and gas extraction, and maritime transport that tend to locate in these areas.



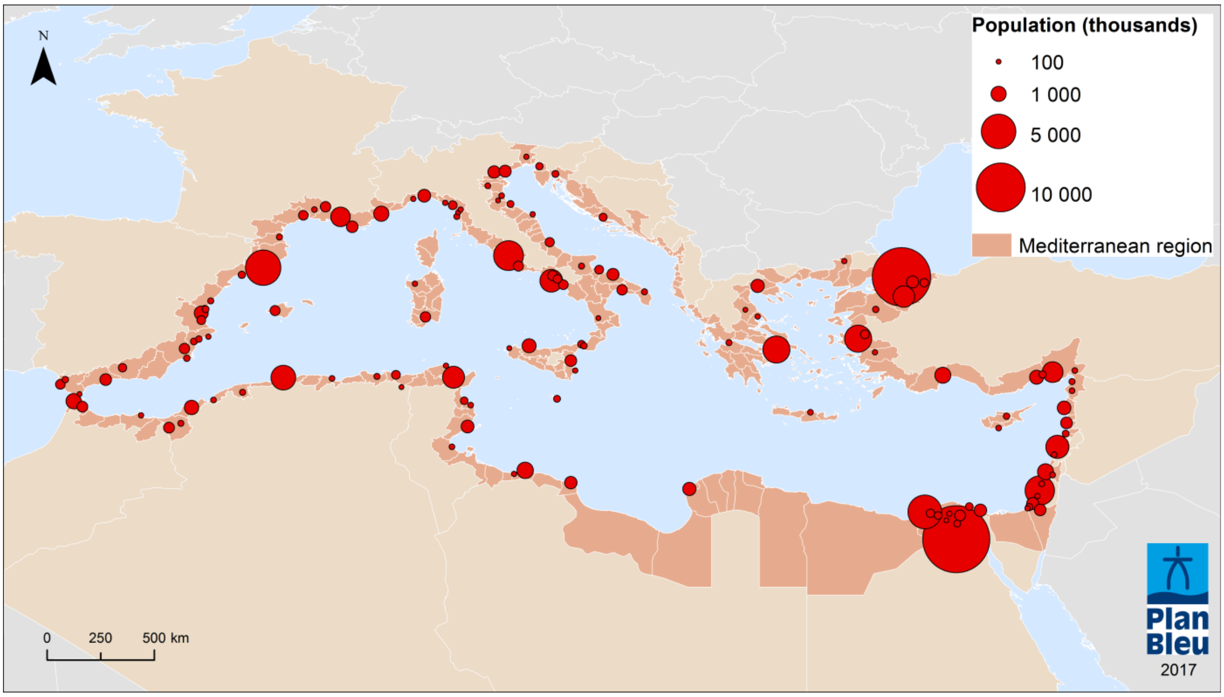
Population density of the Mediterranean coastal regions (Source: Plan Bleu from various sources)

Approximately one third of the Mediterranean population is concentrated along its coastal regions, whereas more than half of the population resides in the coastal hydrological basins. Around 40% of the total coastal zone estimated to be under some form of artificial land cover. Close to 100% of the population in the coastal region reside in urban localities

Mediterranean coastal areas are threatened by coastal development that modifies the coastline through the construction of buildings and infrastructure needed to sustain residential, tourism, commercial, and transport activities. Coastal manmade infrastructures cause irreversible damage to landscapes; habitats and biodiversity; and shoreline configuration by disrupting the sediment transport. The population density is different between the countries of the north of the Mediterranean and the countries of the south and the east. The density is more homogeneous in the European Mediterranean countries.



Adjusted Population Density, 2015 (http://sedac.ciesin.columbia.edu/data/set/gpw-v4-population-density-adjusted-to-2015-unwpp-country-totals)



Major Mediterranean cities (more than 100 000 inhabitants) (Source: Plan Bleu from various sources)

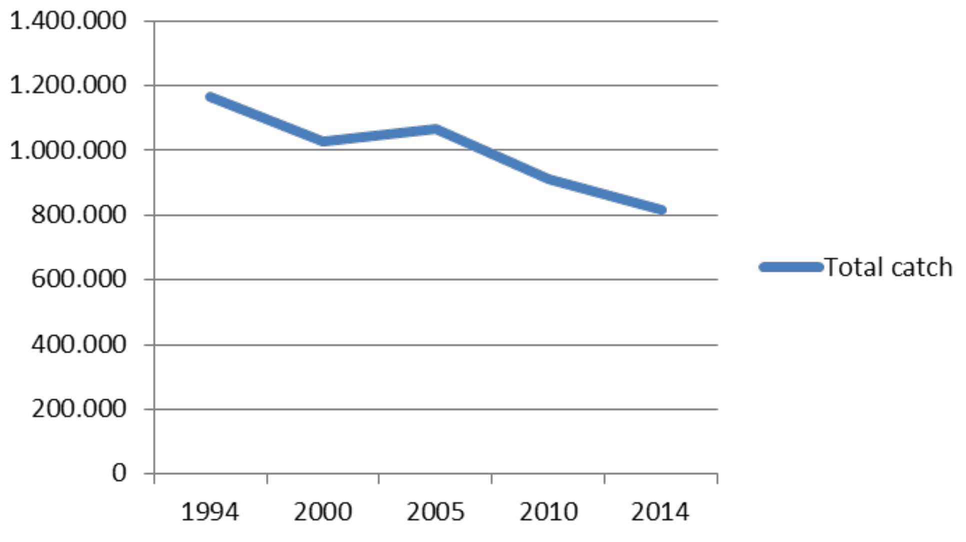
Moreover, about 1 600 cities (more than 10 000 inhabitants) with around 100 million inhabitants are located in the Mediterranean coastal regions

Sea related activities

Fisheries and aquaculture

Despite the steady decrease of Med captures (over 30% since 1994), the value of the sector has steadily increased (over 160% since 1990), in part because of the fast development of the aquaculture sector.

From 1990 to 2010 the total value of Mediterranean fisheries have risen 160 %



Total fish catch 1994 – 2014 in 1000 tonnes

The decrease in fish catch is mainly due to exhausted fish stocks, not because the pressure of fishing decreased.

Cruise

The Mediterranean Sea is among the most important cruise areas in the world: it reached 27 million passengers in 2013, with a sustained increase of around 5% per year. Cruise infrastructures remains located on northern shore: 75% of Mediterranean ports are in Italy, Spain, France, Greece, Croatia and Slovenia, while 9% of ports are in Turkey and Cyprus; and 7% in Northern Africa.

Maritime transport

The Mediterranean Sea is one of the busiest seas in the world, harvesting 20% of seaborne trade, 10% of world container throughput and over 200 million passengers. Furthermore, as maritime traffic is steadily increasing it adds environmental pressure, such as rising CO2 emissions, pollution, marine litter, collisions with large cetaceans, underwater noise and the introduction of non-indigenous species. Container port traffic development shows a clear trend of rapid growth of the sector, which undoubtedly increases the environmental pressure and strengthens the need for a transition to a sustainable maritime.

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