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Agenda Item 3: Assessment Criteria

Adjusted Background (Assessment) Concentrations (BC/BAC) for Common Indicator 17 and Upgraded Approach for Environmental Assessment Criteria (EAC) for IMAP Common Indicators 17, 18 and 20

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UNEP/MAP
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Note by the Secretariat

In line with Decision IG.23/6 related to 2017 Mediterranen Quality Status Report (MED QSR) adopted at COP 20 (Tirana, Albania, December 2017), the Contracting Parties and the Secretariat are encouraged to test the following updated assessment criteria for indicative purposes in the different contexts that exist in the Mediterranean: i) BAC and EAC for trace metals (Cd, Hg, Pb) in sediments and in biota (mussel and fish); ii) BAC for PAHs in biota (mussel); iii) EAC for organochlorinated compounds in sediment and iv) BAC and EAC for biomarkers in mussel. In addition, the Decision IG. 23/6 maintained the following assessment criteria as endorsed by the Decisions IG.22/7 (Athens, Greece, February 2016): i) EAC for sediments and mussel; ii) EAC for a group of organochlorinated compounds in sediment and biota (mussel and fish) complementing updated values and iii) BACs and EACs for biomarkers in mussel, complementing updated values.

Hence new available monitoring data were used to update sub-regional Mediterranean BAC values for heavy metals in biota and sediment in 2019 (UNEP/MED WG.463/Inf.6) in order to contribute to preparation of the State of Environment and Development Report 2019 (SoED). In line with the Programme of Work 2020-2021 adopted by COP21 (Naples, Italy, December 2019) and the Programme of Work 2022-2023 adopted by COP22 (Antalya, Turkey, December 2021) , and conclusions of the Meeting of the Ecosystem Approach Correspondence Group on Pollution Monitoring (Podgorica, Montenegro, 2 - 3 April 2018), the MED POL Programme has undertaken further actions aimed at harmonization and standardization of the monitoring and assessment methods related to IMAP Pollution and Marine Litter Cluster (Activity 2.4.1.4), including the present upgrade of several assessment criteria.

The present document proposes upgraded BC and BAC values for IMAP Common Indicator 17 and possible approaches for upgrade of EAC for IMAP Common Indicators 17, 18 and 20. Their calculation is based on new national monitoring data received up to December 31st, 2021, that have not been previously used for the calculation of the assessment criteria in the 2017 and 2019 assessments. In addition, following the OWG on Contaminants recommendation, data since 2015 were used as well in the calculation, even if used in the previous assessment.

The proposed upgraded assessment criteria were submitted for review and possible endorsement by the Meeting of the Ecosystem Approach Correspondence Group on Pollution Monitoring– CorMon Pollution that was held from 26 – 28 April 2021.

Considering the evolving nature of this document that addresses the need to further upgrade the assessment criteria for IMAP Common Indicators related to Ecological Objective 9, the Meeting of CorMon Pollution agreed to recommend its use as a basis towards development and testing of the methodologies for GES assessment related to Ecological Objectives 9 and 10, and recommended its submission to the Meeting of the MED POL Focal Points, for its consideration, highlighting at the same time the need for its further elaboration, including within the Online Working Group (OWG) on Contaminants. In order to ensure use of the new assessment criteria within preparation of the inputs for 2023 MED QSR, the Contracting Parties were requested to support present work by: i) undertaking analysis of proposed values of the assessment criteria against the new monitoring data to be reported into IMAP Pilot Info System, as well as to be made available through another relevant sources; ii) supporting improvements of existing methodology for calculation of the assessment criteria; and iii) supporting preparation of agreed and integrated GES assessment methodology for IMAP Ecological Objective 9.

Further to the discussion that took place during the resumed session of the Meeting of MEDPOL Focal Points (9 July 2021), the document was recommended for submission to the 8th EcAp Coordination Group Meeting (9 September 2021). Given the short time period between the Meeting of CorMon on Pollution Monitoring and the Meeting of MEDPOL Focal Points (27-28 May 2021), the operating procedures did not allow for the document submitted for consideration of the 8th EcAp CG to include changes undertaken after the Meeting of CorMon Pollution in order to address written comments received during or immediately after this meeting. Given the 8th EcAp CG took note of the that document with the understanding there is a validation process with CORMONS, and on that understanding, to use it as a basis towards development and testing of the methodologies for GES

assessment related to Ecological Objectives 9 and 10 within the preparation of the inputs for the 2023 MED QSR. Consequently, this present document elaborates all the comments received during the Meeting of CorMon Pollution Monitoring, the Meeting of MED POL Focal Points and 8th EcAp CG, as well as the findings and comments received from the members of the OWG on Contaminants during its virtual meeting (18 June 2021) and in the subsequent e-mail consultations that took place from June to December 2021. Therefore, it is submitted for approval of the Meeting of the Ecosystem Approach Correspondence Group on Pollution Monitoring in terms of using upgraded BC and BAC values for IMAP Common Indicator 17 for GES assessment within the preparation of the 2023 MED QSR, along with accepting proposed approaches for future upgrade of EAC for IMAP Common Indicators 17, 18 and 20.

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Annex I: References

List of Abbreviations / Acronyms

ADR	Adriatic Sea sub-region
AEL	Aegean and Levantine Seas sub-region
B	Biota
BDL	Below Detection Limit
CEN	Central Mediterranean Sea sub-region
CI	Common Indicator
CORMON	Correspondence Group on Monitoring
COP	Conference of the Parties
BC	Background Concentration
BAC	Background Assessment Concentrations
CEN	Central Mediterranean Sea sub-region
CI	Common Indicator
CORMON	Correspondence Group on Monitoring
COP	Conference of the Parties
CRM	Certified Reference Material
DW	Dry weight
EAC	Environmental Assessment Criteria
EC	European Commission
EMODnet	European Marine Observation and Data Network
EO	Ecological Objective
ERL	Effect range low
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GES	Good Environmental Status
HCB	Hexachlorobenzene
IMAP	Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria
MAP	Mediterranean Action Plan
MED	Mediterranean
MB	*Mullus barbatus*
MED POL	Programme for the Assessment and Control of Marine Pollution in the Mediterranean Sea
MG	*Mytilus galloprovincialis*
MSFD	Marine Strategy Framework Directive
NOAA	National Oceanic and Atmospheric Administration
OSPAR	Convention for the Protection of the Marine Environment for the North- East Atlantic
OWG	Online Working Group
PAHs	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyl
QSR	Quality Status Report
S	Sediment
SoED	State of Environment and Development Report
TM	Trace metals
TOC	Total Organic Carbon
UNEP	United Nations Environmental Program
USEPA	United States Environmental Protection Agency
WFD	Water Framework Directive
WHO	World Health Organization
WMS	Western Mediterranean Sea sub-region
WW	Wet weight

1 Introduction

1. This revised document updates the original document (UNEP/MED WG.492/12 Rev.2) presented at the Meeting of CorMon on Pollution Monitoring that took place on 26-28 April 2021. It includes a recalculation of the new proposed BCs and BACs concentrations using data that were not available at the time the document was prepared, namely, data received from February 2021 to December 2021. This revised document incorporates also the comments received during the Meeting of CorMon on Pollution Monitoring that took place on 26-28 April 2021; the resuming session of the Meeting of MEDPOL Focal Points that was held on 9 July 2021; and the 8th EcAp Coordination Group Meeting held on 9 September 2021. It also addresses the findings and comments received from members of the OWG (Online Working Group) on Contaminants during the virtual meeting that took place on June 18th, 2021 and in subsequent e-mail consultations.

2. The criteria established by Decisions IG.22/7 (COP 19)[1] and IG. 23/6 (COP 20)[2] are reviewed in Section 2 of present document, whereas Section 3 provides an in-depth analysis of the data available for present upgrade of the assessment criteria. New upgraded regional and sub-regional Mediterranean BC and BAC values for CI17, as well as a proposal of the criteria for IMAP CI20 are presented in Section 4. This section also proposes an approach to upgrade the Mediterranean EACs.

3. The data used for developing updated assessment criteria were collected in the IMAP Pilot Info System during its testing phase, and in particular after launching a formal call for reporting of monitoring data in June 2020, as well as monitoring data stored in MEDPOL database that have not been previously used for calculation of the assessment criteria applied in the 2017 and 2019 assessments, and data since 2015 even if previously used, following the recommendations of OWG on Contaminants. It also took into account data from EU data center (European Marine Observation and Data Network - EMODnet), as a reliable external data source, as well as data collected from the scientific literature. A detailed compilation of the available new data is given in Section 3.

2 The assessment criteria for IMAP Common Indicators 17 and 18

4. Deriving and setting up criteria to determine environmental status is not an easy task. It gets more complicated going from the local to sub-regional and regional assessments. While there are many methodologies to derive criteria, the first step is aimed at defining the background or reference conditions from which to measure/determine the status and trends. In the framework of UNEP/MAP (UNEP/MAP 2016, 2019), the background concentration (BC) is defined as “The concentration of a contaminant at a “pristine” or “remote” site based on contemporary or historical data”. The BC of anthropogenic (man-made) substance was defined as zero.-The same definitions are used by OSPAR and the Marine Strategy Framework Directive (MSFD) based on the Water Framework Directive (WFD) (Tornero et al. 2019).[3]

5. In line with these definitions, the BC determination is the first step of the derivation of indicators that are defined as the measure, index or model used to estimate the current state and future trends, along with thresholds for possible management action.

2.1 Methodology for background concentration (BC) determination

6. Several methods can be used to derive BC values for natural occurring elements/substances in different environmental matrices (i.e. sediment and biota).[4.] Briefly, they include using global average concentrations; pre-industrial age data; current data from pristine sites; data from monitoring programmes, whereas known polluted sites are excluded.

[1] UNEP/MAP (2015). Decision IG.22/7 on Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria (Annex II), (COP 19, 2015).
[2] UNEP/MAP (2017). Decision IG.23/6 on Mediterranean Quality Status Report (COP20, 2017).
[3] Additional definitions for BC can be found in the literature and are explained in UNEP/MED WG.533/Inf.3 submitted for information to present meeting.
[4] See document UNEP/MED WG. 533/Inf.3.

2.2 The methodology for the determination of Background concentration (BC) used by UNEP/MAP

7. The BCs were derived using the following two methodologies: i) data from sediment cores compiled from the scientific literature (UNEP/MAP 2011)[5] and ii) data from the MED POL database (UNEP/MAP 2011, 2016, 2019). A complete explanation of the used methodologies is given in these documents, as well as in UNEP/MED WG 533/Inf.3, submitted for consideration of present Meeting. The specific methodologies used by UNEP/MAP for the different parameters are described in sections 2.2.1-2.2.4.

2.2.1 Trace Metals (Cd, Hg and Pb) in sediments

8. The approved BCs for Trace Metals (TM) in sediments are summarized in Table 1. Briefly, in 2016, the first step was to choose the stations to be considered as reference at a country level. For each country, each parameter was grouped by year and the years without temporal trend chosen. Next, the parameters were grouped by stations and the overall median value computed. Stations where the 75th percentile of the data were below the overall median were chosen as reference stations.[6] Data of the reference stations were aggregated for the whole Mediterranean Sea and the MedBC computed as the median value of all reference stations. In 2019, BC values were computed in a similar way for 3 out of the 4 Mediterranean sub-regions[7]: Western Mediterranean (WMS), Adriatic Sea (ADR) and Aegean-Levantine Seas (AEL)[8.] No data were available to calculate BC for the Central Mediterranean (CEN). It was recommended to normalize the concentrations to Al (5%) concentrations[9].

Table 1. Background concentrations (BC) and Background assessment concentrations (BAC) calculated for trace metals (TM) in sediments for the Mediterranean Sea and sub-regions in 2011 and 2019. The table also presents the MedBAC and MedEAC values agreed upon in Decisions IG.22/7 and IG.23/6. Concentrations are given in µg/kg dry wt, as requested by IMAP[10.]

	Decisions IG.22/7 and IG.23/6 (COP 19 and COP 20)			UNEP/MAP (2011)		UNEP/MAP (2019)			
	MedBAC	MedBAC	MedEAC*	Med BC	Med BC	Med BC	BC	BC	BC
TM	IG.22/7	IG.23/6	IG.23/6	Sed cores	Surf Sed	Ref Stn	WMS	ADR	AEL
Cd	150	127.5	1200	100	20	85	91.2	92.3	56
Hg	45	79.5	150	30	10	53	60	106.8	31.2
Pb	30000	25425	46700	20000	2310	16950	20465	13932	4920

* ERL (Effects Range Low, Long et al. 1995, idem OSPAR values). Sediment (Sed); Surficial (Surf); Reference stations (Ref Stn); Western Mediterranean (WMS); Adriatic (ADR) Aegean; Levantine Sea (AEL). No data were available to set up BCs for the Central Mediterranean (CEN).

[5]For the purpose of this document only the scientific elements have been considered from any reference included in this document. Legal considerations are out of the scope of the present document, which serves exclusively scientific purposes
[6] In OSPAR`s methodology, the stations where the 95th percentile of the data were below the overall median were chosen as reference stations. It should be noted that this value can be very lenient concerning the environment.
[7]Although sub-regional values for the BCs in sediment were proposed, an updated 2019 assessment used the ones calculated in 2016, awaiting further confirmation of sub-regional values when new reference datasets will be available, whilst for mussels the proposed sub-regional values of BCs were exercised.
[8] The Mediterranean sub-regions and subareas are initially proposed according to availability of database sources for calculation of the assessment criteria (UNEP(DEPI)/MED WG.427/Inf.3; UNEP/MED WG.463/8; UNEP/MED WG.467/7).
[9]Normalization should be used with care, and only if field data support that normalization is valid for the area. An explanation on normalization practice for monitoring of IMAP Common Indicator 17 is provided in Monitoring (Guidelines/Protocols for Sample Preparation and Analysis for sediments (UNEP/MAP WG.482/12) and biota (UNEP/MAP WG.482/14)). In this document, data used for calculation of BC values were not normalized, since there were no available data on normalizers (i.e. Al, total organic carbon (TOC)) in the data sets reported by the Contracting Parties. The same is true for the data sets used for an upgrade of the assessment criteria applied in the 2017 and 2019 assessments.
[10]UNEP/MED WG.467/5. IMAP Guidance Factsheets: Update for Common Indicators 13, 14, 17, 18, 20 and 21: New proposal for candidate indicators 26 and 27; UNEP/MED WG.467/8. Data Standards and Data Dictionaries for Common Indicators related to Pollution and Marine Litter.

9. Further to this work, present document (Section 4) provides updated BC and BAC values for TM in sediments. They were calculated by using the new data and the same methodologies as applied in 2016 and 2019.

2.2.2 Naturally occurring organic compounds (PAHs) in sediment

10. MedBC values for PAHs in sediments are summarized in Table 2. The BCs were computed based on data derived from sediment cores compiled from the scientific literature, as well as data available in MED POL database (UNEP/MAP 2011). Normalization of organic compounds concentrations to total organic carbon (TOC) (2.5%) was recommended (See Section 2.2.5, UNEP/MED WG.533/Inf.3). However, the multiplication factor was not provided for calculation of BACs for PAHs in sediments in the previous UNEP/MAP documents (2011, 2016, 2019). The value of multiplication factor is proposed for present calculation as provided in Table 10 (see section 4.1 of UNEP/MED WG.533/Inf.3), looking at the OSPAR values for BC and BAC for PAHs in the sediments and considering now calculated relatively higher values of BCs for PAHs in sediments in comparison to the BCs calculated in 2011.

Table 2. Background concentrations (BC) calculated for PAHs in sediments for the Mediterranean Sea in 2011. The table also presents the MedEAC values agreed upon in Decisions IG.22/7 and IG.23/6. Concentrations are given in µg/kg dry wt, as requested by IMAP.

	Decisions (COP 19 and COP 20)	UNEP/MAP (2011)	
PAH compounds	EAC* IG.22/7 and IG.23/6	BC Sed cores	BC Sur sed
Naphthalene (N)		4	
Acenaphthylene (ACY)		0.5	1.05
Acenaphthene (ACE)		0.38	0.45
Fluorene (F)		0.75	0.33
Phenanthrene (P)	240	4.55	3.95
Anthracene (A)	85	0.8	1.56
Fluoranthene (FL)	600	5.6	6.7
Pyrene (PY)	660[11]	10.28	2.1
Benzo[a]anthracene (BaA)	261	3.45	1.28
Chrysene (C)	384	1.3	6.64
Benzo(b)fluoranthene (BbF)		1.1	8.32
Benzo(k)fluoranthene (BkF)		0.53	6.03
Benzo[a]pyrene (BaP)	430	2.55	3.71
Benzo[g,h,i]perylene (GHI)	85[12]	1.25	3.25
Dibenz [a,h]anthracene (DA)	[13]	0.18	1.37
Indeno[1,2,3-c,d]pyrene (ID)	240[14]	1.7	4.49

* ERL. ERL for Naphthalene (160 µg/kg dw) and Total PAHs (4022 µg/kg dw) were derived by Long et al., 1995, but they do not appear in the COPs decisions.

11. Further to this work, present document (Section 4; UNEP/MED WG.533/Inf.3) provides updated BC and BAC values for PAHs in sediment. They were calculated by using the new data and the same methodologies as applied in 2016 and 2019 for trace metals.

2.2.3 Naturally occurring trace metals (Cd, Hg and Pb) and organic compounds (PAHs) in biota[15]

12. Unlike the sediments, there are no values of the pristine, pre-industrial concentrations of naturally occurring compounds in biota. In 2011, the BC concentrations were computed based on the whole MED POL database (excluding known polluted stations), as the median of the lower 5% of the

[11] Updated value in IG. 23/6 of the value of 665 as provided in in IG.22/7
[12] Correction introduced to correct technical error in document presented to the Meeting of CorMon on Pollution Monitoring
[13] Correction introduced to correct technical error in document presented to the Meeting of CorMon on Pollution Monitoring
[14] Correction introduced to correct technical error in document presented to the Meeting of CorMon on Pollution Monitoring
[15] The mussel *Mytilus galloprovincialis* (MG) and the fish *Mullus barbatus* (MB), the agreed mandatory species for monitoring

data. In 2016 and 2019, the BC concentrations were computed as for trace metals in sediments, based on the data sets from the selected reference stations. The calculated BC values for TM are presented in Table 3 for mussel and fish. The calculated BCs for PAHs in mussel are presented in Table 4. It should be emphasized that BC concentrations are species specific as well as tissue specific (i.e. natural concentrations in muscle are different from the natural concentrations in liver). In addition, BC concentration may depend on age of the specimens, with length and weight usually used as a proxy to age[16].

Table 3. Background concentrations (BC) calculated for trace metals in mussel and fish for the Mediterranean Sea and sub-regions in 2016 and 2019. The table also present the MedBAC and MedEAC values agreed upon in Decisions IG.22/7 and IG.23/6. Concentrations are given in the units requested by IMAP.

	Decisions (COP 19 and COP 20)			UNEP/MAP (2019)			
	MedBAC	MedBAC	#MedEAC	BC	BC	BC	BC
TM	IG.22/7	IG.23/6	IG.23/6	Med	WMS	ADR	AEL
Mussel soft tissue (*Mytilus galloprovincialis*), µg/kg dry wt							
Cd	1088	1095	5000	730	660.5	782	942
Hg	188	173.2	2500	115.5	109.4	126	110
Pb	3800	2313	7500	1542	1585	1381	2300
Fish muscle (*Mullus barbatus*) µg/kg wet wt							
Cd	16**	*3.7	50	*3.7			
Hg	600**	101.2	1000	50.6	68	150.5	44.6
Pb	559[17]**	*31	300	*31	38		20

* Most values below detection limit, ** Concentrations in µg/kg dry wt as given in Decision IG. 22/7. # EACs are the ECs, the maximum levels for certain contaminants in foodstuffs based on European policy (EC/EU 1881/2006, 1259/2011 Directives and amendments 488/2014 and 1005/2015). Western Mediterranean (WMS); Adriatic (ADR) Aegean; Levantine Sea (AEL). No data were available to set up BCs for the Central Mediterranean (CEN)

Table 4. Background concentrations (BC) calculated for PAHs in mussel (*Mytilus galloprovincialis*) soft tissue for the Mediterranean Sea and sub-regions in 2016 and 2019. The table also present the MedBAC and EAC values agreed upon in Decisions IG.22/7 and IG.23/6. Concentrations are given in µg/kg dry wt, as requested by IMAP.

	Decisions (COP 19 and COP 20)		UNEP/MAP (2019)			
	MedBAC	EAC*	BC	BC	BC	BC
PAH compounds	IG.23/6	IG.22/7 and IG.23/6	Med	WMS	ADR	AEL
Naphthalene			(2.4) #	2.24		2.80
Acenaphthylene			(0.6) #			
Acenaphthene			(0.6) #			
Fluorene	2.5		1.0	0.96	1.07	0.60
Phenanthrene	17.8	1700	7.1	4.93	9.04	7.55
Anthracene	1.2	290	0.5	0.52	0.38	0.30
Fluoranthene	7.4	110	3.0	3.38	2.03	6.60
Pyrene	5.0	100	2.0	3.02	0.85	5.90
Benzo[a]anthracene	1.9	80	0.8	1.20	0.53	1.60
Chrysene	2.4		1.0	1.24	0.27	5.20
Benzo(b)fluoranthene						
Benzo(k)fluoranthene	1.4	260	0.6	1.27	0.29	1.50
Benzo[a]pyrene	1.2	600	0.5	0.60	0.32	0.70
Benzo[g,h,i]perylene	2.3	110	0.9	0.90		1.20
Dibenz [a,h]anthracene	1.3		0.5	0.53		
Indeno[1,2,3-c,d]pyrene	2.9		1.2	1.23		0.90

[16] See document UNEP/MED WG.533/Inf.3
[17] Correction introduced to correct technical error in document presented to the Meeting of CorMon on Pollution Monitoring

* EC, maximum levels for certain contaminants in foodstuffs based on European policy (EC/EU 1881/2006, 1259/2011 Directives and amendments 488/2014 and 1005/2015). # most data below detection limit. In red, sub-regional BC values higher than MedBAC (MedBAC= 1.5 MedBC, see Section 2.3.1)

13. Further to this work, present document (Section 4; UNEP/MED WG.533/Inf.3) provides updated BC and BAC values for TM in biota and PAHs in mussel. They were calculated using the new data and the same methodologies as applied in 2016 and 2019.

2.2.4 Synthetic substances (non-naturally occurring) in sediments and biota

14. The BC of any anthropogenic (man-made) substance is defined as zero. However, analytically, it is impossible to measure a concentration that equals zero[18]. Therefore, the BC determination is based on the detection limits of the methods used and its uncertainty (precision and accuracy), as determined from CRMs (Certified reference materials) and proficiency testing. IMAP addresses organochlorinated contaminants (PCBs and pesticides) as detailed in Table 5. This table summarizes the EAC values for the Mediterranean, agreed upon in Decisions IG.22/7 (COP19) and IG.23/6 (COP20). No BC nor LC (Low concentrations) were calculated for the Mediterranean in 2016 nor in 2019 (UNEP/MAP, 2016, 2019).

Table 5. EAC values for organochlorinated contaminants in sediments, in mussel (*Mytilus galloprovincialis*) soft tissue and muscle tissue in fish (*Mullus barbatus*) for use in the Mediterranean Sea. The values were agreed upon in Decisions IG.22/7 and IG.23/6 and follow OSPAR's recommendations. Concentrations are given in the units requested by IMAP.

	Sediments		Mussel	Fish
	EAC* IG.22/7(µg/kg dw)	MedEAC* IG.23/6(µg/kg dw)	EAC IG.22/7 and IG.23/6 (µg/kg dw)	EAC IG.22/7 and IG.23/6 (µg/kg lipid)
PCBs				
CB28		1.7	3.2	64
CB52		2.7	5.4	108
CB101		3	6	120
CB118		0.6	1.2	24
CB138		7.9	15.8	316
CB153		40	80	1600
CB180		12	24	480
Sum 7 PCBs	11.5			
Pesticides				
γ-HCH (Lindane)	3		1.45	11 µg/kg ww
DDE(p,p')	2.2		5-50	
Hexachlorobenzene	20			
Dieldrin	2		5-50	

* ERL (Effects Range Low, Long et al. 1995, idem OSPAR values).

15. Further to this work, present document (Section 4) provides updated BC values for organochlorinated contaminants in sediments and mussel. They were calculated using the new data and the same methodologies as applied in 2016 and 2019 for other contaminants.

2.3 The methodologies for thresholds` determination used by UNEP/MAP

16. UNEP/MAP has adopted the threshold assessment methodology, based on the "traffic light" approach, by defining 2 values to classify 3 environmental categories: 1) good (acceptable, not different from BC); 2) above background but with low risk for environment and biota population, or below dietary limits for fish and sea food concerning human health; and 3) unacceptable. The two values defined were i) the Background Assessment Concentration (BAC) (or T_0) and ii) the Environmental Assessment Criteria (EAC) for TM and organic contaminants in sediments and biota, or EC for TM and organic contaminants in biota, (or T_1). The above Tables 1-5 tabulate the values of

[18] The BCs for man-made substances should be regarded as zero, and therefore, the so-called low concentrations (LCs) might be used instead to derive assessment criteria. The latter could be derived from reliable datasets of analytical variability information reported from either certified reference materials (CRMs) or independent proficiency testing (PTs) scheme databases. However, the Contracting Parties of Barcelona Convention agreed to use the BC terminology and not LC within UNEP/MAP.

BAC and EAC adopted or proposed to be used for the assessment of the quality status of the Mediterranean Sea (IMAP Decisions 22/7 (COP 19) and 23/6 (COP 20)).

2.3.1 Background Assessment Concentration (BAC) determination

17. BAC are the concentrations below which no deterioration of the environment can be expected. Observed concentrations are said to be near BC if the mean concentration is statistically significantly below BAC. For calculation of BAC values from BC concentrations UNEP/MAP adopted the methodology that corresponds to the OSPAR methodology[19]. The BAC values were computed as the BC concentration multiplied by a factor that was determined based on the uncertainty (precision and accuracy) of the determinations. The multiplication factors were computed by applying the following equations: i) MedBAC for trace metals in sediments and shellfish: MedBAC=1.5xMedBC and in fish: MedBAC =2xMedBC; and ii) MedBAC for PAHs in sediments and mussel: MedBAC=1.5xMedBC. iii) MedBAC for organochlorinated contaminants in sediments and mussel were not calculated. Most of the data for the organochlorinated contaminants were below detection limit[20], therefore the proposed BCs should be re-examined when more data became available. Detailed elaboration is provided in the section 2.3.1 in UNEP/MED WG XXX/Inf.1.

18. The MedBAC values endorsed in Decisions IG.22/7 and IG.23/6 are as follows: MedBAC for TM in sediments, mussel and fish (Tables 1,3), PAHs in sediments and mussel (Tables 2, 4). In 2019, the same methodology was used to propose derivation of specific sub-regional MedBAC values.

19. Further to work undertaken in 2019, this document proposes updated regional and sub-regional BAC values for the Mediterranean, using the same methodology as in 2019. The proposed values are presented in Section 4 along with elaboration also provided in UNEP/MED WG.533/Inf.3.

2.3.2 Environmental Assessment Criteria (EAC) determination

20. EAC values are the concentrations above which significant adverse effect to the environment or to human health are most likely to occur. Conversely, EAC values are defined as the concentrations below which it is unlikely that unexpected or unacceptable biological effects will occur in exposed marine species. Due to that fact that it was not possible to develop EAC for MED at that time, it was agreed to use the criteria developed by OSPAR and NOAA/USEPA (ERL values) (Long et al. 1995), as the EAC values for the Mediterranean. The EAC values agreed in Decisions IG.22/7 and IG.23/6 are as follows: EAC values for TM, PAHs and organochlorinated contaminants (PCBs and pesticides) are provided for sediments in Tables 1, 2 and 5; TM and organochlorinated contaminants are provided for mussel and fish in Tables 3 and 5 and PAHs are provided for mussel in Table 4.

21. A proposal of a new methodology to derive EAC values specific for the Mediterranean Sea is described in Section 4[21].

2.3.3 European Union regulations (EC)

22. The EAC values for TM and PAHs in biota as endorsed by Decisions IG.22/7 and IG.23/6 (Table 3) are the concentrations in fish and seafood recommended as dietary limits for human consumption concerning human health (EC). EC values are derived from the following EU Directives regulating maximum levels for certain contaminants in foodstuffs: EC/EU 1881/2006, 1259/2011, 488/2014 and 1005/2015. Section 4.3 gives more details about EC values. It should be mentioned that these values were set up to protect human health and may be too lenient to protect the environment.

23. A proposal of new methodology to derive EAC values for the Mediterranean Sea is described in Section 4[22].

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[19] At present, no statistical assessment was possible for the precision of the monitoring data reported into MEDPOL/IMAP Info system given the quantity of data reported in IMAP info System/ MEDPOL, as well as a frequency of analyzing one sample of either biota or sediment is insufficient for calculation of the precision of monitoring data. Therefore, the variability from OSPAR monitoring program was used, following its application for an upgrade of the assessment criteria in in 2017 and 2019. A detailed explanation is given in section 2.3.1 of the information document UNEP/MAP WG.533/Inf.3.

[20] Annex III, document UNEP/MAP WG.533/Inf.3.

[21] See in UNEP/MAP WG.533/Inf.3

[22] See in UNEP/MAP WG.533/Inf.3

2.4 The assessment criteria for IMAP Common Indicator 18

24. By Decisions IG.22/7 and IG. 23/6, the Contracting Parties endorsed BAC and EAC values for the following biomarkers for the mussel (*Mytilus galloprovincialis*): Acetylcholinesterase activity (AChE), Metallothioneins (MT), Micronuclei frequency (MN), Lysosomal membrane stability (LMS-NRR and LMS-LP methods) and Stress on Stress (SoS). These values are indicative and serve as the initial assessment criteria.

25. Presently there are no new data that can be used to update the biomarkers` assessment criteria. Therefore, they were not addressed in Section 4. More information on biomarkers and related criteria derivation is given in section 2.4. in UNEP/MAP WG.533/Inf. 3.

3 Survey of relevant data not used previously neither for preparation of the Mediterranean Quality Status Report (2017 MED QSR) nor for the State of Environment and Development Report (2019 SoED)

26. New relevant data not used previously neither for the 2017 MED QSR nor for update of the assessment for EO9 within preparation of the 2019 SoED were collected from the following 4 data sources:

1. New data from IMAP Pilot Info System that include national monitoring data uploaded in the system during its testing phase, and in particular after launching formal call for reporting of data in June 2020. This updated document takes into account monitoring data reported until 31 December 2021.
2. Data from the MED POL Database since 2015[23];
3. The EU data center (European Marine Observation and Data Network - EMODnet);
4. Published papers collected from the scientific literature.

27. Details of the available data from these sources are elaborated in UNEP/MED WG. XXX/If.1 and summarized here- below. It must be noted that level of data reported until 31 December 2021 was still less than 30 % of new data that need to be reported for the preparation of the 2023 MED QSR.

3.1 IMAP Pilot Info System and MED POL Database

28. Tables 6, 7 and 8 provide each a detailed examination of the new available data per contaminant category sorted by matrix, country and source of data. The datasets used in the 2017 and 2019 assessments are given in UNEP/MAP WG.463/Inf.6 (2019).

29. It can be seen that the IMAP and MED POL data included only TM and organic contaminants in sediment and biota (CI17). No new data were available for biomarkers (CI18). New biomarker data were not available also for assessments that contributed to 2019 SoED.

Table 6[24]: An overview of the data available for trace metals in sediments and biota (*Mytilus galloprovincialis* and *Mullus barbatus*) for their use for the preparation of the 2023 QSR. The numbers next to the years are the number of observations for each parameter, sorted by country and data source. When available, IMAP-IS file number is given.

Source	IMAP_File	Country	Year	Cd	Hg	Pb
Sediment						
IMAP_IS	&	Albania	2020	6	6	6
IMAP_IS	&	Croatia	2019	30	30	30
EMODNet		Croatia	2017	37	37	37
IMAP_IS	125	Cyprus	2013-2018	22	22	22
IMAP_IS	224	France	2016	23	23	23
EMODNet		France	2016	27	27	27
Literature		Greece	2016-2018	0	0	115
IMAP_IS	410, &	Israel	2019-2020	30	30	30
MEDPOL		Israel	2015,2017	34	34	33

[23] In view of the consultations with the OWG on Contaminants (UNEP/MAP WG.533/Inf.3, Annex I), data from 2015 onwards were included in the calculation, even if they were used previously, in order to increase the number of data points.
[24] A more detailed table is presented in UNEP/MAP WG533/Inf.3 (Table 6).

Source	IMAP_File	Country	Year	Cd	Hg	Pb
IMAP_IS	457,469	Italy	2015-2019	499	390	484
EMODNet		Italy	2015	2	5	5
IMAP_IS	118	Lebanon	2019	17	7	17
Literature		Lebanon	2017	2	3	3
IMAP_IS	489	Malta	2017-2018	22	22	22
IMAP_IS	&	Montenegro	2019-2020	41	41	41
MEDPOL		Montenegro	2016-2018	26	26	26
IMAP_IS	243	Morocco	2015-2018	44	22	44
IMAP_IS	204	Slovenia	2019	1	1	1
MEDPOL		Tunisia	2014	9	9	9
IMAP_IS	445,446	Turkey	2018	65	65	65
MEDPOL		Turkey	2015	21	21	21
Mytilus galloprovincialis						
IMAP-IS	&	Croatia	2019,2020	37	35	37
IMAP-IS	495	France	2018	23	23	23
MedPol		France	2015	24	24	24
EMODNet		France	2017	3	3	3
Literature		France	2014	0	17	0
IMAP-IS	460,494	Italy	2016-2019	26	109	26
EMODNet		Italy	2015-2018	7	61	7
IMAP-IS	&	Montenegro	2019-2020	20	20	20
MedPol		Montenegro	2018	8	8	8
IMAP-IS	439,&	Slovenia	2018-2020	9	9	9
MedPol		Slovenia	2016-2017	9	9	3
Mullus barbatus						
IMAP_IS	&	Croatia	2019,2020	11	10	11
IMAP_IS	41,351,410	Israel	2015,2018,2019	48	48	0
IMAP_IS	152	Lebanon	2019	14	14	14
IMAP_IS	489	Malta	2017,2019	5	5	5
MEDPOL		Montenegro	2018	8	8	8
IMAP_IS	323	Turkey	2015	25	25	25

&Reported to MEDPOL, to be added to IMAP_IS

Table 7[25]: An overview of the data available for PAHs in sediments and biota (*Mytilus galloprovincialis*) for their use for the preparation of the 2023 QSR, sorted by country and source of data. The numbers next to the years are the minimal and maximal number of observations for any PAH compound in the relevant years.When available, IMAP-IS file number is given.

Source	IMAP_File	Country	Year	Minimum	Maximum
Sediment					
IMAP_IS	&	Albania	2020	*	6
EMODNet		France	2016	29	29
Literature		Israel	2013	52	52
IMAP_IS	457,469	Italy	2016-2019	51	377
EMODNet		Italy	2015-2017	0	5
IMAP_IS	152	Lebanon	2019	0	19
IMAP_IS	489	Malta	2017-2018	0	25
IMAP_IS	&	Montenegro	2019-2020	41	41
MedPol		Montenegro	2018	0	6
IMAP_IS	204	Slovenia	2019	0	1

[25] A more detailed table is presented in UNEP/MAP WG.533/Inf. 3 (Table 7).

Source	IMAP_File	Country	Year	Minimum	Maximum
MedPol		Slovenia	2013-2018	0	27
Literature		Tunisia	2019	0	5
IMAP_IS	445,446	Turkey	2018	*	65
Mytilus galloprovincialis					
IMAP_IS	&	Albania*	2020	0	0
Literature		Algeria	2014	6	6
IMAP_IS	495	France	2018	22	23
EMODNet		France	2017	0	2
IMAP_IS	460,494	Italy	2016-2019	0	56
IMAP_IS	&	Montenegro	2019-2020	21	21
MedPol		Montenegro	2018	0	8
IMAP_IS	204,364,439	Slovenia	2015-2016,2019-2020	0	12
IMAP_IS	277	Spain	2015	0	42

&Reported to MEDPOL, to be added to IMAP_IS; * data for Total 4 or Total 5 PAHs

Table 8[26]: An overview of the data available for organochlorinated contaminants in sediments and biota (*Mytilus galloprovincialis*) for their use for the preparation of the 2023 QSR, sorted by country and source of data. The numbers next to the years are the minimal and maximal number of observations for any compound in the relevant years. When available, IMAP-IS file number is given.

Source	IMAP_File	Country	Year	Minimum	Maximum	Minimum	Maximum
				PCBs		Pesticides	
Sediment							
EMODNet		France	2016	29	29	0	29
IMAP_IS	457,469	Italy	2016-2019	126	183	0	364
EMODNet		Italy	2015	0	0	0	5
IMAP_IS	152	Lebanon	2019	0	19	0	0
IMAP_IS	489	Malta	2017-2018	0	0	0	22
IMAP_IS	&	Montenegro	2019-2020	41	41	24	41
Literature		Tunisia	2019	0	5	0	5
IMAP_IS	445-446	Turkey	2018	64	64	0	64
Mytilus galloprovincialis							
Literature		Algeria	2014	6	6	0	0
IMAP_IS	&	Croatia	2019	19	19	0	0
IMAP_IS	495	France	2018	0	23	0	23
IMAP_IS	460,494	Italy	2016-2019	0	30	0	106
IMAP_IS	&	Montenegro	2019-2020	21	21	0	0
IMAP_IS	277	Spain	2015	14	14	14	14

&Reported to MEDPOL, to be added to IMAP_IS

[26] A more detailed table is presented in UNEP/MAP WG.533/ Inf.3 (Table 8).

3.2 Data from the EU data center (European Marine Observation and Data Network - EMODnet)

30. Data from EMODnet used to complement data available in IMAP Pilot Info System and MED POL Database are summarized in Tables 6-8. Some of the data previously available only from EMODNet were now available in IMAP-IS and were used as reported there.

3.3 Data from the scientific literature

31. The available scientific papers reviewed in the preparation of this document are detailed in UNEP/MAP WG.XXX/Inf.1 (Annex II), including also literature sources recommended from the members of OWG on Contaminants. The data from the literature used to complement data available in IMAP Pilot Info System and MED POL Database are summarized in Tables 6-8. It is important to note that the papers are usually limited in scope, both spatially and temporally. Moreover, they usually include contaminated and reference sites, so care should be taken when utilizing the data for BC calculation or verification. The search was geared towards finding recent data, from samples collected since 2012, and towards data from the southern Mediterranean countries.

3.4 Examination of the new data

32. The new data available were examined and used for BC and BAC`s calculation, as appropriate. The computed values were then compared with the environmental criteria for the Mediterranean Sea as endorsed in Decision 23/6 (COP 20). Those are presented in section 4.

33. The additional data available since the original document was finalized in April 4th 2021 improved the calculations. However, data were still limited, therefore data from different years were aggregated per country and outliers identified (using box plots) and not considered in the calculation of the median values. When needed, data were transformed to the concentration units requested by IMAP. It should be mentioned that sediment data were not normalized.

34. This comparison was undertaken in order to confirm data relevance for computing the updated BC and BAC values (Section 4). An in-depth examination of the data is presented in UNEP/MAP WG.533/Inf.3 (Annex III).

4 Critical examination of recommended environmental criteria and proposals for their update

35. In line with Decision 22/7 (COP 19), the assessment criteria for the Mediterranean Sea should follow the “traffic light” system for both contaminant concentrations and biological responses where two thresholds and three status categories are defined. As explained above, the two values defined were the Background Assessment Concentration (BAC) (T_0) and the Environmental Assessment Criteria (EAC) or EC values (T_1), (see Section 2).

4.1 Updated BC and BAC values for IMAP CI 17

36. The new data presented and critically analyzed above in Section 3 were used to calculate BC values for the sub-regional areas of the Mediterranean and for the whole Mediterranean Sea using the same methodology as initially applied in 2016/2017 and replicated in 2019 (see detail explanation in Section 2)[27]. BAC values for trace metals were calculated by multiplying the BCs by a factor, as follows: MedBAC=1.5 x MedBC (for mussel and sediment matrices); MedBAC=2.0 x MedBC (fish). For PAH in sediments, it is proposed to use MedBAC=1.5 x MedBC[28] . When most of the data originated from one sub-region, and there were significant differences among them, the BC values were calculated for the sub-region(s) only.

[27] The calculation was performed using also the limit of detection (LOD) or the limit of quantitation (LOQ) values provided by the countries addressed as below detection limit (bdl) values (see Annexes I and III in UNEP/MAP WG.533/Inf.3).
[28] The calculation of the multiplication factor to calculate BACs for PAHs in sediments was not provided in the previous UNEP/MAP documents (2011, 2016, 2019). Looking at the OSPAR values for BC and BAC for PAHs in the sediments, the multiplication factor used depended on the compound and ranged from 1.6 to 2.1.

37. Tables 9-13 present the new updated BC and BAC values. The tables include also the values of the assessment criteria as endorsed in Decision 23/6 (COP 20), as well as their values updated in 2019.

Table 9. BC and BAC values for trace metals in sediments, calculated from the new data available for upgrade of the criteria in present document (marked with 2022). Concentrations are given in µg/kg dry wt, as requested by IMAP. The number of data points (n) taken to calculate the BCs appear below the values. When most (>50%) of the data points were below the detection limit for the sub-regions, BCs were not calculated.

BCs							
TM	Med (cores)	Med (surf)	MED	WMS	ADR	CEN	AEL
	2011[29]		**2019**				
Cd	100	20	85	91.2	92.3		56
Hg	30	10	53	60	106.8		31.2
Pb	20000	2310	16950	20465	13932		4920
Proposed new updated BC values (2022)							
Cd			107	140	120	#	78.9
n			*803*	*351*	*300*	*31*	*158*
Hg			50.0	90.0	50.0	#	31.5
n			641	241	218	24	147
Pb			15000	16000	15700	1805	15674
n			*927*	*318*	*325*	*29*	*272*
BACs							
		IG.23/6	Med	WMS	ADR	CEN	AEL
		2017	**2019**				
Cd		127.5	127.5	136.8	138.5		84.0
Hg		79.5	79.5	90.0	160		46.8
Pb		25425	25425	30698	20898		7380
Proposed new updated BAC values (2022)							
Cd			161	210	180	#	118
Hg			75.0	135	75.0	#	47.3
Pb			22500	24000	23550	2708	23511

#All data points for Cd are bdl as well as 72% of the Hg data points.

38. It can be seen that the proposed new updated regional Mediterranean BC value for Cd is similar to the one calculated in 2011 from sediment cores while value for Hg is higher and for Pb is lower. Comparison to the BCs values updated in 2019 shows that presently updated regional BC values for Cd is higher, Hg is similar and Pb slightly lower. Comparison of the sub-regional BC values calculated in 2019 and 2022 shows differences as well, in particular Pb for the AEL sub-region. However, the BC for Pb at the AEL is similar to those calculated for the WMS and ADR. Possible reasons for these differences could be due to different sediment mineralogical composition and the location of the sampling stations, as well as the number of data points used in the calculation. It was possible to calculate BC for Pb at the CEN sub-region in 2022, however with only 29 data points (see Table 9). Comparison of the new updated BC values among the sub-regions showed that for Cd and Hg, the concentrations were higher in the WMS, followed by ADR and then AEL. Pb concentrations were similar. The number of data points among the sub-regions taken for the calculation were similar for the WMS and the ADR sub-regions, and lower for the AEL (ca. half the number of data points for Cd and Hg). The BC value for Pb in CEN was about one order of magnitude lower than the BCs calculated for the other sub-regions and should be re-examined when additional data will be available.

[29] The values calculated in 2011 are shown for comparison. The values were calculated from data compiled from the scientific literature (UNEP/MAP 2011) and need no recalculation.

Table 10. BC and BAC values for PAHs in sediments, calculated from data available for upgrade of the criteria in present document (marked with 2022). Concentrations are given in μg/kg dry wt, as requested by IMAP. The number of data points (n) taken to calculate the BCs appear to the right of the values *(inclined)*. When most (>50%) of the data points were below the detection limit for the sub-regions, BCs were not calculated.

	UNEP/MAP (2011)		**Proposed new updated BC values (2022)**									
PAH compounds	BC, Sed cores	BC, Sur sed	MED	*n*	WMS	*n*	ADR	*n*	CEN	*n*	AEL	*n*
Naphthalene	4		2.00	*217*	8.0	*24*	2.0	*165*	#	22	2.3	*49*
Acenaphthylene	0.5	1.05	(1.0)#	*208*	#	*25*	#	*132*	0.4	5	#	*52*
Acenaphthene	0.38	0.45	(2.0)#	*278*	#	*70*	#	*139*		*0*	#	*52*
Fluorene	0.75	0.33	(2.0)#	*270*	#	*88*	#	*139*	0.4	5	#	*41*
Phenanthrene	4.55	3.95	3.10	*212*	14.9	*25*	3.5	*155*	0.8	5	3.1	*48*
Anthracene	0.8	1.56	(2.2)#	*452*	#	*212*	#	*140*	#	28	#	*35*
Fluoranthene	5.6	6.7	5.00	*357*	#	*204*	7.0	*143*	0.1	23	2.7	*47*
Pyrene	10.28	2.1	6.20	*239*	24.8	*88*	8.0	*132*	0.4	5	3.0	*43*
Benzo[a]anthracene	3.45	1.28	3.38	*262*	19.7	*87*	4.1	*155*		*0*	1.8	*50*
Chrysene	1.3	6.64	2.70	*244*	35.9	*75*	4.6	*156*	1.6	5	1.6	*49*
Benzo(b)fluoranthene	1.1	8.32	5.00	*292*	8.7	*144*	15.0	*121*		*0*	2.6	*50*
Benzo(k)fluoranthene	0.53	6.03	4.00	*335*	#	*147*	3.0	*153*		*0*	#	*46*
Benzo[a]pyrene	2.55	3.71	(4.0)#	*397*	#	*201*	4.0	*154*	#	28	1.0	*48*
Benzo[g,h,i]perylene	1.25	3.25	(4.2)#	*370*	#	*205*	5.7	*155*		*0*	1.8	*49*
Dibenz[a,h]anthracene	0.18	1.37	(1.0)#	*246*	7.0	*89*	#	*143*		*0*	#	*50*
Indeno[1,2,3-c,d]pyrene	1.7	4.49	(4.0)#	*384*	#	*201*	4.4	*155*		*0*	2.1	*51*
Total PAHs			27.4	*178*	160	*26*	41.0	*107*	6.3	5	21.4	*60*

		Proposed new updated BAC values (2022)				
PAH compounds		MED	WMS	ADR	CEN	AEL
Naphthalene		3.0	12.0	3.0	#	3.5
Acenaphthylene		(1.5)#	#	#	0.6	#
Acenaphthene		(3.0)#	#	#		#
Fluorene		(3.0)#	#	#	0.5	#
Phenanthrene		4.7	22.4	5.3	1.2	4.7
Anthracene		(3.3)#	#	#	#	#
Fluoranthene		7.5	#	10.5	0.2	4.1
Pyrene		9.3	37.1	12.0	0.6	4.5
Benzo[a]anthracene		5.1	29.6	6.2		2.7
Chrysene		4.0	53.9	6.9	2.4	2.4
Benzo(b)fluoranthene		7.5	13.0	22.5		3.8
Benzo(k)fluoranthene		6.0	#	4.5		#
Benzo[a]pyrene		(6.0)#	#	6.0	#	1.5
Benzo[g,h,i]perylene		(6.3)#	#	8.6		2.7
Dibenz [a,h]anthracene		(1.5)#	10.5	#		#
Indeno[1,2,3-c,d]pyrene		(6.0)#	15.0	6.5		3.2
Total PAHs		41.0	240	61.5	9.5	32.0

#most data (>50%) below detection limit

39. The additional data reported by the CPs in the IMAP-IS up to 31 December 2021 improved the calculation of the BCs for PAHs in sediments. The number of data points used for calculation of BC for the whole Mediterranean increased by 7 times, compared to the data available until February 2021, while for WMS, ADR and CEN by 3-20 times on average. It was possible to calculate new proposed

BCs also for the AEL sub-region due to new data as available until February 2021. However, BC for the sub-regions were calculated only when less than 50% of the data points were below the detection, to prevent bias due to different detection limits among countries (see Annex III, UNEP/MED WG. 533/Inf 3)[30]. The calculated BC values for the whole Mediterranean for most of the compounds were higher than the BC concentrations measured in sediment cores and surficial sediments of the Mediterranean Sea in 2011, while for a few compounds they were similar or lower. However, for 8 compounds, the Mediterranean BC values were calculated with more than 50% values BDL. This could be the one of the reasons for the differences. The BC values calculated for the WMS sub-region were higher than those calculated for the whole Mediterranean. The calculated values for the ADR were lower than for the WMS, and higher or similar to the values of the Mediterranean while for the AEL the values were lower. The lowest values were calculated for the CEN, however the number of data points was low and not representative. Therefore, it is proposed to use presently updated values of BC/BAC for preparation of input assessments for 2023 MED QSR, along with further update of the assessment criteria if more data will be reported by the CPs[31]. Moreover, it is recommended to add the concentration of Total[32] (16) PAHs to the list of parameters in addition to reporting of the concentrations of individual 16 PAHs.

Table 11. BC and BAC values for trace metals in mussel (*M. galloprovincialis*) and fish (*M. barbatus*)[33] calculated from data available for upgrade of the criteria in present document (marked with 2022) The table presents also the values as calculated in 2019 (marked 2019) and previously endorsed values. The units of concentrations are given as requested by IMAP. The number of data points (n) taken to calculate the values appear below the values.

BCs						
TM		**MED**	**WMS**	**ADR**	**CEN**	**AEL**
Mussel soft tissue (*M. galloprovincialis*), µg /kg dry wt						
		2019				
Cd		730	660.5	782		942
Hg		115.5	109.4	126		110
Pb		1542	1585	1381		2300
Proposed new updated BC values (2022)						
Cd		710	1030	629	78	>
n		*165*	*53*	*108*	*4*	
Hg		77.9	85.0	75.4	12	>
n		*300*	*121*	*168*	*8*	
Pb		1100	1260	1000	#	>
n		148	51	94	4	
BACs						
	Med	**MED**	**WMS**	**ADR**	**CEN**	**AEL**
TM	IG.23/6 (2017)	**2019**				
Cd	1095	1095	991	1173		1413
Hg	173.2	173.2	164.1	189		165
Pb	2313	2313	2378	2072		3450
Proposed new updated BAC values (2022)						
Cd		1065	1545	944	117	
Hg		117	128	113	18.4	
Pb		1650	1890	1500	#	

[30] See Annex III in UNEP/MAP WG.533/Inf.3

[31] The values for a few of the compounds in Table 10 are 0, meaning that the concentrations measured were BDL Section 4.1, UNEP/MAP WG.533/Inf.1, addresses the topic of BDL concentrations.

[32] In addition to Total PAH (16 compounds), UNEP/MAP DD cites the following Total PAHs from the EEA reference list of contaminants: Total PAHs (4 PAHs: Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno (1,2,3-cd)pyrene) (EEA_33-62-5); Total PAHs (Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(ghi)perylene, Indeno (1,2,3-cd)pyrene) (EEA_33-56-7); Total Benzo(b)fluoranthene + Benzo(k)fluoranthene (EEA_32-23-5) and Total Benzo(g,h,i)perylene + Indeno (1,2,3-cd)pyrene (CAS_193-39-5) (EEA_32-24-6.

[33] Available data for trace metals in other biota species are presented in Annex IV in UNEP/MED WG.533/Inf.3.

BCs						
TM		MED	WMS	ADR	CEN	AEL
Fish muscle (*Mullus barbatus*) µg/kg wet wt, calculated in 2019						
Cd		*3.7				
Hg		50.6	68	150.5		44.6
Pb		*31	38			20
Proposed new updated BC values (2022)						
Cd		3.9		5.3		3.6
n		*98*		*19*		*87*
Hg		40.6		120		33.7
n		*97*		*18*		*81*
Pb		18.3		40.8		13.5
n		*58*		*19*		*39*
BACs						
	MED	MED	WMS	ADR	CEN	AEL
	IG.23/6 (2017)	**2019**				
Cd	*3.7#	#3.7				
Hg	101.2#	101.2	136	301		89.2
Pb	*31#	#31	76			40
Proposed new updated BAC values (2022)						
Cd		7.8		10.6		7.2
Hg		81.2		240		67.4
Pb		36.6		81.6		27.0

*MedBAC in Decision IG.23/6; # Most values BDL; > it is recommended to use the values calculated in 2019.

40. The regional MedBC values for Hg and Pb in *M. galloprovincialis* calculated in 2022 were lower than those calculated in 2019, while Cd BCs were similar. The sub-regional BCs for the WMS and the ADR were also different: WMS BC for Cd was higher and Hg and Pb lower in 2022 compared to 2019. In the Adriatic the BC concentrations were lower in 2022 than in 2019. In 2019 the values in the ADR were higher than in the WMS while in 2022 they were lower. The differences in the Adriatic could be due to different locations of the sampling stations and to a temporal decrease. A few data points (4 for Cd and 8 for Hg with 4 Pb, all BDL) were available for the CEN. The calculated BCs were lower than in the other sub-regions, however, the few data is not representative of the CEN. Since new data were not available in the AEL to update BC/BAC values for *M. galloprovincialis*, it is recommended to use the values calculated in 2019.

41. The main data for trace metals in muscle of M. barbatus originated from the AEL sub-region, therefore the comparison for all sub-regions between 2019 and 2022 values were limited. The regional MedBC values for Cd and Hg in the muscle of the fish *M. barbatus* calculated in 2022 were similar to the ones calculated in 2019, while Pb was lower in 2022. The concentrations in the AEL in 2022 were slightly lower than for the whole Mediterranean, while in the ADR the concentrations were higher than in the Mediterranean, in particular Hg and Pb. The concentrations in the ADR were also much higher than in the AEL. Comparison to 2019 showed that in the ADR Hg was lower in 2022 and in the AEL, Hg and Pb were lower in 2022. There were 5 data points available for the CEN, however Cd and Pb were all BDL while the median Hg concentration was 152 µg/kg wet wt, much higher than in the other sub-regions. Given the lack of data for the CEN, it was not possible to propose values for BC in this sub-region, therefore it is suggested to use the regional MED BC values for GES assessment.

42. The mussel *M. galloprovincialis* and the fish *M. barbatus* are agreed as IMAP mandatory species. However, they may not be always found in all the areas of the Mediterranean Sea. Therefore, the addition of other (mandatory area specific) species to the monitoring program is recommended for further consideration. The species should be chosen based on their presence in the sub-regions, and relevance as pollution indicators, what will allow a better environmental assessment Data from different species are presented in Annex IV UNEP/MED WG.533/Inf.3.

43. The reporting of new data from CPs to the IMAP-IS allowed for the calculation of new proposed BC and BAC values for PAHs in the mussel *M. galloprovincialis* (Table 12). The calculated

BC values for the whole Mediterranean for some of the compounds were higher than the BC concentrations calculated in 2019, while for others they were similar or lower. As for sediments, data with bdl values were taken in the calculation of the new proposed BCs[34]. The bdl values were different, depending on the country and even different within the same country. Moreover, bdls values constituted 12-90% of the data points depending on the compound[35]. This could be the one reason for the differences.

Table 12. Proposed BC and BAC values for PAHs in the mussel *M. galloprovincialis* calculated from data available for upgrade of the criteria in present document (marked with 2022). The table shows also the values as calculated in 2019 (marked 2019) and previously endorsed values. Concentrations are given in µg/kg dry wt, as requested by IMAP. The number of data points (n) taken to calculate the BCs appear to the right of the values. No data were available for the CEN and AEL sub-regions. When most (>50%) of the data points were below the detection limit for the sub-regions, BCs were not calculated.

UNEP/MAP (2019) BC								
PAH compounds		MED		WMS		ADR		AEL
Naphthalene		(2.4)#		2.24				2.80
Acenaphthylene		(0.6)#						
Acenaphthene		(0.6)#						
Fluorene		1.0		0.96		1.07		0.60
Phenanthrene		7.1		4.93		9.04		7.55
Anthracene		0.5		0.52		0.38		0.30
Fluoranthene		3.0		3.38		2.03		6.60
Pyrene		2.0		3.02		0.85		5.90
Benzo[a]anthracene		0.8		1.20		0.53		1.60
Chrysene		1.0		1.24		0.27		5.20
Benzo(b)fluoranthene								
Benzo(k)fluoranthene		0.6		1.27		0.29		1.50
Benzo[a]pyrene		0.5		0.60		0.32		0.70
Benzo[g,h,i]perylene		0.9		0.90				1.20
Dibenz[a,h]anthracene		0.5		0.53				
Indeno[1,2,3-c,d]pyrene		1.2		1.23				0.90
Proposed new updated BC values (2022)								
		MED	*n*	WMS	*n*	ADR	*n*	
Naphthalene		0.56	*40*	0.52	*20*	#	*17*	
Acenaphthylene		(0.05)#	*39*	#	*20*	#	*21*	
Acenaphthene		(0.50)#	*49*	#	*23*	#	*21*	
Fluorene		2.50	*88*	7.87	*68*	#	*21*	
Phenanthrene		5.35	*87*	19.9	*68*	2.25	*19*	
Anthracene		1.12	*87*	0.94	*65*	#	*21*	
Fluoranthene		4.83	*130*	10.0	*86*	#	*23*	
Pyrene		2.50	*76*	5.54	*62*	#	*18*	
Benzo[a]anthracene		0.60	*90*	0.69	*56*	#	*35*	
Chrysene		2.54	*72*	2.98	*54*	#	*19*	
Benzo(b)fluoranthene		1.00	*106*	1.36	*56*	#	*39*	
Benzo(k)fluoranthene		1.00	*107*	0.73	*57*	#	*40*	
Benzo[a]pyrene		(1.00)#	*134*	0.94	*80*	#	*40*	
Benzo[g,h,i]perylene		1.00	*107*	0.67	*59*	#	*39*	
Dibenz[a,h]anthracene		(0.10)#	*82*	#	*55*	#	*21*	
Indeno[1,2,3-c,d]pyrene		(0.63)#	*111*	0.29	*51*	#	*40*	
Total 16 PAHs[36]		5.80	*48*	5.60	*19*	6.60	*25*	
UNEP/MAP (2019) BAC								

[34] See Annex I in UNEP/MAP WG.533/Inf.3.
[35] See Annex III in UNEP/MAP WG.533/Inf 3.
[36] Data dictionary gives 2 additional categories: Total 4 PAHs Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene) and Total 5 PAHs (Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(ghi)perylene, Indeno(1,2,3-cd)pyrene). It is suggested that they be considered for use in the future data reporting.

	MedBAC IG.23/6	MED		WMS		ADR		AEL
Naphthalene		(3.6)[#]		3.4				4.2
Acenaphthylene		(0.9)[#]						
Acenaphthene		(0.9)[#]						
Fluorene	2.5	1.5		1.4		1.6		0.9
Phenanthrene	17.8	10.7		7.4		13.6		11.3
Anthracene	1.2	0.8		0.8		0.6		0.5
Fluoranthene	7.4	4.5		5.1		3.0		9.9
Pyrene	5.0	3.0		4.5		1.3		8.9
Benzo[a]anthracene	1.9	1.2		1.8		0.8		2.4
Chrysene	2.4	1.5		1.9		0.4		7.8
Benzo(b)fluoranthene								
Benzo(k)fluoranthene	1.4	0.9		1.9		0.4		2.3
Benzo[a]pyrene	1.2	0.8		0.9		0.5		1.1
Benzo[g,h,i]perylene	2.3	1.4		1.4				1.8
Dibenz[a,h]anthracene	1.3	0.8		0.8				
Indeno[1,2,3-c,d]pyrene	2.9	1.8		1.8				1.4
Proposed new updated BAC values (2022)								
		MED		WMS		ADR		
Naphthalene		0.84		0.79		#		
Acenaphthylene		(0.08)[#]		#		#		
Acenaphthene		(0.75)[#]		#		#		
Fluorene		3.75		11.8		#		
Phenanthrene		8.03		29.8		3.38		
Anthracene		1.68		1.40		#		
Fluoranthene		7.25		15.0		#		
Pyrene		3.75		8.31		#		
Benzo[a]anthracene		0.90		1.04		#		
Chrysene		3.81		4.46		#		
Benzo(b)fluoranthene		1.50		2.04		#		
Benzo(k)fluoranthene		1.50		1.09		#		
Benzo[a]pyrene		(1.50)[#]		1.42		#		
Benzo[g,h,i]perylene		1.50		1.01		#		
Dibenz[a,h]anthracene		(0.14)[#]		#		#		
Indeno[1,2,3-c,d]pyrene		(0.94)[#]		0.43		#		
Total 16 PAHs[37]		8.70		8.40		9.90		

[#]most data (>50%) below detection limit

44. The reporting of new data from CPs to the IMAP-IS also allowed for the calculation of BCs for organochlorinated contaminants (PCBs and pesticides) in sediments and in *M. galloprovincialis* (Table 13). BCs for organochlorinated contaminants were not calculated in 2011, nor in 2016 or in 2019. Most of the data for the organochlorinated contaminants were below detection limit[38], therefore the proposed BCs should be re-examined when more data became available.

[37] Data dictionary gives 2 additional categories: Total 4 PAHs Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene) and Total 5 PAHs (Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(ghi)perylene, Indeno(1,2,3-cd)pyrene). They may be considered in the future.
[38] See Annex III in UNEP/MAP WG.492/Inf.11.

Table 13. Proposed BC values for organochlorinated contaminants (PCBs and pesticides) in sediments and in the mussel *M. galloprovincialis* (MG), calculated from data available for upgrade of the criteria in present document (marked with 2022). Concentrations are given in µg/kg dry wt, as requested by IMAP. The number of data points (n) taken to calculate the BCs appear to the right of the values. For sediments, very limited data were available for the CEN sub-region while for biota, no data were available for the CEN and AEL sub-regions. When most (>50%) of the data points were below the detection limit for the sub-regions, BCs were not calculated.

Proposed BC values (2022)										
SEDIMENT	MED	*n*	WMS	*n*	ADR	n	CEN	n	AEL	n
PCBs										
PCB28	0.10	*271*	#	*74*		*137*	#	5	0.09	*57*
PCB52	0.07	*243*	0.10	*69*	0.09	*112*	#	5	0.04	*60*
PCB101	0.10	*227*	0.16	*68*	0.16	*101*		0		*55*
PCB118	0.10	*222*	0.46	*61*	0.18	*105*	#	5	0.01	*55*
PCB138	0.11	*233*	0.26	*66*	0.24	*105*	#	5		*54*
PCB153	0.14	*226*	0.40	*69*	0.28	*102*	#	5	0.02	*54*
PCB180	0.09	*236*	0.13	*67*	0.13	*108*	#	5		*55*
Sum 7 PCBs	0.40	*179*	1.60	*71*	0.21	*31*	#	5	0.19	*68*
Pesticides										
γ-HCH (Lindane)	(0.1)#	*474*	#	*242*	#	*168*		0	0.02	*64*
DDE(p,p')	(0.1)#	*64*	0.23	*26*	#	*35*	#	5		*0*
Hexachlorobenzene	(0.1)#	*325*	#	*156*	#	*155*	#	22		*0*
Dieldrin	(0)#	*105*		*0*	#	*41*	#	5	#	*64*
BIOTA - MG	MED	*n*	WMS	*n*	ADR	*n*	CEN	n	AEL	n
PCBs										
PCB28	0.20	*66*	0.07	*43*	1.38	*40*				
PCB52	0.38	*102*	0.3	*43*	0.5	*65*				
PCB101	1.20	*76*	1.1	*43*	1.4	*40*				
PCB118	1.23	*56*	1.5	*20*	1.4	*40*				
PCB138	2.31	*102*	2.4	*43*	3.3	*70*				
PCB153	3.45	*104*	4.6	*43*	4.6	*70*				
PCB180	0.50	*73*	0.3	*43*	0.5	*40*				
Sum 7 PCBs	18.4	*58*	28.6	*20*	17.3	*40*				
Pesticides										
γ-HCH (Lindane)	(1.0)#	*67*	#	*37*	#	*30*				
DDE(p,p')	3.05	*11*	3.05	*11*		*0*				
Hexachlorobenzene	(0.5)#	*135*	#	*87*	#	*56*				
Dieldrin	(1.0)#	*35*	#	*37*		*0*				

most data (>50%) below detection limit

45. For determination of BC values for CI17, the following key findings can be provided:

- For some parameters there is a marked difference among the Mediterranean sub-regions. Therefore, it is proposed in those cases (i.e. Cd and Hg in sediments, Cd in *M. galloprovincialis*, sum of PAHs in sediments), to consider using the sub-regional Mediterranean Sea assessment criteria.

- A statistical treatment of BDL has been recommended by OWG on Contaminants as explained above in paragraph 36 and section 4.1. of UNEP/MED WG.533/Inf.3. It is recognized that the different BDLs make it hard to use half of the BDL concentration for these values. However, it is not reasonable not to take BDL values into consideration. In this document, the calculations were performed with the bdl values as reported by the countries.

- An in-depth examination of more data points, that need to be reported by CPs, should be performed in particular when large differences were observed between the BC values calculated in 2016, 2019, 2021 and 2022. This is true for TM in sediment and biota in all sub-regions. The examination should include, among others, characterization of the stations used (hot spot, reference, other), as requested for mandatory data reporting regarding CI 17 to

IMAP-IS, analytical methodology, normalization, temporal trends. The reporting the new data to IMAP-IS up to 31 December 2021, improved the recalculation of the upgraded BCs that was presented in 2021.

- The reporting of new data to IMAP-IS made it possible to calculate BCs for PAHs in biota, and organochlorinated contaminants in sediment and biota, that was not possible in the previous UNEP/MAP documents from 2016 and 2019 and in 2021. However, many of the data points are bdl and more data need to be reported to improve the recalculation the BCs. Before new data availability will allow their recalculation, present re-calculated values remain valid for preparing assessment inputs for the 2023 MED QSR.

4.2 An upgraded approach for updating EAC values for IMAP CI 17 and CI 18

46. As explained above (see Section 2), the EAC values endorsed for use in the Mediterranean Sea were NOAAs ERLs (for TM, PAH and pesticides in sediments) and the ECs from EU Directives to protect human health (for TM and organic contaminants in biota). They may be too lenient if the goal is to achieve and maintain GES where the contaminants cause no significant impact on coastal and marine ecosystems. However, EAC values cannot be updated based on existing monitoring data. It needs a very specific in-depth research of the ecotoxicological and environmental scientific literature.

47. Therefore, the methodology detailed in European Commision Guidance Document (2018) and in Long et al. (1995) is recommended for the update of Mediterranean EAC values. It includes a thorough examination of the scientific literature conducted to study where data on no effect or adverse biological effects are given in conjunction with chemical data in the environment and in the biota at the same site and time. Those include but are not limited to sediment toxicity tests, aquatic toxicity tests in conjunction with equilibrium partitioning (EqP) and field and mesocosm studies. Laboratory results on biomarkers (CI18) are also important for the derivation of the EAC values. The data should be assembled into a detailed database and analyzed, as well as the extent of the effect determined. The emphasis should be given to Mediterranean biota species.

48. Upgrade of the EAC values for Mediterranean Sea as recommended above is a long-term task that needs a dedicated, very specific, scientific research. More detailed elaboration is provided in UNEP/MED WG.533/Inf 3.

4.3 Proposal of new EAC values for IMAP CI 20

49. Proposal of the EAC values for IMAP CI 20 related to actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in commonly consumed sea food is based on a survey of existing sources, including Directives of EU related to the maximum permitted levels for contaminants in fish and seafood for the protection of human health. Table 14 details the concentrations cited at different sources for TM (Cd, Hg and Pb) and for organic contaminants (PCBs, dioxin).

50. From Table 14 it is possible to see that the criteria are taxa specific (fish, mussel, crustacean), as well as species specific. For example, maximum allowable Hg concentration in fish muscle is 0.5 mg/kg ww, excluding listed species such as bonito, marlin, halibut, mullet species, among others, in which the maximum allowable Hg concentration in the muscle is 1.0 mk/kg ww (see EC/EU Directive 1881/2006).

51. In addition, Decision IG.23/6 details the indicative regional EAC values for PAHs in mussels (*Mytilus galloprovincialis*) and for organic contaminants in mussel (*Mytilus galloprovincialis*) and fish (*Mullus barbatus*) that are considered biota matrix of IMAP Common Indicator 17. These values are given in Tables 4 and 5. As these values were set up to protect human health, they may be too lenient to protect the environment (see paragraph 22). However, since the values are based on the maximum levels for certain contaminants in foodstuffs as provided in EC/EU Directives 1881/2006, 1259/2011 and amendments 488/2014 and 1005/2015, they are proposed to be also used for IMAP CI 20.

Table 14. Compilation of maximum levels for trace metals in fish and seafood for the protection of human health[39]. The concentrations are presented in mg/kg ww.

Source	**matrix**	**Cd**	**Hg**	**Pb**
		mg/kg ww		
NOAA (see countries below)	fish	0.2	0.5-1	1.5-2
	canned fish (*tuna)		1*	2.5, 5*
	mollusc	2	0.5	2.5
	finfish	0.1		0.5
EU 1881/2006 directive and 488/2014 and 1005/2015 amendments	fish muscle	0.05-0.25	0.5-1	0.3
	cephalopods	1		0.3
	crustaceans	0.5	0.5	0.5
	bivalve mollusc	1		1.5
CODEX Alimentarious (2019)	mollusc, cephalopod	0.05-2		
	fish			0.3
	fish- species dependent		1.2-1.7*	
#MedEAC IG.23/6	Mussel	1	0.5	1.5
	fish	0.05	1	0.3
OSPAR 2017	All species - biota	1	0.5	1.5
Minimum		**0.05**	**0.5**	**0.01**
Maximum		**2**	**1.7**	**2.5**

* methyl-mercury, # Concentrations recalculated in mg/kg wet wt

52. The maximum levels of organic contaminants in fish and seafood for the protection of human health are as follows: NOAA, 0.5 and 2 PCB (mg/kg ww) in fish and other seafood, respectively; EU Directive 1881/2006, 2-5 and 6 (mg/kg ww) of benzo(a)pyrene and 12-30 and 35 (mg/kg ww) for the sum of benzo(a)- pyrene, benz(a)anthracene, benzo(b)fluoranthene and chrysene in smoked fish muscle and on smoked bivalve mollusc, respectively; EU Directive 1259/2011 – 3.5 pg/g ww for the sum of dioxins in fish muscle and liver and in eel muscle; 6.5, 10 and 20 pg/g ww for the sum of dioxins and dioxin like PCBs in fish muscle, in eel muscle and in fish liver, respectively; and 75, 300 and 200 ng/g of the sum of PCB28, PCB52, PCB101, PCB138, PCB153 and PCB180 in fish muscle, in eel muscle and in fish liver, respectively. As for TM, the maximum allowable concentrations are taxa specific.

53. The values as established by above EU Directives are submitted for consideration to present meeting in order to guide the Secretariat and the Parties on their application as EAC values for IMAP CI 20. These values are in the low and mid-range of criteria used around the world and has the advantage to be consistent with regulations of EU. Their consistent application across the region is necessary. It should also be highlighted that these values were agreed at EU level also considering the ecosystem characteristics of Mediterranean Sea.

[39] The following sources are used in Table 14 and paragraph 54:
NOAA (National Oceanic and Atmospheric Administration) tabulation of the export requirements by country for fish and seafood (among others) (https://www.fisheries.noaa.gov/export-requirements-country-and-jurisdiction-f). Requirements by Australia, Brazil, Chile, China and Equador for trace metals;
EU directives for maximum levels for certain contaminants in foodstuffs (EC/EU 1881/2006 , 1259/2011 Directives and amendments 488/2014 and 1005/2015);
CODEX Alimentarius international food standards, guidelines and codes of practice. Joint FAO/WHO Food Standards Programme .

Annex I
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