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UNEP(DEPI)/MED WG.439/20

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ENVIRONMENT PROGRAMME
MEDITERRANEAN ACTION PLAN

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Meeting of the MED POL Focal Points

Rome, Italy, 29-31 May 2017

Report of the Meeting of the MED POL Focal Points

UNEP/MAP
Athens, 2017

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Introduction

1. In accordance with the UN Environment/Mediterranean Action Plan Programme of Work 2016-2017 adopted by COP 19, Athens, Greece, 9-12 February 2016, the Secretariat organized the meeting of the MED POL Focal Points from 29-31 May 2017, at the Food and Agriculture Organization Headquarters in Rome, Italy.

2. The main objectives of the meeting were to:

1. Review the activities carried out during the 2016-2017 biennium and the implementation of the three pollution related Protocols under the MED POL Programme responsibility with a particular focus on NAPs and IMAP implementation.
2. Review a number of important documents and address thematic issues related to key aspects of the MED POL mandate related to guidelines, assessment, possible new regional or updated measures etc.
3. Discuss and agree upon the activities to be implemented during the next biennium for inclusion in the MAP Programme of Work 2018-2019.

Agenda item 1: Opening of the Meeting

3. The meeting was opened by Ms Tatjana HEMA, Deputy Coordinator of UN Environment MAP and Mr Oliviero Montanaro, Head of Unit IV, Directorate General for Nature and Sea Protection, Environment Protection, International Issues, Ministry of Environment, Land and Sea of Italy.

4. The Deputy Coordinator, welcomed the participants and highlighted the coherent work that has been done by MED POL and other MAP components in this biennium for the implementation of the MAP PoW 2016-2017 and COP Decisions.

5. In his welcoming speech, Mr. Oliviero Montanaro, thanked the Secretariat for the work done and the organization of the MED POL Focal Points meeting and welcomed all participants on behalf of the Ministry of Environment, Land and Sea of Italy. In his speech, he pointed out the biggest challenge was to depollute the Mediterranean and underlined some core issues of the work of the Barcelona Convention stressing the importance of tackling these issues as prerequisite to achieve Good Environmental Status (GES).

6. The meeting was attended by representatives from the following Contracting Parties: Albania, Bosnia & Herzegovina, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, Malta, Montenegro, Morocco, Slovenia, Spain, Tunisia, Turkey. The UN Environment/MAP Secretariat was represented by the MAP Coordinating Unit, MED POL Programme and REMPEC. The following United Nations bodies, specialized agencies, convention secretariats and intergovernmental organizations were represented: the General Fisheries Commission for the Mediterranean (FAO/GFCM); the European Environment Agency (EEA) and Union for the Mediterranean (UfM).

7. The following non-governmental organizations and other institutions were represented: the Centre International de Droit Comparé de l’Environnement (International Centre for Comparative Environmental Law).

8. United Nations Environment (UN Environment), including the Mediterranean Action Plan/Barcelona Convention Secretariat (UN Environment/MAP) were also represented, along with the following Mediterranean Action Plan regional activity centres: the Regional Activity Centre for Sustainable Consumption and Production (SCP/RAC), the Regional Activity Centre for Information and Communication (INFO/RAC) and the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC). The full list of participants is attached as Annex I to the present report.

Agenda items 2 and 3: Election of Officers, Adoption of the Agenda and Organization of Work
UNEP(DEPI)/MED WG.439/1; UNEP(DEPI)/MED WG.439/2

a) Adoption of the Agenda

9. The proposed Provisional agenda appearing in document UNEP(DEPI)/MED WG.439/1, was adopted without changes.

b) Election of officers

10. In accordance with the Rules of procedures for meetings and conferences of the Contracting Parties, the meeting elected one (1) President, three (3) Vice-Presidents and one (1) Rapporteur from among the participants, as follows:

Chair:	Mrs Erika Magaletti, Italy
Vice-Chair:	Mrs Mohour Ibrahim, Egypt
Vice-Chair:	Mr Samir Kaabi, Tunisia
Vice Chair:	Mrs Nazli Yenal, Turkey
Rapporteur:	Mrs Valentina Turk, Slovenia

Agenda item 4: Progress Achieved regarding the Implementation of the Programme of Work 2016-2017 related to Land Based Pollution and Governance Themes *UNEP(DEPI)/MED WG.439/3*

11. The Secretariat presented the progress achieved on the implementation of the main activities carried out by MED POL, in accordance with the MAP Mid-term Strategy 2016-2021 and the Programme of Work 2016-2017, regarding the themes on Governance and Pollution reduction, as well as technical aspects of the implementation of the pollution-related Protocols to the Barcelona Convention and related Regional Plans. This presentation was complemented by SCP/RAC, regarding their work on POPs and marine litter prevention.

12. Specific attention was paid to the status of ratifications of the pollution-related Protocols, falling under MED POL mandate. The meeting highlighted the need for increased number of ratifications which would create stronger legal conditions for their effective implementation. Particular focus was paid to the need for the expected entry into force of the 1995 amendments to the Dumping Protocol as well as the increased number of ratifications of the Hazardous Wastes Protocol and enhanced synergies with Basel Convention.

13. The meeting encouraged further development of synergies established with relevant regional and global actors and initiatives, including the work undertaken in the framework of the UN Environment Global Programme of Action (GPA) especially on marine litter (Clean Sea Campaign, MOOC, Plastic Coalition Initiative etc.), the links of MED POL work with the Sustainable Development Goals (SDGs) and related targets, the implementation of H2020 Initiative, as well as the collaboration with the other European Regional Seas Conventions and key actors in the region, including IMO, GFCM, ACCOBAMS, EEA, UfM and WWF.

14. The representative of GFCM pointed out the importance of collaboration with MAP, on the basis of the GFCM- UN Environment/MAP Memorandum of Understanding (MoU), which touches upon different key issues for the sustainable development of the region, including the implementation of IMAP Decision (IG.22/7 COP19, 2016) and preparation of the QSR 2017 (mainly for Ecological Objective 3), and activities on pollution prevention and reduction, mainly regarding marine litter in support of GES achievement/ maintenance.

15. The Secretariat distributed to the meeting participants a statement prepared by ACCOBAMS and stressed the importance of close collaboration established between the two Organizations, especially regarding the implementation of IMAP Decision for Ecological Objective 11 on energy and

underwater noise noise, requesting for comments on the noise-related candidate IMAP indicator factsheet.

16. The meeting acknowledged the importance of internal collaboration established between the relevant MAP components in implementing, in an integrated manner, activities related to pollution control and reduction (MED POL, SCP/RAC, PLAN BLEU, REMPEC, SPA/RAC and INFO/RAC).

Agenda item 5: Status of Implementation of LBS, Dumping, Hazardous Waste Protocols and Regional Plans and related updated Reporting Formats
UNEP(DEPI)/MED WG.439/3; UNEP(DEPI)/MED WG.439/17

17. The Secretariat presented the main findings related to the status of information provided in the national reports for the period 2014-2015, underlining the importance of reporting for compliance and reminded the Contracting Parties of the obligation of timely submission of their reports. The Secretariat also pointed out the main findings of a review carried out by MED POL on the basis of data submitted through the MED POL Monitoring Programme. A number of participants asked the Secretariat to correct information related to their submission of monitoring data that didn't fully reflect the current state of play. A specific reference was made to the quality assurance and quality control issues, underlining the importance of participation of national personnel in charge of monitoring in training courses.

18. The Secretariat presented the revised reporting formats for pollution-related Protocols and briefly informed the meeting about the differences between the current and revised formats, pointing out the main changes introduced in the tables. The Secretariat informed the meeting on the ongoing testing of the revised format and asked the Focal Points to participate and provide feedback as appropriate.

19. Some Contracting Parties informed the meeting that they had submitted their reports and requested the Secretariat to update the information included in the relevant tables presented to the meeting.

20. Following discussions regarding specific issues related to the revised formats, it was proposed to include information on emerging contaminants and a table on placement activities . The need of training of competent authorities on the revised reporting formats which would increase the submission of data, was considered as a priority.

21. The meeting final conclusions related to this agenda item are presented in Annex III of this report.

Agenda item 6: Regional Programme of Measures to achieve Good Environmental Status; Gap Analysis and Need Assessment for New/Updated Measures
UNEP(DEPI)/MED WG.439/4;

22. The Secretariat presented the main findings of its work related to the assessment of the Annexes to the Pollution-related Protocols to the Barcelona Convention, in light of the most relevant and recent developments under the Multilateral Environmental Agreements, other Regional Seas Conventions and European legislation.

23. The meeting embarked on discussions on the assessment, clarifying that the goal at this stage was not to approve any amendment but rather to assess the feasibility and need for such an assessment exercise, in order to inform the MAP Focal Points respectively. The meeting therefore agreed to provide to the Secretariat written comments on the feasibility of the amendments exercise by 20 June 2017.

24. The Secretariat further presented the gap analysis of existing regional measures related to pollution and litter as well as the proposed list of updated/new measures aiming at bridging the identified gaps and achieving/maintaining Good Environmental Status.

25. The meeting discussed on the proposed new/updated measures and established in the margins of the meeting a dedicated working group composed of the MED POL Focal Points of Israel, Croatia, France, Italy, Slovenia, Spain, Tunisia and Turkey, with the view to cluster and propose a list of key priority measures.

26. The meeting reviewed and approved the priority clustering of key measures under six potential regional plans, presented during the second day, and requested the Secretariat to present it to the MAP Focal Points meeting through the EcAp Coordination Group for their consideration and to reflect it as appropriate in the Programme of Work of MED POL for the next biennium, highlighting also the importance of strengthened implementation of existing measures adopted in the framework of the LBS Protocol.

27. The meeting final conclusions related to this agenda item and the latest version of the draft guidelines are presented in Annex III to this report and its Appendix I.

Agenda item 7: **Technical Guidelines and related Assessments**
UNEP(DEPI)/MED WG.439/5; UNEP(DEPI)/MED WG.439/6; UNEP(DEPI)/MED WG.439/7, UNEP(DEPI)/MED WG.439/8; UNEP(DEPI)/MED WG.439/9; UNEP(DEPI)/MED WG.439/10; UNEP(DEPI)/MED WG.439/11; UNEP(DEPI)/MED WG.439/19

a) Updated Guidelines on Management of Dredged Materials
b) Updated Guidelines on Placement for Artificial Reefs
c) Updated Guidelines on the Management of Desalination Activities
d) Guides on BAT Assessment and Inspection
e) Review of the main findings and policy recommendations of Dumping and Desalination related Assessment Reports

28. Mr. Jose Luis Buceta, representative of Spain, in his capacity as chair of the meeting of experts to review the draft Desalination and Dumping Protocol guidelines, held in Loutraki, Greece, on 4-6 April 2017, presented, with technical support from Mr. Fouad Abousamra, MED POL consultant, the Updated Guidelines on Management of Dredged Materials.

29. The meeting reviewed the text of the Updated Guidelines with a particular focus on comments and insertions made in the text by the MED POL Focal Points and the Secretariat, after the Expert Review Meeting in Loutraki. Particular attention was paid by the meeting on the section on confined disposal for which the Secretariat had submitted a legal analysis. Following discussions held by the meeting, the Secretariat was requested to further specify the legal analysis in order to ensure coherence of wording with the Protocol. The meeting cleared all the open paragraphs and notes, approved the amended text of the Updated Guidelines and requested its submission to the MAP Focal Points Meeting.

30. Mr. Jose Luis Buceta, representative of Spain, in his capacity as chair of the meeting of experts to review the draft Desalination and Dumping Protocol guidelines, held in Loutraki, Greece, on 4-6 April 2017, presented, with the technical support from Mr. Fouad Abousamra, MED POL consultant, the Updated Guidelines on Placement for Artificial Reefs.

31. The meeting reviewed the text of the Updated Guidelines with a particular focus on comments and insertions made on the text by the MED POL Focal Points and the Secretariat, after the Expert Review Meeting in Loutraki based on the meeting conclusions and recommendations. Particular attention was paid by the meeting on the section related to placement of vessels' hull and

superstructure and requested the Secretariat to provide a legal analysis to confirm that the placement of vessels hulls and superstructures for the purpose of artificial reefs is not in contravention with Article 4 of the Dumping Protocol which prohibits the dumping of vessels in the Mediterranean Sea area since 2000. Pending this legal analysis, the meeting agreed on the text of the draft guidelines and recommended their submission to MAP Focal Points meeting.

32. Mr. Rani Amir, representative of Israel, in his capacity as vice-chair of the meeting of experts to review the draft Desalination and Dumping Protocol guidelines, held in Loutraki, Greece, on 4-6 April 2017, presented the Updated Guidelines on the Management of Desalination Activities.

33. The meeting reviewed and approved the Updated Guidelines and requested the Secretariat to submit them to the MAP Focal Points meeting.

34. The meeting final conclusions related to this agenda item and the latest version of the Guidelines are presented in Annex III to this report and its Appendixes II, III and IV.

35. Mr. George Melekis, representative of Greece, in his capacity as chair of the meeting of the Mediterranean Informal Network on Compliance and Enforcement, held in Loutraki, Greece, on 6-7 April 2017, presented, with the technical support from Mr. Dimitris Tsotsos, MED POL consultant, the Guide on the Selection of Best Available Techniques (BAT) in Industrial Installations as well as the Guide on Inspection of Industrial Facilities.

36. The meeting reviewed and approved the Guides, paying particular attention on one change proposed by Italy on the Guide on Inspection, suggesting an additional performance indicator, which was accepted.

37. The meeting final conclusions related to this agenda item and the latest version of the Guides are presented in Annex III to this report and its Appendixes V and VI.

38. The Secretariat presented, under the same agenda item, the outcomes of the assessment of dumping and desalination activities in the Mediterranean, undertaken by the Secretariat, and the main policy recommendations, based on those assessments.

39. With regards to dumping activities, the meeting highlighted the need to bridge the identified data gaps, in particular regarding the quantities of material dumped under permit, which can be facilitated through the revised reporting format for the Dumping Protocol implementation.

40. Regarding desalination activities, particular attention was paid on the emerging pollutants from desalination and the need to ensure their monitoring in the framework of the national integrated monitoring and assessment programmes, as appropriate.

Agenda item 8: Implementation of Decision IG 22/7 on IMAP and Articles 7 and 8 of the LBS Protocol
UNEP(DEPI)/MED WG.439/12; UNEP(DEPI)/MED WG.439/13; UNEP(DEPI)/MED WG.439/14; UNEP(DEPI)/MED WG.439/15

41. The Secretariat introduced the agenda item and summarized the work undertaken in 2016-2017 in support of the implementation of the Integrated Monitoring and Assessment Programme (IMAP) decision which was adopted at the 19th Contracting Parties meeting in February 2016.

a) IMAP Common Indicator Guidance Facts Sheets (Pollution and Marine Litter)

42. The Secretariat presented the draft IMAP Common Indicator Guidance Factsheets, which are based on the IMAP Guidance document, and provides guidance to countries in the implementation of their revised national monitoring programmes for the 23 common IMAP indicators. It was stressed

that these indicator factsheets will be revised as appropriate in future biennium's as further information, methods, protocols are developed.

43. Participants provided several suggestions for the revision of the factsheets and detailed comments were submitted in writing to the Secretariat from France and Spain for inclusion in the revision of the document. It was also noted by REMPEC that the Indicator 19 common factsheet, developed by REMPEC had been previously adopted by the REMPEC Focal Points, so if participants wished to comment on this factsheet, these comments should be carefully discussed with respective REMPEC Focal points first. France observed that the GES definition and target previously adopted for Indicator 18 (in the EcAp Decision IG.21/3 in 2013) on the Level of pollution effects of key contaminants where a cause and effect relationship has been established, would need revision in a future COP decision, as it was not an appropriate definition for the indicator.

44. The Secretariat revised the document in track changes in consultation with participants for presentation in Agenda 12. The targets of each indicator were checked against the EcAp decision of GES definitions and targets, adopted in COP 18 in 2013, as minor errors were noted by participants.

b) QSR Fact Sheet Assessment (Pollution and Marine Litter)

45. The Secretariat presented the rationale and work undertaken to develop the first Quality status Report (QSR2017) based on the common indicators of IMAP, and summarized the sources of information used for each indicator assessment, as well as the QSR assessment factsheets for pollution and marine litter.

46. In the discussion that followed Montenegro, France, Croatia and Morocco requested that the Secretariat ensure that their latest data is included in the indicator 17 assessment on contaminants. Participants provided several comments and followed up with written comments. It was agreed that the secretariat would require two weeks to review and integrate all comments to the indicator assessment factsheets for indicators, 17, 18, 20 and 21. Regarding the two assessment factsheets for Marine Litter, minor comments were noted which were revised during the course of the meeting.

47. The Secretariat presented the two assessment factsheets on eutrophication which were shared with participants during the meeting. It was agreed that two weeks would be given for comments to be received in writing following the meeting, and based on these a revised version of the assessment factsheets would be submitted to the MAP Focal Points and EcAp Coordination Group meetings in September 2017.

48. The meeting final conclusions related to this agenda item are presented in Annex III.

Agenda item 9: Other Specific Issues
UNEP(DEPI)/MED WG.439/16

a) Follow up of the implementation of the updated National Action Plans (NAPs) and Programmes of Measures (PoM)

49. The Secretariat recalled the relevant COP decision requesting submission of updated NAPs and Programmes of Measure (PoMs), highlighting the Contracting Parties' commitment to timely submit their updated NAPs/ PoM in view of the upcoming COP 20. The deadline for final submission was set by the meeting for September 2017. However, following discussions, the administrative and technical challenges of approval of NAP/PoMs at national level were pointed out.

50. The Secretariat presented the status of development of core NAP follow-up indicators, their selection criteria and the links with the review process of H2020 indicators. The need for progress indicators to monitor the state of implementation of NAPs/PoM and the importance of priority

investments for their full implementation were highlighted by the meeting. This discussion was complemented by UfM presentation on criteria of selection of flagship projects which would support funding opportunities for key investment projects at national level.

51. The meeting encouraged the continuity of collaboration between MAP and H2020 and its review and monitoring subgroup co-led by EEA and MAP/MED POL and supported further work on indicator development with a view to establish to the extent possible a common list for both NAP and Horizon 2020 progress evaluation.

b) Updated List of Priority Contaminants in the Mediterranean

52. The Secretariat further presented a proposed updated list of priority contaminants, underlining the potential inclusion of the list into national monitoring, if so decided. During the discussions, the meeting paid particular attention to data gaps on contaminants, especially on emerging contaminants, and the need for further information to fill these knowledge gaps. In this regard, the meeting highlighted the importance of ongoing national monitoring programmes and the need to continue periodic analyses carried out by Secretariat, taking also into consideration the work of EU and other Regional Seas Conventions.

c) Implementation of ENI SEIS II South and Marine Litter MED EU funded Projects

53. The Secretariat briefly presented to the meeting the progress achieved on ENI SEIS II project implementation. The meeting supported the importance of close collaboration between SEIS and MED POL Focal Points and highlighted the need for stronger links between MED POL work and the project implementation. The meeting asked for stronger involvement of MED POL FPs in the national SEIS Work Plans preparations.

54. The Secretariat presented briefly the ongoing activities under the EU-funded Marine Litter MED project.

55. SCP/RAC made a presentation focusing on the issue of toxic chemicals in marine litter underlining their effects on marine environment and the potential threats from POPs accumulations and shared with the meeting the respective document for their further consideration.

d) Preparation of pollution related projects under the new MedProgramme funded by GEF

56. The Secretariat, including SCP/RAC, presented the GEF-funded MedProgramme providing opportunities to support activities on elimination and prevention of harmful chemicals (POPs/Mercury) and reduction of excess of nutrients. The meeting emphasized the need to continuing work, in close collaboration with the MED POL Focal Points, with the view to screen and identify available (in terms of amount and location) stocks of POPs/mercury as well as potential sectors for eliminating use of POPs/mercury on the national level.

57. The meeting final conclusions related to this agenda item are presented in Annex III.

58. The Secretariat invited in a side meeting the Focal Points which benefit from the Projects addressed in this agenda item. With regards to ongoing projects (ENI SEIS II South and Marine Litter MED), the objective was to review the progress achieved and the main challenges encountered or anticipated. Most importantly, the Secretariat presented the concept and expected outcomes of the upcoming Projects under the GEF-funded MedProgramme and asked for expression of interest from the countries and the submission of necessary information in order to draft and realize the pollution-related Projects under this Programme.

Agenda item 10: MED POL Programme of Work 2018-2019
UNEP(DEPI)/MED WG.439/18

59. The Secretariat presented the proposed MED POL Programme of Work for the biennium 2018-2019, explaining the rationale and process followed for its preparation, as well as the main principles that underpinned its preparation.

60. The meeting reviewed the proposed PoW, highlighted the links of its activities with the provisions of the MAP Mid-term Strategy 2016-2021(COP 19, Decision IG.22/01) and the importance of effective delivery of the activities of the PoW 2018-2019 for the achievement of the overall MTS objectives and strategic outcomes.

61. The meeting further recommended to apply a priority ranking system for each proposed activity in order to support and guide the Secretariat in allocating funding from MTF accordingly, on the understanding that the activities of second priority should be considered for funding through external resources if core funding is not available.

62. The meeting ensured that main issues that have been discussed and agreed upon (i.e. 6 potential regional plans clustering priority measures, capacity building for inspection activities, assessment of annexes to pollution related protocols, IMAP implementation etc.) are reflected in the PoW. It also requested the Secretariat to consider and ensure that a dedicated section is allocated to MED POL and its deliverables in MAP website to facilitate access to resources.

63. The meeting final conclusions related to this agenda item and the MED POL Programme of Work 2018-2019 are presented in Annex III to this report and its Appendix X.

Agenda item 11: Any other business

64. The representative of International Center for Comparative Environmental Law (CIDCE), presented their statement, distributed by the Secretariat, on the work to design legal indicators for the environment.

Agenda item 12: Conclusions and Recommendations

65. The participants reviewed, commented and approved, the draft Conclusions and Recommendations, attached as Annex III to the present report.

66. The meeting thanked Italy for hosting the meeting and actively supporting the implementation and further development of MED POL programme of work.

Agenda item 13: Closure of the Meeting

67. The Chair in her closing remarks thanked the participants for their constructive contribution to the meeting which resulted in finalizing the documents of the meeting in a timely manner. She also thanked the Secretariat for all efforts made to organize this effective meeting of delivery.

68. After the expression of usual courtesies, the Chair declared the meeting closed at 17:30 p.m. on Friday, 31 May 2017.

Annex I
List of Participants

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Annex II
Agenda of the Meeting

Agenda of the Meeting

Agenda item 1: Opening of the Meeting

Agenda items 2 and 3: Election of Officers, Adoption of the Agenda and Organization of Work

Agenda item 4: Progress Achieved regarding the Implementation of the Programme of Work 2016-2017 related to Land Based Pollution and Governance Themes

Agenda item 5: Status of Implementation of LBS, Dumping, Hazardous Waste Protocols and Regional Plans and related updated Reporting Formats

Agenda item 6: Regional Programme of Measures to achieve Good Environmental Status; Gap Analysis and Need Assessment for New/Updated Measures

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Agenda item 9: Other Specific Issues

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Agenda item 11: Any other business

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Agenda item 13: Closure of the Meeting

Annex III
Conclusions and Recommendations

Conclusions and Recommendations

The Meeting of the MED POL Focal Points was held on 29-31 May 2017, at the Food and Agriculture Organization (FAO) Headquarters, Rome, Italy.

Following review and discussions of all agenda items, the Meeting agreed on the following deliberations, conclusions and recommendations:

Progress Achieved regarding the Implementation of the Programme of Work 2016-2017 related to Land Based Pollution and Governance Themes
(UNEP(DEPI)/MED WG.439/3)

1. Following the introduction by the Secretariat of the progress report, which summarizes the status of implementation of the main activities carried out by the MED POL during the current biennium, as well as some technical aspects of the implementation of the pollution-related protocols and regional plans, the meeting acknowledged the progress and congratulated the Secretariat for the achievements on the Governance and Pollution Reduction themes of the Medium Term Strategy (MTS) and the Programme of Work.

2. The meeting took note of the status of ratification of the Pollution related Protocols of the Barcelona Convention and highlighted the need for further progress with a view to increase the number of Contracting Parties with a particular focus on the entry into force of the 1995 amendments to the Dumping Protocol. The meeting also requested the Secretariat to further provide technical support to enhance the capacities of the Contracting Parties as appropriate and upon request with a view to meet this objective.

3. The meeting took note of the information provided by the Secretariat on the work undertaken by UN Environment Global Programme of Action (GPA) with regard to Marine Litter, eg Clean Sea Campaign, MOOC, Plastic Coalition Initiative and encouraged the participation of all Mediterranean countries.

4. The meeting took note of the information provided by the Contracting Parties on the voluntary commitments for the implementation of Sustainable Development Goals 14 (SDGs) and congratulated the Contracting Parties who have already proposed their voluntary commitments and encouraged all Contracting Parties to do so as appropriate.

5. The meeting appreciated the good collaboration established in the Mediterranean among different regional organizations on matters related to Pollution, such as General Fisheries Commission for the Mediterranean (GFCM), Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS) , etc.., and encouraged further effort in this direction to acknowledge the enhanced impact that the joint action may have in support to Contracting Parties’ effort to achieve/maintain Good Environmental Status.

6. The meeting also appreciated the well-established internal collaboration between the relevant MAP components in implementing, in an integrated manner, activities related to pollution control and reduction (SCP/RAC, PLAN BLEU, REMPEC, SPA/RAC and INFO/RAC).

Status of Implementation of LBS, Dumping, Hazardous Waste Protocols and Regional Plans and related updated Reporting Formats
(UNEP(DEPI)/MED WG.439/3; UNEP(DEPI)/MED WG.439/17)

7. The meeting took note of the status of the level of the information provided by the Contracting Parties in their national implementation reports and encouraged the Focal Points to ensure that the information on Pollution related Protocol is submitted without further delay from the Contracting Parties who have not yet done so.

8. The meeting also recalled the need to timely adjust the existing marine pollution monitoring programme to the requirements of IMAP as decided at the last meeting of the Contracting Parties and submit to MED POL quality assured data as well as ensure the participation of designated laboratories in the calibration exercise organized for this purpose.

9. After an overall discussion of the proposed revised format, the meeting took note of the proposed format and agreed to provide written feedback, if any, to MED POL by 20 June 2017. The meeting also took note of the Secretariat's recommendation to participate in the testing exercise of the proposed revised format as a tool with a view to make it user friendly and avoid duplication and unnecessary reporting burden to the extent possible.

10. With regard to the reporting under the Dumping Protocol, the meeting agreed to consider including a table on the placement as well as the list of "emerging contaminants".

11. The meeting also considered important and requested the Secretariat to prepare a tutorial with a view to facilitate the use of the reporting system by the Contracting Parties and provide adequate training to ensure timely and efficient submission of national reports.

Regional Programme of Measures to achieve Good Environmental Status; Gap Analysis and Need Assessment for New/Updated Measures
UNEP(DEPI)/MED WG.439/4

12. The meeting took note of the analysis made by the Secretariat of the annexes to the four pollution related Protocols of the Barcelona Convention against the most relevant and recent developments under the Multilateral environmental Agreements, other Regional Seas and European legislation where appropriate. The meeting felt that more time is required to review the analysis made and agreed to provide written feedback by 20 June 2017. The meeting agreed to provide some consideration on related activities while reviewing the proposed Programme of Work addressed under Agenda item 10.

13. The meeting took note of the regional gap analysis prepared by the Secretariat and agreed to establish a small group composed of the MED POL Focal Points of Israel, Croatia, France, Italy, Slovenia, Spain, Tunisia and Turkey to cluster and to propose a list of key priority measures.

14. The meeting reviewed and approved the priority clustering of the listed measures under 6 potential regional plans in the framework of the article 15 of the LBS Protocol as contained in Appendix I of these conclusions. The meeting requested the Secretariat to present this proposal to the MAP Focal Points meeting through the EcAp Coordination Group for their consideration as well as to reflect it as appropriate in the Programme of Work of MED POL for the next biennium. Such a process should be guided and carried out with the full involvement of the MED POL Focal Points.

15. The meeting, however, emphasized the importance of implementing in an effective manner the existing regional measures/regional plans already approved by the Contracting Parties with a particular focus on those adopted in the framework of article 15 of the LBS Protocol due to their legally binding obligations.

Technical Guidelines and related Assessments
UNEP(DEPI)/MED WG.439/5; UNEP(DEPI)/MED WG.439/6; UNEP(DEPI)/MED WG.439/7, UNEP(DEPI)/MED WG.439/8; UNEP(DEPI)/MED WG.439/9; UNEP(DEPI)/MED WG.439/10; UNEP(DEPI)/MED WG.439/11; UNEP(DEPI)/MED WG.439/19

16. The meeting reviewed the proposed guidelines on the management of dredged materials with a particular focus on the opened paragraphs and related notes as a follow up to the Expert Review Meeting held in Loutraki, Greece, in April 2017.

17. The meeting approved the draft guidelines as amended and contained in Appendix II to these conclusions for submission to the meeting of MAP Focal Points, September 2017. The meeting also requested the Secretariat to further specify the legal analysis with regards to the wording used in the confinement section to ensure coherence with the Protocol.

18. The meeting reviewed the proposed guidelines on placement for Artificial Reefs with a particular focus on a limited number of opened paragraphs and related notes following the Expert Review Meeting held in Loutraki, Greece, in April 2017.

19. The meeting agreed on the text of the draft guidelines as contained in Appendix III to these conclusions, and recommended their submission to MAP Focal Points meeting in September 2017 highlighting in particular that its part C is not yet approved pending legal analysis by the Secretariat explaining that the placement of vessels hulls and superstructures for the purpose of artificial reefs is not in contravention with Article IV of the Dumping Protocol which prohibits the dumping of ships in the Mediterranean Sea area since 2000.

20. The meeting reviewed and approved the Guidelines on Desalination as contained in Appendix IV of these conclusions.

21. The meeting reviewed and approved the proposed guide on the Selection of Best Available Techniques (BAT) in Industrial Installations as contained in Appendix V to these conclusions.

22. The meeting reviewed and approved as amended the proposed guide on Inspection of Industrial Facilities as contained in Appendix VI to these conclusions.

Implementation of Decision IG 22/7 on IMAP and Articles 7 and 8 of the LBS Protocol
UNEP(DEPI)/MED WG.439/12; UNEP(DEPI)/MED WG.439/13; UNEP(DEPI)/MED WG.439/14, UNEP(DEPI)/MED WG.439/15

23. The meeting welcomed the work undertaken to revise the IMAP Common Indicator Guidance Factsheets (UNEP(DEPI)/MED WG.439/12 and its corrigendum) following the work undertaken during the CORMON meetings for Pollution (October 2016) and Marine Litter (February 2017). The meeting approved the amended version as contained in appendix VII of these conclusions for submission to the EcAp Coordination Group meeting.

24. The meeting reviewed the Quality Status Report (QSR) Assessment Factsheets for Contaminants and Marine Litter (UNEP(DEPI)/MED WG.439/13 and its addendum).With regards to

the Contaminants (EO9), the meeting took note of the latest version of the assessment factsheets proposed by the Secretariat, and requested the Secretariat to include all comments submitted and distribute a revised version to the CORMON members by 15th June latest. Following the receipt of comments submitted by the CORMON by 30th June at the latest, the Secretariat will prepare a revised version of these assessment factsheets for submission to the EcAp Coordination Group meeting in September 2017,

25. With regards to Eutrophication (EO5) assessment factsheets, the meeting took note of the presentation made by the Secretariat and requested that the Focal Points provide written comments by the 20th June. The Secretariat will then prepare a revised version of these assessment factsheets for submission to the EcAp Coordination Group meeting in September 2017.

26. With regards to the Marine Litter (EO10) assessment factsheets, the meeting reviewed and provided several minor comments, and approved the amended version as contained in appendix VIII of these conclusions for submission to the EcAp Coordination Group meeting.

27. The meeting reviewed and approved as amended and contained in Appendix IX to these conclusions the proposed metadata template for contaminants, eutrophication and marine litter.

Other specific issues
UNEP(DEPI)/MED WG.439/16

28. The meeting took note of the proposal for revised and new pollution assessment criteria based on a trend analysis of the data submitted by the Contracting Parties. The meeting requested the MED POL Focal Points to provide their views whether the proposed assessment criteria or some of them for which there is no objection, should be submitted to COP 20 with a view to amend as appropriate the current COP 19 decision on IMAP related assessment criteria.

29. The meeting acknowledged the progress related to the implementation of the updated National Action Plans/Programmes of Measures (NAPs/POMs). Noting that some Contracting Parties have not yet formally submitted the updated NAPs/POMs due to the long administrative procedures for their approval by the competent national authorities, the meeting recommended that such a submission should be done at the latest by September 2017 or before COP 20. This would allow the Secretariat to also revisit the list and the map of the Hot Spots and/or sensitive areas at Mediterranean level.

30. The meeting took note of the proposed list of NAP implementation follow up indicators. The meeting, appreciating the joint work done with the Horizon 2020 and its review and monitoring subgroup, pointed out that further work should be undertaken for refining this list with a view to establish to the extent possible a common list for both NAP and Horizon 2020 progress evaluation. The meeting requested the Secretariat to keep the MED POL Focal Points informed of the outcome of this process on a regular basis.

31. The meeting appreciated the work of UfM for developing criteria for selecting flagship investment projects. The application of the criteria presented would allow a better screening of updated NAP investment projects and increase funding opportunities for those projects with higher impact on achieving Good Environmental Status and/or Hot Spots elimination.

32. The meeting took note of the proposed list of priorities of contaminants in the Mediterranean supported by the background information document *UNEP(DEPI)/MED*

WG.439/Inf.11 and recommended a periodic analysis of emerging contaminants in the Mediterranean for review by the meeting of MED POL Focal Points on a regular basis.

33. The meeting took note of the progress achieved for ENI SEIS II and Marine Litter Med Project and requested the Secretariat to timely provide the necessary technical support and guidance to facilitate the work at national level. Noting that these projects are executed by different MAP components, the meeting encouraged joint coordination and regular consultation among the national Focal Points of the respective MAP components.

34. The meeting took note of the proposed project under the new MED Programme and requested the Secretariat to make sure that project activities are designed in line with the NAP and MTS priorities.

35. The meeting appreciated the presentation and the work carried out by SCP/RAC on the impact of toxic chemicals in marine plastic litter and microplastics in the framework of the Stockholm and Basel Conventions and requested the Secretariat to share this document for feedback from the MED POL Focal Points and encourages SCP/RAC to continue with this workstream keeping MED POL informed on its advances and propose future actions for MED POL to discuss.

MED POL Programme of Work 2018-2019
UNEP(DEPI)/MED WG.439/18

36. The meeting reviewed and approved the proposed Programme of Work as amended and contained in Appendix X to these conclusions and requested the Secretariat to include it in the MAP Programme of Work for submission to the meeting of the MAP Focal Points, September 2017.

37. The meeting also recommended for each activity a priority ranking that would allow the Secretariat to allocate core funding from the MTF accordingly, on the understanding that the activities of the second priority should be considered for funding through external resources if core funding is not available, and taking also into account the need to complement such external funding with core funds in order to ensure that all Contracting Parties benefit from related activities as appropriate.

38. While reviewing the proposed Programme of Work, the meeting requested the Secretariat to consider and ensure that a dedicated section is allocated to MED POL and its deliverables in MAP website to facilitate access to resources.

Appendix I

Priority clustering of the listed measures under 6 potential regional plans in the framework of the article 15 of the LBS Protocol

Suggested Polution Reduction Regional Plans	**Measures**	**Existing (E) or New (N)**
Municipal WWTP	Strengthen implementation of Regional Plans' provision on sewage and WWT systems; strengthening of capacities and provision of support for construction, expansion and upgrading of sewage/ WWT systems	E
	Developefficiency standards for WWTPs; support strengthened control of their operations	E+N
	Setting of targets for secondary treatment; promotion of tertiary treatment (with targets) and of uptake of new improved WWT technologies; setting of targets for reuse of treated wastewater	N
	Adopt an updated list priority contaminants taking into account 'emerging pollutants' such as pharmaceuticals, nano-materials etc.	N
	Promote upgrading of WWTPs to reduce the inflows of plastics into the marine environment	E
Sewage Sludge Management	Strengthen the existing and development of new measures to improve region-wide performance with sewage sludge management	E+N
Agriculture Nutrients Management	Develop technical guidelines and management standards to tackle inputs of nutrients and contaminants from agriculture and to promote sustainable farming practices	N
Aquaculture Nutrients Management	Develop technical guidelines and management standards to tackle inputs of nutrients and contaminants from aquaculture	N
Urban Stormwater Management	Develop guidelines on management of runoff from urban areas and effluents from storm water sewers; promotion of the use of Green Infrastructure and nature based solutions	N
	Establish appropriate sewage and storm water collection systems, WWTPs and waste management systems to prevent runoff and riverine inputs on marine litter	E
Marine Litter (upgrade)	Strengthen solid waste management systems in the region: adopt quantifiable targets as appropriate, promote adequate collection and treatment/ disposal, stimulate recycling and uptake of new waste management technologies	E+N
		E
	Promote waste prevention at source, better integration of SCP principles and measures, decoupling waste generation from economic growth, green procurement and adoption and implementation of circular economy strategies	E+N
	Close the illegal dumps	E
	Incorporate marine litter into national regulations, prepare Marine Litter National Action Plans,	E+N
	Establishma regional marine litter database	E
	Stimulate reduction/ recycling/ prevention of plastics by, for example, adoption of recycling targets, promotion of sustainable consumption patterns, promotion of instruments to reduce packaging wastes, replacement of plastics with bioplastics where feasible,	E+N

	preventing/ reducing use of microplastics (microbeads) in personal care and cosmetics products, and similar	
	Assess options for phasing out landfilling of recyclable wastes (in particular plastics)	N
	Adopt common definition of microplastics and studies to improve knowledge (sources, quantities, impacts, possible reduction/ prevention measures, differentiated for primary and secondary microplastics)	N
	Promote introduction of region-wide plastic bag tax (alternatively promote coordinated approach to restricting single-use plastic bags)	E+N
	Strenghthen the implementation of MARPOL Annex V on the prevention of pollution by garbage from ships	E+N
	Use of port reception facilities at no-special-fee	E+N
	Implement prevention/ retrieval of lost/discarded fishing gear; assessment options for collecting and processing/ recycling fishing gear and equipment at the end of its useful life	E+N
	Encourage and implement to the extent possible 'fishing for litter' schemes	E+N
	Implement pilot projects for removal of marine litter accumulations impacting on MPAs	E+N
	Develop and implement measures to reduce incidence of cigarette butts in marine environment, including provision of adequate facilities and signs on organised beaches, awareness raising and clean-up activities	E+N
		E
	Clean-up activities targeting riverbanks	E+N
	Promote and expand beach stewardship schemes	E+N

Appendix 2

Updated Guidelines on Management of Dredged Materials

Table of Contents

List of Abbreviations / Acronyms

BEP	Best Environmental Practice
Cd	Cadmium
CDF	Confined Disposal Facility
COP	Conference of the Parties
Cu	Copper
Cr	Chromium
DGPS	Differential Global Positioning System
EIA	Environmental Impact Assessment
GES	Good Environmental Status
Hg	Mercury
IMAP	Integrated Monitoring and Assessment Programme
MAP	Mediterranean Action Plan
MED POL	Programme for the Assessment and Control of Marine Pollution in the Mediterranean Sea
MPA	Marine Protected Area
Ni	Nickel
PAH	Polycyclic Aromatic Hydrocarbons
Pb	Lead
PCBs	Polychlorobiphenyls
Sn	Tin
SPAMI	Specially Protected Areas of Mediterranean Importance
Zn	Zinc

Introduction

1. Dredging activities are an essential part of port and harbour activities. Two main dredging categories can be distinguished:

a) Capital dredging, mainly for navigational purposes, to enlarge or deepen existing channel and port areas, or to create new ones; this type of dredging activity also includes some technical activities on the seabed such as trenches for pipes or cables, tunneling, removal of material unsuitable for foundations, or removal of overburden for aggregate extractions;

b) Maintenance dredging, to ensure that channels, berths or construction works are maintained at their designed dimensions.

In addition, other dredging operations such as:

a) Dredging to support coastal protection or management: relocation of sediments for activities such as beach nourishment and construction of levees, dykes, jetties, etc.

b) Environmental dredging: to remove contaminated sediment for the purpose of reducing risks to human health and the environment; construction of confined aquatic disposal cells to hold contaminated sediments.

c) Restoration dredging: to restore or create environmental features or habitats in order to establish ecosystem functions, benefits, and services, e.g. wetlands creation, island habitat construction and nourishment, construction of offshore reefs, and topographic features for fisheries enhancement, etc.;

d) Dredging to support local and regional sediment processes: includes engineering to reduce sedimentation (e.g. construction of sediment traps), retaining sediment within the natural sediment system to support sediment-based habitats, shorelines and infrastructure.

2. All these activities may produce large quantities of material that have to be managed in an environmentally sound manner including their beneficial use, disposal, confinement or treatment. In the case of disposal at sea, it should be ensured that adverse impacts on the marine and coastal ecosystems of the Mediterranean do not occur.

3. It must be also recognised that dredging operations as such may harm the marine environment, especially when they take place in the open sea close to sensitive areas (key habitats, SPAMIs, Marine Protected Areas (MPAs), aquaculture areas, recreational areas, etc.). This is the case in particular when dredging operations have a physical impact (increased turbidity) or lead to the re-suspension or the re-releasing of major pollutants (heavy metals, organic or bacterial pollutants and nutrients).

4. Dredging operations may result in the re-mobilization of pollutants contained in the sediments and their suspension, which may, at certain levels, have an adverse impact on the environment, either at sea during dredging or capping when these sediments are submerged, or on land when these sediments are stored. Dredging can also result in hydromorphological, sedimentologic and hydrographic changes to dredged areas and have a more global impact on disposal sites or onshore management.

5. In the above context, the Contracting Parties are urged to exercise control over dredging operations in parallel with that exercised over dumping. Beneficial uses and use of Best Environmental Practices (BEP) for dredging activities are essential pre-condition for dumping, in order to dispose on land and/or minimise the quantity of material that has to be dredged and the impact of the dredging and dumping activities in the maritime area.

6. On the other hand, un-polluted dredged material can have positive environmental effects and externalities. In fact, dredged materials can be integrated, under certain conditions and subject to the existence of a local market, into treatment systems allowing their exploitation, in particular in building materials. They can also be used for beach nourishment in the fight against erosion of the coastline and thus come as an alternative to other more harmful disposal methods. Finally, in the case of sediment pollution, dredging can be a removal solution that decontaminates the marine environment, but with the risk of transferring the problem to the land or being re-dumped to another sea area.

7. The basic principle of these updated Guidelines is that dumping or re-suspension of dredging sediments in the coastal zone of the Mediterranean should be minimized as much as possible, in order to avoid the deterioration of the Good Environmental Status and/or maintain its good status in relation to a number of relevant MAP ecosystem approach based Ecological Objectives and related Operational Objectives and GES targets (1, 2, 2.1, 2.2, 5.1,5.2, 7.1, 7.2, 7.3, 8.1, 9.1,9.2,9.4,10.2) as adopted in 2013 by COP 18 (Decicion IG.21/3). Therefore **beneficial uses and land management should be primarily and ultimately considered before any decision on dumping at sea**.

8. The updated guidelines also provide ample information and links related to land disposal and low cost treatment and disposal options[1].

I. SCOPE OF THE APPLICATION OF THE GUIDELINES

9. Several Articles of the Dumping Protocol[2] provide ground base for the development of the guidelines. Under Article 4.1 of the Protocol, the dumping of waste and other matter is prohibited. Nevertheless, pursuant to Article 4.2 (a) of the Protocol, this principle may be waived and the dumping of dredged material authorized under certain conditions. Under Article 5, dumping requires a prior special permit from the competent national authorities.

10. Furthermore, in accordance with Article 6 of the Protocol, the permit referred to in Article 5 shall be issued only after careful consideration of the factors set forth in the Annex to the Protocol. Article 6.2 provides that the Contracting Parties shall draw up and adopt criteria, guidelines and procedures for the dumping of wastes or other matter listed in Article 4.2 so as to prevent, abate and eliminate pollution. In addition, the Protocol recognizes the importance of on land beneficial uses and BEPs as important steps before granting a dumping permit by relevant authorities.

11. In accordance with Article 9 (8) of the Regional Plan on the Management of the Marine Litter in the Mediterranean, the Contracting Parties should apply by the year 2020 the cost effective measures to prevent any marine littering from dredging activities taking into account the relevant guidelines adopted in the framework of Dumping Protocol of the Barcelona Convention.

12. In this context, the updated Guidelines for the Management of Dredged Materials, provide guidance to the Contracting Parties on the fulfilment of their obligations related to:

(a) the issue of permits for the dumping of dredged material in accordance with the provisions of the Protocol; and Article 9 (8) of the Regional Plan on the Management of the Marine Litter in the Mediterranean
(b) monitoring, sampling and assessment methods consistent with IMAP Decision
(c) transmission to the Secretariat of reliable data on the inputs of contaminants by the dumping of dredged material and other harmful impacts on marine and coastal ecosystems, in line with reporting under the MAP Barcelona Convention.

[1] In this respect advice is available from a number of international organisations, including the Permanent International Association of Navigation Congresses (PIANC) 1986: Disposal of Dredged Material at Sea (LDC/SG9/2/1). Through its Environmental Policy Framework and close links with industry in developing Cleaner Industrial Production Technologies, the United National Industrial Development Organisation (UNIDO) is able to offer expert advice and training to enhance capabilities to develop an integrated management plan for dredged material.
[3] Amended text of 1995

(d) good dredging, best available practices and equipment
(e) data as regards thresholds and contaminant concentrations in the dredged material

13. The updated guidelines are designed to allow Contracting Parties to manage dredged material without polluting the marine environment. In accordance with Article 4.2 (a) of the Dumping Protocol, these updated guidelines relate specifically to the dumping of dredged material from ships and aircraft. They do not concern either dredging operations or the disposal of dredged material by methods other than dumping.

14. The updated guidelines are presented in two parts. Part A deals with the assessment and management of dredged material, while part B provides guidance on the design and conduct of monitoring of marine dumping sites.

15. The updated guidelines commences with a guidance on the conditions under which permits might be issued. Sections 4, 6 and 7 address the relevant considerations related to the characteristics, composition of the dredged material and priority is given to beneficial uses and low cost treatment of dredged material (part A). In case dumping at sea is to be considered, guidance on the monitoring of the dumping site is provided in part B. The references provide extensive information, among others, on analytical techniques and normalization procedures which could be used by national authorities to implement these updated Guidelines. In addition, the updated Guidelines have two Annexes on:

a) Analytical requirements for the assessment of dredged materials

b) Contaminant action levels and thresholds

II. DEFINITION OF TERMS

16. For the purpose of these updated guidelines the following definition of terms apply:

Action levels	Guidance values used to trigger action
Benthic	Relating to, or occurring at the bottom of a body of water.
Bioaccumulation	Accumulation of environmental contaminants in living tissue.
Bioassay	Tests in which organisms are exposed to dredged materials to determine their biological effects or toxicity.
Biological testing	Testing via bioassays.
Biota	Living organisms.
Capital dredging	Capital dredging includes geological material dredged from previously unexposed layers beneath the seabed and surface material from areas not recently dredged.
Clay	Sedimentary mineral particles 0.2 to 2.0 µm in size, usually with a negative charge (anion); the size and charge have profound implications for sediment chemistry and other physical interactions.
Contaminated Dredged Material	Dredged material not meeting national assessment criteria (e.g. exceeding upper action levels).
Dredged material Management	An overarching term describing a variety of handling methods of

	dredged materials including, inter alia: dumping (deliberate disposal), re-use, beneficial use, re-location, placement, confinement and treatment.
Eco-toxicological Testing	Biological testing via bioassays.
Fractions	Categories of sediments using grain size.
Harbour	Harbours include enclosed and semi-enclosed docks, docks entrances, marinas, wharves and unloading jetties
Maintenance Dredging	Maintenance dredging is the dredging required to maintain berths and navigation channels at advertised depth. It includes material dredged from recently deposited by sedimentation processes in harbour or sea areas
National Action List	List or inventory of dredged material contaminants that Contracting Parties might consider in the permitting process and decision. The Action List is used as a screening mechanism for assessing properties and constituents of dredged material with a set of levels for specific substances. It should be used for dredged material management decisions, including the identification and development of source control measures
National Action Levels	Levels for a particular contaminant concentration below which there would be little concern (lower NALs), or above which there would be concern due to increased risk or increased probability of effects (upper NALs). The levels should reflect experience gained relating to the potential effects on human health or the marine environment. Action List levels should be developed on a national or regional basis and might be set on the basis of concentration limits, biological responses, environmental quality standards, flux considerations or other reference values. They should be derived from studies of sediments that have similar geochemical properties to those from the ones to be dredged and/or to those of the receiving system. Thus, depending upon natural variation in sediment geochemistry, it may be necessary to develop individual sets of criteria for each area in which dredging or deposit is conducted.
Sediment	Naturally occurring material that is produced through the processes of weathering and erosion of rocks, and is subsequently transported by the action of fluids such as wind, water, or ice, and/or by the force of gravity acting on the particle itself.
Σ PAH9	anthracene; benzo[a]anthracene; benzo[ghi]perylene; benzo[a]pyrene; chrysene; fluoranthene; indeno[1,2,3-cd]pyrene; pyrene; phenanthrene
Σ PAH16	acenaphthene, acenaphthylene, anthracene, benzo[a]anthracene, benzo[b]fluoranthene, benzo[k]flouranthene, benzo[a]pyrene, benzo[ghi]perylene, chrysene, dibenz(ah)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene and pyrene

III. CONDITIONS UNDER WHICH PERMITS FOR DUMPING OF DREDGED MATERIAL MAY BE ISSUED

PART A ASSESSMENT AND MANAGEMENT OF DREDGED MATERIAL

1. Characterization of dredged material

17. For the purpose of these updated guidelines, the following definition[s] apply[ies]:
"dredged material" means any sedimentary formation (clay, silt, sand, gravel, rocks, and any indigenous parent rock material) removed from areas that are normally or regularly covered by sea water, by using dredging or other excavation equipment; For any other relevant definition, the text of Art. 3 of the Dumping Protocol, applies.

2. Assessment of the characteristics and composition of the dredged material

a) Physical characterization

18. For all dredged material to be dumped at sea, the following information should be obtained:
(a) quantity of dredged material (gross wet tonnage);
(b) method of dredging (mechanical dredging, hydraulic dredging, pneumatic dredging, and application of BEP's);
(c) rough preliminary determination of sediment characteristics (i.e. clay/silt/sand/gravel/rock).

b) Chemical and biological characterization

19. In order to assess the capacity of the site to receive dredged material, both the total amount of material and the anticipated or actual loading rate at the dumping site should be taken into consideration. Chemical and biological characterization is also needed to fully assess the potential impact. Information may be available from existing sources, for example from field observations on the impact of similar material at similar sites, or from previous test data on similar material tested not more than five years previously, and from knowledge of local discharges or other sources of pollution, supported by a selective analysis. In such cases, it may be unnecessary to measure again the potential effects of similar material in the vicinity.

20. Chemical, and as appropriate biological, characterization will be necessary as a first step in order to estimate gross loading of contaminants, especially for new dredging operations. The requirements for the elements and compounds to be analyzed are set out in Section 5. The purpose of testing under this section is to establish whether the dumping at sea of dredged material containing contaminants might cause undesirable effects, especially the possibility of chronic or acute toxic effects on marine organisms or human health, whether or not arising from their bioaccumulation in marine organisms and especially in food species.

21. The following biological test procedures might not be necessary if the previous physical and chemical characterization of the dredged material and of the receiving area, and the available biological information, allows an assessment of the environmental impact on an adequate scientific basis.

22. However, suitable biological test procedures should be applied if:

(a) the previous analysis of the material shows the presence of contaminants in quantities exceeding the upper reference threshold in paragraph 24 (a) above or of substances whose biological effects are not understood,
(b) there is concern for the antagonistic or synergistic effects of more than one substance,

(c) there is any doubt as to the exact composition or properties of the material, it is necessary to apply suitable biological test procedures.

23. These procedures, which should involve bio-indicators species may include the following:

(a) acute toxicity tests;
(b) chronic toxicity tests capable of evaluating long-term sub-lethal effects, such as bioassays covering an entire life cycle;
(c) tests to determine the potential for bioaccumulation of the substance of concern;
(d) tests to determine the potential for alteration of the substance of concern.

24. Substances in dredged material may undergo physical, chemical and biochemical changes when deposited in the marine environment. The susceptibility of dredged material to such changes should be considered in the light of the eventual fate and potential effects of the dredged material. This may be reflected in the impact hypothesis and also in the monitoring programme.

c) Exemptions

Dredged material may be exempted from the testing referred to in paragraphs 33 to 37 of these guidelines if it meets one of the criteria listed below; in such cases, the provisions of the Parts B and C of the Annex to the Protocol (see Sections 6 and 7 below) should be taken into account, after an initial sampling and testing proving that they are not contaminated.
(a) It is composed of previously undisturbed geological material;
(b) It is composed almost exclusively of sand, gravel or rock;
(c) It is suitable for beneficial uses and is composed predominantly of sand, gravel or shell, with particle sizes compatible with information included in section 6-part A of these updated guidelines.

25. In the case of Capital dredging projects national authorities may, taking into account the nature of the material to be dumped at sea, exempt part of that material from the provisions of these guidelines, after representative sampling. However, Capital dredging in areas which may contain contaminated sediments should be subject to characterization in accordance with these guidelines, notably paragraph 34.

3. Disposal of dredged material

26. In the vast majority of cases, dumping harms the natural environment so before taking any decision to grant a dumping permit other methods of management should be considered. In particular, all possible beneficial uses of dredged material should be primarily and ultimately assessed and (see section 6) considered before granting dumping at sea permit.

4. Decision making process

General Introduction

27. In case where, after exploring all possibilities of beneficial use of dredged materials according to section 6 of part A of these updated guidelines, dumping operations at sea should be considered, it is recommended to select proper dumping sites to maintain GES for the Mediterranean Sea and to minimise the impact on commercial areas, MPA’s, SPAMI’s, key habitats, estuaries, and recreational fishery areas. This approach is a major consideration in resource protection and is covered in greater detail in Part C of the Annex to the Dumping Protocol.

28. In order to define the conditions under which permits for the dumping of dredged material may be issued, the Contracting Parties should develop on a national and/or regional basis, as appropriate, a

decision-making process (Fig .1) for evaluating the properties of the material and its constituents, having regard to the protection of human health and the marine environment.

Criteria for Decision Making Process

29. The decision-making process, for dumping at sea of dredged materials, is based on a set of criteria developed on a national and/or regional basis, as appropriate, which meet the provisions of Articles 4, 5, and 6 of the Protocol and are applicable to specific substances. These criteria should take into consideration the experience acquired on the potential effects on human health and the marine environment.

30. These criteria may be described in the following terms:
(a) physical, chemical and geochemical characteristics (e.g. sediment quality criteria);
(b) application of beneficial use decision-making approach as mentioned in section 6 of part A of these guidelines;
(c) biological effects of the products of the dumping activity (impact on marine ecosystems and estuary systems);
(d) reference data linked to particular methods of dumping and to dumping sites;
(e) environmental effects that are specific to dumping of dredged material and are considered undesirable outside and/or in close proximity to the designated dumping sites;
(f) the contribution of dumping to already-existing local contaminant fluxes (flux criteria);
(g) mitigation measures during dumping operations

31. Criteria should be derived from studies of sediments that have similar geochemical properties to those to be dredged and/or to those of the receiving system. Depending upon the natural variation in sediment geochemistry, it may be deemed necessary to develop individual sets of criteria for each area in which dredging or dumping is conducted.

32. The decision-making process, with respect to the background natural baseline reference levels and to some specified contaminants or biological responses and with the aim to maintain GES as adopted in 2013, may lay down a national upper and a lower reference threshold and action level, giving rise to three possibilities:

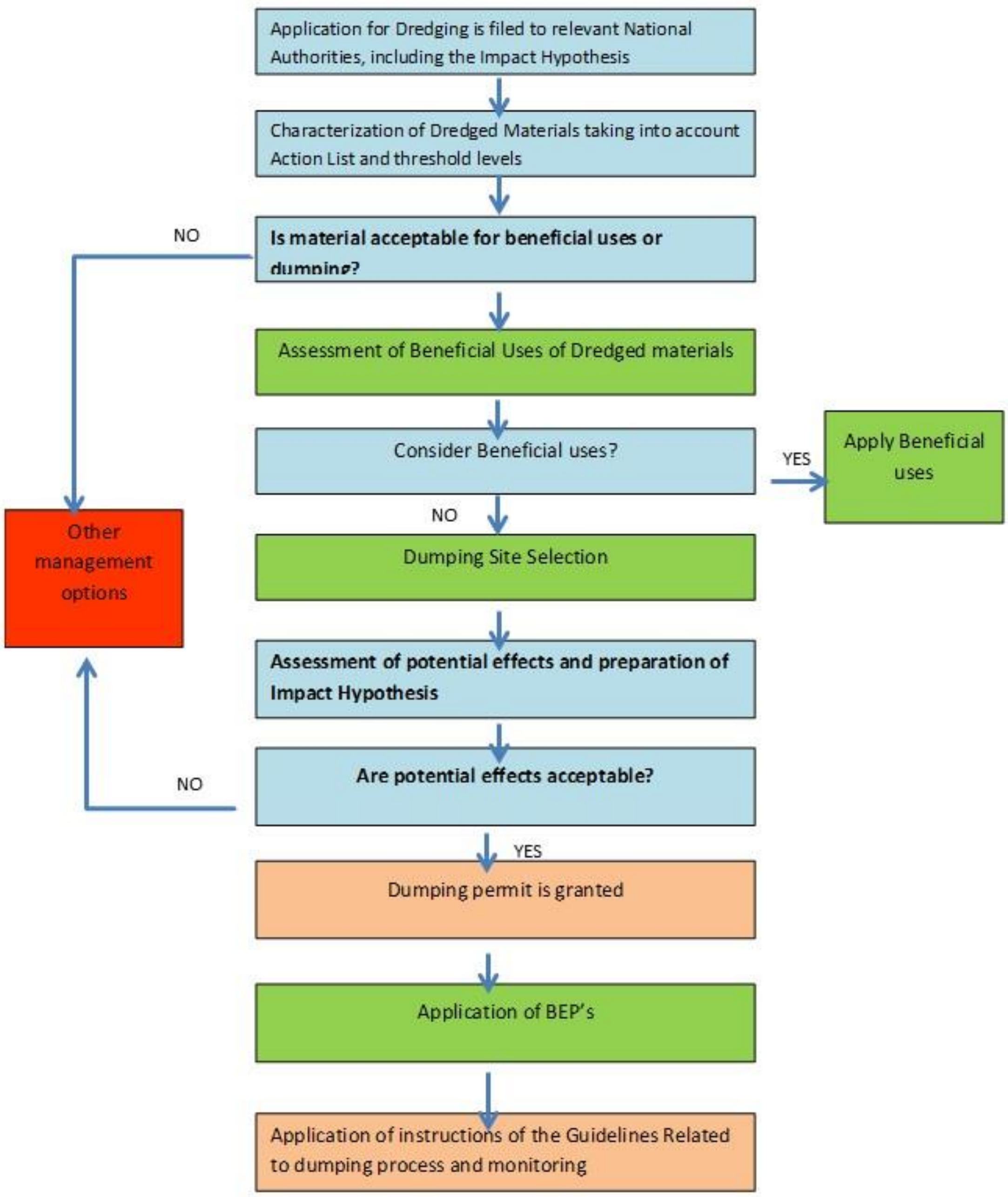
(a) material which contains specified contaminants or which causes biological responses in excess of the relevant upper threshold should generally be considered as unsuitable for dumping at sea, subject to confinement or/and treatment;
(b) material which contains specified contaminants or which causes biological responses below the relevant lower threshold should generally be considered of low environmental concern for dumping at sea;
(c) material of intermediate quality should be subject to more detailed assessment before suitability for dumping at sea can be determined.

33. Data related to threshold levels from Mediterranean countries are provided in Annex II to the updated Guidelines for information purposes with the view to guide as appropriate the competent national authorities in the process of setting national threshold level values. It is recommended to review this Annex on a regular basis to take into account global, regional and national relevant developments and adjust it accordingly

34. When the criteria and the associated regulatory limits cannot be met (case (a) above), a Contracting Party should not issue a permit unless detailed consideration in accordance with Part C of the Annex to the Protocol indicates that dumping at sea is, nonetheless, the least detrimental option, compared with other management techniques. If such a conclusion is reached, the Contracting Party should:

(a) implement a programme for the reduction at source of pollution entering the dredged area, where there is a source that can be reduced by such a programme, with a view to meeting the established criteria;
(b) take all practical steps to mitigate the impact of the dumping operation on the marine environment including, for example, the use of confinement (capping or CDF) or treatment methods;
(c) prepare a detailed marine environment impact hypothesis;
(d) initiate monitoring (follow-up activity) designed to verify any predicted adverse effects of dumping, in particular with respect to the marine environment impact hypothesis;
(e) issue a specific permit for each specific operation;
(f) report to the Organisation on the dumping which has been carried out, outlining the reasons for which the dumping permit was issued.

Figure 1. Decision making process of the Updated Gudelines



Additional Criteria for Decision Making Process

35. Additional criteria for evaluating the need for dumping and alternatives to dumping are provided herewith to assist the national authorities in the decision making process. They are therefore to be evaluated, if applicable, for each proposed dumping on an individual basis using information included in these updated guidelines.

36. The need for dumping at sea is to be determined by evaluation of the following factors:

(a) Amount of dredged material;
(b) Degree of treatment -useful and feasible- for the dredged materials to be dumped and whether or not it has been or will be treated to this degree before dumping;
(c) The relative environmental risks, impact and cost for dumping as opposed to other feasible alternatives as mentioned in section 6 of part A of these updated Guidelines.
(d) Irreversible or irretrievable consequences of the use of alternatives to dumping.

Beneficial Use

37. A need for dumping is considered to have been demonstrated when a thorough evaluation of the factors listed above has been made, and the relevant authorities, as the case may be, have determined that the following conditions exist, where applicable:

(a) There are no practicable improvements which can be made in process technology or in overall possible treatment to reduce the adverse impacts of the dredged materials on the marine ecosystems;
(b) There are no practicable beneficial use alternatives which have less adverse environmental impacts or potential risk than dumping.
(c) Treatment alternatives or improvements in processes and alternative methods of disposal are practicable when they are available at reasonable incremental cost and energy expenditures, which need to be competitive with the costs of dumping, taking into account the environmental benefits derived from such activity, including the relative adverse environmental impacts associated with the use of alternatives to dumping.

Aesthetic, Recreational and Economic Values

38. Impacts of the Proposed Dredging or Dumping operations on Aesthetic, Recreational and Economic Values are determined on an individual basis, taking into account the uses and activities in the area and using the following considerations:

(a) Potential for affecting recreational use and values of sea waters, inshore waters, beaches, or shorelines;
(b) Potential for affecting the recreational and commercial values of living marine resources;
(c) Nature and extent of present and potential recreational and commercial use of areas which might be affected by the proposed dumping;
(d) Existing water quality, and nature and extent of disposal activities, in the areas which might be affected by the proposed dumping;
(e) Applicable GES's values and its targets and assessment criteria;
(f) Macroscopic [or organoleptic] characteristics of the materials (e.g. color, suspended particulates) which result in an unacceptable aesthetic nuisance in recreational areas;
(g) Presence in the material of pathogenic organisms which may cause a public health hazard either directly or through contamination of fisheries or shellfisheries;
(h) Presence in the material of toxic chemical constituents released in volumes which may affect humans directly;
(i) Presence in the material of chemical constituents/heavy metals which may be bioaccumulated or persistent and may have an adverse effect on humans directly or through food chain interactions; [reference to Annex I of these updated Guidelines]

(j) Presence in the material of any constituents which might significantly affect living marine resources of recreational or commercial value.

39. For all proposed dumping, full consideration will be given to such non quantifiable aspects of aesthetic, recreational and economic impact, such as:

(a) Public consultation of the proposed dumping and dredging sites;
(b) Consequences of not authorizing the dumping including without limitation, on aesthetic, recreational and economic values with respect to the municipalities and industries involved.

5. Guidelines on dredged material sampling and analysis

a) Sampling for the purpose of issuing a dumping permit

40. For dredged material which requires detailed analysis (i.e. which is not exempted under paragraph 39 above), the following guidelines indicate how sufficient analytical information may be obtained for the purpose of issuing a permit. Judgment and knowledge of local conditions will be essential in the application of these guidelines to any particular operation (see paragraphs 51 and 52).

41. An in situ survey of the area to be dredged should be carried out. The distribution and depth of sampling should reflect the size of the area to be dredged, the amount to be dredged and the expected variability in the horizontal and vertical distribution of contaminants. In order to evaluate the number of samples to be analyzed, different approaches might be retained.

42. The table that follows gives an indication of the number of sample sites to be used in relation to the number of m3 to be dredged in order to obtain representative results, assuming a reasonably uniform sediment in the area to be dredged.

Amount dredged (m3 in situ)	Number of stations
Up to 25000	3
from 25 000 to 100 000	4-6
from 100 000 to 500 000	7-15
from 500 000 to 2 000 000	16-30
> 2 000 000	extra 10 per million m3

43. Core samples should be taken where the depth of dredging and the expected vertical distribution of contaminants warrant; otherwise a grab sample is considered appropriate. Sampling from the dredger is not acceptable.

44. Normally, the samples from each sampling site should be analyzed separately. However, if the sediment is clearly homogeneous with respect to sediment features (grain-size fractions and organic matter load) and expected level of contamination, it may be possible to analyze composite samples from adjacent locations, two or more at a time, provided care has been taken to ensure that the results give a justified mean value for the contaminants. The original samples should be retained until the procedure for the issue of a permit has been completed, in case the results indicate that further analysis is necessary.

b) Sampling in the case of the renewal of a dumping permit

45. If a survey indicates that the material is essentially below the lower reference threshold in paragraph 24 (b) above and no new events of pollution have taken place indicating that the quality of the material has deteriorated, surveys need not be repeated.

46. If the dredging activity involves material with a contaminant content between the upper and lower reference thresholds in paragraph 24 (a) and (b) above, it may be possible, on the basis of the

initial survey, to reduce either the number of sampling stations or the number of parameters to be measured. However, sufficient information must be provided to confirm the initial analysis for the purpose of issuing a permit. If such a reduced sampling programme does not confirm the earlier analysis, the full survey should be repeated.

47. However, in areas where there is a tendency for sediments to show high levels of contamination, or where contaminant distribution changes rapidly in response to varying environmental factors, analysis of the relevant contaminants should be frequent and linked to the permit renewal procedure.

c) Provision of Input Data

48. The sampling scheme described above provides information for the purpose of issuing permits. However, the scheme can at the same time provide a suitable basis for estimating of total inputs and, for the time being in the current situation, can be considered the most accurate approach available for this purpose. In this context it is assumed that materials exempt from analysis represent insignificant inputs of contaminants and therefore it is not necessary to calculate or to report contaminant loads.

d) Parameters and methods

49. Since contaminants concentrate mainly in the fine fraction (< 2 mm) and even more specifically in the clay fraction (> 2 µm), analysis should normally be carried out on the non-coarse fraction sample (< 2 mm). It will also be necessary, in order to assess the likely impact of contaminant levels to provide information on:

(a) grain size fractions (% sand, silt, clay);
(b) load of organic matter;
(c) dry matter (% solids).

50. In those cases where analysis is required, it should be mandatory for primary metal substances and arsenic. With respect to organochlorines, polychlorobiphenyls (PCBs) should be analysed on a case-by-case basis in non-exempt sediments because they remain a significant persistent environmental contaminant. Other organohalogens should also be measured if they are likely to be present as a result of local inputs as indicated in the Action List Threshold Levels contained in Annex II of the updated Guidelines.

51. In addition, the authority responsible for issuing permits should carefully consider specific local inputs, including the likelihood of contamination by PCB, PAH and TBT, as indicated in Annex I to the updated Guidelines. The authority should make provision for the analysis of these substances as necessary.

52. In applying paragraphs 51 and 52, the following should be taken into account :

(a) potential routes by which contaminants could reasonably have been introduced into the sediments;
(b) probability of contamination from agricultural and urban surface run-off;
(c) spills of contaminants in the area to be dredged, in particular as a result of port activities;
(d) industrial and municipal waste discharges (past and present);

53. Further guidance on the selection of determinants and methods of contaminant analysis under local conditions, and on procedures to be used for harmonization and quality assessment purposes, will be found in the Annex I to the updated Guidelines as adopted, and updated periodically, by the Contracting Parties.

54. National relevant authorities are the ultimate responsible for the application of national normalized and standardized methods for sampling and analysis of determinants. References include information that could be consider in this matter.

6. Considerations before taking any decision to grant a dumping permit

6.1 Dredging Operations

55. Dredging operations may result in the re-mobilization of contaminants contained in the sediments and their suspension, which may, at certain levels, have an adverse impact on the environment, either at sea during dredging or clapping when these sediments are settled, or on land when these sediments are stored. Dredging can also result in hydromorphological and hydrographic changes to dredged areas and have a more global impact on disposal sites or onshore management.

56. On the other hand, dredging can have positive environmental effects and externalities. In fact, dredged materials can be integrated, under certain conditions and subject to the existence of a local market, into treatment systems allowing their exploitation, in particular in building materials. They can also be used to beaches nourishment in the fight against erosion of the coastline, and thus come as an alternative to more structural solutions. Finally, in the case of sediment pollution, dredging can be a removal solution that decontaminates the marine environment, but transfers the problem to the land.

57. It is important, while assessing the value of sediment as a resource, to consider opportunities for beneficial uses of dredged material, taking into account the physical, chemical and biological characteristics of the material. Generally, a characterization carried out in accordance with part A of these updated Guidelines will be sufficient to match a material to possible beneficial uses in water, at the shoreline and on land.

6.2 Physical Classifications of Dredged materials

a) Rock

58. Rock may vary from soft marl via weak rocks (for example, sandstone and coral) to hard rocks (such as granite and basalt). Rock may also vary in size from large to small, depending on the dredging equipment used and the type of material. Rock may also result from blasting, cutting, or ripping and is seldom of only one material type. Whether the rock can be used economically depends on its quantity and size. Rock is a valuable construction material and may be used for both terrestrial and aquatic projects. Usually, dredged rock is not contaminated.

b) Gravel and Sand

59. Gravel and sand (granular) are generally considered the most valuable materials derived from a dredging project. Gravel and sand are suitable for most engineering uses without processing. Some additional processing (such as freshwater washing) may be needed for certain agricultural or product uses. Granular material can be used for beach nourishment, parks, turtle nesting beaches, bird nesting islands, wetlands restoration and establishment, and many other applications. Granular material is usually not contaminated.

c) Consolidated Clay

60. Consolidated clay varies from hard to soft clay and is material obtained from capital dredging. The material may occur as lumps or as a homogeneous mixture of water and clay, depending on the material type and the dredging equipment used. If the water content is high, dredged clay may have to be dewatered before being transported. Possible uses of consolidated clay range from forming industrial products, such as bricks and ceramics, to building erosion control structures, such as dikes and berms. Consolidated clay is not usually contaminated.

d) Silt/Soft Clay

61. Silt and soft clay are the most common materials acquired from maintenance dredging in rivers, canals, and ports. These materials are most suitable for agricultural purposes (such as topsoil) and all forms of wildlife habitat development. Depending on national regulations and laws, mildly contaminated silt and soft clay may be used for some engineered uses or product uses such as bricks, tiles, and ceramics and cap layer for aquatical confinement of polluted material. Because of the high water content, silt and soft clay must be dewatered for any product use. Dewatering can require months or years and, depending on the draining process used, can require temporary storage.

e) Mixture (rock/sand/silt/soft clay)

62. Capital dredged material usually occurs in layers as deposited from some past hydraulic process and may require the use of different dredging methods. Maintenance dredged material is usually a mixture of materials such as boulders, lumps of clay, gravel, organic matter, and shells, with varying densities. Even though engineered and product uses will be somewhat restricted because of the mixture, mixed material may be used for a wide range of beneficial uses, such as land reclamation, habitat improvement, and landfill capping, filling materials in harbour facilities.

6.3 *Beneficial uses*

63. « Beneficial use of sediments includes making use of opportunities for retaining clean sediment within natural sediment processes and cycles that support aquatic, estuarine, and marine systems. »

(a) In water :

◦ *Habitat restoration and development* using direct placement of dredged sediments for enhancement or restoration of ecosystem habitat associated with wetlands, other nearshore habitats, coastal features, offshore reefs, fisheries enhancement, etc.

◦ *Sustainable relocation* by retaining sediment within the natural sediment system to support sediment-based habitats, shorelines and infrastructure.

(b) At the shoreline :

◦ *Beach Nourishment*

◦ *Shoreline Stabilization and Protection*

(c) on land

◦ Engineered Capping of soils or waste materials, e.g. landfill covers or remediation of former mining sites. (This form of beneficial use also applies to capping of contaminated sediments in aquatic environments.)

◦ Aquaculture, Agriculture, Forestry, and Horticulture involving direct placement of dredged material to create or maintain an aquaculture facility, replace eroded topsoil, elevate an area for improved site use, or otherwise enhance the physical and chemical characteristics of land.

◦ Recreational Development through direct placement of dredged material for the foundation of parks and recreational facilities; for example, waterside parks providing such amenities as swimming, camping, or boating.

◦ Commercial Land Development (also known as reclamation) using direct placement of dredged sediments to support commercial or industrial development activities, including "brownfield" redevelopment, as well as marine port, airport, and residential developments. These activities typically occur near navigational channels by expanding the land footprint or providing bank stabilization material.

◦Commercial Product Development involving the use of dredged material to create marketable products such as construction materials, e.g. bricks, aggregate, cement, top soil, etc.

64. Operational feasibility, that is, the availability of suitable material in the required amount at a particular time, is a crucial aspect of many beneficial uses.

a) Beach Nourishments

65. The influences of waves and tidal currents keep beach material in continuous motion. Where the prevailing wave direction is at an angle to the beach of less than 90 degrees, some material will be moved along the beach or foreshore or even offshore in a process called littoral transport. This movement is most rapid under storm conditions. If the moved material is not replaced, the beach and eventually the shoreline will erode. If lost beach material is not replaced naturally, beach nourishment may be necessary to enhance the beach profile and moderate the wave climate at the shoreline. In addition to the improvement of beaches for coast protection, improvement may also be required for recreation beaches. Recreation beaches may be improved or new beaches may be created. Dredging can supply the required large quantities of sand and gravel-sized material for beach nourishment. A life span of 10 years is a common design target for many beach nourishment schemes but a shorter life may be acceptable, particularly where the cost of nourishment material is low.

Recommended materials: Gravel and Sand.

b) Berm Creation

66. Dredged material may be used for creating berms or embankments to modify shoreline wave climate and thus improve beach stability. The berm may also be designed to alter wave direction and modify the rate or direction of local sediment transport. Generally, the berm is aligned roughly parallel to the beach, but the optimum alignment at a specific site will be determined by the direction of the most destructive wave climate.

67. The formation of berms may provide a particularly attractive use for a wide range of dredged material. Because the berm is generally a submerged formation, most or all of the formation usually can be created by the bottom discharge of dredged material from hoppers. Berms may gradually erode and be dispersed, but the dispersed material will probably benefit the local coastal regime, either through beach feeding or by increasing foreshore levels.

68. Modification of the wave climate by berms may also improve recreational opportunities for surfing, swimming, sailing, and other activities. Care must be taken in placement of the berm to avoid interference with other users such as fisheries, ports, harbours, outfalls, and intakes.

Recommended Sediment Types: rock, gravel and sand, consolidated clay and mixture

c) CCover material for capping sites

69. Capping involves the placement of clean dredged material over a deposit of contaminated dredged material in open-water or upland locations as a means of isolating the contaminated sediment from the surrounding environment. Open-water caps provide a wave-and current-resistant layer on top

of previously deposited contaminated materials. Sand, clay, or mixed materials may be used for open-water capping, whereas clay is usually most suitable for upland locations.

d) Land Creation

70. Land creation using dredged material includes filling, raising, and protecting an area that is otherwise periodically or permanently submerged. The creation of coastal land may also involve constructing a perimeter enclosure for protection against erosion by waves and currents. This may not be necessary in estuarine waters or in other sheltered coastal locations that have a small tidal range. Coarse or fine dredged material may be used in land creation. The suitability of a particular dredged material for land creation will depend largely on the intended use of the land. Material from maintenance dredging is usually silt or sand, while material from capital dredging may be of almost any kind or may be mixed. Sometimes the fine-grained material may be separated from the coarse material and the two resulting materials used in different ways.

71. Fine material will require a long time to drain and consolidate; therefore, the strength achieved may be low. Land created using these fine-grained materials may be limited to recreational uses, such as parks, or uses where the imposed loads will be small. If land must be created rapidly, material from capital dredging are primarily used. Where longer development times are acceptable, materials from maintenance dredging may also be used. Land created for industrial development or to accommodate roads or railways normally requires only sand or coarser material. Often the constraints of time and the availability of suitable material limit the use of dredged material in land creation. Such constraints may be overcome by long-term planning, which provides for land creation over extended periods. Land creation may also be constrained by compelling environmental considerations.

Recommended Sediment Types: rock, gravel and sand, consolidated clay, silt/soft clay, mixture

e) Land Improvement

72. Dredged material may be used for land improvement when the quality of existing land is not adequate for a planned use or where the elevation of the land is too low to prevent occasional flooding. As with land creation, the suitability of a particular dredged material for land improvement will depend largely on the intended use of the improved land.

73. Proven methods have been developed for land improvement by filling with the fine material, such as silts and clays, produced by maintenance dredging. Various dewatering techniques may be utilized, such as: subdividing the placement area to allow filling to a limited depth on a rotational basis; reworking the filled area with low ground-pressure agricultural or earth-moving equipment; and mixing coarse-grained material with the fine-grained upper layer.

74. Dredged material of fluvial origin is primarily eroded top soils and organic matter that may be used on land of poor agricultural quality to improve the soil structure. Even material dredged from a saline environment may, after treatment, be suitable for use as topsoil. Mildly contaminated soils can be used for non-consumptive land uses. Land improved using fine material is generally of lower strength than land improved using coarse-grained material. Potential applications include dairy and arable farming, recreation areas, playing fields, golf course, parks, light residential development or light commercial storage areas.

Recommended Sediment Types: rock, gravel and sand, consolidated clay, silt/soft clay, mixture.

f) Replacement Fill

75. Dredged material may be used as a replacement fill when the physical qualities are superior to soils near the dredging site. In industrial fill sites, peat and clayish soils are usually removed and replaced by sand or other granular dredged material to improve physical properties needed to meet

building requirements. Weak soils may be replaced with sand from construction of tunnels, bridges, fairways, and ports. Fine-grained soils do not have the necessary physical properties for industrial fill in most civil works projects; however, green areas or parks may be suitable applications. Some examples of replacement fills include:

(a) Filling holes in the landscape left from gravel or clay mining.
(b) Removal of soft layers so that an area is reclaimed with dredged sand.
(c) Trenching peat or soft clay and filling with sand to get a more stable layer of soil; for example, for abutments, tunnels, roads, and railways.
(d) Filling obsolete canals and docks to improve the use of the land.

*Recommended Sediment Types**:** rock, gravel and sand, mixture*

g) ***Aquaculture***

76. Aquaculture of coastal fish, shellfish, and other species is a rapidly expanding worldwide industry. The expansion of aquaculture has led to a shortage of suitable sites in many areas, especially coastal sites. Lack of access, legal constraints, competing land uses, and high land costs have limited aquaculture development for many locations. One way these constraints may be overcome is to use maintenance dredged material containment areas for aquaculture.

77. Aquaculture is a promising beneficial use because aquaculture ponds and dredged material containment areas share many design characteristics. Common features include perimeter levees to retain water, construction on relatively impervious soils, and control structures for water discharge and drainage. Both types of facilities have similar regulatory and permitting requirements for construction and operation, and both types of facilities include locations adjacent to waterways in coastal areas, often on large tracts of land and near transportation routes and major markets.

Recommended Sediment Types: Consolidated clay; Silt/soft clay; Mixture

h) Shore Protection

78. Shore protection methods include dike construction as well as beach nourishment and underwater berms, which were discussed earlier. Dike construction may use dredged material in the form of a pumped sand, directly dredged clay material, or rock. Rock produced by dredging may be used as riprap slope protection, armor stone, groins, or breakwater core material. Dredging does not usually produce large quantities of rock, but where it does, a range of useful engineering applications exists.

Recommended Sediment Types: rock, gravel and sand, consolidated clay.

i) Construction Materials

79. Some dredged material can be used as construction material. In some parts of the world, dredging to obtain construction material is a common practice. Because of the growing demand for construction materials and dwindling inland resources, this may be an important beneficial use. In many cases, dredged material consists of a mixture of sand and clay fractions, which requires some type of separation process. Dewatering may also be required because of high water content.

80. Depending on the sediment type and processing requirements, dredged material may be used as: concrete aggregates (sand and gravel); backfill material or in the production of bituminous mixtures and mortar (sand); raw material for brick manufacturing (clay with less than 30 per cent sand); ceramics, such as tile (clay) pellets for insulation or lightweight backfill or aggregate (clay); raw material for the production of riprap or blocks for the protection of dikes and slopes against erosion (rock, mixture); and raw material for the production of compressed blocks for security walls at military installations and for gated communities and home subdivisions.

Recommended Sediment Types: rock, gravel, sand, silt, clay, mixture

j) Decorative Landscaping Products

81. Dredged material can be blended with recycled residual materials such as glass, gypsum, plastic bottles, and automobile interiors, etc. to manufacture statues, figures, garden benches, stepping patio pavers, plant vases, artificial rocks and water fountains. These products can be used to landscape gardens, backyards, swimming pool environments, monument stones, miniature golf courses, highway rest areas, tourist welcoming centers, zoos, and theme parks such as Disney World.

Recommended Sediment Types: sand, silt, clay, mixtures

k) Topsoil

82. Maintenance dredging in harbours, access channels, and rivers produce mixtures of sand silt, clay and organic matter that can be excellent ingredients for topsoil. Some dredged materials may be excellent topsoil as they are. Other dredged material may require blending with other residual materials such as organic matter (yard waste, wastepaper, storm debris, etc.) and bio-solids (human sewage sludge or animal manure) to manufacture enhanced fertile topsoil. The dredged material may be used to improve soil structure for agricultural purposes. For production of food, uncontaminated material must be used. For other uses, the allowed contaminant level will depend on the use of the topsoil. In some cases, suitable material may be placed in a thin layer directly by pumping. After dewatering, the material is suitable topsoil for seeding and planting.

83. Dewatering may require several years, depending on the granular texture of the dredged material and is influenced by additional substances or by the type of dewatering process. Dredged material from coastal or tidal areas will require special attention to salinity, since most agricultural species cannot tolerate and grow in salty soil. Salinity may be reduced naturally by rain or by the dewatering process. Other uses of topsoil might include using dredged material to cap poor soils or to cover a fill of coarse material (e.g., urban or industrial waste sites). Dredged material can also be used in the manufacture of blended artificial topsoil products. The blended topsoil can be used for athletic fields such as sport fields and ball fields, home landscaping, golf courses, parks, brownfield redevelopment, etc. Required topsoil specifications for a specific use can be met through blending appropriate materials together in specific amounts.

Recommended Sediment Types: sand, silt, clay, mixtures

l) Fish and Wildlife Habitats

84. Dredged material can be used beneficially to enhance or create various wildlife habitats. This may be either incidental to the project purpose or planned. For example, nesting meadows and habitat for large and small mammals and songbirds have been developed on upland or floodplain (seasonally flooded) dredged material placement sites. Numerous examples are available where dredged material has been used to create nesting islands for water birds and waterfowl.

85. Many technical and legal considerations are necessary for the creation of nesting islands. An island can be built where none existed, and vegetation states (bare ground versus sparse herb cover versus tree/shrub habitat) can be managed using periodic dredged material applications. The types of dredged material can be manipulated to provide proper substrates for nests; in that view, softer silts and clays can be capped with sand, shell, and cobbles. The placement of the dredged material can be manipulated to provide the most acceptable habitat characteristics.

86. Upland wildlife habitats are typically dredged material containment areas that are no longer used or have long periods between maintenance dredged material placement. This allows native vegetation to grow and provide food and cover for wildlife. Site management is minimal, but can be intensified to

provide special food crops, overwintering waterfowl feeding areas, and numerous other natural resource opportunities.

Recommended Sediment Types: rock, gravel and sand, consolidated clay, silt/soft clay, mixture

m) Fisheries Improvement

87. Appropriate placement of dredged material can improve ecological functions of fishery habitat. Fishery resource improvement can be demonstrated in several ways. Bottom relief created by mounding of dredged material may provide refuge habitat for fish. Fine-grained sediment transport can be stabilized by planting seagrasses or capping with shell or other coarse dredged material. The seagrasses or shell caps additionally improve fishery habitat.

Recommended Sediment Types: rock, gravel and sand, consolidated clay, silt/soft clay, mixture

n) Wetland Restoration

88. Dredged material has been extensively used to restore and establish wetlands. Where proper sites can be located, wetlands restoration is a relatively common and technically feasible use of dredged material. Wetlands restoration or rehabilitation using dredged material is usually a more acceptable alternative to creation of a new wetland. Many of the natural wetlands in the Mediterranean region are degraded or impacted, or have been destroyed, and the recovery of these wetlands is more important than the creation of new ones. Most former wetlands still have hydric soils, even though the hydrologic characteristics of the site may have been altered. When a new wetland is created, hydric soil conditions, appropriate hydrologic conditions, and wetland vegetation must all be introduced to the site. Creation of a new wetland would also mean replacing one habitat type with another, which is not always desirable. Long-term planning, design, maintenance, and management are necessary to maintain a created wetland.

89. Wetland restoration using dredged material can be accomplished in several ways. [For example, dredged material can be applied in thin layers to bring degraded wetlands up to an intertidal elevation, as has been done extensively in the Mediterranean]. Dewatered dredged material can be used in wind and wave barriers to allow native vegetation to regrow and restore the viability of a wetland. Dredged material sediment can be used to stabilize eroding natural wetland shorelines or nourish subsiding wetlands. Dewatered dredged material can also be used to construct erosion barriers and other structures that aid in restoring a degraded or impacted wetland.

Recommended Sediment Types: consolidated clay, silt/soft clay, mixture

6.5 Decision process for beneficial uses

a) *Contaminant Status of Materials*

90. Evaluating the contaminant status of the dredged material is the first step to determine if the material is acceptable for beneficial use. In general, highly contaminated sediments will not normally be suitable for most proposed beneficial use applications and particularly for proposed wildlife habitat development projects. However, after appropriate examination, testing, and treatment, the material may be classified as suitable. Dredged material from ongoing activities (maintenance dredging) should be re-evaluated periodically to ensure that the sediment contamination level has not worsened since the last dredging cycle. These updated Guidelines provide information related to the assessment of the level of contamination of dredged materials.

b) *Site Selection*

91. Selecting a placement site and choosing a beneficial use are interdependent decision processes. Dredged material may have multiple beneficial use options and there may be several different potential placement sites. Often, the characteristics of the sediments determine or limit the types of sites that may be selected and the beneficial uses that can be achieved. Once a potential use and site have been identified, various implications should be assessed such as technical feasibility, environmental acceptability, cost/benefits, and legal constraints.

c) *Technical Feasibility*

92. The technical feasibility of implementing a particular beneficial use at a designated site must be evaluated. Various constraints must be considered, such as pumping distance, water depth, access, etc. If technical feasibility constraints will not allow the proposed beneficial use and/or selected site, then alternate beneficial uses or disposal options must be pursued.

d) *Environmental Acceptability*

93. Before any substantial work can be undertaken, the environmental impact prior, during, and subsequent to construction of the proposed project must be investigated. An Environmental Impact Assessment (EIA) and/or impacts hypothesis should be performed on all projects. The chosen beneficial use options may be pursued if it is concluded that the environmental effects will not be significantly harmful. Permission to undertake the dredged material placement may be denied if the proposed work is likely to have any significant adverse environmental effects.

e) *Cost/Benefit*

94. After one or more potential beneficial use options have been identified and the engineering methods have been defined, estimated costs and benefits should be analysed. The costs are usually estimated by standard methods. Options for beneficial use may lower the cost for disposal of dredged material in many instances, but increase costs in other scenarios. Costs are frequently lower when distances from dredging site to placement site are reduced. In cases with higher costs, the increase may be more than offset by the value of the benefits. Although difficult to quantify, intangible benefits should always be taken into account when assessing overall costs and benefits. These benefits may include improved habitat, aesthetic enhancement, a more viable local community, and other benefits.

f) *Legal Constraints*

95. Early and concentrated coordination between relevant authorities, e.g. local interest groups, and environmental protection agencies is mandatory. Some beneficial use options or sites selected may be prohibited or rendered inappropriate by law or regulation.

6.6. Characteristics of the dumping site and method of deposit

96. The selection of a site for dumping at sea does not only involve the consideration of environmental parameters, but also economic and operational feasibility.

97. In order to be able to assess a new dumping site, basic information on the characteristics of the dumping site have to be considered by national authorities at a very early stage of the decision-making process.

98. For the purpose of studying the impact, this information should include the geographical coordinates of the dumping area (latitude, longitude), the distance to the nearest coastline as well as proximity of the dumping area to the following:

a) recreational areas;
b) spawning, recruitment and nursery areas of fish, crustaceans and molluscs;
c) known migration routes of fish or marine mammals;
d) commercial and sport fishing areas;
e) mariculture areas;
f) areas of natural beauty or significant cultural or historical importance;
g) areas of special scientific, biological or ecological importance;
h) shipping lanes;
i) military exclusion zones;

99. Engineering uses of the seafloor (e.g. potential or ongoing seabed mining, undersea cables, desalination or energy production sites).

100. The dumping of dredged material should not interfere with nor devalue legitimate commercial and economic uses of the marine environment. The selection of dumping sites should take into account the nature and extent of both commercial and recreational fishing, as well as the presence of aquaculture areas, spawning, nursery and feeding areas.

101. In selecting dumping sites, the habitats of rare, vulnerable or endangered species must be avoided, taking into account the preservation of the biodiversity.

102. In view of uncertainties regarding in the diffusion of marine contaminants giving rise to transboundary pollution, dumping of dredged material in the open sea should be prohibited.

103. For dredged materials, the only data to be considered for this purpose should include information on:

- disposal method (e.g. vessels, hopper discharge; and other controlled methods);
- dredging method (e.g. hydraulic or mechanical), having regard to Best Environmental Practice (BEP).

104. For the evaluation of dispersal characteristics, the use of mathematical diffusion models requires the collection of certain meteorological, hydrodynamic and oceanographic data. In addition, data on the speed of the vessel dumping the material and the rate of dumping should also be made available.

105. The basic assessment of a site, whether a new or existing includes the consideration of possible effects that might arise due to the increase in certain constituents or to interaction (e.g. synergistic effects) with other substances introduced in the area, either through other dumping, input from rivers, discharges from coastal areas, exploitation areas, maritime transport, or through the atmosphere.

106. The existing stress on biological communities as a result of such activities should be evaluated before any new or additional dumping operations are conducted.

107. The possible future uses of resources and amenities in the sea receiving area should be kept in mind.

108. Information from baseline and monitoring studies at existing dumping sites will be important in the evaluation of any new dumping activity at the same site or nearby.

6.7. General considerations and conditions: Nature, prevention and minimization of the impact of disposal of dredged material

109. Particular attention should be given to dredged material contaminated by hydrocarbons and containing substances that have a tendency to float following re-suspension in the water column. Such

materials should not be dumped in a manner or at a location which may interfere with fishing, shipping, amenities or other legitimate uses of the sea.

110. In addition to toxicological effects and bioaccumulation of the constituents of dredged material, other potential impacts on marine life should be considered, such as:

a) alteration of the sensorial and physiological capacities and the behaviour of fish in particular in respect of natural predators;
b) nutrient enrichment;
c) oxygen depletion;
d) increased turbidity;
e) modification of the sediment composition and blanketing of the sea floor.

Physical impact

111. All dredged materials, whether or not contaminated, have a significant physical impact at the point of disposal. This impact includes covering of the seabed and a localised increase in the levels of suspended solids.

112. The physical impact may also extend to zones outside the dumping zone as such, resulting from the forward movement of the dumped material due to wave and tidal action and residual current movements, especially in the case of fine fractions.

113. In relatively enclosed waters, oxygen-consuming sediments (e.g. organic carbon-rich) could adversely affect the oxygen regime of receiving systems. In the same way, dumping of sediments with high levels of nutrients may significantly affect the nutrient fluxes and, subsequently, in extreme cases, contribute significantly to the eutrophication of the receiving zone.

Chemical impact

114. The chemical impact of dredged material disposal on the marine water quality and the marine biota, is mainly from the dispersion of pollutants in association with suspended particles, and the release of pollutants from the dumpsite sediments.

115. The binding capacity of contaminants may vary considerably. Contaminant mobility is dependent upon several factors among which are chemical form of contaminant, contaminant partitioning, type of matrix, physical state of the system (e.g. pH ,TE), waterflow, suspended matter (organic matter), physico-chemical state of the system, type of interactive processes, such as sorption/desorption - or precipitation/dissolution - mechanisms, and biological activities.

Bacteriological impact

116. Bacteriologically, dredging activities and dumping of dredged material may involve a resuspension, of sedimentary microorganisms, particularly faecal bacteria, which are trapped in the sediment. Studies carried out show that, in particularly on dredging sites, there is a significant correlation between turbidity and concentrations of germs tested (faecal coliforms, faecal streptococci).

Biological impact

117. The immediate biological consequence of this physical impact includes smothering of benthic flora and fauna in the dumping area.

118. Nevertheless, in some instances, after dumping activities stop, there may be a modification of the ecosystem, in particular when the physical characteristics of the sediments in the dredged material are very different to those in the receiving zone.

119. In certain special circumstances, disposal may interfere with migration of fish or crustaceans (e.g. if dumping is in the coastal migration path of crabs).

120. In other respects, the chemical pollution impact resulting from the dispersion of pollutants associated with suspended matter, and from the contaminants "relargage" from the sediments which are accumulated on the dumping site, can induce a change in the composition, biodiversity and abundance of benthic communities.

Economic impact

121. An important consequence of the physical presence of dumping of dredged material is interference with fishing activities and, in some instances, with navigation and recreation. The former concerns both the smothering of areas that may be used for fishing and interference with fixed fishing gear; shoaling following dumping can lead to navigational hazards and clay or silt deposition may be harmful in recreational areas. These problems can be aggravated if the spoil is contaminated with bulky harbour debris such as wooden beams, scrap metal, pieces of cable etc. that according the Regional Plan for the Marine Litter Management in the Mediterranean should be retired prior disposal at sea.

Approaches to management

122. This section deals only with management techniques to minimise the physical effects of disposal of dredged material. Measures to control the contamination of dredged materials are covered in other sections of these guidelines.

123. The key to management lies in careful site selection and assessment of the conflict between marine resources, the marine environment and activities. These notes are intended to supplement these considerations.

124. To avoid excessive use of the seabed, the number of sites should be limited as far as possible and each site should be used to the maximum extent possible without interfering with navigation (sand-shoals formation).

125. All measures should be taken to allow recolonization to take place once deposition stops.

126. Effects can be reduced by ensuring as far as possible that the sediments in the dredged material and receiving area are similar. Locally, the biological impact may be further reduced if the sedimentation area is naturally subject to physical disturbance (horizontal and vertical currents). Where this is not possible, and the materials are clean and fine, a deliberately dispersive style of dumping should be utilised so as to limit blanketing to a small site.

127. With capital and maintenance dredging, the material may be different in character to the sediments at the receiving site and re-colonisation may be affected. Where bulky material such as rock and clay are deposited, there may be interference with fishing activity, even in the long term.

128. Temporal restrictions on dumping activities may have to be imposed (for example tidal and seasonal restrictions). Interference with fish or crustacean migration or spawning or with seasonal fishing activities may be avoided by imposing a calendar for dumping operations. Trench digging and refilling activities may also interfere with migratory patterns and similar restriction measures are needed.

129. Where appropriate, disposal vessels should be equipped with accurate positioning systems for example, satellite systems. Disposal vessels should be inspected and operations controlled regularly to ensure that the conditions of the dumping permit are being observed and that the crew is aware of its responsibilities under the permit. Ships' records and automatic monitoring and display devices (e.g. black-boxes), where these have been fitted, should be inspected to ensure that dumping is taking place at the specified dumping site.

130. Where solid waste is a problem, it may be necessary to specify that the disposal vessel (or dredger) is fitted with a grid to facilitate removal for disposal (or recovery) on land, rather than being dumped at sea.

131. Monitoring is an essential component of management action (see Part B).

7. Confined disposal

132. Confined disposal means that the dredged material is placed in an engineered containment structure, that is, within dikes or bunds, or in natural or constructed pits, or borrow pits. This isolates the material from surrounding waters or soils during and after disposal. Other terms used in the literature for this type of disposal include “confined disposal facility" (CDF), “diked disposal site” and “containment area”. CDFs may be constructed in open waters (known as island CDFs), at near-shore sites or on land. The function of CDFs is to retain the dredged material solids whilst releasing the carrier water. For facilities receiving contaminated material, an additional objective is to provide the efficient isolation of contaminants from the surrounding area. To achieve this, depending on the degree of intended isolation, CDFs may be equipped with a complex system of control measures such as surface covers and liners, treatment of effluent, surface runoff and leachate.

8. Treatment technologies

Definition

133. Treatment is defined as the processing of contaminated dredged material to reduce its quantity or to reduce the contamination. Treatment generally refers to removed dredged material, since treatment in situ is not usually an option. The quality of the sediment defines whether a treatment is feasible or not. In most cases the content of heavy metal and organic contaminants is primarily related to grain size. In general the finer the particles and the higher the content of organic matter are in the sediment, the higher the potential for contamination is. It is important to find realistic solutions for treating dredged material based on site- specific conditions and type of dredged material.

Treatment technologies

134. The main treatment technologies available include separation, dewatering, thermal immobilisation and bioremediation. Simple technologies such as sand separation, ripening and stabilisation can be applied if the material is not heavily contaminated. More advanced technologies such as immobilisation may be required to treat heavily contaminated sediments. Technology is available for all kinds of treatment processes, however treatment costs should be considered within the cost- benefit analysis of each case, in particular when there is contamination, which requires stabilization or removal that increases its costs.
More detailed information on treatment technologies can be found at www.PIANC.org

89 Best Environmental Practices for dredging and dredged material management

Introduction

135. A dredger is a piece of equipment which can dig, transport and dump a certain amount of underwater laying soil in a certain time. Dredging equipment can be divided in Mechanical and Hydraulic Dredgers, depending on the way that the soil is excavated.

(a) Digging
Hydraulic digging make use of the erosive working of a water flow. For instance, a water flow generated by a dredge pump is lead via suction mouth over a sand bed. The flow will erode the sand bed and forms a sand-water mixture before it enters the suction pipe. Hydraulic digging is mostly done with special water jets. Hydraulic digging is mostly done in cohesionless soils such as silt, sand and gravel. Mechanical dredges are characterized by the use of some form of bucket to excavate and raise the bottom material. Mechanical dredges may be classified into two subgroups by how their buckets are connected to the dredge: wire rope-connected (clamshell or dragline) and structurally connected (a backhoe). Mechanical diggingis apply to cohesive soils.

(b) Transport
The transport of the dredged soil can be also done hydraulically or mechanically, either continuously or discontinuously.

(c) Deposition
Deposition of soil can be done in simple ways by opening the grab, turning the bucket or opening the bottom doors in a ship. Hydraulic deposition happens when the mixture is flowing over the reclamation area. The sand will settle while the water flows back to sea or river.

136. Dredgers can have the aforementioned three functions integrated or separated. The choice of the dredger for executing a dredging operation depends not only on the above mentioned functions but also from other conditions such as the accessibility to the site, weather and wave conditions, anchoring conditions, required accuracy etc.

More detailed information on dredgers can be found at http://www.dredging.org/media/ceda/org/documents/resources/othersonline/vlasblom1-introduction-to-dredging-equipment.pdf]

Best Environmental Practices

137. The applicability of BEPs is generally varying according to the particular circumstances of each dredging operation and it is clear that different approaches may then be appropriate. Generally, the objectives of BEPs are to:

(a) (Minimize the impacts of dredging operation on the marine ecosystems
(b) Keep volume of dredged material minimal
(c) Optimize dredging operations management through accurate survey systems
(d) Improve sediment quality

138. Optimization of the quantities for deposit:

A. Minimize the impacts of dredging

Minimizing the impacts in reducing the increase in turbidity and minimizing oxygen depletion

<u>Proposed BEP</u>:
(a) use excavation tools /dredger heads appropriate to minimize turbidity
(b) use silt screens/shields
(c) minimize overflow by e.g. recirculation of overflow water
(d) use specially designed dredgers to dredge contaminated sediments

(e) avoid the use of dredgers which introduce large amounts of suspended sediments into the water column where this may lead to problems with oxygen depletion or contamination e.g. agitation dredgers
(f) avoid periods when dredging induced turbidity will lead to unacceptable reductions in oxygen levels due to high temperatures.

B. Keep volume of dredged material minimal

To this aim, operators would consider the following:

a. Minimize need for dredging such as:

i. *in fluid mud areas: introduce the concept of Navigable depth based on:*
(a) physical and chemical evaluation of the sediment (including rheometry and densitometry)
(b) full scale trials

Proposed BEP:
Dredging only the amount of material required for maintaining a particular density level to allow navigation. This may require e.g. continuous underway measurement of sediment density by using a nuclear transmission gauge or measurement of shear forces.

ii. in areas with sandy waves.

Proposed BEP:
Selective dredging of sand waves and other mobile sand structures

iii. hydraulic engineering

Proposed BEP:
Use of hydraulic structures to reduce sedimentation
iv. *accurate monitoring of dredged depths at an appropriate frequency*

Proposed BEP:
Accurate positioning systems e.g.:
(a) microwave systems
(b) radio wave technology
(c) differential Global Positioning System (DGPS)
(d) apply rapid survey equipment
(e) continuous measurement systems
(f) echo sounders
(g) swath/multi beam systems

C. Optimization of dredging operations management through accurate survey systems

i. *availability of survey data on board*

Proposed BEP:
(a) online visualization of updated bathymetric charts, including topographic data, coastlines, deposit areas, dredge position, dredge head position
(b) tidal information

ii. *process evaluation*

Proposed BEP:

(a) visualization/evaluation of dredged tracks/profiles/zones
(b) dredging intensity chart
(c) in case of muddy material, sand and gravel: establish optimum overflow time by analysis of load diagrams

iii. *Improve dredging process, through*

i. *effective dredging process control*

Proposed BEP:

(a) Continuous on-line measurements and presentation e.g. of area, heading, speed of the dredgers and position of the suction head/buckets/cutter/backhoe/grab/ wheel/...
(b) measurement of mixture velocity and concentration
(c) measurement of macro production (load diagram)
(d) hopper-measurement system monitoring the filling process

ii. *output improving techniques*

Proposed BEP:

(a) best suited suction head/cutters wheel/ backhoe/buckets
(b) submerged dredge-pumps
(c) degassing installations

iii. *selective dredging techniques*

Proposed BEP:

(a) selective dredging to e.g. separate contaminated material

D. Improve sediment quality

Improvement of sediment quality through an in situ operation before dredging and after deposit and improvement of physical aspects (cohesion, consistency, density) of dredged material

Proposed BEP in situ before dredging:

(a) where relevant, increase sediment density by physical means e.g. vibration or mechanical separation

Proposed BEP during the dredging process:

(a) hydro cyclones for separation of granulometric fractions
(b) flotation
(c) dewatering (under development) (consider potential problems with process water and associated contaminants e.g. re- circulation will reduce problems)

PART B MONITORING OF DREDGED MATERIAL DUMPING OPERATIONS

1. Definition

139. In the context of assessing and regulating the environmental and human health impacts of dredged material dumping operations, monitoring is defined as all measures whose purpose is to determine, from the repeated measurement of a contaminant or an effect, whether direct or indirect, of the introduction of this contaminant into the marine environment, the spatial and temporal modifications undergone by the receiving zone as a result of the activity under consideration.

140. It should be noted that the provisions of Part B cover all dredged material operations at sea.

2. Rationale

141. Monitoring of dredged material dumping operations is generally undertaken for the following reasons:

(a) to establish whether the dumping permit conditions have been respected - compliance monitoring - and consequently have, as intended, prevented adverse effects on the receiving area as a consequence of dumping;
(b) to improve the basis on which permit applications are assessed by improving knowledge of the field effects of major discharges which cannot be directly estimated by a laboratory evaluation or from the literature;
(c) to provide the necessary evidence to demonstrate that within the framework of the Protocol the monitoring measures applied are sufficient to ensure that the dispersive and assimilative capacities of the marine environment are not exceeded, and so dumping operations do not cause damage to the environment and deteriorate GES.

3. Objectives

142. The purposes of monitoring are to determine contaminant levels in all sediments above the lower reference threshold in paragraph 24(b) of the guidelines and in bio-indicator organisms, and the biological effects and consequences for the marine environment of the dumping of dredged material and, ultimately, to help managers to combat exposure of organisms to dredged materials and associated contaminants.

143. Whenever possible, the monitoring programme should be aligned with the current MEDPOL monitoring programmes for the Ecological Objectives 5, 8, 9, and 10, in line with the Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Sea and Coast and Related Assessment Criteria set out in Decision IG. 22/7 of the COP 19.

4. Strategy

144. Monitoring operations are expensive since they require considerable resources both to carry out measurement and sampling programmes at sea and the subsequent analytical work on the samples. In order to approach the monitoring programme in a resource-effective manner, it is essential that the programme has clearly defined objectives, that the measurements made can meet those objectives, and that the results are reviewed at regular intervals in relation to the objectives.

145. Since the effects of dredged material dumping are likely to be similar in many areas, there appears to be little justification for monitoring all sites, particularly those receiving small quantities of dredged material. It would be more effective to carry out more detailed investigations at a few carefully chosen sites based on risk-based approach e.g. those subject to large inputs of dredged material) in order to obtain a better understanding of the processes and effects involved.

146. This is particularly the case for zones which present the same physical, chemical and biological characteristics, or nearly the same characteristics, for which there is strong presumptive evidence that the effects of dredged material dumping are similar, and it is very difficult to justify monitoring of all sites on scientific and economic grounds, particularly for those receiving small quantities of dredged material (e.g. less than 25,000 tons per year).

5. Impact Hypothesis

147. In order to establish such objectives, it is first necessary to derive an impact hypothesis describing predicted effects on the physical, chemical and biological characteristics both of the dumping zone and of the surrounding zones. The impact hypothesis forms the basis for defining the field monitoring programme.

148. The aim of an impact hypothesis is to provide, on the basis of the available information, a concise scientific analysis of the potential effects of the proposed operation on human health, living resources, marine life, amenities and other legitimate uses of the sea. For this purpose, an impact hypothesis should incorporate information on the characteristics of the dredged material and on conditions at the proposed dumping site. It should encompass both temporal and spatial scales of potential effects.

149. One of the main requirements of the impact hypothesis is to produce criteria which describe the specific environmental effects of dumping activities, taking into account the fact that such effects have to be avoided outside the designated dredging and dumping zones (see Part A, Section 3).

6. Preliminary Evaluation

150. The preliminary evaluation should be as comprehensive as possible. The primary areas of potential impact should be identified as well as those considered to have the most serious consequences for human health and the environment. Alterations to the physical environment, risks to human health, devaluation of marine resources, and interference with other legitimate uses of the sea are often seen as priorities in this regard.

151. The expected consequences of dumping could be described in terms of the habitats, processes, species, communities and uses affected by the dumping in line with GES definitions and targets. The precise nature of the predicted change, response, or interference (effect) could then be described. The GES and the effect should be described (quantified) together in sufficient detail to eliminate any doubt as to the parameters to be measured during post-operational field monitoring. In the latter context, it might be essential to determine "where" and "when" the impacts can be expected.

7. Reference Baseline

152. In order to develop an impact hypothesis, it may be necessary to conduct a baseline survey and checking the GES's values which describe not only the environmental characteristics, but also the variability of the environment. It may also be helpful to develop sediment transport, hydrodynamic and other mathematical models, to determine the possible effects of dumping.

153. Where either physical or chemical effects at the seabed are expected, it will be necessary to examine the benthic community structure in areas where the dredged material disperses. In the case of chemical effects, it may also be necessary to examine the chemical quality of the sediments and the biota (including fish), in particular the major pollutant contents.

154. In order to assess the impact of the proposed activity on the surrounding environment, it will be necessary to compare the physical, chemical and biological quality of the affected areas with reference sites located away from dredged material dumping pathways and with similar physical and biological

characteristics with the affected areas. Such areas can be identified during the early stages of the impact assessment.

8. Impact Hypothesis Verification: Defining the Monitoring Programme

155. The measurement programme should be designed to ascertain that physical, chemical and biological changes in the receiving environment are within baseline survey values and don't affect adversely the achievement or maintenance of GES.

156. The measurement programme should be designed to determine:
(a) whether the zone of impact differs from that projected; and,
(b) whether the extent of changes outside the zone of direct impact is within the scale predicted.

157. The first question can be answered by designing a sequence of measurements in space and time that circumscribe the projected zone of impact to ensure that the projected spatial scale of change is not exceeded.

158. The second question can be answered by making physical, chemical and biological measurements that provide information on the extent of change that occurs outside the zone of impact, after the dumping operation takes place (verification of a null hypothesis). Then, before any programme is drawn up and any measurements are made, the following questions should be addressed:

(a) what testable hypothesis can be derived from the impact hypothesis?
(b) what exactly should be measured to test these impact hypotheses?
(c) in what compartment or at which locations can measurements most effectively be made?
(d) for how long should measurements continue to be made to meet the original aim?
(e) what should be the temporal and spatial scale of the measurements made?
(f) how should the data be processed and interpreted?

159. It is recommended that the choice of contaminants to be monitored should depend primarily on the ultimate purposes of monitoring. It is definitely not necessary to monitor regularly all contaminants at all sites and it should not be necessary to use more than one substrate or effect to meet each aim.

9. Monitoring

160. The dumping of dredged material has its primary impact at the seabed. Thus although a consideration of water column effects cannot be discounted in the early stages of monitoring planning, it is often possible to restrict subsequent monitoring to the seabed.

161. Where it is considered that effects will be largely physical, monitoring may be based on remote methods such as side-scan sonar, to identify changes in the characteristics of the seabed, and bathymetric techniques (e.g. echo sounding) to identify areas of dredged material accumulation. Both these techniques will require a certain amount of sediment sampling to establish ground-truth. In addition, multispectral scanning can be used for monitoring the dispersion of suspended material (plumes, etc.) during the disposal operations.

162. Tracers may also be proved useful in following the dispersal of the dredged material and assessing any minor accumulation of material not detected by bathymetric surveys. Where, in relation to the impact hypothesis, either physical or chemical effects at the seabed is expected, it will be necessary to examine the benthic community structure in areas where the dredged material disperses. In the case of chemical effects, it may also be necessary to analyse the possible bio accumulation of pollutants (including fish).

163. The spatial extent of sampling will need to take into account the size of the area designated for dumping, the mobility of the dumped dredged material and water movements which determine the direction and extent of sediment transport. It should be possible to limit sampling within the dumping site itself if effects in this area are considered to be acceptable and their detailed definition unnecessary. However, some sampling should be carried out to aid the identification of the type of effect which may be expected in other areas and for scientific purposes.

164. The frequency of surveying will depend on a number of factors. Where a dumping operation has been going on for several years, it may be possible to establish the effect at a steady state of input and repeated surveys would only be necessary if changes are made to the operation (quantities or type of dredged material dumped, method of disposal, etc.). If it is decided to monitor the recovery of an area which is no longer used for dumping dredged material, more frequent measurements might be needed.

10. Notification

The Contracting Parties should inform the Organization of their monitoring activities. Concise reports on monitoring activities should be prepared and transmitted to the Organization as soon as they are available, in conformity with Article 26 of the Barcelona Convention and the Integrated Monitoring and Assessment Programme adopted by COP 19 (Decision IG22/7).

11. Feedback

165. Information gained from field monitoring (and/or other related research) can be used to:

(a) modify or, in the best of cases, terminate the field monitoring programme;
(b) modify or revoke the permit;
(c) serve as a basis to improve the permitting system refine the basis on which applications for permits are assessed.

ANNEX I
ANALYTICAL REQUIREMENTS FOR THE ASSESSMENT OF DREDGED MATERIAL

Analytical Requirements for the Assessment of Dredged Material

1. This Annex amplifies the analytical requirements set out in paragraphs 50-52 of the Updated Guidelines on Management of Dredged Material.

2. Evaluations of dredged material are most efficiently conducted following a tiered process that begins with collecting existing relevant information, sediment chemistry data, and results from simple screening approaches. The evaluation then progresses, as needed, to more detailed assessments where information from multiple lines of evidence is collected to reach conclusions about contaminant exposure, effects and, ultimately, the risks posed by the disposal of dredged material into the sea (PIANC 2006). The term line of evidence is commonly used to refer to broadly-defined categories of information, physical, chemical and biological data, e.g. sediment chemistry, toxicity test data, and benthic community survey results.
The recommended sequence of tiers is as follows:

- the physical properties;
- the chemical properties;
- the biological properties and effects.

3. At each tier it will have to be determined whether there is sufficient information to allow a management decision to be taken or whether further analysis is required. Further information determined by local circumstances can be added at each tier.

4. As a preliminary to the tiered analysis scheme, information required under Part A Section 4 (par. 32) of the guidelines will be available. In the absence of appreciable pollution sources and if the visual determination of sediment characteristics leads to the conclusion that the dredged material meets one of the exemption criteria under paragraphs 39-40 of the guidelines, the material will not require further analysis.

5. It is important that, at each stage, the assessment procedure takes account of the method of analysis.

6. Analysis should be carried out on the non-coarse fraction sediment (less than 2 mm).

Tier I: PHYSICAL PROPERTIES

7. In addition to the preliminary assessment of the characteristics of the sediments required by paragraph 32 of these guidelines, the basic physical characteristics required are the amount of material, particle size distribution, other geotechnical attributes and mineralogical source and color of the sediment.
It is strongly recommended that the following determinations be carried out:
• grain size analysis
• percentage of solids (dry matter)
• density/specific gravity
• organic matter (as total organic carbon)

Tier II: CHEMICAL PROPERTIES

Primary group list:

8. In all cases where chemical analysis is required, the concentrations of the following trace elementsshould be determined:

Arsenic (As)
Cadmium (Cd)
Chromium (Cr)
Copper (Cu)
Lead (Pb)
Mercury (Hg)
Nickel (Ni)
Zinc (Zn)

9. In certain cases, the analysis may also include other pollutants. In the case of mercury, special attention should be paid to speciation.

10. When examining the toxicity of contaminated dredged sediment, the analysis should be carried out also onthe water phase. Lastly, the total organic carbon should be measured.

11. With regard to organic pollutants, the sum of PCB congeners IUPAC numbers 28, 52, 101, 118, 138, 153 and 180, should be analyzed. If local circumstances so require, the analysis should be extended to other congeners.

12. The polycyclic aromatic hydrocarbons (PAH) (sum of 16PAH or sum of 9 as a subgroup including at least the following, but not limited to: anthracene; benzo[a]anthracene; benzo[ghi]perylene;benzo[a]pyrene;chrysene; fluoranthene; indeno[1,2,3-cd]pyrene; pyrene; phenanthrene)) and the tri-butyl tin compounds (TBT) and their degradation products should also be measured.
As a minimum requirement, national action levels need to be established for the primary list above.

13. The measurement of PCB, PAH and TBT will not be necessary when:

- sufficient information from previous investigations indicates the absence of contamination ;
- there are no known sources (point or diffuse) of contamination nor historic inputs;
- the sediments are predominantly coarse; and
- the levels of total organic carbon are low.

Secondary group list:

14. Based upon local information on sources of contamination (point or diffuse sources) or historic inputs, other determinants may need to be measured for instance:
Other chlorobiphenyls
organophosphorus pesticides;
organochlorine pesticides;
polychlorinated dibenzodioxins (PCDD);
polychlorinated dibenzofurans (PCDF);
Petroleum hydrocarbons C10, C40
Phthalates (DEHP and optionally - DBP/BBP)
Tri-phenyl tin (TPhT)
Other anti-fouling agents

In deciding which additional individual organic contaminants to determine, reference should be made to existing priority substance lists, such as those prepared by the EU (as applicable).

Tier III: BIOLOGICAL PROPERTIES AND EFFECTS

15. In a significant number of cases the physical and chemical properties do not allow the biological impact to be measured directly. Moreover, they do not adequately identify all the physical disturbances nor constituents associated with sediments present in the dredged material.

16. If the potential impact of the dredged material to be dumped cannot be adequately assessed on the basis of chemical and physical characteristics, biological measurements should be made.

1. Toxicity bioassays

17. The primary purposes of the biological bioassays is to provide direct measures of effects of all sediment constituents acting together, taking into account their bioavailability. For ranking and classifying the acute toxicity of harbour sediments prior to maintenance dredging, short term bioassays may often suffice as screening tool :

- To evaluate the effects of the dredged material, bioassays for acute toxicity can be carried out with pore water, on elutriate or the whole sediment. In general, a set of 2-4 bioassays is recommended with organisms from different taxonomic groups (e. g. crustaceans, molluscs, polychaetes, bacteria, echinoderms), using species that are considered appropriately sensitive and ecologically relevant and methods have been standardized and validated;
- In most bioassays, survival of the test species is used as an endpoint. Chronic bioassays with sub-lethal endpoint (growth, reproduction, etc.) covering a significant part of the test species life cycle may provide a more accurate prediction of potential impacts of dredging operations, thus are recommended.

18. The outcome of sediment bioassays can be unduly influenced by factors other than sediment associated chemicals. Confounding factors like ammonia, hydrogen sulphide, grain size, oxygen content and pH should therefore be determined during the bioassays.

19. Guidance on the selection of appropriate test organisms, use and interpretation of sediment bioassays is given by e.g. EPA/CE (1991/1994) and IADC/CEDA (1997) or PIANC (2006) while guidance on sampling of sediments for toxicological testing is given by e.g. ASTM (1994).

2. Biomarkers

20. Biomarkers may provide early warning of more subtle (biochemical) effects at low and sustained levels of contamination. Most biomarkers are still under development but some are already applicable for routine application on dredged material (e.g. one which measures the presence of dioxin-like compounds - Murk et al., 1997) or organisms collected in the field (e.g. DNA strand/breaks in flat fish).

3. Microcosm experiments

21. There are short-term microcosm tests available to measure the toxicant tolerance of the community e.g. Pollution Induced Community Tolerance (PICT) (Gustavson and Wangberg, 1995).

4. Mesocosm experiments

22. Because of the costs and time involved these experiments cannot be used for issuing permits but are useful in cases where the extrapolation of laboratory testing to field conditions is complicated or when environmental conditions are very variable and hinder the identification of toxic effects as such. The results of these experiments would be then available for future decisions on permits.

5. Field observations of benthic communities

23. In situ monitoring of benthic communities (fish, benthic invertebrates) in the area of the disposal site can provide important indications of the condition of marine sediments. Field observations give an insight into the combined impact of physical disturbance and chemical contamination. Guidelines on the monitoring of benthic communities are provided by e.g. the Paris Convention, 1992, ICES.

6. Other biological properties

24. Where appropriate, other biological measurements can be applied in order to determine, for example, the potential for bioaccumulation and for tainting.

SUPPLEMENTARY INFORMATION

25. The need for this information will be determined by local circumstances and may form an essential part of the management decision. Appropriate data might include: redox potential, sediment oxygen demand, total nitrogen, total phosphorus, iron, manganese, mineralogical information or parameters for normalising trace metal data (e.g. aluminium, lithium, scandium).

ANNEX II
CONTAMINANT ACTION LEVELS AND THRESHOLDS

Lower and Upper threshold levels adopted by Italy
IMO- LC/SG 40/INF.30,17 February 2017,

	L1	L2
Trace elements	**[mg kg-1] dry weight**	
Arsenic	12	20
Cadmium	0.3	0.8
Chromium	50	150
Chromium VI	2	2
Copper	40	52
Mercury	0.3	0.8
Nickel	30	75
Lead	30	70
Zinc	100	150
Organic contaminants	**[µg kg-1] dry weight**	
Organotin compounds	5 (TBT)	72 (MBT, DBT, TBT)
Σ PCB*	8	60
Σ 2,4′-4,4' DDD	0.8	7.8
Σ 2,4′-4,4' DDE	1.8	3.7
Σ 2,4′-4,4' DDT	1.0	4.8
Chlordane	2.3	4.8
Aldrin	0.2	10
Dieldrin	0.7	4.3
Endrin	2.7	10
a-HCH	0.2	10
b-HCH	0.2	10
γ-HCH (Lindane)	0.2	1.0
Heptachlor epoxide	0.6	2.7
HCB	0.4	50
Petroleum Hydrocarbon C>12	Not available	50000
ΣPAHs16	900	4000
Anthracene	24	245
Benzo[a]anthracene	75	500
Benzo[a]pyrene	30	100
Benzo[b]fluoranthene	40	500
Benzo[k]fluoranthene	20	500
Benzo[g,h,i]perylene	55	100
Crysene	108	846
Indenopyrene	70	100
Phenantrene	87	544
Fluorene	21	144
Fluoranthene	110	1494
Naphtalene	35	391
Pyrene	153	1398
T.E. PCDD,PCDF and Dioxin Like PCBs	2 x 10-3	1 x 10-2

Sum of CB: 28, 52, 77, 81, 101, 118, 126, 128, 138, 153, 156, 169, 180.

Chemical Levels L1 and L2 are elaborated by specifically developed weighted criteria, which allow abandoning the pass-to-fail approach. The chemical classification is based on the development of a Chemical Hazard Quotient (HQ_C) which considers the typology and number of parameters exceeding limits of L1 and L2, the magnitude of such exceedances and type of contaminant (priority or priority hazardous substances, according to Annex II of Directive 2008/105/EC). The sediment quality classification is the integration of chemical and ecotoxicological Hazard Quotients. In general, above

L2, dumping at sea is never allowed.

Lower and Upper threshold levels adopted by Spain

ACTION LEVELS (DW)

CONTAMINANT	N.A. A (Action level A) Limit for disposal at sea in restricted areas	N.A. B (Action level B) Limit for disposal at sea in case that bioassays are not conducted	N.A. C (Action level C) Limit for conducting bioassays
Hg (mg/kg)	0.35	0.71	2.84
Cd (mg/kg)	1.20	2.40	9.60
Pb (mg/kg)	80	218	600
Cu (mg/kg)	70	168	675
Zn (mg/kg)	205	410	1640
Cr (mg/kg)	140	340	1000
Ni (mg/kg)	30	63	234
As (mg/kg)	35	70	280
Σ 7 PCBs (mg/kg) (1)	0.05	0.18	0.54
Σ 9 PAHs (mg/kg) (2)	1.88	3.76	18.80
TBT(3) (mg Sn/kg)	0.05	0.20	1.0

(1) Sum of IUPAC congeners 28, 52, 101, 118, 138, 153 and 180.
(2) Sum of Anthracene, Benzo(a)anthracene, Benzo(ghi)perylene, Benzo(a)pyrene, Chrysene, Fluoranthene, Indeno(1,2,3-cd)pyrene, Pyrene and Phenanthrene).
(3) TBT and their degradation products (DBT and MBT).
According the chemical (and biological characterization if it is done) the dredged material is classified in 3 classes:

- Class A: The concentration of all pollutants below action level A.
- Class B: The concentration of all pollutants below action level B or action level C (only in the case that biological characterization is conducted and the results indicate a negative toxicity).
- Class C: The concentration of one or more pollutants is above action level C or action level B in the case that biological characterization is conducted and the results indicate a positive toxicity). This material is not allow to be dumped and sub be subject to confinement, treatment or management on land.

Lower and Upper threshold levels adopted by France

When, pursuant to the nomenclature decree, analysis is required to assess the impact of the operation on the aquatic environment (or to assess the impact on the aquatic environment of a specific operation):

- the quality of marine or estuarine sediments is assessed relative to the thresholds in field 4.1.3.0 of the nomenclature, for which reference levels N 1 and N 2 are specified in tables II and III;

Table I

Levels relating to trace elements (in mg/kg of dry sediment analyzed on the fraction below 2 mm)		
TRACE ELEMENTS	**LEVEL N1**	**LEVEL N2**
Arsenic	25	50
Cadmium	1,2	2,4
Chrome	90	180
Copper	45	90
Mercury	0,4	0,8
Nickel	37	74
Lead	100	200
Zinc	276	552

Table II

Levels relating to polychlorobiphenyls (PCBs) (in µg/kg of dry sediment analyzed on the fraction below 2		
PCB	**LEVEL N1**	**LEVEL N2**
PCB congener 28	5	10
PCB congener 52	5	10
PCB congener 101	10	20
PCB congener 118	10	20
PCB congener 138	20	40
PCB congener 153	20	40
PCB congener 180	10	20

Table IIbis

Levels relating to polycyclic aromatic hydrocarbons (PAH) (in µg/kg of dry sediment analyzed on the fraction below 2 mm)		
PAH	LEVEL N1	LEVEL N2
Naphthalene	160	1 130
Acenaphthene	15	260
Acenaphthylene	40	340
Fluorene	20	280
Anthracene	85	590
Phenanthrene	240	870
Fluoranthene	600	2 850
Pyrene	500	1 500
Benz[a]anthracene	260	930
Chrysene	380	1 590
Benzo[b]fluoranthene	400	900
Benzo[k]fluoranthene	200	400
Benzo[a]pyrene	430	1 015
Dibenz[a,h]anthracene	60	160
Benzo[g,h,i]perylene	1 700	5 650
Indeno[1,2,3-cd]pyrene	1 700	5 650

Table II ter

Levels relating to tributyltin (TBT) (in µg/kg of dry sediment analyzed on the fraction below 2 mm)		
PARAMETER	**LEVEL N1**	**LEVEL N2**
TBT	100	400

During the analyses, in order to evaluate the quality of discharges and sediments according to the reference levels specified in the above tables, the content to be taken into account is the maximum measured content. However, the following may be tolerated:

1 exceedance for 6 samples analyzed;

2 exceedance for 15 samples analyzed;

3 3 exceedances for 30 samples analyzed;

1 exceedance per batch of 10 additional samples analyzed provided that the measured contents of the samples exceeding the limits remain below 1.5 times the reference levels in question.

ANNEX III
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Appendix 3

Updated Guidelines on Placement for Artificial Reefs

Table of Contents

List of Abbreviations / Acronyms

BEP	Best Environmental Practice
CFCs	Chlorofluorocarbons
CPs	Contracting Parties
COP	Conference of the Parties
FAO	Food and Agriculture Organization of the United Nations
GFCM	General Fisheries Commission for the Mediterranean
GES	Good Environmental Status
IMAP	Integrated Monitoring and Assessment Programme
IMO	International Maritime Organization
MAP	Mediterranean Action Plan
MED POL	Programme for the Assessment and Control of Marine Pollution in the Mediterranean Sea
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
PCBs	Polychlorobiphenyls
RAC/SPA	Regional Activity Centre for Specially Protected Areas
SPAMIs	Specially Protected Areas of Mediterranean Importance
UNEP	United Nations Environment Programme
UNEP/MAP	United Nations Environment Programme/Mediterranean Action Plan

PART -A- REQUIREMENTS OF THE DUMPING PROTOCOL AND BARCELONA CONVENTION

1. Introduction

1. Under Article 4.1 of the Dumping Protocol, the dumping of wastes or other matter into the sea, with the exception of those listed in Article 4.2, is prohibited. Article 3(4b) of the amended Dumping Protocol excludes from the definition of "dumping" the placement of matter for a purpose other than the mere disposal provided that such placement is done in accordance with the relevant provisions of the Protocol.

2. In this regard the 'relevant provisions of the Convention' include the general obligations in Article 4, in particular the obligation that Contracting Parties shall, in accordance with the provisions of the Convention, take all possible steps to prevent and eliminate pollution and to protect the marine area against the adverse effects of human activities so as to safeguard human health and to conserve marine ecosystems and, when practicable, restore marine areas which have been adversely affected (Article. 4.2, 4.3). More specifically, the provisions of Article 5 of the Convention, requires that: "The Contracting Parties shall take all appropriate measures to prevent, abate and to the fullest possible extent eliminate pollution of the Mediterranean Sea Area caused by dumping from ships and aircraft or incineration at sea".

3. Moreover, and at the outset of the adoption of Ecosystem Approach for the conservation of the marine ecosystems of the Mediterranean Sea , the CP's shall consider in their placement activities the Operational objectives and Good Environmental Status definitions relating to trace metals and selected organics, as included in the Decision IG.21/3, adopted by the COP18, in 2013.

4. Furthermore, in accordance with Article 6 of the Dumping Protocol, the permit referred to in Article 5 shall be issued only after careful consideration of the factors set forth in the Annex to the Dumping Protocol.

5. These updated guidelines are prepared in pursuance to Article 3(4, b) of the amended Dumping Protocol of 1996. Their purpose is to assist Contracting Parties in:

(a) Considering the consequences for the marine environment of the placement of artificial reefs on the seabed. Construction of artificial reefs is one example of 'placement' and the guidelines that follow contain elements that are relevant for a wide range of other coastal and offshore developments that have potential to cause adverse effects in the marine environment and that, therefore, should fall under the control of appropriate national authorities.
(b) Fulfilling their obligations relating to the issue of permits for the placement of matter
(c) Transmitting to the Organization reliable data on the input of matter covered by the Dumping Protocol.

6. Data and information provided by national authorities, in the framework of reporting exercise to IMO and MAP based on the respective London and Barcelona Conventions, indicate that the placement of vessels is, besides dredging, one of the major dumping activities in the Mediterranean coastal zones. In addition, considering the scientific findings which indicate a number of drawbacks in the placement of matter, and specifically of vessels, for reefs development and the resulting risks for tourist and ecosystems purpose and working in the framework of precautionary principle, the basic concept of these updated Guidelines is to provide instructions on the placement of artificial reefs for ecosystems enhancement and recommendations to ensure the stability of barges, small fishing boats, tow and tug boats, small ferry boats etc. and, in general all vessels, under 30 m long which are placed at depth of less than 40 m, due to their possible human risks. These updated guidelines provide as well ample information on placement of vessels in general, and clean-up procedures, which should be implemented before placement of all types of vessels to prevent pollution of the marine ecosystems

and to contribute in achieving/maintaining GES in line with the Ecological Objectives 1, 2, 6, 7, 8, 9, and 10 and related GES definitions and targets.

2. Scope

7. Artificial reefs are used in coastal waters in many regions of the world for a range of coastal management applications. The development of artificial reefs in the maritime area is growing. . Among the uses being examined by the scientific community are:

(a) reduction of flooding and coastal erosion due to tidal waves;
(b) providing sheltered anchorages for shipping and small boats;
(c) development of habitat for crustaceans' fisheries (e.g. lobsters), particularly in conjunction with juvenile restocking;
(d) providing substrate for algae or mollusc cultivation;
(e) providing means of restricting fishing in areas where stocks or ecosystems are in need of protection;
(f) creating fish aggregation areas for fisheries, sport anglers and diving;
(g) replacing habitats in areas where particular substrates are under threat;
(h) mitigation for habitat loss elsewhere (e.g. consequence of land reclamation);
(i) production of marine resources.

3. Definitions and Purpose

8. An artificial reef is a submerged structure deliberately constructed or placed on the seabed to emulate some functions of a natural reef such as protecting, regenerating, concentrating, and/or enhancing populations of living marine resources.

9. Objectives of an artificial reef may also include the protection, restoration and regeneration of aquatic habitats, and the promotion of research, recreational opportunities, and educational use of the area.

10. The term does not include submerged structures deliberately placed to perform functions not related to those of a natural reef - such as breakwaters, mooring, cables, pipelines, marine research devices or platforms even if they incidentally imitate some functions of a natural reef.

11. These guidelines address those structures specifically built for protecting, regenerating, concentrating and/or increasing the production of living marine resources, whether for fisheries or nature conservation. This includes the protection and regeneration of habitats.

12. Any authorization for the creation of an artificial reef should identify clearly the purposes for which it may be created.

PART-B- ASSESSMENT AND MANAGEMENT OF PLACEMENT OPERATIONS AT SEA

1. Requirements for Construction and Placement

1.1 Materials

13. Artificial reefs should be built from inert materials. For the purpose of these guidelines, are considered those which do not cause pollution through leaching, physical or chemical weathering and/or biological activity. Physical or chemical weathering of structures may result in increased exposures for sensitive organisms to contaminants and lead to adverse environmental effects.

14. Materials used for the construction of permanent artificial reefs will of necessity be bulky in nature, for example geological material (i.e. rock), concrete or steel. Vessel structures could be placed, under the provisions of the Protocol, provided that the instructions of these updated guidelines are properly implemented.

15. No materials should be used for the construction of artificial reefs which constitute wastes or other matter whose placement at sea is otherwise prohibited.

1.2 Design

16. Modules for artificial reefs are generally built on land unless they consist solely of natural materials placed in an unmodified form. The materials chosen for the construction of artificial reefs will need to be of sufficient engineering strength, both as individual units and as an overall structure to withstand the physical stresses of the marine environment and not break up, potentially causing serious interference problems over a wide area of the seabed. Artificial reefs must also be constructed and installed in such a way as to ensure that the structures are not displaced or overturned by force of towed gears, waves, currents or erosion processes for their objectives to be fulfilled at all times.

17. Artificial reefs should be designed and built in such a way that they could be removed, if required. The design of the artificial reef should strive to achieve its objectives with minimum occupation of space and interference with the marine ecosystems.

1.3 Placement

18. The placement of artificial reefs should be done with due regard to any legitimate activity underway or foreseen in the area of interest, such as navigation, tourism, recreation, fishing, aquaculture, nature conservation or coastal zone management.

19. Prior to placement of an artificial reef, all groups and individuals who may be affected or interested, should be informed on the characteristics of the artificial reef as well as on its location and depth of placement. They should be given the opportunity to make their views known in due time prior to its placement.

20. The location of a proposed artificial reef and the timing of its construction/placement should be carefully considered by the competent body at an early stage in the planning, especially with regard to:

(a) distance to the nearest coastline;
(b) coastal processes including sediment movement;
(c) recreational areas and coastal amenities;
(d) spawning and nursery areas;
(e) known migration routes of fish or marine mammals;
(f) sport and commercial fishing areas;
(g) areas of natural beauty or significance cultural, historical, or archaeological importance;

(h) areas of scientific or biological importance (e.g. key habitats, SPAMIs, protected areas designated under Council Directive 92/43/EEC on the conservation of natural habitats and wild flora and fauna and Council Directive 79/409/EEC on the conservation of birds and under International Conventions or corresponding legislation of other Contracting Parties, Specially Protected Areas cover by the provisions of the Protocol concerning Specially Protected areas and Biological Diversity in the Mediterranean);
(i) shipping lanes or anchorages;
(j) designated marine placement sites;
(k) old military exclusion zones, including closed dumpsites;
(l) engineering uses of the seafloor (e.g. potential or ongoing seabed mining, seabed pipelines; undersea cables, desalination or energy conversion sites).
(m) previous dumping sites in the area

21. While in many cases the aim should be to avoid conflict with the above interests, the management objectives for an artificial reef could be directed specifically at interference, such as discouraging the use of certain types of fishing gear. It will also be important to consider information on the following:

(a) water depths (maximum, minimum, mean);
(b) influence on stratification;
(c) tidal period;
(d) direction and velocity of residual currents;
(e) wind and wave characteristics;
(f) impact on coastal protection;
(g) influence of the structure on local suspended solid concentrations.

22. The competent authority to issue the permit should ensure that the position surveyed, depth and dimensions of the artificial reef is indicated on nautical charts. In addition, the authority should ensure that advance notice is issued to advise mariners and hydrographic surveying services of the placement.

1.4 Assessment of potential effects-impact hypothesis

23. Assessment of potential effects should lead to a concise statement of the expected consequences on the marine environment, i.e., the "Impact Hypothesis". It provides a basis for deciding whether to approve or reject the proposed placement option and for defining environmental monitoring requirements.

24. The assessment for placement should integrate information on matter characteristics, conditions at the proposed placement-site(s), proposed placement techniques and specify the potential effects on human health, living resources, amenities and other legitimate uses of the sea. It should define the nature, temporal and spatial scales and duration of expected impacts based on reasonably conservative assumptions.

25. In constructing an impact hypothesis, particular attention should be given to, but not limited to, potential impacts on amenities, sensitive areas (e.g., spawning, nursery or feeding areas), habitat (e.g., biological, chemical and physical modification), migratory patterns and marketability of resources. Consideration should also be given to potential impacts on other uses of the sea including: fishing, navigation, engineering uses, areas of special concern and value, and traditional uses of the sea.

26. All matter may have a variety of physical, chemical and biological effects. Impact hypotheses cannot attempt to reflect them all. It must be recognized that even the most comprehensive impact hypothesis may not address all possible scenarios such as unanticipated impacts. It is therefore, imperative that the monitoring programme be linked directly to the hypothesis and serve as a feedback mechanism to verify the predictions and review the adequacy of management measures applied to the

placement operation and at the placement-site. It is important to identify the sources and consequences of uncertainty. The only effects requiring detailed consideration in this context are physical impacts on biota.

27. The expected consequences of placement should be described in terms of affected habitats, processes, species, communities and uses. The precise nature of the predicted effect (e.g., change, response, or interference) should be described. The effect should be quantified in sufficient detail so that there would be no doubt as to the variables to be measured during field monitoring. In the latter context, it would be essential to determine "where" and "when" the impacts can be expected. Emphasis should be placed on biological effects and habitat modification as well as physical and chemical change. The following factors should be addressed:

(a) physical changes and physical effects on biota; and
(b) effects on sediment transport.

28. Where the impact hypothesis indicates any transboundary impacts a consultation procedure should be initiated in accordance with Section 2.5.

1.5 Scientific Experiments

29. Trials involving smaller scale[3] placement for scientific purposes may be required before proceeding with a full scale deployment in order to evaluate the suitability of artificial reef and to assess the accuracy of the predictions of its impact on the local marine environment. As the use of artificial reefs develops, scientific experiments may be carried out. In these cases, full justification referred to under section 3 of Part A “Definitions and Purposes” may not be possible or necessary.

1.6 Management and Liabilities

30. Authorisations for constructing artificial reefs should:

(a) specify the responsibility for carrying out any management measures and monitoring activities required and for publishing reports on the results of any such monitoring;
(b) specify the owner of the artificial reef and the person liable for meeting claims for future damage caused by those structures and the arrangements under which such claims can be pursued against the person liable.

2. Requirements for the authorization of placement at sea of matter

2.1 Requirements for a permit application

31. Any application for a permit has to contain data and information specifying:

(a) the purpose for the placement of the artificial reefs,
(b) the impact hypothesis
(c) the types, amounts and sources of the matter to be placed;
[(d) the design – which includes selecting appropriate materials and designing the detailed structure, based both on the purpose of the reef
(d) the location of the placement site(s);
(e) the history of previous placement operations and/or past activities with negative environmental impacts;
(f) the method of placement; and

[3] In the planning phase for a full scale artificial reefs scientists usually carry out small scale placement experiments before proceeding with a full scale deployment in order to evaluate the suitability of the artificial reef and to assess the accuracy of the impacts hypothesis on the local marine environment

(g) the proposed monitoring and reporting arrangements.

2.2 Criteria for the evaluation of a permit application

32. Artificial reefs should only be established if, after due consideration of all environmental costs and socio-economic aspects (e.g. undesirable impacts or alteration), a net benefit can be demonstrated, in relation to the defined objectives. In such assessment of potential effects (which may have to be a formal environmental impact assessment if major impacts cannot be ruled out) the following steps should be followed:

(a) Studies should be carried out that yield the information required to assess:
   i. Possible impacts of the installation of an artificial reef on the indigenous fauna and flora and the environment of the site and the wider surroundings;
   ii. The benefits expected to be obtained from the installation of an artificial reef;
(b) The best alternatives for the design and placement of the artificial reef should be identified. At this stage, the benefits of all options including that of no action should be assessed in relation to their environmental costs and socio-economic aspects ;
(c) Before installing an artificial reef, baseline studies should be conducted to provide benchmark data for the subsequent monitoring of the effects of an artificial reef on the marine environment.

33. Where the comparative assessment reveals that adequate information is not available to determine the likely effects of the proposed placement option, including the potential long-term harmful consequences, then this option should not be considered further. In addition, where analysis of the comparative assessment shows that the placement option is less preferable than other option, a permit should not be issued for the placement.

34. Each assessment should conclude with a statement in support of a decision to either issue or refuse a permit for placement. Opportunities should be provided for public review and participation in the permit evaluation process.

2.3 Conditions for issuing a permit

35. A decision to issue a permit should be based on the elements provided by the preliminary survey. If the characterisation of these conditions is insufficient for the formulation of an impact hypothesis, additional information will be required before any final decision is made with regard to issuing a permit.

36. A decision to issue a permit should only be made where all the impact assessments are complete, taking into account the defined criteria, and where the monitoring requirements have been determined. The conditions set out in the permit should be such as to ensure, in so far as practicable, that environmental disturbance and detriment are minimized, and that benefits are maximized.

37. Regulators should strive at all times to enforce procedures which ensure that environmental changes are as far below the limits of allowable environmental change as practicable, taking into account technological capacities and economic, social and political considerations.
The authority responsible for issuing the permit should take into consideration relevant research findings when specifying permit requirements.

2.4 Supplemental conditions for issuing a permit for an existing placement site

38. The issuing of a permit for placement at a site where past placement activities were carried out should be based on a comprehensive review of results and objectives of existing monitoring programmes. The review process provides an important feedback and informed decision-making

regarding the impacts of further placement activities, and whether a permit may be issued for further placement on site. Furthermore, such a review will indicate whether the field-monitoring programme needs to be continued, revised or terminated.

[2.5 Consultation procedure in case of transboundary impacts

39. With reference to Section 1.4 of Part B and in case the impacts hypothesis indicates any transboundary impacts a consultation procedure should be initiated at least 32 weeks before any planned date of a decision on that question by sending to the Secretariat a notification containing:

(a) an assessment prepared in accordance with Part B to this Guidelines, including the summary in accordance with Part B of these guidelines;
(b) an explanation why the relevant Contracting Party considers that the requirements of Section 1.4 of Part B of these Guidelines may be satisfied;
(c) any further information necessary to enable other Contracting Parties to consider the impacts and practical availability of options for re-use, recycling and placement.
(d) MAP Secretariat shall immediately send copies of the notification to all Contracting Parties.

40. If a Contracting Party wishes to object to, or comment on, the issue of the permit, it shall inform the Contracting Party which is considering the issue of the permit not later than the end of 16 weeks from the date on which the MAP Secretariat circulated the notification to the Contracting Parties, and shall send a copy of the objection or comment to the MAP Secretariat. Any objection shall explain why the Contracting Party which is objecting considers that the case put forward fails to satisfy the requirements of Section 1.4 of Part B of these Guidelines. That explanation shall be supported by scientific and technical arguments. MAP Secretariat shall circulate any objection or comment to the other Contracting Parties.

41. Contracting Parties shall seek to resolve by mutual consultations any objections made under the previous paragraph. As soon as possible after such consultations, and in any event not later than the end of 22 weeks from the date on which the MAP Secretariat circulated the notification to the Contracting Parties, the Contracting Party proposing to issue the permit shall inform the MAP Secretariat of the outcome of the consultations. The MAP Secretariat shall forward the information immediately to all other Contracting Parties.

42. If such consultations do not resolve the objection, the Contracting Party which objected may, with the support of at least two other Contracting Parties, request the MAP Secretariat to arrange an ad hoc meeting as appropriate to discuss the objections raised. Such a request shall be made not later than the end of 24 weeks from the date on which the MAP Secretariat circulated the notification to the Contracting Parties.

43. The Secretariat shall arrange for such an ad hoc meeting to be held within 6 weeks of the request for it, unless the Contracting Party considering the issue of a permit agrees to an extension. The meeting shall be open to all Contracting Parties, the operator of the installation in question and all observers to MAP Secretariat. The meeting shall focus on the information provided in accordance with section 1 of Part B of these Guidelines.

44. The chairman of the meeting shall be MAP Coordinator or a person appointed by MAP Coordinator. Any question about the arrangements for the meeting shall be resolved by the chairman of the meeting.

45. The chairman of the meeting shall prepare a report of the views expressed at the meeting and any conclusions reached. That report shall be sent to all Contracting Parties within two weeks of the meeting.

46. The competent authority of the relevant Contracting Party may take a decision to issue a permit at

any time after:

(a) the end of 16 weeks from the date of dispatch of the copies under paragraph 39 (d) of the consultation procedure, if there are no objections at the end of that period;
(b) the end of 22 weeks from the date of dispatch of the copies under paragraph 39 (d) of the consultation procedure, if any objections have been settled by mutual consultation;
(c) the end of 24 weeks from the date of dispatch of the copies under paragraph 39 (d) of the consultation procedure, if there is no request for an ad hoc meeting;
(d) receiving the report of the ad hoc meeting from the chairman of that meeting.

47. Before making a decision with regard to any permit, the competent authority of the relevant Contracting Party shall consider both the views and any conclusions recorded in the report of the ad hoc meeting, and any views expressed by Contracting Parties in the course of this procedure.

48. Copies of all the documents which are to be sent to all Contracting Parties in accordance with this procedure shall also be sent to those observers who have made a standing request for this to the Secretariat.]

PART-C- PLACEMENT OF VESSELS HULL AND SUPERSTRUCTURE[4]

[For the purpose of these updated guidelines the term vessel applies to the vessel's hull, which is the main body of the vessel and its superstructure, which consists of parts of the vessel that project above her main deck.]

Placement of vessels should not be permitted by competent national authorities before securing that cleaning has been completed, in accordance with requirements under section 4 of the part C of these updated Guidelines.

49. Placement of vessels for the creation of artificial reefs is practiced by growing numbers of CPs in the Mediterranean region. This practice has, in principle, many ecosystems, economic and recreational benefits. Nevertheless, experiences from the Mediterranean region and other part of the world revealed several limitations and drawbacks which make vessels placement practices non beneficial to the marine ecosystems, the economy of coastal municipalities, maritime traffic and creating human health risks. Taking into consideration these facts, these updated guidelines provide recommendations to the CPs to be consider by national relevant authorities before granting a vessel placement permit. It should be read in conjunction with the Art 3(4b) of Dumping Protocol and offer guidance, based on observation and experience, on how to perform vessels placement. In this respect it is highly recommended to consider the provision of other relevant international Conventions (such as Hong Kong Convention, Basel Convention etc.).

1. Benefits

50. Benefits could be summarized, among others, as follows**:**

(a) Vessels make interesting diving locations for both recreational divers and technical deep diving mixed-gas users. Vessels are also regularly utilized as angling sites by recreational fishermen and the charter fishing industry.
(b) Vessels used as artificial reefs, can, alone, or in conjunction with other types of artificial reefs, generate reef-related economic contributions to coastal municipalities.
(c) Steel-hulled vessels are considered durable artificial reef material when placed at depths and orientations that insure stability in major storm events. Large vessels have life spans as artificial reefs that may exceed 60 years, depending on vessel type, physical condition, location of deployment, and storm severity.
(d) Reuse of large steel-hulled vessels as artificial reefs may be more economical than scrapping the vessels domestically.
(e) Vessels, due to high vertical profile, attract both pelagic and demersal fishes. Vertical surfaces produce upwelling conditions, current shadows, and other current speed and direction alterations that are attractive to schooling forage fishes, which in turn attract species of commercial and recreational importance, resulting in increased catch rates for fishermen.
(f) Vessels, like other artificial reef material, can augment benthic structure which locally increases shelter opportunities and reef fish carrying capacity in locations where natural structure is sparse, or create structure which is more preferable or attractive to certain fish species than locally less complex hard bottom.
(g) Steel-hulled vessel reefs that are not well publicized, located far offshore, or otherwise

[4] Pending submission of the legal advice by the Secretariat to the meeting of MAP Focal Points with the view to ensure the the placement of vessel hulls and superstructures for the purpose of artificial reefs is not in contravention with Article 4 of the Dumping Protocol which prohibits the dumping of ships in the Mediterranean Sea area since 2000.

difficult to access for fishing and diving because of depth and currents may, if properly sited, provide important refuge for reef fish species. Such vessels can provide important aggregation, shelter, and residence sites for reef fish species that have been traditionally over-fished.

(h) Vessels under certain conditions may provide habitat for spawning aggregations of some managed reef fishes.

(i) Vessels may provide extensive surface area for epibenthic colonization. This colonization results in the enhancement of lower trophic level biomass at the vessel site.

(j) Under some circumstances, depending on location and season, some vessels may hold greater abundances and higher biomass of fish species, including some recreationally important species (i.e. snappers), than nearby natural reefs.

(k) Vessels may reduce anchor damage and other physical damage by directing a proportion of the reef users away from nearby natural reefs. Similarly, vessels provide diving alternatives to natural reef sites where physical damage to natural reefs through anchor damage, grounding, handling, crawling on, specimen collecting, and spear fishing have accelerated deterioration of natural reefs and their associated fauna.

2. Limitations and drawbacks

51. The literature highlighted number of limitations and drawbacks related to placement of vessels for artificial reefs:

(a) Vessels were originally designed and utilized for purposes other than artificial reef construction. They can be contaminated with pollutants, including: PCBs, radioactive control dials, petroleum products, lead, mercury, zinc, and asbestos. Hazardous wastes and other pollutants are difficult and expensive to remove from ships. Hazardous material itself, once removed must be disposed of under proper guidelines without any damage to the environment.

(b) Damage to private and public property during cleaning operations or subsequent towing, vessels sinking outside of the designated site creating hazards to navigation, and ships damaging natural habitats due to improper deployment or subsequent movement.

(c) Vessel stability during storms is variable. Vessels placed in shallow depths (less than 50 m) are more susceptible to movement during major storm events than vessels placed at greater depths and local oceanographic characteristics should be taken into account.

(d) Damage to the structural integrity of vessels sunk as artificial reefs can also occur from storms. However, it should be noted that natural reefs, and some other less durable types of artificial reef structures have also experienced storm damage. Some vessels that may resist significant hull movement in a storm can still experience substantial structural damage. Loss of structural integrity can increase hazards to divers on artificial reefs by creating a disorienting environment or increasing potential for snagging equipment or for physical injury from jagged metal, etc.

(e) Removal of hazardous materials, pollutants, and other material not authorized for artificial reef disposal under the permit requires additional expense, time, and in some cases special equipment and expertise. The cost to safely place a vessel in the sea as an artificial reef increases as the size of the vessel, number of compartments, void spaces, and overall complexity increase.

(f) Vessels typically provide proportionately less shelter for demersal fishes and invertebrates than other materials of comparable total volume. This is because the large hull and deck surfaces provide few, if any, holes and crevices. This lack of shelter from predation greatly reduces the usefulness of a ship as nursery for the production of fishes and invertebrates. Also, while a high vertical profile can be attractive to pelagic fish species, unless a vessel hull is extensively modified to allow for access, water circulation and light penetration, most of the interior of the vessel is not utilized by marine fishes and macro invertebrates.

(g) Use of vessels for artificial reef can result in conflicts between divers and fishermen and any other legitimate use of the sea. Although such conflicts can occur on natural reefs, there is often preferential use of vessels by divers resulting in domination of some vessel reef sites by diving user groups. This is particularly true in areas with large tourist and resident diving populations that are selectively attracted to vessels sunk in shallow, clear and warm water environments.

(h) The surface of a steel hull is a less ideal surface for colonization by epibenthos than rocks or concrete. Sloughing of steel, due to corrosion, results in loss of epibenthic animals

(i) The placement of vessels has an impact on the integrity of seabed, during the placement operations and their movement during storms

3. Recommendations and Considerations

52. On the basis of the benefits, limitations and drawbacks it is highly advisable to:

(a) The applicant for a vessel placement should ensure the stability of barges, small fishing boats, tow and tug boats, small ferry boats etc. and, in general all vessels under 30 m long which are placed at depth of less than 40 m due to their possible human risks.

(b) Recommend a buffer zone of about 450 m between any natural hard and soft bottom occupied by protected species or habitats and vessels deployed as artificial reef material in depths less than 50 m. This safety buffer is based upon documented movement of vessels, or parts thereof, in storm events. At depths below 50 m but less than 100 m, a buffer distance of a least 100 m is recommended. For the purposes of these guidelines, hard bottom includes living natural reefs such as coral reefs, oyster reefs, worm reefs, and areas of naturally occurring hard bottom or rocky outcrops to which are attached well developed varying biological assemblages such as perennial algal species, and/or such invertebrates as sea fans, bryozoans, sea whips, hydroids, ascidians, sponges, or corals.

(c) Literature and regional experiences have demonstrated that it is possible to have a viable artificial reef program without vessels. It is important for managers to assess their objectives when securing a vessel, since cleaning and towing costs, especially when transboundary transport is involved, can be prohibitive.

(d) With the rapid increase in recreational sport diving activities in some areas, ship deployment in certain areas may have greater value to the diving industry than to the recreational hook and- line fishery. Vessels deployed in shallow water (18-30 m) are especially attractive to recreational SCUBA divers. If the funding source is fishing license revenues, and the site is dominated by divers, this issue should be considered.

(e) If the intent of developing an artificial reef is to provide recreational fishing opportunities with some level of fishing success, while at the same time avoiding user conflict, the combined effect of spear fishing and hook-and-line harvest and liability associated with diver accidents during wreck diving, may lead to a recommendation to sink vessels at greater depths (40 to 100 m).

(f) Consider using only those steel hulled vessels which are designed for operating in heavy sea conditions, such as sea tugs, oil rig re-supply vessels, trawlers, and small freighters, which are all structurally sound, the focus should be on structural and habitat complexity of vessels, rather than strictly vertical height or sheer overall length.

(g) Some contractors or other organizations tasked with cleaning vessels, or their hired laborers and volunteers have historically not always followed proper hazardous materials and other waste handling and disposal, and/or clean up instructions, including in these updated guidelines, due to lack of expertise or training, inadequate facilities, equipment and manpower, desire to reduce project time and expenses, or insufficient guidance or over sight provided by the contract or project manager, and focus on removal of salvageable material to the detriment of meeting other cleaning and preparation objectives.

(h) All petroleum products, both liquid and semi-solid must be removed from tanks on ships with follow-up inspection. It is not sufficient to draw the tanks down and then weld the hatch closed. Experience has demonstrated that corrosion of the metal of the ship will eventually release residual fuel into the environment and that relatively small quantities can trigger regulatory and public relations consequences.

(i) Resistance to a 20-year storm event is a minimum acceptable level of stability. For vessels deployed within approximately 900 m of natural coral reefs, well developed hard bottom communities, or oil and gas infrastructures recommend that the vessel stability requirement at the depth placed increase to resistance to movement in a 50-year storm event.

(j) Avoid the use of explosives to the extent possible in sinking vessels under 45m in length where alternate sinking methods (opening sea cocks, flooding with pumps, opening up temporarily sealed pre-cut holes, etc.) are feasible. If explosives must be used for sinking larger vessels with many watertight compartments, there should be careful placement by experts of the minimal amount of structural cutting explosives necessary to sink the vessel safely and efficiently. The minimization of vessel damage and the avoidance of harm to marine life are important vessel sinking objectives. Potential impacts to marine mammals, turtles, and fishes should be considered

(k) It is important to develop and implement cleaning standards for pollutants known to occur on ships; require testing for PCBs on boats and ships constructed prior to 1975 (when PCB manufacture ended); require an asbestos inspection. Identified asbestos that is secured or encased may be left undisturbed, and in place prior to sinking.

(l) Liability issues must be recognized and addressed by permittees who are required to provide long-term responsibility for materials on their permitted artificial reef sites, including ships. Demonstration of this responsibility could include liability insurance, posting a bond or other indemnifying instrument to ensure resolution of liability issues associated with the towing, cleaning and sinking of ships on state submerged lands. This liability includes damages caused by movement of the materials during storm events.

(m) All constraints that may be placed on sinking a ship (i.e. minimum depth, distance from shore, complexity of vessel that may require additional technical assistance, stability requirements, vessel orientation, cost, time involved in project, etc.) should be reassessed, in order to decide early on whether one or more of these constraints will result in a final outcome that will not be successful in achieving the project’s objectives.

(n) It is recommended to establish a national coordinated reefing plan. Prior to the release of any ships under such a program, the national authority should be encouraged to the maximum extent possible to take all necessary steps to ensure the funding of the cleaning, preparation, towing and sinking of vessels in their entirety as a turnkey project, at a location selected by the state reef program designated to obtain the vessel.

4. Vessels Clean up

53. Suggestions for planning work:

a) Gather Information About the Vessel, ship and Boat

54. Several parts of these Guidelines require that information concerning the vessel, ship and boat be provided to the Designated Authority. If this information is not available, the clean-up organization or

the permit applicant will have to develop some or all of the information, which typically come at a significant cost. As a condition of purchase of the vessel, ship and boat, permit applicants should collect from the owner of the vessel, ship and boat the following information and certificates (issued by competent authorities):

(a) asbestos certificates, indicating that the vessel, ship and boat is asbestos-free, or detailing the location of asbestos remaining in the vessel, ship and boat;
(b) PCB certificates, indicating that the vessel, ship and boat is PCB-free, or detailing the location of PCBs remaining in the vessel, ship and boat;
(c) for warships and naval auxiliaries, an “ammunition-free” certificate issued by defense authorities;
(d) for warships, naval auxiliaries, vessel, ship and boats that have been engaged as research ships, and other vessel, ship and boats that may have carried radioactive materials, a radiation inspection certificate;
(e) a certificate that refrigerants and halons have been removed from shipboard systems;
(f) other certificates relating to removal/addition of equipment, components or products;
(g) information on hazardous materials left in the vessel, ship and boat;
(h) information on exterior hull paint including paint type, detailed technical information on the paint, and date of application;
(i) information on machinery, compartment and tank layout, ideally in the form of a general arrangement drawing or firefighting compartment diagram;
(j) information on the fuels carried and used by the vessel ship and boat;

b) Develop a Work Plan to Reduce Costs

55. The two main operations (salvage and clean-up) will typically overlap and may proceed in parallel in different sections of the vessel, ship and boat. Experience has shown that it is critical, from an economic perspective, to have a comprehensive plan detailing the activities to be undertaken. Failure to develop and use a plan has in the past, led to several repetitions of the same cleaning operations, or inability to salvage certain components due to access issues or lack of time. As funding for projects is usually finite, it is important for the viability of the project that efforts are not being wasted or opportunities missed to generate funds through salvage. The Designated Authority will not weaken the requirements as set forth in the Guideline because the applicant or clean-up contractor has not adequately organized the work. Salvage and clean-up operations that could be considered a success from an economic as well as environmental perspective have required an extensive planning effort.

56. In general terms, salvage operations should come first, aiming to minimize debris and contamination with oils or other products that will have to be cleaned-up at a later stage. Experience indicates that a close link is required between the salvage and clean-up effort. Previous salvage operations that have not considered subsequent clean-up operations have resulted in massive cleaning requirements.

57. Clean-up would typically be the last operation in the continuum of activity. In any given section, clean-up would normally start at the highest part of the compartment or tank and proceed downwards to the bilge.

58. The following general principles have been developed from previous efforts:

(a) deal with the large concentrations of oil and hazardous products early in the operation;
(b) keep compartments clean and make concerted efforts to avoid spillage during salvage and clean-up;

(c) consider removing, instead of cleaning, heavily contaminated machinery and piping;
(d) removal is typically far quicker and allows for less overall effort in clean-up as access is improved and ongoing contamination from drips and seepage is minimized;
(e) maintain a strong project management presence at the site.

c) Maintain Security During Clean-up

59. Security of the vessel, ship and boat and the surrounding site should be addressed in the clean-up and salvage plan. Experience indicates that security issues are not static and need constant attention over the life of the project. However, to assist applicants and ensure the safety, it is recommended that the following issues be addressed:

(a) public safety: Vessel, ship and boat undergoing salvage operations are dangerous sites. The public must be prevented from accidentally or casually accessing the interior of the vessel, ship and boat and the clean-up site.
(b) salvage security: This is closely linked to the public safety issue. Inevitably, some members of the public will actively seek to gain illegal entrance to the site and vessel, ship and boat. This security issue requires constant vigilance and repeated assessment.
(c) -liability insurance should also be considered
(d) -environmental liability: Some of the material removed from the vessel, ship and boat could become a significant environmental liability if it were to be mishandled, disturbed or spilled. Material should not be allowed to accumulate at the site. Personnel involved in clean-up and salvage operations must be aware of environmental due diligence responsibilities.
(e) It is highly recommended that a secure lock-up (for tools, valuable salvage items, items that are potentially hazardous, etc.) be made available.

d) Prepare for Inspections

60. Under normal circumstances the responsible of the Designated Authority will require a minimum of three weeks' notice to arrange an inspection. It is expected that two inspections will be conducted, with all deficiencies being corrected for the second and final inspection. If subsequent inspections are required these will likely involve further expenses being charged directly to the permit applicant.

61. The inspection team will consist of the responsible of the Designated Authority, plus any necessary specialist support staff. The permit applicant should ensure that the senior personnel from the clean-up team, and the salvage team, if it is a different organization, are onsite for the inspection(s). These personnel should accompany the Designated Authority during the inspection to allow full insight into any findings. The Designated Authority may, but is not obliged to, make suggestions concerning the clean-up effort. Where it is possible to correct minor findings during the course of the inspection, the Designated Authority may, if time allows, re-inspect the particular finding.

62. Special attention needs to be given to questions of access and personnel safety. The Designated Authority needs to inspect every part of the vessel, ship and boat without incurring undue personal risk.

e) General notes on salvage and recycling

63. A notable portion of most vessel, ship and boats is normally economically salvageable. Items that have been salvaged and sold intact in previous clean-up and salvage projects include diesel generators and associated equipment, various types of lockers, anchors and chain, watertight hatches and doors, furniture, and certain galley equipment. Valves, especially those of large diameter, are a further

potential source of revenue. Depending on the rated voltage and frequency employed in the vessel, ship and boat, motors may be a further source of revenue. The difference between "used" value and scrap value can be significant. Salvage and clean-up contractors are encouraged to actively seek markets for used equipment and outfit items.

64. Equipment that has no current market may still have scrap value based on the raw material. Commonly found metals that are salvageable include:

(a) Bronze: This metal is typically cast, and is found in propellers, valve bodies, cooler bodies, and various machinery castings.
(b) Brass: Brass is typically found in machined form. Items likely to be found in a vessel, ship and boat include tube plates in coolers, small valves, decorative fittings, flush-deck covers for valves, and various machinery components.
(c) Copper-nickel: Copper-nickel is used extensively in seawater piping systems, and is commonly used as tubing material in coolers and condensers. Both 90-10 (most common) and 70-30 grades have been in use in the marine industry.
(d) Aluminum: Most aluminum is in sheet, plate or stiffener form. It may be found in a wide variety of outfit items including lockers, desks, bunks and shelving. Structural aluminum has been used in some vessel, ship and boats to minimize top weight, and is commonly found in masts and deck-houses.
(e) Copper: Copper is found in electrical cables, small diameter tubing (pressure gauges), motors, generators, and miscellaneous electrical fittings. Copper salvage is generally a break-even process in economic terms.
(f) Stainless Steel: Stainless steel is most commonly employed in sheet or plate form and is found in food preparation and serving areas, medical facilities, upper deck lockers, and some exterior fittings.
Although steel is not generally economical to salvage, in many instances it will be cheaper and more effective overall to remove and recycle steel piping and equipment. This is a particularly effective strategy where the effort to clean the material in-situ is significant, or the material would cause access problems for the clean-up effort.

f) General notes on personnel safety during clean-up and inspections

65. Clean-up and salvage contractors are advised that their activities in the vessel, ship and boat and at the surrounding site will be subject to national requirements.

g) Notes on vessel, ship and boat stability during clean-up and transits

66. Operations associated with salvage, clean up and diver access have the potential to adversely impact vessel, ship and boat stability. This can be an important issue, especially if the vessel, ship and boat have to be moved to its sinking location. Failure to consider intact and damaged stability during operations could result in premature and uncontrolled capsizing and/or sinking of the vessel, ship and boat. This situation is entirely preventable.

67. Organizations embarking on SCUBA diving attraction projects are advised to obtain the services of a naval architect who is provincially registered to practice as a Professional Engineer, to review salvage plans and serve as a stability consultant.

68. Issues that need to be considered during the planning phase include, inter alia:

(a) Weight Removal: Weight removal will impact on the center of gravity, and hence the stability, of the vessel, ship and boat. In general terms, weight removed low in the ship (ballast bars, bilge piping, etc.) has an adverse impact on stability while weight removed high in the ship has a positive impact on stability.

(b) Hull Openings: Hull openings are often required for salvage efforts but they do present a risk of flooding. Hull openings should be well above the water line. Permit applicants must consider carefully hull breaches, especially if the vessel, ship and boat must be moved after hull openings are made.
(c) Natural roll, list, loll, and the possibility of encountering higher sea states must be borne in mind by the permit applicant.
(d) Watertight Integrity: Internal watertight integrity may not be at initial design Guidelines at the time of vessel, ship and boat disposal and is often further compromised by salvage activity.
(e) Free Surface Effects: Free surface may be an issue if fluids are allowed to accumulate in bilges, or if tanks are kept in a partially full condition. Stability of the vessel, ship and boat should be considered as an integral part of the salvage and clean-up plan. The permit applicant must continuously be aware of vessel, ship and boat stability conditions and be prepared to take action to improve vessel, ship and boat stability when required

h) Tank cleaning

69. Here are several accepted and widely used methods to clean fuel and oil tanks. The best method to use will depend on the type of hydrocarbon in the tank, the amount of residue in the tank, and the extent of any hard or persistent deposits and residues. In general, lower quality fuels will require more cleaning effort. Similarly, tanks for dirty or water-contaminated oils will require more cleaning effort.

70. When cleaning tanks, the factors that need to be considered are the Guideline requirements, the machinery and resources available, and the method or facilities available to deal with cleaning residues. It may be necessary to experiment with several cleaning methods to find one that will work in the particular circumstances. Where cleaning is expected to be complex or difficult the permit applicant should consider securing the services of a professional tank cleaning contractor. Options for cleaning tanks include, inter alia:

(a) mechanical cleaning

71. Mechanical cleaning involves mechanical removal of sludge and remaining fluids and wiping down all surfaces with oil absorbent material. Although costly in terms of manpower, it does limit the spread of contamination and minimize production of fluids which are expensive to dispose of.

(b) steam or hot water washing:

72. This method is quite effective, although it requires special equipment and generates large volumes of oily water. If this method is contemplated, the organization should have a plan to deal with the oily water that complies with local regulations and the National Shipping Act. Surfactants (or soaps) are not recommended, as they tend to emulsify any oil present and make the oily water exceptionally difficult to treat. This would likely drive disposal costs higher than necessary. In tanks where deck heads and sides are reasonably free of contamination, pressure washing can cause significant contamination of these otherwise clean surfaces through splashing, misting, and carry-over.

(c) solvent washing

73. Solvent washing may be an option where exceptionally tenacious deposits or films are encountered. Note that the used solvent will require subsequent removal and all of the liquid product generated will require special handling and disposal. In isolated cases, especially where low grade fuels have been stored, it may be necessary to resort to more advanced tank cleaning methods such as ultrasonic or special solvents.

74. It may be advantageous to employ all three methods in any given vessel, ship and boat, depending on the nature and location of the contamination. In general, mechanical cleaning would be the first method to try, followed by steam/hot water washing, then solvent washing in exceptionally difficult cleaning situations.

75. Whichever method is employed, the effluent and waste must be collected and treated. Large volumes will require the services of a pumper truck while smaller quantities may be handled in barrels. Care must be exercised in transfer operations to avoid spills. If large quantities of oil or oil-contaminated liquids are to be transferred the use of a boom around the vessel, ship and boat should be considered.

i) Cleaning compartments with bilges

76. Cleaning bilges is frequently complicated by poor access caused by piping, gratings, and equipment. During the planning phase the clean-up contractor should consider the access issue carefully. In many cases it is cheaper and easier to remove interference items (especially when they themselves are dirty or contaminated) than it is to attempt to clean the items and the adjacent bilge.

77. Bilges, once clean, are very vulnerable to recontamination. Contractors should be aware of the following types of situations which have given rise to problems in the past:

(a) Piping, valves and fittings in hydrocarbon systems will continue to weep for some time after initial draining. These drips can -over a quite short period of time- lead to a significant rework effort. Drips should be captured whenever possible;
(b) Containers used for clean-up are vulnerable to tipping, especially in the uncertain footing and poor lighting conditions often found in vessel, ship and boats undergoing sinking preparation. Buckets should be removed as they are used, or if they are employed for catching drips, emptied regularly;
(c) Water should not be allowed to enter bilges unless it is part of a planned clean-up campaign. Water generally complicates clean-up of bilges as the water must be handled as oily wastewater. In general, the approach and methods for cleaning bilges is the same as for cleaning tanks.

j) Dealing with piping and fittings

78. Contractors should identify those pipes and fittings that contain fuels, oils and oily water as part of the planning activity. If ship's drawings are not available, it will be necessary to develop this information on site. Authority will generally assume that piping has contained hydrocarbons unless the piping is clearly identified as being part of a non-hydrocarbon system, or there is clear evidence to indicate that the piping was not part of a hydrocarbon system (e.g. sea water piping to coolers, fresh water piping to domestic spaces). As per the Guideline, piping in the bilge will be assumed to be contaminated with oil until proven clean.

k) Cleaning fitted machinery

79. Cleaning fitted machinery is a lengthy and difficult process. Whenever possible, fitted machinery should be sold into the used machinery market or removed for recycling.

80. The general approach to cleaning diesel engines/generators, gearboxes, compressors, etc. is similar. The clean-up plan should identify the fluids and other contaminants in the machine to be removed. Care should be exercised to capture fluids to avoid further clean-up effort. Fluid types should not be mixed, as this may increase disposal costs. Large reservoirs of fluids should be drained first, followed by smaller accumulations in machinery housings, piping, and fittings. The force of gravity will assist in collecting the fluids over a period of time, and the clean-up plan should allow for

an adequate drainage period. The precise period required will vary with internal machinery clearances, length and size of piping, fluid viscosity and temperature. As weeping of oils and fuels will continue for several days or weeks, clean-up plans should recognize the requirement to catch the seepage during this period so as to minimize collateral contamination of bilges, decks, piping bundles, etc.
General guidance for specific equipment follows.

l) Combustion Engines

81. External Oil System: Drain the sump. Identify all external oil lines, coolers and other fittings. Open and drain these items. After draining, consideration should be given to removing these items from the vessel, ship and boat to prevent oil weeping from connections. Remove all oil filter and strainer elements, pressure gauges and gauge lines.

82. Fuel System: Remove fuel injectors. Identify all external fuel pressure lines, return lines and fittings. Open and drain these items. After draining, consideration should be given to removing these items from the vessel, ship and boat to prevent fuel weeping from connections. Remove all fuel filters and strainers, pressure gauges and gauge lines. Open and drain any governors.

83. Engine Internals: Open all explosion doors, hand-hole doors, maintenance access panels, etc. On some engines it may be desirable to cut further access openings. Remove heads and clean thoroughly, or drain and remove from vessel, ship and boat—note that heads may have salvage value depending on engine type and condition. Open all internal oil lines and galleries. Remove oil pump or open it and clean it for inspection. Open bearing pedestals and clean. Open turbo charger or supercharger bearings. At this point it is generally desirable to cut open the main oil sump for better access. Wipe out internal surfaces of engine. Persistent weeping indicates an oil or fuel accumulation that requires investigation.

84. Cooling System: Drain all treated water.

m) gearboxes

85. Gearboxes may be stand-alone items of equipment or integrated into a piece of machinery. The feature in common is a lubricating oil system. Treat initially as for “external oil system” covered under combustion engines. Open all covers and access panels. In most cases it will be necessary to cut further access holes to allow for the interior of the gearbox to be adequately cleaned. Open all internal oil lines. Open bearing pedestals (especially those in a horizontal plane) if there are oil accumulation pockets. The Designated Authority will need to see at least one bearing open to assess construction. Remove or drain gearing sprayers. Wipe down all surfaces.

n) other Machinery

86. Other machinery, often termed *auxiliary machinery*, can be considered in two broad classifications for clean-up purposes. The first group is machinery that does not employ oil lubrication, and does not contain grease other than within sealed rolling element bearings.
These machines do not generally require hydrocarbon clean-up unless they were employed pumping fuel or oil, or have large grease reservoirs. Typical pieces of machinery that would usually not require clean-up include small water pumps and ventilation fans.

87. The second broad classification of machinery is equipment that utilizes lubricating oil, or contains greases outside of sealed bearings. While auxiliary machinery (air compressors, refrigerant compressors, circulating pumps, steam turbines, etc.) varies considerably in purpose and construction detail, the individual pieces can be dealt with in a similar manner during clean-up. Any working fluids that are hydrocarbon-based or otherwise hazardous (e.g. CFCs) should be removed first, and the pump-end left open. Fitted lubricating oil systems should be cleaned as noted under the heading

"external oil system" in the combustion engine section. If a gearbox is fitted, it should be treated as for the section on gearboxes.

88. Experience indicates that oil sumps in small pieces of machinery will almost always need to be cut open to allow adequate access for cleaning. Wipe down all internal oiled surfaces.
Grease packed couplings, stuffing boxes, chain sprockets, worm drives, etc. must generally be opened, unless they meet the restrictive "small quantities" exemption in the Guideline.

89. The grease is usually best removed by mechanical means, although in some cases of very limited access (such as gun rings), it may be necessary to resort to steam or solvent washing.

90. Basic knowledge of machines and an understanding of the purpose of the specific equipment typically allow the clean-up effort to proceed more efficiently.

o) Suggestions on handling debris

91. Salvage and clean-up operations will generate a large quantity of material that needs to be removed from the vessel, ship and boat.

p) Salvage

92. The salvage and clean-up plan must address separating various types of salvage and debris. Care should be exercised in separating metals for recycling, as contamination with other metals, or with debris, will significantly lower the salvage value. Bins may be considered for salvage materials but access should be controlled. Material that is placed in salvage bins should be clean and free of oils or other products. Failure to observe this guideline may lead to difficulties with control of contaminated run-off at the site.

q) waste and debris

93. Hazardous material must be carefully segregated from the normal waste stream to avoid contaminating the normal stream, thus incurring large costs to dispose of the whole amount as hazardous material.

94. Liquid waste presents special handling problems for clean-up crews. Recovered oils and fuels may be employed for site or vessel, ship and boat heating purposes if suitable, but other liquids will typically need to be processed through licensed hazardous waste contractors. To keep disposal costs in check, waste liquids should not be mixed and containers should be labelled with all available information on the product. Liquid storage and movement around the site must be tightly controlled. Spills will generate significant clean-up costs. Control of run-off from temporary storage sites is an issue and must be addressed in the clean-up plan. A covered area with an impermeable floor and berm is highly recommended and may be required by local authorities.

95. Solid waste requirements vary by province and sometimes by municipality. Local requirements and restrictions must be determined during the planning phase. Items that should be addressed include disposal of used oil absorbent materials, non-asbestos insulation, wallboard, tile, linoleum and underlayment, carpet, and furniture.

96. An area will need to be set aside for oil and fuel pipes, fittings, etc. to drain. This must be done in a covered area and is often best accomplished in a compartment in the vessel, ship and boat set aside for this purpose.

PART –D- MONITORING OPERATIONS FOR PLACEMENT AT SEA OF MATTER FOR A PURPOSE OTHER THAN MERE DISPOSAL

1. Definition

97. For the purposes of assessing and regulating the environmental impacts of placement operations, monitoring is defined as the repeated measurement of an effect, whether direct or indirect, on the marine environment and/or of interferences with other legitimate uses of the sea.

98. The monitoring programme should also be aimed at establishing and assessing the environmental impacts and/or conflicts of the artificial reef with other legitimate uses of the maritime area or parts thereof. Depending on the outcome of such monitoring, it may be necessary to carry out alterations to the structure or to consider its removal. In the case of placements taking extended periods of time (years), monitoring should be concurrent with the construction in order to influence modification of the reef, as required.

2. Objectives

99. In order to carry out the monitoring programme in a resource-effective manner, it is essential for the objectives of the programme to be clearly defined. The monitoring observations required at a placement site tends to fall into two basic categories:

(a) pre- placement investigations designed to assist in the selection of the site or to confirm that the selected site is suitable; and
(b) post-placement studies intended to verify that: the permit conditions have been met; this process is referred to as compliance monitoring; and, the assumptions made during the permit issuing and site selection processes were valid and adequate to prevent adverse human health and environmental effects as a consequence of placement; this process is referred to as field monitoring, with the results of such reviews providing the basis for modifying the criteria for issuing a new permit for future placement operations at existing and proposed placement sites.

100. Whenever possible, the monitoring programme should be aligned with the current MEDPOL monitoring programmes for the Ecological Objectives 1, 2, 5, 6, 7, 8, 9, and 10 in line with the Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Sea and Coast and Related Assessment Criteria set out in Decision IG. 22/7 of the COP 19.

3. Quality control

101. Quality control is defined as the operational techniques and activities that are used to fulfil requirements relating to quality. These include monitoring criteria and Guidelines, sampling methods, sample locations and frequency, and reporting procedures.

102. Before any monitoring programme is developed and implemented, the following quality control issues have to be addressed:

(a) What testable hypotheses can be derived from the impact hypothesis?
(b) What exactly should be measured?
(c) What is the purpose of monitoring a particular variable or physical, chemical or biological effect?
(d) In what compartment and at which locations can measurements be made most effectively?
(e) For how long should the measurements be carried out to meet the defined aim?
(f) With what frequency should measurements be carried out?
(g) What should be the temporal and spatial scale of the measurements made to test the impact hypothesis?

(h) How should the data from the monitoring programme be managed and interpreted?

103. Monitoring observations are typically concerned with the physical, chemical and biological characteristics of the placement site.

(a) Physical observations consist of hydrological surveys of water mass properties, such as temperature, salinity and density, over the entire water column and extending horizontally over the entire region likely to be affected by the placement of matter.
(b) Chemical observations conducted in and around the placement site need to be related to the type of matter involved. Generally, where it is not possible to remove all potentially contaminating material before placement and where chemical effects may therefore be expected, proper analyses need to be carried out of the surface microlayer of sea, which constitutes an extremely active biological zone in which a wide range of chemicals, such as heavy metals and oil soluble substances, tend to accumulate. Chemical observations also need to be conducted on sea where substances, although not present in the matter placed in major quantities or concentrations may, because of their persistent nature, accumulate either on the seabed or in benthic communities in the vicinity of the placement site.
(c) The frequency of biological observations should depend on the scale of the placement operation and the degree of risk to potential resources. Where physical effects on the seabed are expected, it may be necessary to conduct an assessment of the phytoplankton and zooplankton biomass and productivity prior to placement to establish a general picture of the area. Observations of the plankton immediately following placement can help to determine whether acute effects are occurring. Monitoring of the benthic and epibenthic flora and fauna is likely to be more informative because they tend to be subjected not only to the influence of the overlying water column and any changes that occur in it.

104. Post-placement monitoring should be designed to determine:

(a) Whether the impact zone differs from the zone predicted; and
(b) Whether the extent of changes outside the impact zone differs from those predicted.

105. The former can be ascertained by designing a sequence of measurements in space and time with a view to ensuring that the projected spatial scale of change is not exceeded. The latter can be shown through measurements which provide information on the extent of the change occurring outside the impact zone as a result of the placement operation. These measurements are often based on a null hypothesis, i.e. that no significant change can be detected. The spatial extent of sampling depends on the size of the area designated for placement.

106. However, it must be recognised that long-term variations arise as a result of purely natural causes and that it may be difficult to distinguish them from changes which are induced artificially, particularly in relation to populations of organisms.

107. Where it is considered that effects are likely to be largely physical, monitoring may be based on remote methods (e.g. acoustic measurements, side-scan sonar). It must be recognized, however, that certain ground measurements will always remain necessary for the interpretation of the remote sensing images.

108. Concise reports on monitoring activities should be prepared and made available to relevant stakeholders and other interested parties. Reports should detail the measurements made, the results obtained and the manner in which these data relate to the monitoring objectives and confirm the impact hypothesis. The frequency of reporting will depend on the scale of the placement operation, the intensity of monitoring and the results obtained.

Quality assurance

109. Quality assurance may be defined as all planned and systematic activities implemented to provide adequate confirmation that monitoring activities are fulfilling requirements related to quality.

110. The results of monitoring activities should be reviewed at regular intervals in relation to their objectives in order to provide a basis for:

(a) modifying or terminating the field monitoring programme;
(b) amending or revoking the placement permit;
(c) redefining or closing the placement site; and
(d) modifying the basis for assessing placement permit in the Mediterranean Sea.

111. The results of any reviews of monitoring activities should be communicated to all Contracting Parties involved in such activities. The licensing authority is encouraged to take relevant research findings into consideration with a view to the modification of monitoring programmes

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Appendix 4

Updated Guidelines on the Management of Desalination Activities

Table of Contents

Table of Content (continued)

Annexes

List of Abbreviations / Acronyms

AD	Adsorption desalination
BAT	Best Available Technology
BEP	Best Environmental Practice
CDI	Capacitive deionization
CFCs	Chlorofluorocarbons
CPs	Contracting Parties
CSP	Concentration Solar Power
COP	Conference of the Parties
EcAp	Ecosystem Approach
ED	Electrodialysis
EDR	Electrodialysis reversal
EEA	European Environmental Agency
EIA	Environmental Impact Assessment
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FO	Forward Osmosis
GES	Good Environmental Status
GHG Emissions	Greenhouse Gas Emissions
GWI	Global Water Intelligence (GWI)
IAEA	International Atomic Energy Agency
IDA	International Desalination Association
IMAP	Integrated Monitoring and Assessment Programme
IMO	International Maritime Organization
IPCC	Intergovernmental Panel on Climate Change

LBS Protocol	Land-Based Sources Protocol
LTD	Low Temperature distillation
MAP	Mediterranean Action Plan
MD	Membrane distillation
MED	Multiple Effect Distillation
MED POL	Programme for the Assessment and Control of Marine Pollution in the Mediterranean Sea
MSF	Multi Stage Flash Distillation
PRO	Pressure retarded osmosis
RO	Reverse Osmosis
RE	Renewable Energies
RED	Reverse Electrodialysis
SW	Seawater
SWIM-Programme	Sustainable Water Integrated Management Programme
TVC	Thermal Vapor Compression
UNEP	United Nations Environment Programme
UNEP/MAP	United Nations Environment Programme\Mediterranean Action Plan
ZLD	Zero Liquid Discharge

1. Introduction

1. The MED POL Programme of UNEP/MAP following approval by the MED POL Focal Point meeting, published in 2003 the MAP Technical Report No. 139: Sea Water Desalination in the Mediterranean. Assessment and Guidelines. At the time, the guidelines, largely used by the Contracting Parties, were up to date and described the need for seawater desalination, the basic technologies, the state and trends of seawater desalination in the Mediterranean region and touched on the environmental impacts and legal aspects of brine disposal.

2. Since 2003, the global desalination effort has increased exponentially due to increase in freshwater demand and improvement of technologies and economic viability. The Mediterranean region followed the global trend and the installed desalination capacity increased from ca. 4 million m3/day (Mm3/day) in 2003 to 12 Mm3/day in 2013. Technologies changed as well, together with increased awareness of the possible environmental impacts, in particular on the marine environment. Moreover, the legal framework for the regulation of waste disposal into the Mediterranean and pollution-related Regional Plans (in the framework of the Land-based sources (LBS) and Dumping protocols and the SAP/MED) evolved to integrate the aspects of the Ecosystem Approach (EcAp) to achieve and preserve Good Environmental Status (GES).

3. Therefore, MEDPOL is now reviewing and updating the 2003 MAP Technical report 139, to better describe the desalination effort around the Mediterranean, and assess its impacts on the coastal and marine environment. The new guideline aims to provide guidance to the Contracting Parties on how to desalinate in a sustainable way and how to monitor the environment. The new guideline builds on previous publications: MAP Technical report 139 (UNEP/MAP/MEDPOL 2003), SWIM report (Khordagui 2013), UNEP and NRC publications (NRC 2008, UNEP 2008) among others, and publications that are cited along this report.

2. Seawater desalination

4. Seawater (SW) desalination accounts for ca. 60 % of the global desalination effort and more than 80 % around the Mediterranean. It is also the most energy consuming desalination type because of the high salt concentration of the feed water. Therefore, the updated guidelines address desalination as seawater desalination, with the understanding that brackish water desalination is common in many world areas but not in the Mediterranean (Khordagui 2013, Lior 2017).

5. An additional point to be considered is the difference between installed desalination capacity and actual desalination production. Most of the statistics on desalination (originating mainly from the International Desalination Association (IDA) and Global Water Intelligence (GWI) reports) address installed desalination capacity. However, the installed desalination capacity may be higher than the production due to changes in desalination needs, usually correlated to climatic variability (draught or rainy years), availability of natural or reused water supply and financial costs.

2.1. The need for seawater desalination

6. Global water use has been growing at more than twice the rate of population increase in the last century (FAO 2012). This, in conjunction with increased incidence of draughts and changes in

precipitation patterns, as a result of climate change, have reduced the availability of freshwater. Two out of every three persons on the globe may be living in water-stressed conditions by the year 2025, if present global consumption patterns continue[5].

7. The water crisis and the dwindling access to potable water in many regions and the ever improving desalination technology prompted the increase in desalination worldwide, in particular seawater desalination. Historically, desalination on a commercial scale started around 1965 having a global capacity of about 8,000 m^3/day in 1970, reaching an estimated 86.6 Mm^3/day at the end 2015[6]. From 1997 to 2008 the compound annual growth rate of desalination was 17%. Desalination grew exponentially at a rate of 14%/year from 2007 to 2012, and the rate declined to 3%/year from 2012 to 2015 (Gude 2016, Lior 2017). Large, mega-size plants turned economically viable and were constructed. Desalination in the Mediterranean countries reflected the global progression and will be discussed in Section 3.

2.2. Brief description of current established (mature) seawater desalination methods

8. Desalination technologies can be divided into two major processes:

a) membrane process (non-phase change), in which semi-permeable membranes are used to separate water from dissolved salts, and
b) thermal process (phase change), in which feedwater is boiled (under suitable operating temperatures and pressures) and the vapor condensed as pure water.
c) Hybrid technologies that include both processes, such as membrane distillation, are starting to being used as well (see below).

9. The thermal processes dominated the desalination industry up to 2003-2005 when membrane technology, in particular reverse osmosis (RO), surpassed it (Gude 2016). Following is a brief description of the established (mature) desalination methods by technology.

2.2.1. Membrane Processes

10. Reverse Osmosis (RO) uses pressure to force water molecules from the feed solution through semi-permeable membranes that retains the salts and filter particles, producing fresh water and brine. The efficiency of the process is 0.45 for seawater (SW) and 0.75 for brackish water (BW) (World_Bank 2012). The brine produced from SWRO has about twice the seawater salinity.

11. At the various stages of the process chemicals may be added, that are subsequently disposed with the brine at sea or inland: coagulants in the pre-treatment stage (iron or aluminum salts, polymers); biocides (such as chlorine) and neutralizers (sodium sulfite); antiscalants to prevent fouling of the membranes (such as polyphosphates, polyphosphonates, polyacrylic acid, polymaleic acid); cleaning solutions for RO membranes (acidic and alkaline solutions and detergents); and pH and hardness adjustors for the product water (limestone).

12. The successive steps, usage of chemicals, energy recovery and improved efficiency were extensively described (Fritzmann et al. 2007, Greenlee et al. 2009, Elimelech and Phillip 2011, Ghaffour et al. 2013).

[5] http://www.who.int/heli/risks/water/water/en/ (accessed February, 6th 2017)
[6] http://www.iwa-network.org/desalination-past-present-future/

At the current state of the art SWRO plants consume 3-4 kWh/m^3 energy and emit 1.4-1.8 $kgCO_2/m^3$ and 10-100 g NO_x/m^3 of produced water (Lior 2017).

13. Electrodialysis (ED), is an electrochemical separation process in which ions are transferred through ion-exchange membranes by a direct current voltage, leaving desalinated water as the product (NRC 2008). Electrodialysis reversal (EDR), a modification of ED, can operate with highly turbid feed waters.

2.2.2. Thermal Processes

14. Multi Stage Flash Distillation (MSF) uses a series of stages, each with successively lower temperature and pressure, to rapidly vaporize (or “flash”) water from the bulk liquid. The vapor is then condensed by tubes of the inflowing feedwater, thereby recovering energy from the heat of condensation (NRC 2008). The process efficiency is 0.25 and the brine produced from SW desalination has about 1.5 the seawater salinity and temperature higher by ca. 5 degrees.

15. At the various stages of the process chemicals may be added, that are subsequently disposed with the brine at sea or inland: antifoaming agents, corrosion inhibitors, biocides (such as chlorine) and neutralizers (sodium sulfite); antiscalants to prevent fouling (such as polyphosphates, polyphosphonates, polyacrylic acid, polymaleic acid); cleaning solutions; and pH and hardness adjustors for the product water (limestone). Thermal desalination plants are subjected to corrosion and subsequent discharge of metals (such as copper) with the brine.

16. Multiple Effect Distillation (MED) is a thin-film evaporation approach, where the vapor produced by one chamber (or “effect”) subsequently condenses in the next chamber, which exists at a lower temperature and pressure providing additional heat of vaporization. The process efficiency is 0.34. Compared to MSF it uses less power due to reduced pumping requirements (NRC 2008). Large MED plants incorporate thermal vapor compression (TVC) where the pressure of the steam is used (in addition to heat) to improve efficiency (NRC 2008).

2.3. Future directions of seawater desalination technology – emerging technologies, process improvement and use of renewable energy.

17. The ever increasing desalination industry promoted the research and engineering to develop new technologies, hybrid technologies, to redesign components of existing systems to improve efficiency, reduce energy and chemical consumption and reduce waste and brine discharge. Following is a brief description of the future directions in desalination.

18. Forward osmosis (FO). The FO process is based on the principle that water (solvent) diffuses through a semi-permeable membrane from low concentration region to high concentration region by the natural osmotic process. A semipermeable membrane is placed between a low concentration feed solution and a high concentration draw solution. The chemical potential difference between the two solutions drives water molecules through the membrane from the feed to the draw solution while solutes are retained. The water is then separated and the draw solution reused. The separation process can be expensive depending on the draw solution characteristics (Gude 2016, Straub et al. 2016, Amy et al. 2017).

19. Membrane distillation (MD) is a thermally driven process that utilizes a hydrophobic, microporous membrane as a contactor to achieve separation by liquid-vapor equilibrium. The driving force of MD is the partial vapor pressure difference maintained at the two interfaces of the membrane (hot feed and cold permeate). The hot feed solution is brought into contact with the membrane which allows only the vapor to pass through its dry pores so that it condenses on the coolant side. The process uses lower temperatures and pressures compared to the established thermal and membrane processes and can reach 90% recovery (World Bank 2012, IAEA 2015, Kim et al. 2016, Amy et al. 2017).

20. Adsorption desalination (AD) is a heat-driven adsorption/desorption cycle process. In this process raw seawater is fed into an evaporator at its ambient temperature and an adsorbent is used to adsorb the vapor generated at very low pressure and temperature, under low pressure environment. When saturated, the adsorbent is heated to release the vapor (desorption process) and is then condensed inside an external condenser. There is no need to heat the feed water as in other thermal processes (Kim et al. 2016).

21. Among the emerging processes and technologies are: Pressure retarded osmosis (PRO), Reverse electrodialysis (RED), Low Temperature distillation (LTD), Capacitive deionization (CDI). Most of these technologies are not mature and are not utilized in large scale plants. Close circuit RO is now emerging into the commercial arena. FO and MD are used in niche applications (Amy 2017).

22. Improvements of current technologies: Many improvements are constantly taking place in the ever changing field of desalination, especially in yield improvement and reduction of energy and chemical consumption and brine discharge. Below are a few examples:

a) Zero liquid discharge (ZLD), is a process that recovers water from the concentrates, to eliminate liquid wastes. Most of the emerging technologies can theoretically be employed in zero liquid discharge schemes. ZLD is particularly important in inland brackish desalination (Gude 2016, Tong and Elimelech 2016) and may be feasible in small seawater desalination plants;
b) Improvement of conventional and design of new membranes (membrane engineering) to increase yield, reduce energy consumption and associated GHG emissions are under constant development. Among them are the development of biomimetic membranes, based on aquaporins (a water channeling protein), synthetic water and ion channels, graphene;
c) Renewable energies (RE). RE, solar (concentration solar power (CSP), photovoltaic (PV)), geothermal, wind and marine renewable energy (wave, tide and currents), will eventually replace conventional energy in desalination when economically viable (Gude 2016, Amy et al. 2017). However, IAEA (IAEA 2015) forecasts that in 2030 RE powered desalination will be sufficient only for domestic water supply but will expand to meet industrial supply by 2050.
d) Improvement of diffuser technology to improve the dilution processes during the brine discharge at sea (Portillo et al 2013, Vila et al 2011).

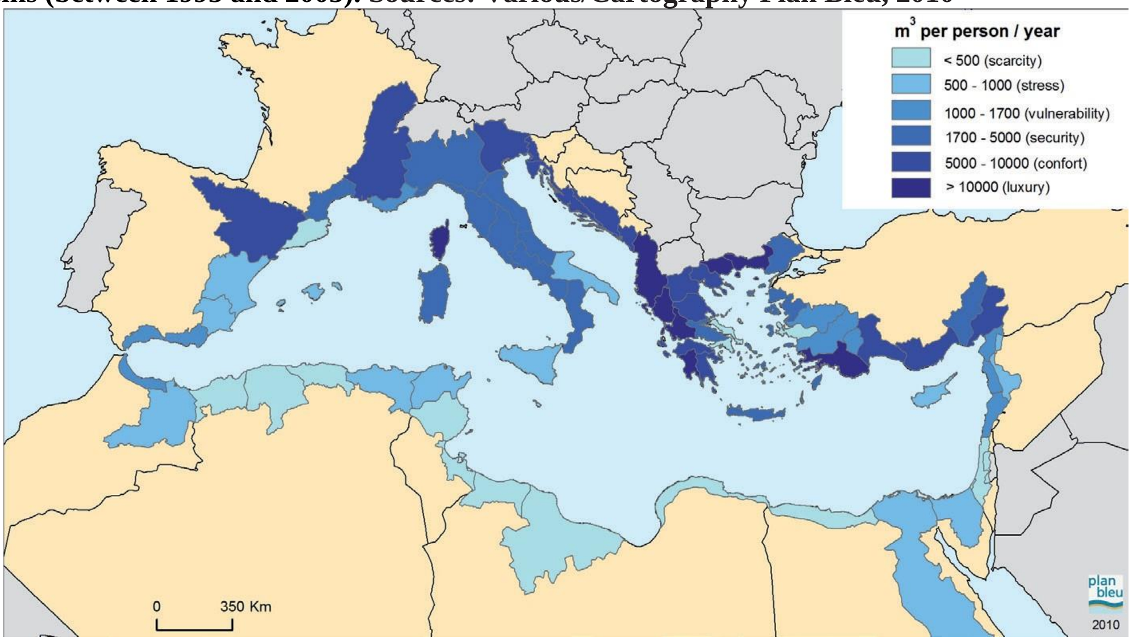
3. The state and trends of seawater desalination in the Mediterranean region

23. The renewable natural water resources per inhabitant in the countries surrounding the Mediterranean Sea ranges from scarcity (<500 m^3/person year) to comfort and luxury (>5000 m^3/person year) (AQUASTAT[7], Plan Bleu, 2010).

[7] http://www.fao.org/nr/water/aquastat/water_res/index.stm

24. There is an imbalance between the northern and southern shores of the Mediterranean, the latter considered as one of the most water-scarce regions of the world. As a result, most of the desalination effort around the Mediterranean is concentrated in the southern and eastern shores and in Spain. In 2013, over 1532 seawater desalination plants had been installed around the Mediterranean Sea with a total cumulative installed capacity of about 12 Mm^3/day. Seawater desalination by reverse osmosis accounted for ca. 80 % of the production. Nearly all the desalinated water produced is consumed by municipalities as drinking water (Khordagui 2013).

Figure 1. Renewable natural water resources per inhabitant in the various basic Mediterranean Basins (between 1995 and 2005). Sources: Various/Cartography Plan Bleu, 2010



25. In 2014, the European Environmental Agency with UNEP/MAP published a report compiling the pollution levels in the region, in particular the major drivers of environmental changes and their implications on the protection of the marine environment which didn’t address desalination (EEA-UNEP/MAP 2014). However, in UNEP/MAP State of the Mediterranean report in 2012, desalination was mentioned as a new pressure and a key sector affecting the marine and coastal environment in the Mediterranean (UNEP/MAP 2012).

3.1. Evolution of seawater desalination in Mediterranean countries from 1999 to 2013

26. The total desalination capacity around the Mediterranean in 1970 was 0.025 Mm^3/day.

27. By the end of 1999, it had increased by almost 2 orders of magnitude to a total capacity of close to 2 Mm^3/day, with 41% produced by RO (UNEP/MAP/MEDPOL 2003). Spain was the bigger producer of desalinated water with 33% of the total capacity, mainly from RO process. Libya was the second producer, with 30% or the total capacity, mainly from MSF process. Italy, Malta, Algeria and Cyprus accounted for 18, 6, 5 and 2% of the total capacity, respectively (UNEP/MAP/MEDPOL 2003).

28. In 2007, the total desalination capacity in the Mediterranean was 4.0 Mm^3/day (14% of the total global capacity). Spain was the main producer, with 35% of the total capacity in the Mediterranean followed by Libya, with 20%. Algeria, Israel, Italy, Malta and Cyprus accounted for 19, 10, 7, 5 and 4% of the total capacity, respectively (Lattemann et al. 2010a, Lattemann et al. 2010b). The main process utilized was RO.

29. In 2011, the capacity was increased to 11.6 Mm^3/day in the Mediterranean countries, however this estimate may include desalination in the Atlantic and Red Sea. Spain was the main producer (41% or the total capacity in the Mediterranean) followed by Algeria and Israel with 15 and 10%, respectively. Libya accounted for 7% of the total production and Italy and Egypt, 6% each (Cuenca 2013).

30. The potential environmental impacts of desalination around the Mediterranean Sea was assessed within the EU Program SWIM- Sustainable Water Integrated Management, Activity 1.3.2.1 (Khordagui 2013), as well as the installed capacity. In 2013, the total cumulative installed desalination capacity was about 12 Mm^3/day. From 2000 to 2013 the installed capacity increased by 560% (40%/year). RO was the most common desalination technology in the area (ca. 82%) followed by MSF (11%) and MED (6.5%). In 2013, Spain was the main producer (31% of the total capacity) followed by Algeria, Israel and Libya with 20, 18 and 11%, respectively.

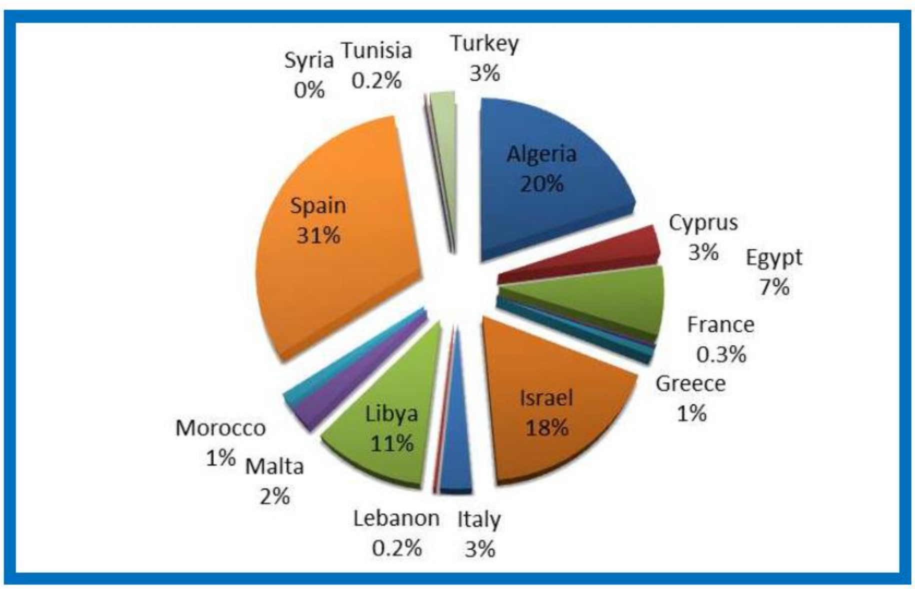


Figure 2. Relative contribution of each Mediterranean country to the total desalination capacity of 12 Mm3/day in 2013. Figure from Khordagui (2013) compiled with data from GWI Desal Data.

3.2. Installed capacity for seawater desalination in the Mediterranean and actual production

31. The SWIMM report (Khordagui 2013) is the most updated collective report on the state of desalination in the Mediterranean region. In order to revise and amend the current knowledge, partially filled questionnaires were send to the Contracting Parties, asking for their collaboration in completing

them. The Questionnaire includes general questions (installed desalination capacity, actual production, the contribution of seawater desalination to the actual production and future plans) and specific questions (number of plants that desalinate more than 10,000 m^3/day, their location, process used details on chemical usage and discharges to the environment). A questionnaire template for collecting information and data related to desalination activities is contained in Annex I to the updated Guidelines to be used for assessment purposes.

4. Environmental impacts of seawater desalination with particular reference to the marine environment

32. This section addresses the impact of seawater desalination on the marine environment following the start of plant operations, based on Kress and Galil (2015) and on additional published reports and peer reviewed literature cited along the text. The possible effects during the construction and operating phases are described in sections 5 and 6. The main impacts of seawater desalination on the marine environment are associated with two components: intake of seawater (feed water) into the desalination plant and brine discharge. However, the number of articles publishing quantitative effects *in situ* or in lab experiments is small and limited in scope (Roberts et al. 2010), but growing in the last years. Those suggest that desalination effluents impact the marine biota at the vicinity of the outfall, but are not definitive because of conflicting results. The results are site specific, depending on the sensitivity of the receiving environment, the desalination process, size of plant and discharge composition and hindered by the lack of long term studies. GHG emissions may also affect the marine environment through ocean acidification but will not be discussed in this section.

4.1. Intake of seawater

33. The main effects associated with source water (seawater) withdrawal are entrainment and impingement of marine organisms (NRC 2008, UNEP 2008). They are also the least studied and known effects, in particular the impact on the population level.

34. Entrainment is the transport of small planktonic organisms with the flow of seawater into the desalination plant. It is generally recognized that the entrained flora and fauna that enters the desalination plant will perish during the different stages of the desalination process, including biocide application. This is in contrast with cooling waters from power stations, where a lower mortality has been reported (Mayhew et al. 2000, Barnthouse 2013). Entrainment can be reduced by locating the intakes away from biologically productive areas, such as in deeper water farther offshore, or by using underground beach wells although the latter are difficult to implement for large-scale desalination plants (NRC 2008, Elimelech and Phillip 2011).

35. Impingement occurs at open intakes when organisms sufficiently large to avoid going through the installed intake screens are trapped against them by the force of the flowing seawater into the desalination plant. Impingement of jellyfish at the intake have been known to block intakes and reduce production[8]. Impingement can be reduced through a combination of appropriate screens and low intake velocity. The

[8] http://gulfnews.com/news/uae/general/jellyfish-choke-oman-desalination-plants-1.355525

US-EPA recognizes intake flow velocity of 0.152 m/sec as BAT for impingement reduction. The EU funded ProDes project suggested a maximum intake velocity of 0.1 m/sec[9].

4.2. Brine discharge

4.2.1. Brine dispersal (Abiotic impacts)

36. Brine is defined here as the hypersaline discharge from a membrane based plant and as the hyper saline and warm discharge from a thermal desalination plant, without the chemicals used in the process. Brine dispersion may vary significantly depending on site characteristics, effluent volume, mode of discharge, and the prevailing hydrographic conditions. Nevertheless, salinity and temperature are higher than reference at the discharge sites but as mentioned, the area affected is highly variable (Fernandez-Torquemada et al. 2009, Holloway 2009, McConnell 2009, Drami et al. 2011, Kress and Galil 2012). Studies of the effect of thermal desalination in the enclosed Gulf showed an effect on water temperature and salinity and a regional increase in salinity (Purnama et al. 2005, Lattemann and Hopner 2008, Uddin et al. 2011).

37. Brine discharge may increase seawater stratification that together with higher salinity and temperature may reduce oxygen levels in the water. This concern was raised during the EIA of the Perth (Australia) SWRO, but although monitoring showed slight water stratification close to the diffuser, no significant effect was found on dissolved oxygen concentrations (Holloway 2009).

38. An additional abiotic impact of brine discharge may be aesthetic due to the discharge of turbid brine. This effect was described for the Ashkelon (Israel) SWRO that until 2010 discharged in pulses backwash containing iron hydroxide used as coagulant in the pre-treatment stage. The iron hydroxide formed a conspicuous “red plume” (Safrai and Zask 2008, UNEP 2008, Drami et al. 2011).

4.2.2. Brine (salinity and temperature) effects on biota

39. Salinity and temperature have long been perceived as inhibitory environmental factors for survival and growth of marine biota (Murray and Wingard 2006, Wiltshire et al. 2010) and therefore, both are expected to affect the biota near desalination brine discharge areas.

i. <u>Laboratory and mesocosm studies</u>

40. Laboratory and mesocosm experiments on *Posidonia oceanica*, a seagrass endemic to the Mediterranean Sea of particular habitat importance, and included in Annex II of the SPA Protocol, have shown that at certain conditions, increased salinity affected physiological function, leaf growth and survival rates (Fernández-Torquemada et al. 2005, Ruiz et al. 2009, Sandoval-Gil et al. 2012, Marín-Guirao et al. 2013).

41. Two other Mediterranean seagrasses, *Cymodocea nodosa* and *Zostera noltii*, also included in Annex II of the SPA Protocol, were proved sensitive to increases in salinity (Fernández-Torquemada and Sánchez-Lizaso 2011) while other seagrasses’ tolerance to hypersalinity stress varied (Walker and

[9] http://www.prodes-project.org/fileadmin/Files/D6_2_Legislation_Guidelines.pdf

McComb 1990, Koch et al. 2007, Sandoval-Gil et al. 2012) (Walker et al. 1988, Koch et al. 2007, Sandoval-Gil et al. 2012a, Sandoval-Gil et al. 2012b).

42. Stressful combinations of temperature and salinity substantially reduced larval performance and development of the barnacle *Amphibalanus improvises* (Nasrolahi et al. 2012), while salinity was shown to affect the silica structure of diatoms (Vars et al. 2013).

43. Hypersalinity decreased embryos survival of the giant Australian cuttlefish *Sepia apama* and reduced mean weight and mantle length (Dupavillon and Gillanders 2009). Whole effluent toxicity testing (WET) performed using locally relevant species as part of the EIA for the Olympic Dam SWRO plant, Australia, attributed toxicity to increased salinity (Hobbs et al. 2008). On the other hand, no significant effect was found in 18 common species during an extensive EIA performed for the Carlsbad SWRO plant (Southern California) (Le Page 2005).

44. Recently, a mesocosm experiment on the impact of high salinities (5% and 15% higher than ambient salinity) on microbial coastal populations of the Eastern Mediterranean found that after ca. 12 days of exposure, chlorophyll a and primary productivity increased and the composition of the microbial population changed. The latter was dependent on the initial, seasonal dependent, population and on the intensity of the salinity enrichment (Belkin et al. 2015).

ii. *In situ* studies

45. A field survey of a shallow *P. oceanica* meadow in Spain showed it to be affected after 6 years of exposure to RO brine (Sánchez-Lizaso et al. 2008), in agreement with the laboratory studies. Also in Spain (southeastern Mediterranean coast) brine discharge was shown to change the benthic community (Del Pilar Ruso et al. 2007, Del Pilar -Ruso et al. 2008, de-la-Ossa-Carretero et al. 2016). Echinoderm disappeared near the outfall of the Dhekelia SWRO in Cyprus (Argyrou 1999). However, no effect of brine discharge was found in the northwest Mediterranean (Raventos et al. 2006) nor in southwest Florida (Hammond et al. 1998). Moreover, in some instances, results of monitoring of the benthic community were inconclusive due to a shift in sediment particle size that can induce changes in community composition (Shute 2009, Riera et al. 2011, Riera et al. 2012).

46. *In situ* studies detected changes in microbial communities and functioning in the Mediterranean and Red Sea (Drami et al. 2011, van der Merwe et al. 2014a, Belkin et al. 2017). The photophysiology of the algal symbiont of the coral *Fungia granulosa* was not influenced by rapid and prolonged changes in salinity but varied with changes in light conditions (van der Merwe et al. 2014b).

4.2.3. Effect of chemicals used in the desalination process and discharged with the brine

47. Impacts of chemicals discharged with the brine on the marine environment are scarcely known. The co-occurrence of stressors: salinity, temperature, chemicals and co-discharged waste effluents (such as cooling waters from power stations) also confound the discussion of results in the few existing studies, preventing the establishment of a cause-response relationship.

48. Chlorine is used in both desalination and power plants to prevent fouling. In RO plants the residual chlorine is oxidized to prevent damage to the membranes, in thermal desalination plants, as in power plants, residual chlorine may be discharged with the brine. Residual chlorine reacts swiftly with seawater to form toxic complexes such as bromoform (Taylor 2006) shown to accumulate in the liver of the european seabass, *Dicentrarchus labrax* . In the same study it was impossible to separate the effect of bromoform from temperature on *Mytilus edulis*.

49. Corrosion products (metals) from thermal desalination plants, in particular copper, a common material in heat exchangers, were shown to accumulate in the vicinity of outfalls. Many of the studies state that the presence of copper does not mean an adverse effect because copper is a natural compound found in nature (Lattemann and Hopner 2008). However, earlier studies found that copper affected echinoderms, tunicates and Florida seagrass and micro-organisms (Chesher 1971, Brand et al. 1986). Recently, higher than natural concentrations of copper and zinc in sediments and bivalves was reported at the brine discharge of two SWRO in Taiwan (Lin et al. 2013).

50. Sodium metabisulphite ($Na_2S_2O_5$) is commonly used in cleaning reverse osmosis membranes. Short-term pulses to the marine environment may result in acidification and hypoxia. Toxicity bioassays on the lizard fish *Synodus synodus* in the Canary Islands revealed a high sensitivity to short-term exposure to low concentrations, with total mortality occurring at higher concentrations (Portillo et al 2013).

51. The toxicity found during WET test on the diatom *Nitzschia closterium* was attributed to salinity (70% of the toxic effects) while 30% was attributed to the polyphosphonate antiscalant (Hobbs et al. 2008). In a recent mesocosm study in the Eastern Mediterranean, addition of phosphonate relieved immediately the phosphorus stress of the microbial community and in 10 days reduced bacterial diversity and increased eukaryotic diversity (Belkin et al. 2017).

52. Iron salts used a coagulants in the pre-treatment stage at the Ashkelon (Israel) SWRO and discharged in pulses at sea were found to decrease phytoplankton growth efficiency at the outfall in *in situ* studies while during a mesocosm experiment, the iron addition immediately altered the microbial community composition, enhanced the bacterial production and efficiency and decreased primary production. After 10 days, autotrophic biomass and assimilation number decreased compared to the reference (Drami et al. 2011, Belkin et al. 2017).

4.3. Emerging contaminants

53. The desalination industry is, as stated before, very dynamic, striving to improve yield, to reduce the amount of chemicals used in the process and discharged with the brine, and to use less hazardous substances (green chemistry). Therefore, it is hard to keep up with the changes and the environmental scientist should work in close cooperation with the desalination plants operators to be advised on the changes made in the process. For example, the Hadera (Israel) desalination plant now uses bioflocculation instead of coagulation with iron salts as a pre-treatment step and therefore iron is no longer discharged with the brine.

54. An additional hindrance is that many of the chemicals (mainly coagulants and anti-scalants) are protected by patents; therefore the exact composition is usually proprietary and cannot be divulged. In this case, the active compound should be identified and compiled together with its toxicological properties. It should be mentioned that known pollutants are also used in the process: such as acids, bases, cleaning solutions, metal salts as well as known corrosion products (metals).

55. Based on a review of existing technologies and state of play, the following contaminants emerge from desalination technologies:

Contaminants	Used/produced in desalination process	
	Membrane	Thermal
Fe salts, Al salts, organic polymers	Coagulant	Not used
Heavy metals Fe, Ni, Cr, Mo	Stainless steel Corrosion	Stainless steel Corrosion
Heavy metals Cu, Ni, Ti	Not relevant	Corrosion from heat
Chlorine, other oxidants	Biocide, Used but neutralized with bisulfite prior to disposal	Biocide Residual chlorine
Bisulfite	Biocide neutralizer	Not used
Polyglycol, detergents	Not Used	Antifoaming agent
Detergent, oxidants, complexing agents	Membrane cleaning	Not used
Polyphosphate, Polyphosphonate, organic polymers (polymaleic and polyacrylic acids)	Antiscalant	Antiscalant
Nutrients (phosphorus, nitrogen, carbon)	Antiscalant	Antiscalant
Alkaline solutions	Cleaning (neutralized prior to disposal)	Not used
Acidic solutions	Cleaning (neutralized prior to disposal)	Cleaning
	Not used	Corrosion inhibitors
Limestone ($CaCO_3$)	pH and hardness adjustor of produced water	pH and hardness adjustor of produced water
Salt	Brine	Brine
Temperature	Not applicable	Brine

5. Legal aspects of brine disposal, in relation to the amended LBS Protocol, as well as commitment to achieve Good Environmental Status based on the Ecosystem Approach.

5.1. The amended LBS Protocol and seawater desalination

56. The amended LBS Protocol states that point source discharges into the marine environment should be authorized or regulated and a system of inspection and monitoring put into place. It includes 4 annexes and although desalination is not named as one of the sectors of activity to be considered when setting priorities for the preparation of action plans, the principles outlined in them can be applied to the desalination industry.

i. Annex I lists 19 categories of substances and sources of pollution to be taken into account in the preparation of action plans, most of them relevant to desalination, such as organohalogen and nitrogen and phosphorus compounds, heavy metals, non-biodegradable detergents, thermal discharges, non-toxic substances that may have an adverse effect on oxygen concentration or on the physical and chemical characteristics of seawater.
ii. Annex II describes the elements to be taken into account in the issue of the authorizations for discharges of wastes and provides a check list to be used during the Environmental Impact Assessment procedure (EIA, see chapter 6).
iii. Annex III, atmospheric discharge touches the desalination industry only in the context of energy use and GHG emissions.
iv. Annex IV specifies the criteria for the definition of Best Available Technology (BAT) and Best Environmental Practice (BEP) (See chapter 6).

5.2. Implementing Ecosystem approach (EcAp) to achieve and maintain Good environmental status (GES)

57. The term Ecosystem approach (EcAp) was first applied in a policy context at the Earth Summit in Rio in 1992, where it was adopted as an underpinning concept of the Convention on Biological Diversity (CBD) (Beaumont et al. 2007, UNEP/MAP 2016) and defined as "a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way". The EcAp requires several elements, based on the DPSIR (driver, pressure, state, impact, response) conceptual framework (Farmer et al. 2012, Borja et al. 2016a, Borja et al. 2016b) :

i. defining the source of the pressures emanating from activities;
ii. a risk assessment and risk management framework for each hazard;
iii. a vertical integration of governance structures from the local to the global;
iv. a framework of stakeholder involvement; and
v. the delivery of ecosystem services and societal benefits (Elliott 2014).

58. It also requires and adaptive management to deal with the complex and dynamic nature of ecosystems and the absence of complete knowledge or understanding of their functioning.

59. Ecosystem Approach is the overarching principle of UNEP/MAP with the ultimate objective to achieve and maintain Good Environmental Status (GES) of the Mediterranean Sea and Coast (UNEP/MAP 2012, 2014a,b, 2016). This principle was incorporated into the work of UNEP/MAP through a series of decisions agreed upon at meetings of the Barcelona Convention COP:

60. Decision IG.17/6 set forth the ecological vision for the Mediterranean: "A healthy Mediterranean with marine and coastal ecosystems that are productive and biologically diverse for the benefit of present and future generations" and outlined a roadmap for the implementation of the Ecosystem Approach, setting out 7 steps including definition of vision and goals, development of 11 ecological objectives, operational objectives and respective indicators, the development of GES descriptors and targets, monitoring programs, and necessary measures to achieve GES. Decision IG.20/4 validated the work done regarding the 11 ecological objectives, operational objectives and indicators for the Mediterranean.

Decision IG.21/3 on the Ecosystems Approach adopted definitions of GES and agreed on regionally common targets and indicators. The latest development related to the implementation of the Ecosystem Approach in the Mediterranean is the adoption of Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and related assessment criteria (IMAP) by the COP 19 (Decision IG. 22/7).

61. The 11 Ecological Objectives are[10]:

i. Biodiversity is maintained or enhanced.
ii. Non-indigenous species do not adversely alter the ecosystem.
iii. Populations of commercially exploited fish and shellfish are within biologically safe limits.
iv. Alterations to components of marine food webs do not have long-term adverse effects.
v. Human-induced eutrophication is prevented.
vi. Sea-floor integrity is maintained.
vii. Alteration of hydrographic conditions does not adversely affect coastal and marine ecosystems.
viii. The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved.
ix. Contaminants cause no significant impact on coastal ad marine ecosystems and human health.
x. Marine and coastal litter does not adversely affect coastal and marine ecosystems.
xi. Noise from human activities cause no significant impact on marine and coastal ecosystems.

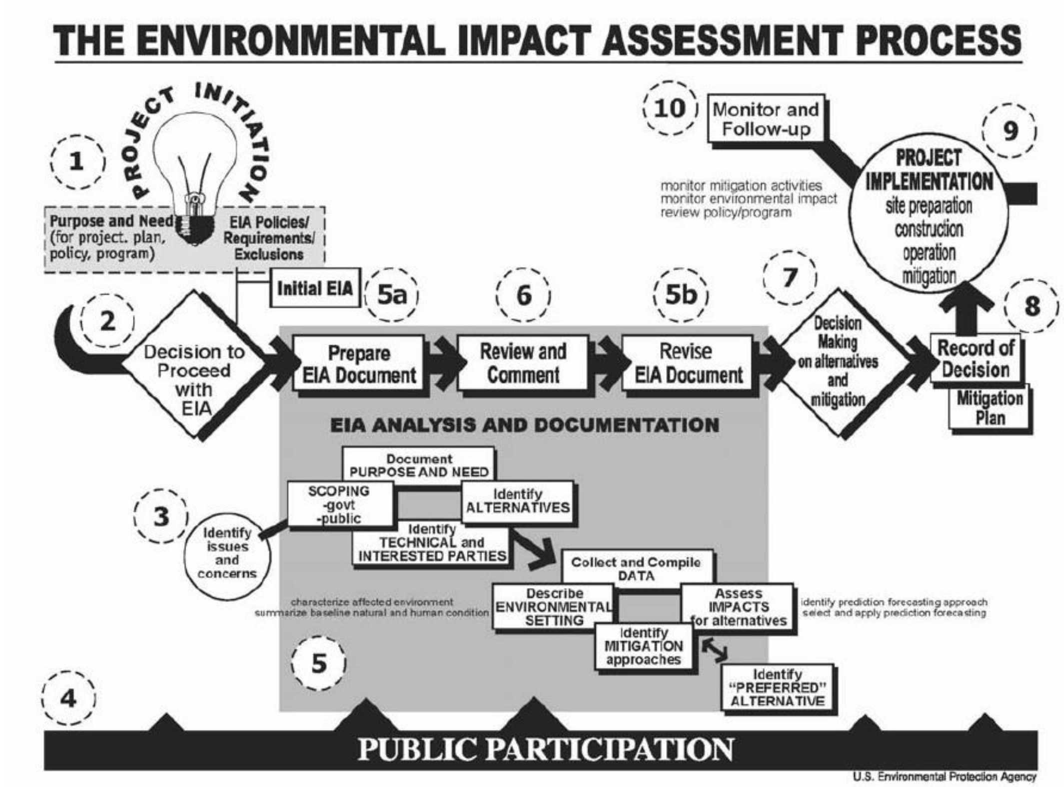
62. Most of the Ecological and Operational objectives are applicable to the desalination industry both at the intake and discharge sites (see chapter 4). Therefore, while examining and monitoring the disposal site, care should be taken to add the parameters that will help define the environmental status prior to the start of operations and to follow long term trends.

6. Environmental Impact Assessment (EIA)

63. Environmental Impact Assessment (EIA) is a process by which the anticipated effects on the environment of a proposed development or project are identified at the design and planning stages. If the likely effects are unacceptable, design measures or other relevant mitigation measures can be taken to reduce or avoid those effects. The EIA should be prepared by professionals and specialists in a multidisciplinary manner, and include engineers, environmental specialists, designers, and be performed within the national regulatory framework in conjunction with the decision makers. Stakeholders input

[10] http://web.unep.org/unepmap/who-we-are/ecosystem-approach

should be encouraged. The EIA procedure has been extensively described in UNEP's guidance manual published in 2008 (UNEP 2008). A succinct depiction of the EIA is given in the following diagram[11].



64. Below is a description of the suggested steps and emphasis for an EIA process concerning the desalination industry. It serves as a general guideline; it is not all inclusive and should be adapted based on the specifics of the project and location of the desalination plant.

6.1. Project description

65. A general description of the purpose and need of the project should be given at the beginning of the EIA document. It should include the following information:

- Proposed location of the desalination plant
- Co-location with other industries (such as power plants)

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11 https://nepis.epa.gov/Exe/ZyNET.exe/50000I6K.txt?ZyActionD=ZyDocument&Client=EPA&Index=1995%20Thru%201999&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&UseQField=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5CZYFILES%5CINDEX%20DATA%5C95THRU99%5CTXT%5C00000013%5C50000I6K.txt&User=anonymous&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=hpfr&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&slide

- The onshore and offshore components of the plant (buildings, pumps, pipelines, brine outfall), planned construction activities and timeline
- Connection to the water supply grid.

6.2. Technology selection and characterization of discharges

66. A detailed technological description of the chosen desalination process should be part of the EIA, including the rational for the choice. It should include the following information:

- The desalination technology chosen and engineering specifications
- Desalination capacity of the plant and future expansion plans
- Energy usage and source
- Area and method of source water intake (open intake, well intake)
- The treatment steps of the source water during the desalination process (among others the pre-treatment, biocide application, anti-scaling measures, cleaning stages, desalinated water treatment)
- Type of discharges and emissions (marine, terrestrial and atmospheric)
- Total volume of discharges and emissions (daily, yearly)
- Area and method of brine discharge (open discharge, co-discharge, marine outfall with or without diffusers)
- Brine discharge pattern (continuous, intermittent, variable)
- Physico-chemical characteristics of the brine (salinity, temperature, etc...)
- Concentrations and loads of discharged substances and their environmental characterization (such as persistent, toxicity, bioaccumulation)

6.3. Brine dispersion modeling

67. The EIA process in choosing the disposal site and methodology should be accompanied by modelling the dispersion of the brine. The models include, among others, near field and far field numerical modeling, circulation models, ecosystem models (Brenner 2003, Christensen and Walters 2004, Botelho et al. 2013, Purnama nd Shao 2015, Abualtayef et al. 2016)

6.4. Environmental setting description (terrestrial and marine)

68. Existing data on the land and marine habitat from the proposed planed desalination plant site, including the intake and discharge areas, should be compiled and critically analyzed. When no available data exist or when there are only partial or out of date data, surveys should be conducted prior to construction. The number of surveys and timing (i.e. seasonal) should be decided on a site specific basis. This information (compiled and/or new) will also provide a valuable reference (baseline) to be used for

environmental monitoring following the start of operations (see Section 7). It is important that the methodology used in undertaking baseline investigations is documented so that the results of later monitoring can be referenced.

6.4.1 Terrestrial environment description

- Physical landscape characteristics (soil, habitat, geology)
- Current uses
- Archeological and cultural value
- Environmental value
- Proximity to protected areas, occurrence of protected species in the area

6.4.2 Marine environment description

- Oceanographic conditions and water quality in the area
- Current uses
- Sediment composition and bathymetry
- Biota in the seawater and benthic compartments, including endangered and alien species, proximity to protected areas.

6.5. Assessment of possible impacts

69. Assessment of possible impacts should be performed based on existing literature and when needed, complemented with laboratory studies such as toxicity and whole effluent test (WET), mesocosm experiments. As noted in section 4, the effects of seawater desalination on the marine environment are not well documented although the number of publications and the awareness have been increasing in the past years. The impacts emanate during the construction activities at land (building the desalination facility, pumping stations, pipelines, connecting to infrastructure), during the construction activities at sea (installation of intake and outfall), and during the operational phase (feed water intake and brine discharge).

6.5.1 Possible impacts during the construction phase

70. During the construction phase, the possible impacts originate from the construction activities at land (building the desalination facility, pumping stations, pipelines, connecting to infrastructure) and at sea (installation of intake and outfall). Most impacts are localized and may cease after the construction phase but may be significant during construction (UNEP 2008, Lokiec 2013).

Terrestrial

- Alteration of the natural terrain
- Impact on flora and fauna
- Impacts of construction wastes and excess soil
- Soil and groundwater pollution (fuels, oil)

- Air pollution (dust emission)
- Noise emission during construction work
- Damage to archeologic values and natural preserves

Marine

- Alteration of seabed (composition and bathymetry)
- Sediment resuspension during marine works (increased turbidity)
- Release of nutrients and pollutants (if present) with sediment resuspension
- Impact on the benthic biota due to alteration of the seabed and on benthic and pelagic biota due to increased turbidity and pollutants
- Effect on sensitive marine life due to noise, vibration and light
- Oil pollution from ships involved in the construction works.

6.5.2 Possible impacts after start of operations

71. After start of operations the following impacts may occur:

Terrestrial

- Permanent alteration of the coastal habitat environment
- Aesthetic impact due to plant structure, and obstruction of free passage along the seashore due to the location of the plant, onshore pipelines and pumping station
- Emission of GHG and air pollutants in the case of power generation on site
- Noise and light pollution
- Accidental spillage or leakage of chemicals
- Solid waste and sanitary sewage

Marine

- Permanent alteration of the marine habitat
- Changes in hydrography and sediment transport
- Impingement and entrainment of marine biota
- Water quality deterioration and biological effects due to the discharge of brine and chemicals used in the desalination process.
- Facilitating the introduction of non-indigenous species due to changes in habitat, in particular increased salinity and temperature
- Noise and light pollution

6.6. Impact mitigation

72. The EIA should include a description of measures to be undertaken in order to avoid, and mitigate likely negative impacts of the desalination plant on marine and coastal environment. Below is a list of steps to be considered in this regard, during the construction phase and after the start of the operations.

6.6.1 Impact mitigation during construction

73. During construction stage the following steps should be considered to mitigate the possible impacts

- Use of environmental friendly construction methods, such a pipe-jacking instead of open trenches for the installation of pipelines
- Rehabilitation of areas affected during construction
- Design assuring minimal alteration of the natural environment
- Recycling of construction wastes
- Use of containment basins for fuel and oil tanks
- Surface wetting to prevent air pollution by dust.
- At sea, pipe-jacking (as far as possible from shore), and controlled dredging beyond microtuneling technique.
- Covering of the trench after pipeline installation and restoration of the original bathymetry

6.6.2 Impact mitigation after start of operations

Terrestrial

- Minimal energy consumption (power plant fueled by natural gas or renewable energy)
- Acoustic insulation and minimal external lighting
- Minimal use of process chemicals – safety measures for transportation, storage and handling, containers for solid waste and authorized landfill disposal
- Pipelines laid underground

Marine

- Intake and outfall pipelines below the seabed to minimize marine habitat alteration
- Slow suction velocity to prevent impingement (or well drilling)
- Self-cleaning traveling screen for debris collection at the intake system and disposal in authorized waste disposal sites
- Chlorine dosing (shock treatment) into the intake in the direction of the plant avoiding discharge to the sea

- Outfall diffuser system to increase initial dilution and reduce salinity and temperature, or in open discharge, dilution with co-discharge, i.e. cooling water of power plant
- Reduction of brine discharge, increased recovery
- Reduction of use of chemicals in the process
- Land based treatment of backwash
- Use of environmental friendly chemicals
- Treatment of limestone reactors washing together with backwash
- Neutralize inorganic membrane cleaning solution prior to discharge.

6.7. Best Available Technology (BAT) and Best Environmental Practice (BEP)

74. The best available technology and the best environmental practice are defined in Annex IV of the amended LBS Protocol as follows: BAT “means the latest stage of development (state of the art) of processes, of facilities or of methods of operation which indicate the practical suitability of a particular measure for limiting discharges, emissions and waste” and BEP “the application of the most appropriate combination of environmental control measures and strategies”.

75. These definitions were further addressed in the IPCC Directive to explain that "available" techniques shall mean those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages while "best" shall mean most effective in achieving a high general level of protection of the environment as a whole.

76. It is recognized that BAT and BEP change with time following technological and scientific advances and with changes in economic and social factors. This is true in particular for the desalination industry that is in a constant state of rapid improvement and change due to the large research and engineering effort put into technological development. Therefore, BAT and BEP processes should follow them closely in order to:

- Increase recovery rates (efficiency of desalination)
- Minimize energy and chemical consumption
- Replace chemicals, such iron salts coagulants, antiscalants, with more environmental friendly substances or with processes that do not require the use of chemicals
- Decrease discharges or increase near field dilution
- Reuse brine in novel desalination technologies to further increase freshwater yield
- Promote cleaner production

6.8. Sustainability

77. Sustainability integrates the evaluation of economic, environmental and social impacts in large projects, among them seawater desalination. The impacts are strongly interconnected and should be evaluated in an integrative way. The main goals are to save material and energy resources and reduce

waste. Sustainability analysis should be implemented in the planning and design of the project prior to its construction and operation (Gude 2016, Lior 2017).

78. The sustainability evaluation defines indicators that measure economic, environmental economic and social impacts, their relative importance (or weights) and if possible, computes a single composite sustainability index, aggregating the indicators and their relative importance. While the viability of desalination used to be judged mainly on economics and production reliability now it includes environmental and social aspects as well.

79. Following are some of the indicators and considerations that should be taken into account during a sustainability study.

i. Economics
- Water use and demand
- Cost of alternative water sources (conservation of natural resources, rain collection, water treatment and re-use, prevention of water waste due to leaks and faulty pipes, more)
- Total unsubsidized cost of the desalinated water.
- Energy source and process technology
- Labor operation and maintenance cost

ii. Environment
- EIA and BAT approaches
- Effects on feedwater and its domain (intake and brine discharge)
- Resource depletion (brackish water desalination)
- GHG emissions
- Transboundary pollutant transport (brine discharge)

iii. Social
- Impacts on human health (desalinated water quality)
- Land use and rapid unplanned local growth, without accompanying infrastructure
- Social acceptance, confidence in desalinated water supply
- Impact on water consuming sectors such as agriculture
- Impact on recreational activities or other legitimate uses of the sea and the coastline

7. Environmental Monitoring

80. Environmental monitoring is a legal requirement addressed in the amended LBS protocol (article 8) as well as a scientific requirement to follow possible impacts of seawater desalination on the marine environment. The environmental monitoring should follow the baseline survey performed during the EIA

(see paragraph 68) but not restricted by it. Monitoring during the construction phase will be different from the long term environmental monitoring needed during plant operations. There are a few publications addressing environmental monitoring at desalination plants (NRC 2008, UNEP 2008, Lattemann and Amy 2012). It is recommended to inform the relevant national authorities as soon as possible when deviations from the permitting conditions are observed during the monitoring survey.

7.1. Monitoring during the construction phase

81. Monitoring during the construction phase should be planned based on the possible effects originating from the construction activities in land and at sea (Section 6.5). The purpose it to assess if an activity is within acceptable impact and if not, introduce mitigation measures as soon as possible.

82. The terrestrial monitoring during construction should include:

i. Monitoring the disposal of construction wastes on site to prevent damage to land not within the area
ii. Monitoring accidental discharge of fuel, oil, other substances and dust, to prevent soil, atmosphere and ground water pollution
iii. Monitor noise and light levels and if needed, limit hours of operations
iv. At the end of construction, the area should be inspected to check if measures were applied to rehabilitate the area that no trenches were left open, that all non-permanent constructions were removed, etc.

83. The marine monitoring during the construction should include

i. Monitoring the water turbidity levels, and if above a pre-determined value, regulate dredging operations
ii. At sensitive areas were the sediments are suspected to be polluted, follow the release of pollutants into the water column
iii. Monitor noise, vibration and light levels that may be a hindrance to marine mammals and other sensitive marine life
iv. Monitor the sediment quality used to cover the pipelines, if not from local source
v. At the end of construction, all marine installations should be mapped in an updated bathymetry map.
vi. Seagrass and macroalgae beds should be monitored for recovery

7.2. Long term monitoring following start of operations

84. Regular monitoring of the marine environment following the start of plant operations should be a long term commitment, throughout the lifetime of the desalination plant and some years beyond, in line with the permitting conditions. These long term data series with proper controls are essential to normalize for natural temporal variability in order to prevent erroneous conclusions on the environmental effects of seawater desalination.

85. The monitoring plan should be based on the EIA document and other environmental management documents performed prior to the plant construction and in line with the permitting conditions. The monitoring data should be analyzed regularly and critically to allow for changes in the monitoring design when needed, to enforce permitting license requirements, and to require mitigation steps when effects are

deemed excessive. The data should be published and disseminated to the community to afford feedback to the regulators and scientist performing the monitoring.

86. Following are the general recommended components of a monitoring study. The specific monitoring should be adapted based on the environmental setting and sensitivity, the desalination technology, including the intake and brine discharge methods, and in accordance with international and national legislation and requirements. The monitoring program should be approved by the national regulators prior to its implementation.

7.2.1. Marine Sampling

87. *Sampling frequency and methods* should be decided based on the site-specific characteristics. It is recommended that at the beginning, monitoring should be conducted at least twice each year at relevant seasons (i.e, winter and summer or spring and fall). It is recommended to include additional surveys during plant cleaning operations.

88. *Sampling stations.* The initial design of the sampling stations should be based on the brine dispersion pattern obtained from the modelling results. Two sampling grids are required: one extensive grid of stations to follow and delimit the brine plume dispersion and spreading at the time of the survey (hereafter dispersion stations), and one smaller grid of stations to sample water, sediment and biota to assess the effects of brine discharge (hereafter sampling stations). The dispersion stations array should be flexible, and updated *in situ* based on the actual brine dispersion (as determined by seawater temperature and salinity measured during the survey) and/or following the examination of the monitoring data[12]. The sampling stations should be positioned in three general areas: impacted areas (within the mixing zone, where salinity and temperature are at the highest), affected areas (beyond the mixing zone but still under the influence of the brine) and reference areas (where no brine is present). Three to four stations are recommended to be sampled at each area.

89. The *Sampling vessel* should be equipped with accurate global positioning system and be able to accommodate the scientific instrumentation and personnel. During sampling a detailed log should be kept, including the survey date, name of participants, meteorological and sea state condition (air temperature, winds, currents, waves), the exact position of each station (latitude, longitude, depth), time that station was occupied and what was sampled, any unusual occurrence during sampling or at the sea.

90. *Parameters to be measured.* In general, the decision on the parameters to be measured should be based on the expected discharges from the desalination plant, identified in the EIA, and on the ecological and operational objectives and GES definition.

91. At the dispersion stations, continuous depth profiles of temperature, salinity, dissolved oxygen, fluorescence and turbidity should be measured.

92. At the sampling stations, three compartments will be sampled: seawater, sediment and biota.

[12] In situ monitoring stations with instruments recording temperature, salinity, dissolved oxygen and fluorescence should be considered. However it is recognized that this may be difficult to implement due to the high cost of the instrument and maintenance.

i. Seawater: The basic parameters include continuous depth profiles as in the dispersion stations, the concentration of suspended particulate matter, nutrients (nitrate, nitrite, ammonium, total nitrogen, phosphate, total phosphorus, silicic acid), metals, chlorophyll-a, substances discharged at sea and identified in the EIA. The following parameters of seawater biota are optional and should be considered based on the area characteristics: microbial population (phytoplankton and bacterial numbers) and composition, primary and bacterial production rates, zooplankton population (number and composition)[13].
ii. Sediment. The basic parameters include sediment size distribution (granulometry), heavy metal (such as mercury, cadmium, copper, zinc, iron, aluminum) and organic carbon concentration, in fauna community structure (number of specimens, taxonomic determination to the species level if possible)[14]. If the discharge area is rocky, the sessile population should be characterized and assessed. If the discharge area is located near seagrass and macroalgae beds, those should be also characterized and assessed.
iii. Biota. In addition to the parameters mentioned in the seawater and sediment samples, endangered species and invasive species identified in the EIA should be monitored.

93. _Sampling methods_ should be adequate to allow for the representative collection of the samples. *In situ* measuring instrumentation should be calibrated according to the manufacturer specifications.

94. _Sample collection._ Samples should be marked and assigned unique identifiers. On a long term monitoring program the same station will be occupied repeatedly, therefore the sampling date should be one of the identifiers to prevent confusion. The samples should be preserved adequately following sampling, during transportation and up to the measurement stage in the laboratory.

95. _Analytical methods._ The analytical measurements should be performed preferable by accredited laboratories, and if unavailable, by laboratories with quality control/ quality assurance methodologies. The analytical method chosen should be accurate and precise to allow for the assessment of the brine impact, and to follow temporal changes.

7.2.2. Monitoring report

96. The monitoring report should include:

i. An introduction describing the desalination plant technology, monthly production, intake and brine discharge (volume and composition), any malfunction that may have impacted the marine environment (such as unplanned discharge of solid material)
ii. A detailed description of the monitoring survey, including dates, sea state, sampling station locations, identity of samples taken at each station, sampling methods, sampling preservation methods and analytical methods
iii. Results, with tables of all the data collected in situ and in the laboratory
iv. Discussion, including maps of the brine dispersal, assessment of impacts based on the EIA and literature

[13] Genomic tools are seen as a promising and emerging avenue to improve ecosystem monitoring, as these approaches have the potential to provide new, more accurate, and cost-effective measures. The most promising is metabarcoding
[14] Genomic tools are seen as a promising and emerging avenue to improve ecosystem monitoring, as these approaches have the potential to provide new, more accurate, and cost-effective measures. The most promising is metabarcoding

v. Conclusions
vi. Recommendations for the continuing monitoring such as changes in station number and location, in parameters measured, in the frequency of sampling.

7.2.3. In-plant monitoring

97. In-plant monitoring should include water quality of the source water (seawater intake) and the volume and composition of the brine.

i. Seawater intake: Concentrate in parameters that may affect the desalination process and the quality of the desalinated water.
ii. Brine prior to disposal: Discharge volume, temperature, salinity, concentration of chemicals used in the desalination process and discharged with the brine.

Annex I
Questionnaire
Seawater desalination status in the Mediterranean Region

Questionnaire

Seawater desalination status in the Mediterranean Region

1. Introduction

Seawater desalination has for a long time been a major source of water in parts of the Mediterranean to meet water demands, supplying ca. 12 Mm^3/day desalinated water in 2013. The desalination effort is expected to continue to increase. The MED POL Programme of UNEP/MAP is assessing now the implementation of its desalination guidelines published in 2004 and evaluating the state of play of the desalination section in the Mediterranean. The purpose is to produce an updated guideline and provide the Contracting Parties with adequate technical guidance to reduce to a minimum all environmental impacts. For this we would appreciate your collaboration in completing this short questionnaire.

2. General Questions– Only for plants along or near the Mediterranean Coast

2.1. Country:

2.2. How many desalination plants are in operation in your country along or near the Mediterranean Coast? ________

2.2.1. How many plants desalinate seawater? ________

2.2.2. How many plants desalinate brackish water? ________

2.2.3. How many plants have a production capacity >50,000 m^3/day? ________

2.3. What is the total annual production of desalinated water? __________

2.3.1. What is the total annual production of desalinated water? __________

2.3.2. What is the actual total annual production originating from seawater desalination?

2.4. Are there more desalination plants at the planning/construction stage along the Mediterranean coast? __________

2.4.1. How many? __________

2.4.2. Total planned desalination production __________

2.4.3. Expected year for start of production __________

3. Detailed information for large size plants (>10,000 m^3/day, 3.65 Mm^3/year production) only along the Mediterranean Coast. (Please copy table for additional columns).

	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name	Plant Name
Name						
Year starting to operate						
Location[1]						
Desalination Technology[2]						
Production, m^3/day						
Method of brine discharge[3]						
Co- discharge with brine[4]						
Chemicals used in the desalination process[5]						
Coagulants						
Anti-Scalant						
Biocides						
Water Hardener						
Other						
Chemicals co-discharged with brine[6]						
Is there a marine monitoring program in place?						

[1]Location: city, area
[2]Desalination technology: **RO**-Reverse Osmosis, **MSF-** Multi Stage Flash , **MED -** Multi Effect Distillation, **Other** – please add technology
[3]Method of Brine discharge: **OD**-Open discharge, **MO-** Marine outfall, **Other** – please add details

[4]Co-discharge with brine: Other discharges, for example, cooling waters from Electric power stations
[5]Please name the chemicals: i.e Coagulants – iron salts **(FE)**; anti-scalant- polyphosphonates (Ppho), **If the identity of the chemical is unknown, please add yes or no**
[6]Please name the chemicals discharged with the brine

Annex II

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Appendix 5

Guide on the Selection of Best Available Techniques in Industrial Installations

Guide on the Selection of Best Available Techniques in Industrial Installations

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Tables

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List of Abbreviations /Acronyms

AEL	Associated Emission Limit
BAT	Best Available Techniques
BREF	Bat Reference Document
CE	Cost Effectiveness
EEA	European Environment Agency
EIPPCB	European Ippc Bureau
ELV	Emission Limit Value
EQS	Environmental Quality Standards
GHM	Good Housekeeping Measure
IED	Industrial emissions directive
IPPC	Industrial Pollution Prevention & Control
O/M	Operating Maintenance (Costs)
TOR	Terms of Reference
UO	Unit Operation
WHO	World Health Organization

Introduction

1. This Guide on BAT assessment aims to assist the permitting authorities of the UNEP/MAP contracting parties to extract and evaluate the necessary information contained in the complex BREF documents in order to assess the information provided by the applicants for IPPC permits concerning BAT introduction in industrial installations. On the other hand the guide will also help the applicants to justify in their IPPC application the reasons why they have selected the respective BAT for each case.

2. It is based on a methodology for BAT assessment and contains 5 phases/15 steps to be followed in order to justify the finally selected BAT for each industrial process (unit operation).

3. At the end of the description of each phase of the methodology (1 – 5) a "checklist" of tasks to be performed by the operator (submitting the application) and the permitting authorities summarizes the "things to do".

4. The Guide should be seen as a "pathway" to be followed when the information contained in a submitted application has to be checked by the permitting authorities in order to understand why/in which way the applicant (i.e. the industrial operator) has proposed specific BAT; on the other hand it will help the operators to select from various complex literature sources those BAT which apply best for their specific situation without losing too much time by examining the vast number of BAT contained in these sources. In this context it must be mentioned that the main literature source about BAT are the BAT Reference Documents (BREF) prepared by the European IPPC Bureau (EIPPCB).

Phase 1 - Framework of BAT analysis (baseline)

Step 1 – Inventory of main pollutants

Rationale

5. Potentially harmful substances emitted into the environment from each unit operation of an industrial installation have to be classified and estimated. This first analysis gives an insight into the environmental "importance" of the installation as a whole and of the respective unit operations in particular.

6. It is important to allocate the emissions from all production steps; therefore an analysis of the emissions of **each separate** Unit Operation (UO) **and not of the installation as a whole** (cumulative emissions) has to be elaborated and the relevant emissions registered.

7. As **main (priority) pollutants** are meant those main parameters which are classified as **air emissions** and **wastewater discharges**. In cases where the prescriptions of local Environmental Quality Standards (EQS) ask for additional parameters, these ones have also to be considered as priority pollutants. Additionally **solid waste quantities** generated during a production process are also considered as priority pollutants.

8. Necessary data for the inventory of the main pollutants.

9. In the following tables examples of priority pollutants (air emissions, effluent discharges) and the data needed are listed. Solid waste types depend entirely on each industrial production process and have to be listed accordingly whereas the parameters for air emissions/effluent discharges are mostly common in all processes.

10. The notations “Before Treatment (BT)” and “After Treatment (AT)” respond to situations where either treatment facilities already exist or are planned to be installed. These treatment facilities should not be connected with BAT: they are considered as “end-of-pipe” techniques in existing industrial installations (wastewater treatment plants, filters/cyclones etc.).

11. For new (planned) installations which are subject to a permit, the notation AT is not applicable at this stage: Step 1 aims to find out which UO contribute more to the installation’s pollution loads emitted/discharged into the environment without any “intervention” (i.e. end-of-pipe treatment) so that these UO have to be prioritized for BAT selection (Steps 4 + 5).

Table 1: Emissions to air

UO name	**UO number**	**Duration of operation: daily/annually (h)**	**Pollutant**	**Concentration BT / AT (mg/m^3)**	**Quantity BT / AT (g/s) / (t/year)**
			SO_2		
			Other S compounds		
			NO_x		
			Other N compounds		
			CO		
			VOC		
			Metals		
			Metals compounds		
			Fine particulate matter		
			Asbestos suspended particulates		
			Asbestos fibers		
			Cl		
			Cl compounds		
			F		
			F compounds		
			As		
			As compounds		
			CN		
			Substances / mixtures possessing carcinogenic/ mutagenic properties		
			Polychlorinated dibenzodioxins		
			Polychlorinated dibenzofurans		

Table 2: Effluent discharges to surface/ground water

UO name	UO number	Point of discharge (SW, S/GW,TP)*	Wastewater quantity (m^3/day)	Pollutant	Concentration BT / AT (mg/l)	Quantity BT / AT (kg/day)
				Organohalogen compounds		
				Organophosphorus compounds		
				Organotin compounds		
				Substances / mixtures possessing carcinogenic/mutagenic properties		
				Persistent hydrocarbons and persistent and bioaccumulable organic toxic substances		
				CN		
				Metals		
				Metals compounds		
				As		
				As compounds		
				Biocides		
				Suspended solids		
				Nitrates		
				Phosphates		
				BOD_5		
				COD		

*SW = Surface Water, S = Soil, GW = Ground Water, TP = Treatment Plant

Table 3: Waste quantities

UO name	UO number	Waste generated (description)	Waste classification	Hazardous / non-hazardous	Quantity (kg/day)	Disposal / Recycling (according to Annex I + II of the Waste Framework Directive)

How the pollutants quantities/concentrations will be assessed?

12. For the most effective selection of BAT (Steps 5, 6 and 7) it is preferable, at this stage, to leave aside from the analysis any “end-of-pipe” techniques which are already used in **existing** installations: their inclusion and the related quantitative assessment of the finally released waste streams (after treatment) can mislead the decisions to be taken at a later stage (for BAT introduction) because the problem of the “in-situ” generation of waste streams (i.e. by the production process) will not be revealed to its full extent if they will be pre-treated at any stage before being finally emitted into the environment.

13. For **existing** installations the monitoring records for air emissions, wastewater discharges and solid waste give reliable information about the quantities and the pollutants released into the environment in both cases (before/after treatment). In cases where monitoring/treatment devices are installed at the exit of some UO (e.g. if significant air emissions are channeled via a bag filter through a chimney in the atmosphere) then the **inputs** to the monitoring/treatment devices will be considered as UO’s **outputs**.

14. For **new** installations where monitoring records do not exist yet, load coefficients (kg and m^3 of pollutants/kg of product) for several industrial sectors can be applied for a first approximation of the relevant quantities. The produced values are obviously not as accurate as those coming out from the monitoring records; however they allow a good insight into the magnitude of the environmental emissions **(rapid assessment)** and the prioritization of those UO which are of high environmental “importance”.

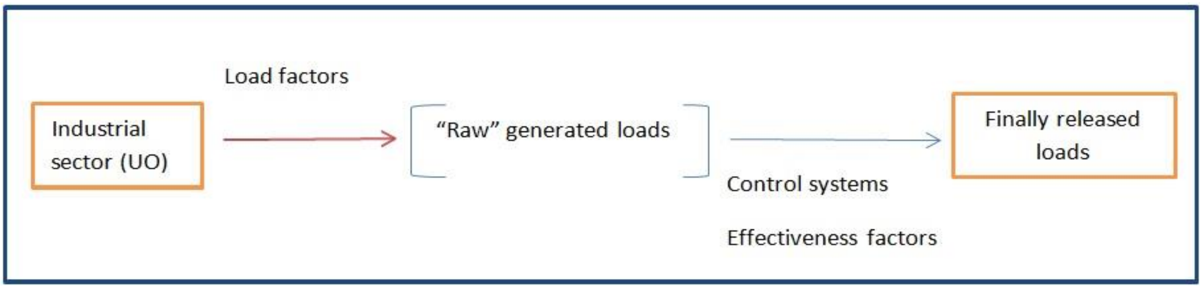

Figure 1: Rapid assessment scheme

15. The World Health Organization (WHO) has produced sets of pollution load factors for several industrial sectors (Rapid Assessment of sources of air, water and land pollution, World Health

Organization, 1993) which can be used as a basis for the calculation of the estimated quantities of air emissions, effluents and solid waste quantities coming out from the relevant sectors.

16. Alternatively the technical prescriptions of the equipment of each UO, except of the basic parameters (water/energy usage, temperature, chemicals, raw materials), shall include information about its environmental performance, so that the operator knows by purchasing the equipment what is expected to be emitted into the environment. The provision of this information is an important criterion to be considered during the market research for the equipment purchase.

An industrial production process is schematically presented in figure 2.

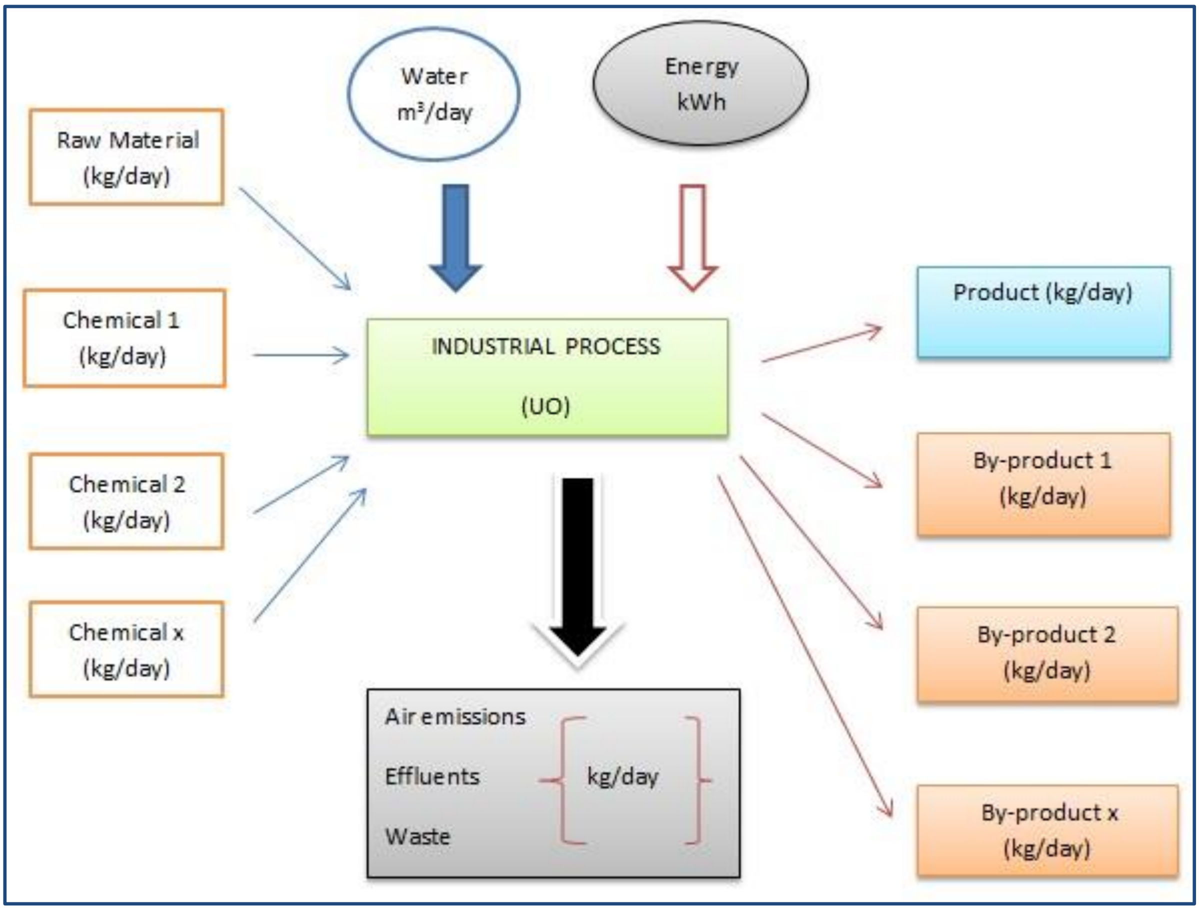

Figure 2: Scheme/flow diagram of an industrial production process/UO

17. A **mass balance flow** will allow the definition of quantities which leave the production process as a pollution stream (air emissions, effluents, waste).

Example:

Total inputs = mass $_{\text{raw material}}$ + mass $_{\text{chemical 1}}$ + mass $_{\text{chemical 2}}$ + mass $_{\text{water}}$

kg/day = 10,000 + 500 + 300 + 1,000

= 11,800 kg/day

Total outputs = mass $_{\text{product}}$ + mass $_{\text{by-product1}}$ + mass $_{\text{by-product2}}$ + mass $_{\text{wastewater}}$

Kg/day = 8,000 + 300 + 100 + 800

= 9,200 kg/day

Total quantity of pollutants (air emissions, effluents, waste) produced:

Total inputs – total outputs = 11,800 – 9,200 = 2,600 kg/day

(Note: The calculation of the effluents quantity occurs by multiplying the concentration of pollutants expressed as mg/l with the wastewater quantity expressed as m^3/day).

18. This mass balance analysis gives a reliable first assessment of the "intermediate" emissions by each UO: inputs/outputs for this mass balance analysis are measureable and can be quantitatively assessed.

Step 2 – Assessment of the Environmental Quality Standards (EQS) in the region

Rationale

19. Local factors, such as proximity of the installation to particularly sensitive receptors, existing air/water quality standards and the conditions of the water resources in the area can have a significant influence on the BAT techniques and options to be chosen and on the level of pollution control required for the industrial activity concerned. The aim of Step 2 is to identify whether there are any local sensitivities to emissions from the industrial installation although at this stage only a qualitative response is needed. Further scientific investigation may be carried out (Step 10 – BAT options) depending on the magnitude of risk to the receiving environment.

20. Existing EQS (ambient air standards, quality of water recipients, underground water quality, soil conditions) in the region where the installation is operating should be reviewed in order to assess which of them are in danger to be negatively influenced in conservation or achievement of the environment quality standards by the various discharges from the installation.

21. At this level the EQS and the associated Emission Limit Values (ELV) will not be reviewed and eventually modified; they are taken as granted and as basis for the prioritization of those pollutants emitted from an installation which, in addition to existing emissions from other installations in the same geographical area, can negatively affect the environmental quality of the water recipients, the soil, the ambient air.

Actions to be taken

22. Existing EQS and the related ELV for the area will be reviewed by the permitting authorities in order to list those pollutants emitted by the installation which as first priority have to be reduced. This review should be accomplished in light of the **actual situation** namely whether, in the time elapsed between initially setting the EOS, some more industrial facilities (and other pollution sources such as agricultural farms etc.) have been installed in the area and the cumulative quantities emitted/discharged by them will in the near future endanger the maintenance of the quality of the ambient air, water bodies and soil even if the set ELV are met: it is possible that, due to many activities in the area, the ELV for the particular installation has to be more strict (compared to those ones for the other installations in the area).

23. Actions to be taken by the **permitting authorities**:

Water

1. Assessment of the monitoring records (from the monitoring stations) in the particular geographical region where the **effluents** of the industrial installation are supposed to be discharged:

For

Water recipients (rivers, lakes, ground water)

Resulting in

EQS + ELV inventory in the area

2. Inventory of existing industrial and other sources of water pollution in the area

3. Priority pollutants as potential risks (generated by the candidate installation) - **Water**

Air

4. Assessment of the monitoring records (ambient air monitoring stations) in the particular geographical region where the industrial installation is/will be located
5. Review/evaluation of the ELV of all stationary air emission sources in the area

6. Priority pollutants as potential risks (generated by the candidate installation) – **Air**

Soil

7. Review/assessment of any studies (scientific, technical) prepared by institutions/universities on soil conditions in the area where the industrial installation is/will be located
8. Inventory of the conditions of waste disposal (controlled/uncontrolled landfills) in the area
9. Assessment of eventual risks to the soil quality if the installation's waste quantities are disposed in the area

24. Setting of priorities for waste types to be treated/disposed – **Soil**

Tasks to be performed by the **operators** are summarized in table 4. The submitted information will be validated by the permitting authorities and taken into consideration when the existing EQS are evaluated (underlined text describes needed amendments of the application form).

Table 4: Operators' tasks for Step 2

Recipient	**Action**
Water (surface/ground)	1. Presentation of the situation of the surface/ground water quality (incl. the hydrological conditions) 2. Comparative review of the prescribed allowed concentrations for each polluting substance in the ground and surface water 3. Cumulative list of the points of discharge, together with the maps, drawings and the adjoining documentation 4. Detailed list of hazardous substances to be discharged into ground and surface water 5. Cumulative data and impact assessment of the existing or proposed emissions into the aquatic environment i.e. surface and/or ground water 6. Full data on the assessment and other relevant information on the recipient as well as the usual water quality analyses at the recipient point, i.e. the water body.
Air	1. Presentation of the situation of the air quality (including the meteorological conditions and factors) 2. Comparative review of the prescribed allowed concentrations for each polluting substance in the air 3. Cumulative list of point source emissions 4. Full data on atmospheric dispersion modelling of the emissions 5. Cumulative data on fugitive sources of pollution, the control measures and information on their environmental impact 6. Control measures that planned in the future (equipment, control parameters, limit values, types of measures, validity, time of measurement, sampling, measurement points distribution, frequency, method of analysis etc.).
Soil	1. Comparative review on the presence of hazardous and harmful substances in the

	soil, as well as morphological characteristics of the superficial soil layer including current/potential emissions from the installation 2. Comparative review of the prescribed allowed concentrations for each polluting substance in the soil according to existing standards (legislation) 3. Cumulative overview of data on superficial and ground contamination on the location or under it (including data sets of research studies, assessments or reports, monitoring results, location and measuring equipment, plans, drawings and other adjoining documentation) 4. Cumulative data on all direct emissions of hazardous substances on land/soil 5. Full data on the location of discharge (including maps, drawings and the adjoining documentation) 6. Information about the type of processing and the waste quantities and location of deposition in the geographical area concerned 7. Description of existing controlled or uncontrolled landfills in the area where the installation's waste quantities will be disposed.

For the qualitative assessment of the potential risks for the local environment a checklist of basic questions/responses should be finally prepared by the **authorities** as follows:

Table 5: Checklist (authorities)

Local environment	**Question**	**Response (YES/NO)**
Air quality	Are there any Environmental Quality Standards relating to substances released from the installation which may be at risk due to additional contribution from the installation?	
	Are there any sensitive groups of population e.g. schools or hospitals in the area?	
Water quality	Are there any Environmental Quality Standards relating to substances released from the installation which may be at risk due to additional contribution from the installation?	
	Is the installation located in a groundwater vulnerable zone?	
	Are groundwater reservoirs used for drinking water uptake in the area which can be affected from the installation's activities?	
Soil conditions	Are there any sensitive agricultural areas or wildlife habitats, e.g. Special Areas of Conservation, or Special Protection Areas, likely to be affected by releases from the installation?	
	Are there any controlled/ uncontrolled landfills which will be used for disposal of solid wastes from the installation?	

25. On the basis of the collected and revised information and the responses of this checklist a **qualitative** assessment of the risks for the local environmental conditions is possible which allows the permitting authorities to set the priorities for the reduction of the pollutants generated by the installation. At this stage the above mentioned analysis is focusing on the current status of the emissions from existing installations i.e. without any BAT implementation so far (Step 10).

Step 3 – Prioritization of pollutants and emissions

Rationale

26. Based on the outcomes of Steps 1+2 a list of "priority" pollutants (**emission indicators**), which have the potential to break existing or envisaged EQS, will be established. These pollutants will be correlated with the relevant sources (UO) in the production process ("weak spots").

27. This list will give an insight into those UO which have to be prioritized for BAT introduction thus enabling primarily the permitting authorities to focus on those spots in the production process which cause the major environmental concern; on the other hand the operators will be able, on the basis of this "weak spot prioritization" to plan the necessary investments as well as to negotiate with the authorities a gradual adoption of the prescribed Emission Limit Values (ELV) if necessary.

Actions to be taken

28. Tables 1, 2 and 3 (Step 1) have to be re-arranged in such a way that the priority pollutants in qualitative (hazardous substances) and quantitative (volume of emissions/wastewater, quantities of emitted substances) terms are listed in a descending order. The dominating factor to prioritize the pollutants will be their **cumulative quantity emitted:**

Quantity (tn/day) = Volume (m^3/day) X Concentration (kg/m^3)

29. The priority list of pollutants will be given to the operators by the **authorities** and its correlation with the relevant UO will be performed by the **operators.**

Step 4 – Analysis of each production process/unit operation (UO)

Rationale

30. For each unit operation – "weak spot" an analysis of the production process will be conducted in terms of **process design** (e.g. needs for changes or replacements of processes/equipment), **selection of inputs (**e.g. raw materials, water/energy usage), **process control (**e.g. process optimization), **good housekeeping type measures (**e.g. cleaning regimes, improved maintenance), **non-technical measures (**e.g. organizational changes, staff training, introduction of environmental management systems), **emitted pollutants.** This analysis will show the potential for improvement of each UO and consequently where/how to search in the relevant BREF to find the most appropriate BAT.

31. This analysis is the most important step towards the introduction of BAT in an industrial installation and it is of the operator's own interest to perform it because it helps allocating those production units which generate "pollution": one must be aware that pollutants emitted into the environment are, to a large extent, raw materials/chemicals/water/energy which could not be fully used in the manufacturing process and therefore they comprise "lost money".

Points of analysis of an industrial process – UO

32. Industrial **processes** are procedures involving chemical or physical steps needed for the manufacture of a product, usually carried out on a large scale.

33. This Step 4 is entirely relying on the competences of the **operators** who know best the respective production processes, the equipment/devices applied, the process arrangements etc. Therefore only some general “hints” can be given here which can be used as **starting points** for the further investigation of the industrial processes. In doing so and for the purposes of this Guide an analysis of the basic features of each process/UO has to be accomplished in terms of:

- Equipment used for the production
- Civil/mechanical engineering devices
- Quality/quantities of raw materials and chemicals
- Water quantity used in the process (industrial water)
- Energy input and types of energy sources used.

34. As basic tools for this analysis the **mass balance flow** (see Figure 2 in Step 1), the **equipment’s technical specifications** and **literature references** (see Figure 1 in Step 1) should be taken into consideration. In any case however, the operator’s **own experience** is the most important “tool” for the assessment of the processes’ technical performance**.**

1. The focus of this analysis will be the allocation of those points in each process where pollutants are generated **(waste streams).** These waste streams can either be:
- Further processed (downstream) or
- Inevitably released into the environment (air emissions, effluents, waste)

2. For the most effective selection of BAT (Steps 5, 6 and 7) it is preferable, at this stage, to leave aside from the analysis any “end-of-pipe” techniques which are already used in **existing** installations: their inclusion and the related quantitative assessment of the finally released waste streams (after treatment) can mislead the decisions to be taken at a later stage (for BAT introduction) because the problem of the “in-situ” generation of waste streams (i.e. by the production process as such) will not be revealed to its full extent if they will be pre-treated at any stage before being finally emitted into the environment.

Tasks of operators

3. The following checklist (Table 6) can be used by the **operators** for each UO. The pollutants (types, quantities) emitted have to be registered for those responses where an assessment of the pollutants is feasible.

Table 6: Checklist for operators ("weak spots")

Question	**Response (YES/NO)**	**Comments / Explanations**	**Pollutants generated (air emissions, effluents, waste)**	**Quantity of pollutants – measured/estimated (kg/day)**
Is the configuration of the process' modules arranged according to the manufacturer's instructions?				
Have any design's modifications occurred? If YES, for which reasons?				
Are there any improvements occurred from these modifications?				
Are there any corrective measures planned to overcome any malfunctions of the process? If YES, specify the achieved improvement of the process features (in environmental terms i.e. less use of water/ energy)				
Has the equipment being installed/ operated according to its technical specifications?				
Any changes/ modifications occurred? If YES, specify the achieved improvements				

Question	**Response (YES/NO)**	**Comments / Explanations**	**Pollutants generated (air emissions, effluents, waste)**	**Quantity of pollutants – measured/estimated (kg/day)**
Is the equipment regularly checked for defects, leakages?				
Is maintenance performed regularly according to the equipment's specifications?				
Are the quantities of raw materials, water, chemicals, energy introduced in the production process **(inputs)** according to the technical prescriptions? If NO, specify the reasons and the achieved improvements in the production process				
Are measured/ weighted quantities of raw materials, chemicals, water registered? If NO, specify why				
Is the less polluting energy source used for the production e.g. natural gas? If NO, specify why				
Is the energy input measured? If NO, specify why				
Which process **outputs** (products, by-products,				

Question	Response (YES/NO)	Comments / Explanations	Pollutants generated (air emissions, effluents, waste)	Quantity of pollutants – measured/estimated (kg/day)
air emissions, effluents, waste) are measured? If NO, specify why				
Is there any management system (i.e. EMAS, ISO 14000) applied in the industry?				
Is regular training of the process personnel organized?				

35. The responses to be listed above will help the operators to allocate potential points of process improvement which can be simple, low-cost but effective e.g. detection of leakages, possibilities of cooling water recycling. It is advisable that these "small-scale" **good housekeeping measures** should be implemented immediately namely before searching for greater process interventions i.e. BAT introduction.

Phase 1 – Summary of tasks (Steps 1 – 4)

36. The tasks for the authorities and for the operators are summarized in table 7.

Table 7: Tasks for operators/authorities - Summary (Phase 1)

Step	Operators	Authorities
Inventory of main pollutants + prioritization of pollutants/ emissions + correlation with UO **(Steps 1 + 3)**	Prepare tables 1 + 2 + 3	1. Check If all expected priority pollutants for air emissions and effluent discharges are included in the tables submitted by the operator 2. Cluster the air emissions/effluent discharges/waste quantities in a descending order (quantities/hazardousness of pollutants)

Step	Operators	Authorities
		3. Correlate UO with the clustered pollutants 4. Prepare a priority list of UO according to point 2
Review of Environmental Quality Standards (EQS) in the region **(Step 2)**	Prepare table 4	1. Evaluate monitoring records (ambient air + water quality) 2. Review existing ELV for air emissions + effluents from all pollution sources in the area 3. Make an inventory of all pollution sources in the area 4. Review of any studies on soil conditions in the area where the industrial installation is/will be located 5. Assess the conditions of waste disposal (controlled/uncontrolled landfills) in the area 6. Assessment of eventual risks to the soil quality if the installation's waste quantities are disposed of in the area 7. Make a list of priority pollutants (air, water) as potential risks for EQS 8. Set priorities for waste types to be treated/disposed of
Analysis of each production process /unit operation **(Step 4)**	Prepare table 6	Prioritize those UO which are "weak spots" and should be subject for BAT introduction

Outputs of Phase 1

4. By completion of Phase 1 the following outputs will be produced:
1. A list of priority pollutants which can endanger the local EQS
2. A priority list of UO for BAT introduction which generate high pollution loads
3. A set of information of "weak spots" in each UO e.g. high energy consumption/water usage
4. Based on 1-3, a set of intervention points (BAT search)

5. Phase 1 is considered as the **baseline** for the BAT assessment and gives the necessary information for a targeted BREF search.

Phase 2 – List of candidate BAT

Step 5 - Correlation of candidate BAT with “weak spots”

Rationale

37. The aim of Step 5 is to perform an effective search in the BREF documents in such a way that the most appropriate BAT for each “weak spot” can be found and duly described in order to be a candidate for the final selection. This search will allow the operators to find from the extensive BREF information those BAT which fit into their own requirements and leave aside incomplete, badly documented or very sophisticated techniques/technologies which, although technically “correct”, do not respond in the simplest possible way with the needs and actual conditions prevailing in each industry: it must be clear that the selection of candidate BAT without taking into consideration the local circumstances can end into a failure of the BAT operation when installed.

38. Step 5 is the basis for the further “downstream” analysis (Steps 6 to 10) because it will provide the “matrix” for the evaluation of each BAT technical, economic and environmental characteristics and thus its viable/sustainable introduction in the industrial production processes.

Find the “weak spots” of a UO in the BREF documents

39. Although there is no standard form of information in all BREF the following major chapters are at least contained:

1. Industry overview
2. Environmental issues
3. Applied production processes (UO) and techniques
4. Associated emissions into the environment from each UO
5. Techniques to consider in the determination of BAT
6. Environmental and technical characteristics of proposed BAT (sometimes economic issues are also included).

40. In each BREF the relevant unit operations (UO) of the industrial sector concerned are described in the first chapters (before embarking to BAT description at a later stage); therefore each operator can find if the particular UO is included in the BREF. This first insight into the BREF (and the allocation of the UO) will be the “road map” for the further BREF investigation.

41. BREF chapters 1 – 4 define the UO and the associated air emissions, effluents and wastes. The operator can then verify to which extent the UO -“weak spot” is matching with the usual emissions generated in similar cases.

List the candidate BAT for each UO

42. BREF chapters 5 and 6 are focusing on the candidate BAT for each UO and comprise the “heart” of the BREF by delivering various **BAT options** to mitigate the emissions from each particular UO. Therefore, after having found that the sequence of UO is described in these BREF chapters, the relevant BAT should be listed.

43. At this stage a first “screening” of the candidate BAT according to some qualitative criteria can be done (Step 6).

44. This basic information can be summarized in Table 8 and has to be undertaken by the **operators**. The respective citation in the BREF chapter should also be included so that the **authorities** can track the "logic" behind the selection of the final BAT options. If for each UO more than one BAT options exist the relevant cells of the following tables have to be modified accordingly by adding the needed rows.

Table 8: List of candidate BAT options

Source (UO) of pollutants (name, number)	Pollutants (kg/ton)	Candidate BAT (BREF citation: chapter/page)	BAT-associated emission limit (AEL) (kg/ton, mg/Nm^3)	Reduction of emissions expected if BAT is applied (%)
UO 1				
UO 2				
UO x				

Step 6 – Clustering of candidate BAT

Rationale

45. Having in mind that the criteria for BAT selection are aiming at the use of pollution prevention measures instead of end-of-pipe technologies, the candidate BAT should be clustered according to these criteria as well as to the extent of the reduction of the "priority" pollutants.

46. Therefore this BAT clustering allows the grouping of BAT options according to their preventive nature, simplicity, use of less resources and the envisaged reduction of the "priority" pollutants.

47. Step 6 is closely related with Step 5, both can be combined in one common Step.

How to cluster/group the candidate BAT

48. A checklist (Table 9) will allow the **operators** to group the BAT according to:
- The relevant UO where the BAT is applicable
- The types and quantities of emissions (air, water, waste) expressed as BAT- AEL

- The achievable reduction of the "priority" and other (if applicable) pollutants
- The preventive nature (resource consumption, low-waste production)
- The simplicity for installation/operation (e.g. good housekeeping measures)
- The related environmental impacts and eventual trans-boundary effects after BAT introduction

49. At this stage a rather **qualitative** approach is preferable because it gives the "flavor" of the possible interventions without a lengthy analysis of all BAT options and eventually will allow the "screening-out" of those options which, from a first insight, do not meet the set requirements or does not match the local conditions (e.g. BAT is too complex). The **quantitative** analysis of the BAT environmental parameters, which is the major factor to decide about the applicability of a BAT, will follow at a later stage (Steps 7 – 8).

50. BAT clustering can be accomplished in 2 ways:
For each UO (table 9) or
For each "priority" pollutant emitted from all UO if those pollutants are emitted from different UO (table 10)

51. The candidate BAT (and the associated emission limit – AEL) should be in both cases listed in a descending order according to the expected reduction of the "priority" pollutants (column 7 in tables 9 and 10).

Table 9: Clustering of candidate BAT - UO

UO	Candidate BAT	Good housekeeping measure (GHM)/major intervention	Preventive / End-of-pipe	Emissions expected (air, water, waste)	BAT-AEL (kg/ton, mg/Nm^3)	Reduction of emissions expected if BAT is applied (%)
UO 1						
UO 2						
UO x						

Table 10: Clustering of candidate BAT - "Priority" pollutants

“Priority” pollutants	UO	Candidate BAT	Good housekeeping measure (GHM)/major intervention	Preventive /End-of-pipe	BAT-AEL (kg/ton, mg/Nm^3)	Reduction of emissions expected if BAT is applied (%)
Air emissions						
SO_2						
Other S compounds						
NO_x						
Other N compounds						
etc.						
Wastewater discharges						
Organohalogen compounds						
Organophosphorous compounds						
Organotin compounds						
etc.						
Waste generation						

Step 7 – Assessment of inputs/outputs of candidate BAT

Rationale

52. After the completion of the preparatory Steps 5 and 6 the relevant inputs/outputs for each candidate BAT will be assessed, prioritized and registered. This final Step of Phase 2 completes the assessment of candidate BAT by giving a **quantitative** basis for the final evaluation of their environmental performance which will follow (Steps 8 + 9) and allows a first insight into the expected achievements, in terms of environmental benefits (resource conservation, reduced emissions into the environment), if the BAT will be introduced in the industrial production processes. Figure 2 can be taken as a "guide" for this analysis.

Which inputs should be assessed

- ✓ Raw materials (ton/day)
- ✓ Chemicals/other additives (kg/ton of raw material)
- ✓ Water consumption (m^3/day)
- ✓ Energy usage (kWh/day)

Which outputs should be assessed

- ✓ Air emissions (mg/Nm^3)
- ✓ Wastewater (effluents) discharges (kg/ton of raw material or mg/l)
- ✓ Waste (kg/ton)
- ✓ Products (ton/day)
- ✓ By-products (ton/day)

53. The above mentioned information is summarized in table 11 (for each UO).

Table 11: Candidate BAT - Inputs/outputs

UO				
INPUTS	**BAT 1**	**BAT 2**	**BAT 3**	**BAT X**
Raw materials (ton/day)				
Chemical 1 (kg/ton of raw material)				
Chemical 2 (kg/ton of raw material)				
Chemical x (kg/ton of raw material)				
Water (m^3/day)				
Energy (kWh/day)				
OUTPUTS				
Products (ton/day)				
By-product 1 (ton/day)				

UO				
By-product 2 (ton/day)				
By-product x (ton/day)				
	BAT 1-AEL	**BAT 2-AEL**	**BAT 3-AEL**	**BAT x-AEL**
Air emissions **(kg/ton, mg/Nm^3)**				
SO_2				
Other S compounds				
NO_x				
Other N compounds				
etc.				
Wastewater (kg/ton, mg/l)				
Organohalogen compounds				
Organophosphorus compounds				
Organotin compounds				
etc.				
Wastewater quantity (m^3/day)				
Waste (kg/ton)				

Phase 2 – Summary of tasks (Steps 5 - 7)

6. The tasks for the authorities and for the operators are summarized in table 12.

Table 12: Tasks for operators/authorities - Summary (Phase 2)

Step	Operators	Authorities
Correlation of candidate BAT to each UO **(Step 5)**	Prepare table 8	Check BAT-AEL for each candidate BAT according to BREF citations (provided by the operator – table 8)
Clustering/grouping of candidate BAT **(Step 6)**	Prepare tables 9 + 10	
Registration of inputs/outputs of each candidate BAT **(Step 7)**	Prepare table 11	

Outputs of Phase 2

54. By completion of Phase 2 the following outputs will be produced:

1. A list of candidate BAT for all “problematic” UO aiming at the reduction of the respective “priority” pollutants containing
    - BAT-AEL
    - Level of reduction of the “priority” (and other) pollutants and
    - Inputs (raw materials, chemicals, water, energy) for each candidate BAT
    - Outputs (products, by-products, air emissions, effluents, waste quantities) for each candidate BAT

Phase 3 – Evaluation of environmental performance of candidate BAT

Step 8 – Comparison/benchmarking of BAT outputs to “old” emissions

Rationale

55. The assessment of the achievable reduction of the pollutants of the conventional (“old”) production processes-UO has to be documented in order to find out to which extent the introduction of the respective BAT would significantly (or not) reduce the emissions of the existing/non-BAT process: the analysis performed so far (Steps 5 – 7) has allowed a first “screening” of possible candidate BAT whereas Step 8 will document the achievable results by detailed comparison of the existing processes to the envisaged BAT so that the prioritization of the candidate BAT according to their “capability” to reduce the “priority” and other pollutants to the desirable level can be accomplished.

How to compare “new” with “old” emissions

56. The BAT-AEL stated in the relevant BREF citations have to be compared with any monitoring records (for existing installations) or figures derived from load coefficients referred in the literature (for new installations).

57. In doing so, the tables 9, 10 and 11 have to be re-shuffled accordingly so that the indicated expected reduction of the emissions (Steps 5 and 6) can be now documented for each UO (table 13). BAT-AEL are usually expressed in ranges (lower – upper figures), therefore the “conventional” emissions should be expressed either as average or as maximum/minimum values (deriving from existing monitoring results).

Table 13: Comparison of existing emissions to BAT-AEL

UO	Value	BAT 1-AEL	Reduction (%)	BAT 2-AEL	Reduction (%)	BAT X-AEL	Reduction (%)
Air emissions (kg/ton, mg/Nm^3)							
SO_2							
Other S compounds							
NO_x							
Other N compounds							
etc.							
Wastewater (kg/ton, mg/l)							
Wastewater quantity (m^3/day)							
Organohalogen compounds							
Organophosphorus compounds							
Organotin compounds							
etc.							
Waste (kg/ton)*							

*State any recycling options for solid waste quantities

58. After having completed this Step a clear picture of those candidate BAT will arise which allows the pre-selection of those BAT by which the highest possible reduction of emissions can be achieved. Within this context a **combination** of candidate BAT by which several emissions from one UO can be reduced (or the same pollutants from more than one UO) is possible.

59. A **ranking** of all available BAT options shall now be established **preferably referring to the "priority" pollutants** instead to the UO (where the BAT will be applied to). This ranking is presented in table 14.

Table 14: Ranking of BAT options according to outputs

"Priority" pollutant	**Ranking**	**Candidate BAT option (name, number)**	**UO (name, number)**	**Achieved reduction of pollutants (%)**
Air emissions **(kg/ton, mg/Nm^3)**				
SO_2				
Other S compounds				
NO_x				
Other N compounds				
etc.				
Wastewater (kg/ton, mg/l)				
Wastewater quantity (m^3/day)*				
Organohalogen compounds				
Organophosphorus compounds				
Organotin compounds				
etc.				
Waste (kg/ton)**				

* State any recycling options for liquid waste quantities
**State any recycling options for solid waste quantities

Step 9 – Comparison/benchmarking of BAT inputs to the conventional process

Rationale

60. By applying some of the candidate BAT high environmental performance can be achieved by reducing the consumption of water/energy, the use of chemicals etc.: as a matter of fact, pollution is to a large extent loss of resources which were not used in the production process.
Therefore a thorough investigation of the inputs prescribed for each BAT is of high interest for the **operators** because, besides the good environmental results (expected), the lower consumption of resources leads to cost savings; on the other hand this perspective is interesting also for the **permitting authorities** because they can assess whether some preventive criteria (use of low-waste technology, the consumption and nature of raw materials/water used in the process and energy efficiency) has been

duly addressed by the operators in order to apply an economically sustainable BAT: obviously BAT using less resources are economically more sustainable than other techniques which are not associated with this aspect.

61. Therefore the analysis of BAT inputs is important allowing putting those candidate BAT which achieve good AEL results combined with the rational consumption of the resources (inputs) on a high priority.

How to compare BAT inputs to those of the conventional process

62. The first part of table 11 has to be re-shuffled accordingly (Table 15). As a change/modification is meant any reduction of quantities used in the conventional process and/or change of raw materials/chemicals etc. It should be expressed in % of reduction and/or description of the new materials used (if any).

Table 15: Comparison of inputs (conventional process – BAT)

UO	Value	BAT 1	Change/ modification	BAT 2	Change/ modification	BAT X	Change/ modification
Raw materials (ton/day)							
Chemical 1 (kg/ton of raw material)							
Chemical 2 (kg/ton of raw material)							
Chemical X (kg/ton of raw material)							
Water (m^3/day)							
Energy (kWh/day)							

Steps 8 + 9 Formation of BAT options

Rationale

63. It is obvious from the above analysis that both aspects (reduction of emissions + reduced use of resources) are quite important, so that they have to be compared and, if possible, combined. Therefore the results of the analysis in Steps 8 and 9 have to be assessed by trying to formulate those BAT options which primarily reduce significantly the releases into the environment and secondly are using less resources/produce less waste quantities. As a matter of fact those BAT which use less resources most probably generate less emissions: **both aspects, reduction of emissions (outputs) and of the use of resources (inputs), form the core of the BAT selection process.**

How to rank BAT options

64. In table 16 the final ranking of the BAT options ready for pre-selection is presented (ranking criteria: 1 - reduction of emissions, 2 - reduction of inputs). BAT options which combine **both criteria** are ranked on the 1st place followed by those causing less environmental emissions without any significant changes concerning inputs.

Table 16: Ranking of BAT options – environmental performance

Ranking	BAT	Pollutants reduced (name, % of reduction)	Raw materials savings (type, % of reduction, substitution of materials)	UO (1 or more UO addressed by the respective BAT)

Step 10 – Assessment of the potential risk to harm EQS

Rationale

65. The conclusions from Step 2 (affordable pollutants' concentrations to maintain the existing EQS) will be taken into consideration when the candidate BAT's outputs will be evaluated, namely to which extent existing EQS are better served when the respective BAT will replace/supplement the conventional production process and allow the emission of less quantities of pollutants.

66. This analysis will provide a clear picture of the environmental performance of all candidate BAT and distinguish those which achieve the best results.

67. This Step can become very complex since, from a scientific point of view, a quantification of the environmental impacts (to be caused by the emitted pollutants) should be undertaken

The BREF on economics and cross-media effects gives an insight on methodologies for the quantification of the environmental impacts.

68. Having in mind that this Guidance document aims to describe a simple/comprehensive methodology on how BAT can be selected (by the operators) and evaluated (by the permitting authorities), the analysis on BAT impacts is kept to a minimum level: the same tasks as in Step 2 will be undertaken by the operators and the authorities by highlighting only those changes in emissions which are eventually caused by the candidate BAT i.e. if a pollutant emitted so far will be "replaced" by another one.

How the potential risks will be assessed when BAT options will be applied

69. The tasks described in Step 2 for the **operators** will be supplemented for the emissions coming out from all those BAT options deriving from the analysis of Steps 8 + 9. Therefore table 4 has to be modified as follows (in bold letters):

Water

Point 3

- List of **new** points of discharge **(where BAT are installed)** together with the maps, drawings and the adjoining documentation

Point 4

- Detailed list of hazardous substances **(if others than those emitted from the conventional processes)** on discharge into ground and surface water

Point 5

- Cumulative data and impact assessment of the **BA**T emissions to the environment i.e. surface and/or ground water – **BAT process contribution compared to the conventional process (% of increase/decrease of emitted pollutants)**

Air

Point 3

- Cumulative list of **BAT** point source emissions **- BAT process contribution compared to the conventional process (% of increase/decrease of emitted pollutants)**

Point 4

- Full data on atmospheric dispersion modelling of the **BAT** emission

Point 6

- Control measures that planned in the future (equipment, control parameters, limit values, types of measures, validity, time of measurement, sampling, measurement points distribution, frequency, method of analysis etc.) **for the BAT emissions**

Soil

Point 4

- Cumulative data on all direct **BAT** emissions of hazardous substances on land/soil

Point 5

- Full data on the location of discharge **of BAT waste quantities** (including maps, drawings and the adjoining documentation)

Point 6

- Information about the type of processing and the waste quantities and location of deposition **of BAT waste quantities** in the geographical area concerned.

In table 17 these changes (bold) are summarized.

Table 17: Operators' tasks for Step 10

Recipient	Action
Water (surface/ground)	1. Presentation of the situation of the surface/ground water quality (incl. the hydrological conditions) 2. Comparative review of the prescribed allowed concentrations for each polluting substance in the ground and surface water 3. List of **new** points of discharge (**where BAT are installed)** together with the maps, drawings and the adjoining documentation 4. Detailed list of hazardous substances **(if others than those emitted from the conventional processes)** 5. Cumulative data and impact assessment of the **BA**T emissions to the environment i.e. surface and/or ground water – **BAT process contribution compared to the conventional process (% of increase/ decrease of emitted pollutants)** 6. Full data on the assessment and other relevant information on the recipient as well as the usual water quality analyses at the recipient point, i.e. the water body.
Air	1. Presentation of the situation of the air quality (including the meteorological conditions and factors) 2. Comparative review of the prescribed allowed concentrations for each polluting substance in the air 3. Cumulative list of **BAT** point source emissions **- BAT process contribution compared to the conventional process (% of increase/decrease of emitted pollutants)** 4. Full data on atmospheric dispersion modelling of the **BAT** emissions 5. Cumulative data on fugitive sources of pollution, the control measures and information on their environmental impact 6. Control measures that planned in the future (equipment, control parameters, limit values, types of measures, validity, time of measurement, sampling, measurement points distribution, frequency, method of analysis etc.) **for the BAT emissions**.
Soil	1. Comparative review on the presence of hazardous and harmful substances in the soil, as well as morphological characteristics of the superficial soil layer including current/potential emissions from the installation

	2. Comparative review of the prescribed allowed concentrations for each polluting substance in the soil according to existing standards (legislation) 3. Cumulative overview of data on superficial and ground contamination on the location or under it (including data sets of research studies, assessments or reports, monitoring results, location and measuring equipment, plans, drawings and other adjoining documentation) 4. Cumulative data on all direct emissions of hazardous substances on land/soil 5. Full data on the location of discharge (including maps, drawings and the adjoining documentation) 6. Information about the type of processing and the waste quantities and location of deposition in the geographical area concerned 7. Description of existing controlled or uncontrolled landfills in the area where the installation's waste quantities will be disposed.

70. The tasks of the **authorities** will be to compare the data of table 17 with those of table 4 and to review table 5 to check whether the introduction of BAT in an installation has significantly altered the prevailing environmental conditions in the geographical area concerned.

Phase 3 – Summary of tasks (Steps 8 – 10)

71. The tasks for the authorities and for the operators are summarized in table 18.

Table 18: Tasks for operators/authorities - Summary (Phase 3)

Step	Operators	Authorities
Comparison of existing emissions to BAT-AEL **(Step 8)**	Prepare table 13	
Ranking of BAT according to outputs **(Step 8)**	Prepare table 14	
Comparison of inputs of conventional process to BAT **(Step 9)**	Prepare table 15	
Ranking of BAT options **(Steps 8 + 9)**	Prepare table 16	Check the compliance of BAT ranking (table 16) to the data of tables 13, 14, 15.
Assessment of potential risks of BAT emissions to EQS **(Step 10)**	Prepare table 17	Compare table 4 to table 17 to assess the expected changes of emissions according to the proposed BAT options.

Outputs of Phase 3

72. By completion of Phase 3 the following outputs will be produced:

1. A list of candidate BAT options pre-selected according to their environmental importance (reduction of emissions, reduced use of resources)
2. A list of the UO which the candidate BAT options can be applied to
3. A report about the expected impacts of BAT emissions to the environment (water, air, soil)

In figure 3 a summary of the procedures presented so far (Phase 3) for the pre-selection of the candidate BAT is schematically presented.

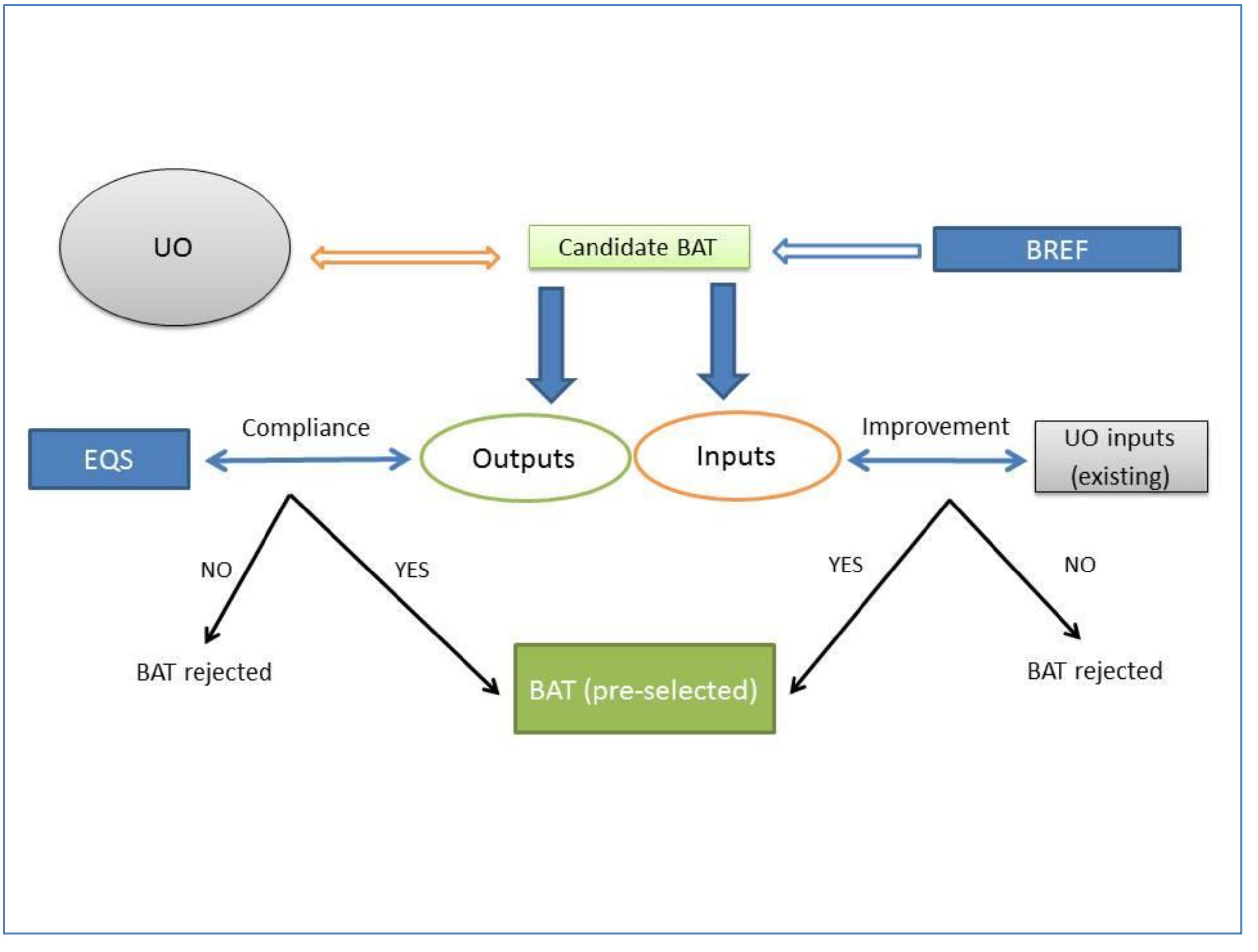

Figure 3: Pre-selection of candidate BAT

Phase 4 – Evaluation of the technical performance of candidate BAT

Step 11 – Analysis of the technical characteristics of candidate BAT

Rationale

73. Any technique can be easily rejected and not considered as a BAT if, despite its excellent environmental characteristics (i.e. reduction of outputs/inputs), it is not technically mature to be adopted by an operator: the danger that it will not perform properly in a large industrial scale is a major constrain for any final decision about BAT selection.

74. Therefore only those candidate BAT have to be adopted for further investigation which can prove their technical sustainability.

75. In this Step an assessment of the technical characteristics of each candidate BAT has to be performed in order to get a first insight about the technical character of the BAT e.g. whether it is simple/complex in operation or whether major technical interventions are needed for its introduction in the existing production process.

76. This analysis is important for **existing** as well as for **new** installations: whereas in the first case (existing installations) the technical modifications needed for replacing/supplementing existing equipment are crucial since they define the magnitude of interventions/investments, for new installations a clear picture of the BAT technical characteristics allows the operators to plan the whole production chain (i.e. the sequence of the UO) in advance of any other technical (or other) interventions (e.g. construction works, setting of canalization devices etc.).

Which technical characteristics must be examined

77. Besides the process inputs/outputs which have already been examined (raw materials, chemicals, water, energy/products, environmental parameters, heat release) the following technical characteristics of the candidate BAT have to be described:

- ✓ Process flow/parameters (hydraulic flow, temperature/heat exchange, cooling devices etc.)
- ✓ Types of equipment
- ✓ Type/magnitude of technical modifications in the existing production process needed for BAT introduction (mechanical/civil engineering issues)
- ✓ Operational requirements (manpower, training, recruitment of new personnel, any changes in the daily work, safety considerations)

78. This is an "internal" task of the **operators**: it is in their own interest to find out whether the candidate BAT can perform the assigned technical requirements in a full scale operation and under the "classical" industrial conditions (non-stop operation, alterations in process feeding, exploitation of full capacity of equipment over long/short periods etc.).

79. For the analysis of the technical characteristics a checklist has to be prepared by the operator which will be used as a general "guide" for the examination of the technical characteristics of the envisaged BAT options. In doing so, any technical description mentioned in the relevant BREF/literature will be the starting point whereas additional inquiries may be needed by direct correspondence with the BAT inventors and/or users.

Table 19: BAT technical characteristics - Checklist for operators

Analysis of: (sections - tables of application form)	**Question**	**Response (YES/NO)**	**Description/Comments**
Process design	Is the BAT configuration (i.e. sequence of UO) different in comparison to the conventional process?		
	If YES, describe the new configuration of UO (process flow)		
	Basic BAT technical features (describe if different of the conventional process - NEW installations: describe accordingly)		
	Heating/cooling system?		
	Feeding devices of inputs (raw materials, chemicals)?		
	Special storage devices for raw materials/chemicals needed?		
	Water feeding system?		
	Energy source?		
	Collection, treatment/ recycling of wastewaters?		
	Collection, treatment/ recycling of solid waste?		
Equipment	**BAT Equipment (describe if different of the conventional process –NEW installations: describe accordingly)**		
	Major devices?		
	Major auxiliary equipment (e.g. pumps)?		
	Electro-mechanical modifications?		

Analysis of: (sections - tables of application form)	Question	Response (YES/NO)	Description/Comments
	Civil engineering interventions?		
Operation	**BAT operational requirements (describe if different of the conventional process - NEW installations: describe accordingly)**		
	Training needs of equipment's operators?		
	Monitoring requirements of emissions?		
	New staff needed?		
	Safety requirements?		

Step 12 – Assessment of the technical viability of candidate BAT

Rationale

80. After the technical characteristics of the candidate BAT are assessed (Step 11) a further analysis is needed in order to find out whether the proposed BAT are technically viable or not.

81. This assessment is important not only for the **operators** (for obvious reasons) but also for the **permitting authorities**: it is in their interest to secure that the BAT will continuously be operated and not that, after some time, it will be left aside due to malfunctioning, technical complexity etc.

How the technical viability of candidate BAT will be assessed

82. The operator has to prepare a summary on the technicalities associated with each candidate BAT highlighting the major technical features (as described in table 19) and defining the "character" of each one of them. The following criteria should be taken into consideration in order to convince the permitting authorities that the proposed BAT are technically mature and ready for application:

1. The use of low-waste technology
2. The use of less hazardous substances
3. The potential for recovery and recycling of substances generated and used in the process and of waste, where appropriate
4. Comparable processes, facilities or methods of operation which have been tried with success on an industrial scale
5. Technological advances and changes in scientific knowledge and understanding
6. The nature, effects and volume of the emissions concerned

7. The commissioning dates for new or existing installations
8. The length of time needed to introduce the best available technique
9. The consumption and nature of raw materials (including water) used in the process and energy efficiency
10. The need to prevent or reduce to a minimum the overall impact of the emissions on the environment and the risks to it
11. The need to prevent accidents and to minimize the consequences for the environment
12. Information published by public international organizations
13. The simplicity of operation (e.g. good housekeeping measures) if applicable.

83. The major technical features assessed during the implementation of Step 11 (table 19) will be the "inputs" for checking the compliance of each candidate BAT with the above mentioned criteria (table 20).

Table 20: Technical viability of candidate BAT

Candidate BAT	Advantages (in comparison to the conventional process)	Disadvantages (in comparison to the conventional process)	Comments/Conclusions
Process design			
BAT configuration (i.e. sequence of UO)			
Heating/cooling system			
Feeding devices of inputs (raw materials, chemicals)			
Specific storage devices for raw materials/chemicals			
Water feeding system			
Energy source			
Collection, treatment/ recycling of wastewaters			
Collection, treatment/ recycling of solid waste			
BAT Equipment			
Major devices			

Candidate BAT	**Advantages (in comparison to the conventional process)**	**Disadvantages (in comparison to the conventional process)**	**Comments/Conclusions**
Major auxiliary equipment (e.g. pumps)			
Electro-mechanical modifications			
Civil engineering interventions			
BAT operational requirements			
Training needs of equipment's operators			
New staff needed			
Monitoring requirements of emissions			
Safety requirements			

Table 21: Ranking of BAT options - technical viability

Ranking	**BAT**	**Compatibility with the simplicity criterion (installation/operation)**

Phase 4 – Summary of tasks (Steps 11 – 12)
The tasks for the authorities and for the operators are summarized in table 22.

Table 22: Tasks for operators/authorities - Summary (Phase 4)

Step	Operators	Authorities
Analysis of the technical characteristics of each candidate BAT **(Step 11)**	Prepare table 19 for each candidate BAT	
Assessment of the technical viability of each candidate BAT **(Step 12)**	Prepare table 20 for each candidate BAT	
Ranking of BAT options on the basis of technical characteristics **(Step 12)**	Prepare table 21	Check tables 20 + 21 to assess the compatibility of the proposed BAT with set criteria

Outputs of Phase 4

84. By completion of Phase 4 the following outputs will be produced:

1. A list of pre-selected BAT containing the main technical characteristics of each one of them
2. A “preference” list of those BAT which show the best compatibility with the set criteria i.e. simplicity of operation, use of low-waste technology etc. (ranking of BAT).

Phase 5 – Evaluation of the economic viability of candidate BAT

Step 13 – Calculation of investment costs for the introduction of candidate BAT

Rationale

85. The selection of a BAT inevitably goes finally through a thorough investigation of the associated costs for its introduction in an existing industrial process or when a new installation is planned: in many cases high investment costs can prohibit the introduction of a very promising BAT (from the technical and environmental point of view). Therefore the assessment of the costs related to the investment needed for the introduction of a BAT is, to a certain extent, the most decisive factor for the final selection of a BAT.

86. Although this analysis has to be performed entirely by the **operators**, its outcomes cannot be overlooked by the permitting **authorities** since in most cases this point is the most difficult issue to be tackled when BAT-AEL (and consequently ELV) are proposed by the operator (and accepted by the permitting authorities) for a specific industrial process: usually operators refer to the high investment costs of associated with a BAT introduction in the production process which would endanger the economic sustainability of the industry when they have to negotiate with the authorities about the introduction of “strict” ELV. Therefore a solid analysis of the economical parameters is needed so that the relevant arguments can be subject of a well-documented discussion.

87. It must be pointed out that within the framework of this Guide, only indications and general instructions on how to proceed with cost estimations are given since a detailed economic/cost analysis

is beyond the scope of this document. More detailed information dealing with cost validation, pricing of equipment, documentation about data uncertainty etc. can be found in various literature sources and especially in the BREF on Economics and cross-media effects and in the EEA report Guidelines for defining costs of environmental protection measures.

Which costs can be considered as investment costs

88. As investment (or capital) costs are meant the costs for **the purchase of equipment, construction of devices (civil/mechanical engineering services) and the modification of existing unit operations** (not relevant for new installations). When these costs have to be calculated a list of the relevant items has to be conducted as follows:

Major components
- ✓ Reactor vessels
- ✓ Furnaces boilers
- ✓ Turbines
- ✓ Treatment plants

Intermediate components
- ✓ Heat exchangers/cooling systems
- ✓ Filters
- ✓ Handling equipment
- ✓ Other pollution control equipment

Minor components
- ✓ Motors
- ✓ Drives
- ✓ Burners

Buildings/construction (civil engineering)
- ✓ Building where the BAT should be placed
- ✓ Storage devices for raw materials and chemicals (buildings, coverage etc.)
- ✓ Site preparation (e.g. excavations)
- ✓ Arrangements on existing devices (floors, coverage of equipment, canalization etc.)

Other components
- ✓ Purchase of land
- ✓ Land clean-up (if appropriate)
- ✓ Design/planning of works/hiring of consultants

89. Cost data can be obtained from a variety of sources but whatever the source, the user (operator) needs to think critically about the validity of the data since costs/prices can vary over time and location of the installation. In any case the cost data has to be as representative as possible for the specific case (industrial process – BAT concerned). In any case the data should be well documented and their sources registered and reported. In this context it must be pointed out that **confidentiality** of information must be always secured in any case of information exchange e.g. between the operator and the permitting authorities.

90. Possible sources of cost data can be:

- Industry (i.e. installations which have applied the same/similar BAT), e.g. construction plans, documentation of industrial projects, permit applications of similar BAT, cost estimates for comparable projects in other industries or sectors
- Technology suppliers, e.g. catalogues, tenders of BAT manufacturers/suppliers
- Consultants specialized in BAT assessment
- Research groups, e.g. demonstration programs of BAT applications in similar industries
- Published information e.g. reports, journals, websites, conference proceedings.

Which factors have to be considered when investment costs are evaluated/assessed

91. Some important factors which have to be considered when the investment costs of a BAT option will be calculated are given below as indication/advice to the operator for further and more detailed investigation of cost factors:

- Technological solutions **already available on the market** are easier to be economically assessed and evaluated from those which are still on a semi-industrial scale development level or implemented in a specific geographical area). In the latter cases a direct contact with the BAT suppliers/users have to be envisaged in order to understand the specific circumstances and conditions associated with the BAT applications and to carefully evaluate whether the costs estimations can be also applied in their own case.

- The **base case** namely the existing industrial production system (i.e. UO, equipment, buildings, existing pollution abatement systems etc.) has to be the reference on which all cost comparisons should be based when the costs for the introduction of a BAT option are evaluated: As a matter of fact all costs should be measured in relation to an alternative. The alternative most commonly employed is a projection of the existing situation, i.e. the situation in which the BAT option has not been yet installed (base case):

    - Will there be additional costs in the future for the modernization of the installation (e.g. because some of the equipment has to be replaced or new end-of-pipe treatment facilities have to be installed)?
    - Can any forthcoming environmental standards be met by the existing installation without any change of the process?
    - Are there any plans for new products? And if yes, is the existing production process capable to fulfill the relevant quality standards?

92. Therefore, the additional costs actually incurred relative to the base case should be compared with the costs needed to apply the proposed BAT and thus form the decisive factor to understand the magnitude of the investment costs required.

- The **life time** of facilities and of main/auxiliary equipment is an important factor to be considered when cost estimations are made. This factor defines the physical but also the economic life (i.e. depreciation) of buildings, equipment etc. so that any cost calculation should not exceed this time frame. Some indications about life time of facilities/equipment are given in table 23.

Table 23: Life time of facilities/equipment

Facilities/equipment	Life time (years)
Buildings	20
Major components (e.g. reactor vessels, furnaces, boilers, turbines, effluent treatment plant)	15
Intermediate components (e.g. heat exchangers, filters, handling equipment)	10
Minor components (e.g. motors, drives, burners)	5

- The **base year** namely the year when the BAT investment will be implemented has also to be defined. This year will define on the one hand the prices/costs for equipment purchase and the construction works as well as the level of depreciation of the "base case".

- **Discounting** is another factor to be taken into consideration by economic calculations: it is the mechanism whereby costs that accrue at different points in time are weighted to facilitate comparison (EEA report Guidelines for defining costs of environmental protection measures p. 20, BREF on economics and cross-media effects p.46). It states for example that the value of EUR 1 today will be different to the value of that same EUR 1 in one years' time due to inflation and prices changes. A discount rate has to be defined (usually based on official economic/statistical figures) which will be used as basis to calculate the "discounted" capital cost. It should be as close to the reality as possible and the information source where the discount rate is derived from has also to be stated. A simple example of the meaning of discount is presented in table 24.

Table 24: Discount rates (Example)

Year	**0**	**1**	**2**
Capital expenditure (€)	2000	2000	2000
Discount rate (%)		10	10
Value today (€)	2000	2000 x 0.9 = 1800	2000 x 0.9 x 0.9 = 1620

- **Inflation/interest** rates and **taxation** are factors which have also to be taken into consideration by a serious economic analysis of investment costs. Usually they are considered at the final stage of the economic analysis.

93. A checklist of the investment (capital) costs is given on table 25. It has to be prepared for each pre-selected candidate BAT option for which the environmental performance and technical viability have been proven so far (up to Step 12).

Table 25: Checklist - capital costs of a BAT option

COST COMPONENT	Included in capital costs (YES/NO)	Costs (€/$/national currency)/ % of capital costs	Year of purchase
Major equipment			
Reactor vessels			
Furnaces			
Boilers			
Turbines			
Pollution control equipment			
Instrumentation			
Installation costs			
Land purchase			
Site preparation			
Buildings and civil works (e.g. foundations, piping, canalization etc.)			
Labor and materials (engineering, construction and field expenses)			
Other capital costs			
Project definition, design and planning			
Testing and start-up costs			
Contingency			
Working Capital			
Clean up costs			
TOTAL CAPITAL COSTS		**€/$/national currency**	

Step 14 – Calculation of the operational costs for the introduction of candidate BAT

Rationale

94. The whole concept of BAT introduction is focused, besides the better environmental performance, in the possibility of cost savings through reduced inputs in the production process. It is expected that they are lower than those of the conventional process and can be reflected as cost savings in the operating costs component. Therefore the calculation of the operating and maintenance costs is a crucial factor for the final selection of the relevant BAT options by giving a first insight into the cost saving potential of the candidate BAT option and the possibility for the investment's amortization in the (near) future.

Which are the operational costs of a BAT?

95. An indicative list of the main items defining the **operating and maintenance (O/M) costs** is given below:

Energy costs - purchase and use of

- Electricity
- Petroleum products
- Natural gas
- Coal or other solid fuels

Materials and services costs

- Replacement (spare) parts
- Chemicals
- Water usage
- Environmental services such as waste treatment and disposal services

Labor costs

- Operating, supervisory, maintenance staff
- Training of the above staff

Fixed O/M costs

- Insurance
- License fees
- Emergency provisions
- Other general overheads

How O/M costs should be classified and calculated

96. In table 26 a checklist of the O/M costs is given. The checklist should be prepared by the operators for each pre-selected candidate BAT option for which the environmental performance and technical viability have been proven so far (Step 12).

Table 26: Checklist - operating costs of a BAT option

COST COMPONENT	Included in O/M costs (YES/NO)	Quantity - Unit (No of staff/man-hours, tons of water etc.)	Costs/unit (€/$/national currency)	Total Cost (€/$/national currency) per year/% of total operating cost	Year
Existing situation					
Labor costs					
Operating, supervisory, maintenance staff					
Training of the above staff					
Energy costs					
Electricity					
Petroleum products					
Natural gas					
Coal or other solid fuels					
Materials and services costs					
Replacement (spare) parts					
Chemicals					
Water usage					
Environmental services such as waste treatment and disposal services					
Fixed O/M costs					
Insurance					
License fees					

COST COMPONENT	**Included in O/M costs (YES/NO)**	**Quantity - Unit (No of staff/man-hours, tons of water etc.)**	**Costs/unit (€/$/national currency)**	**Total Cost (€/$/national currency) per year/% of total operating cost**	**Year**
Existing situation					
Emergency provisions					
Sanctions (if any)					
Other general overheads					
TOTAL O/M COSTS (without savings/revenues)			**€/$/national currency**		
Existing situation			**€/$/national currency**		
Cost savings/revenues (in comparison to the conventional process)					
Energy savings					
Reduced water usage					
By-products recovered/ sold					
Reduced environmental tax/ charge					
Savings on labor costs					
Savings on the operation of pollution control equipment					
Savings on the monitoring of emissions					
Savings on maintenance					

COST COMPONENT	**Included in O/M costs (YES/NO)**	**Quantity - Unit (No of staff/man-hours, tons of water etc.)**	**Costs/unit (€/$/national currency)**	**Total Cost (€/$/national currency) per year/% of total operating cost**	**Year**
Existing situation					
Savings on disposal costs					
Savings on capital due to more effective use of plant					
Other savings (specify)					
TOTAL SAVINGS/REVENUES			**€/$/national currency**		
NET O/M COSTS (total O/M costs – savings/revenues)			**€/$/national currency**		

Step 15 – Assessment of the break-even point of the investment
Rationale

97. This is the final Step of the overall analysis which allows the operator to see whether the BAT investment will be somehow paid back due to the expected O/M cost savings (in comparison to the conventional process). This will be the case only if, by introducing one or more BAT in an industrial installation, savings of raw materials/chemicals/energy/water as well as less environmental remediation devices are needed. This is usually the case for BAT of preventive nature which consumes fewer resources, is simple and consequently cheap.

98. This is finally the most important consideration in the whole economic analysis performed so far: it reflects the full extent of the usefulness of the BAT introduction and can convince the investor about the necessity to introduce one or more good BAT options into the industrial production process. Within this context the calculation of the investment and O/M costs aim to act as “inputs” for this final Step which practically will demonstrate whether the introduction of a BAT option in a production process is economically feasible. This analysis however is not only useful for the operator but also for the permitting authorities in their discussions/negotiations with the operator about the conditions of a permit: they can understand the prospects of a smooth operation of the BAT in the daily process and the interest of the operator to apply the BAT in a full extent (because there will be potential benefits) and consequently the fulfilment of the permit’s conditions.

99. It must be pointed out that the **ideal** situation would be that a BAT investment can be paid back during its life time from the cost savings of the O/M costs; however this is not always feasible. In any case the introduction of BAT leads to clear cost savings which principally contribute positively to the economic results of a company to a small or large extent.

How the amortization of a BAT investment can be assessed

100. The calculation of the annual costs is the starting point for the assessment of the duration of the amortization period of the BAT investment.

101. This calculation can be expressed by the following equation:
Annual Costs = capital cost (annual depreciation plus interest) + annual operating costs - annual savings

The following points are a summary of how the cost information should be processed and presented:

- Express the original cost data in the price level of a common year
- The discount or interest rate used should be clearly stated
- The 'real discount rate' and 'real prices' should be used
- The basis of the rate used should be explained, as well as any underlying assumptions made
- If the actual rate used is country/sector/company specific then this should be stated and the source of the rate should be referenced
- Discount and interest rates should be applied before any tax consideration

102. Although it seems most appropriate to express cost data as annual costs for the assessment of industrial pollution control systems, there are other common and useful ways to express the data, such as:

- **The cost per unit of product**

103. This may be useful for assessing the affordability of the technique in comparison with the market price for the goods produced. The cost per unit can be calculated from the annual cost divided by the best estimate of the yearly average production rate during the period being considered.

- **The cost per unit of pollutant reduced or avoided** (annual costs per annual reduction of emissions)

104. This may be useful as a basis for analyzing the cost-effectiveness (CE) of the technique

105. It is up to the operator to choose the way he thinks that reflects better the calculations made and can be the whole economic process understandable to the industry's stakeholders as well as to the authorities.

How the economic attractiveness of a BAT investment can be described

106. There are no general economic rules or indicators which can numerically define whether an investment is attractive to be undertaken. Some **viability indicators** however can give an indication to decision makers about the fate of the BAT investment (table 27).

Table 27: Viability indicators for BAT investment

Annual BAT cost related to:	Acceptable	To be discussed further	Unacceptable
Turnover	< 0.5 %	0.5 – 5 %	> 5 %
Gross profit	< 10 %	10 – 100 %	>100 %
Added value	< 2 %	2 – 50 %	>50 %
Total investments	< 10 %	10 – 100 %	>100 %

107. A simplified example of application of the above mentioned considerations is presented in table 28 in order to explain how the savings in O/M costs can lead to acceptable economic results related with the BAT application. For reasons of simplicity not all economic factors have been taken into consideration and some simple assumptions have been made such as:
Interest rates = constant over the time period

Discount rate = not considered

O/M costs = constant over the time period

Table 28: Pay back of BAT investment (Example)

Year	**0**	**1**	**2**	**3**	**4**	**5**
Interest rate		5 %	5 %	5 %	5 %	5 %
Costs (€)						
Investment expenditure	**200,000**	**10,000**	**10,000**	**10,000**	**10,000**	**10,000**
Equipment	150,000					
Installation of equipment	50,000					
O/M costs (before BAT introduction)		**60,000**	**60,000**	**60,000**	**60,000**	**60,000**
a) Energy		15,000	15,000	15,000	15,000	15,000
b) Water		5,000	5,000	5,000	5,000	5,000
c) Materials		7,000	7,000	7,000	7,000	7,000
d) Labor		30,000	30,000	30,000	30,000	30,000
e) Other (insurance etc.)		3,000	3,000	3,000	3,000	3,000

Year	**0**	**1**	**2**	**3**	**4**	**5**
Total annual costs (before BAT introduction): O/M costs + annual expenditure		**70,000**	**70,000**	**70,000**	**70,000**	**70,000**
O/M costs (after BAT introduction)		**25,000**	**25,000**	**25,000**	**25,000**	**25,000**
a. Energy		5,000	5,000	5,000	5,000	5,000
b. Water		1,000	1,000	1,000	1,000	1,000
c. Materials		3,000	3,000	3,000	3,000	3,000
d. Labor		14,000	14,000	14,000	14,000	14,000
e. Other		2,000	2,000	2,000	2,000	2,000
Savings (O/M costs)		**35,000**	**35,000**	**35,000**	**35,000**	**35,000**
Total annual costs (after BAT introduction): O/M costs + annual expenditure		**35,000**	**35,000**	**35,000**	**35,000**	**35,000**
Pay back of investment (from O/M cost savings)	**5.7 years**					

Phase 5 – Summary of tasks (Steps 13 – 15)

108. The tasks for the authorities and for the operators are summarized in table 29.

Table 29: Tasks for operators/authorities - Summary (Phase 5)

Step	**Operators**	**Authorities**
Assessment of BAT investment costs **(Step 13)**	Prepare table 25 for each candidate BAT	
Assessment of the BAT O/M costs **(Step 14)**	Prepare table 26 for each candidate BAT	
Calculation of break-even point of BAT investments **(Step 15)**	Assess when a BAT investment is economically feasible - consider examples (tables 27 + 28) – prepare a list of candidate BAT for final selection	Discuss with operator about the economic viability of selected BAT options

Outputs of Phase 5

109. By completion of Phase 5 the following outputs will be produced:

1. A list of pre-selected BAT containing calculations about expected investment and O/M costs

2. A “preference” list of those BAT which show a certain economic “attractiveness” i.e. seem to be economically viable.

Final selection of BAT

110. Having taken into consideration all the above mentioned factors a list of “most favorable” BAT for each production process (unit operation) will be compiled.
The final selection of BAT will be done on the basis of the following main criteria:

- Meeting of environmental targets (set by the authorities) in a “sustainable” way (emission of less hazardous substances)
- Preventive nature (low consumption of resources)
- Potential of recycling of waste
- Simplicity (technical/economical sustainability)
- Cost effectiveness (costs related to the reduction of environmental emissions)
- Operational health and safety considerations

Conclusions

111. This Guidance document on BAT selection is providing to the **authorities** and the **operators** through a rather simple systematic way a “roadmap” on how to select the most appropriate BAT for each industrial process which needs environmental improvement. Its philosophy is to help its users to find the most suitable environmental, technical and economic data in the literature (i.e. BREF and elsewhere) by applying a targeted search into a rather complex documentation so that the collected information can lead to reasonable decisions.

112. This methodological approach, inevitably, has to be tested in practical life. In doing so, a close and fruitful cooperation between the national/regional/local authorities and the industry is crucial for the actual testing of the methodology and the respective guidance document when IPPC applications will be submitted for approval.

113. This is an interactive process which has to be based on mutual agreements and compromises. For sure the industry has to realize that the introduction of one (or several BAT) does not end with the submission of the application and its approval: it is for the industry’s own interest to find ways for the modernization of its equipment which, sometimes, starts and ends with simple good housekeeping measures. Even in cases of larger investments there will be substantial benefits if the envisaged BAT are resource effective and pollution preventive.

114. It should be clear that pollutants are “lost” raw materials/resources, therefore their prevention saves money on both sides: fewer costs for material/chemicals purchase, less treatment of pollutants.

References

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Appendix 6

Guide on Inspection of Industrial Facilities

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Annnexes

Abbreviations/Acronyms

AEL	Associated Emmission Limit
AOD	Argon Oxygen Decarburization
BAT	Best Available Technique
BREF	Reference Documents
EAF	Electric Arc Furnace
ELV	Emission Limit Value
EMAS	Environmental Management and Audit System
EMS	Environmental Management System
EQS	Environmental Quality Standards
EU	European Union
IMPEL	European Union Network for the Implementation and Enforcement of Environmental Law
ISO	International Standards Organization
PCB	Polychlorinated Biphenyls
PCDD/F	Polychlorinated Dibenzodioxins / Furans
PRTR	Pollution Release and Transfer Register
UO	Unit Operation
VOD	Vacuum Oxygen Decarburization
WWTP	Wastewater Treatment Plant

Introduction

1. The Guide on inspection of industrial facilities is aiming at the acquaintance of the national inspecting authorities with the general framework for conducting of inspections which includes issues such as planning, preparation and execution of an inspection focusing on practical issues such as the relevant checklists to be used during a site visit. Therefore the Guide will contain a general part which is essential to understand the steps to be taken for a successful conduction of an inspection; on the other hand the practical checklists will give an insight into the technologies (introduced in a facility, either as production units or as pollution abatement measures) as well as on the main pollutants to be checked for some industrial sectors (as examples). As a matter of fact the Guide will be mainly tailored to assess the BAT performance of an industrial installation in order to find out whether the relevant BAT described in the permit are put in place and perform according to the permit's conditions (ELV).

2. In doing so, the inspector has to be provided with a set of information which will help him to assess whether the installed BAT are fulfilling the scope of their introduction in the industrial process i.e. meeting the ELV as well as reducing the consumption of resources.

3. The target groups for the use of the Guide are mainly the national inspectors who are generally familiar with the conduction of inspections but they need well documented tools to facilitate their work i.e. the relevant checklists. Additionally the permit writers will also benefit because they will understand the practical context where the on-site inspections are conducted so that they will be able to modify the relevant permits according to inspections' findings.

4. The purpose of routine/non-routine inspections is to check compliance of the inspected installations with legal requirements and permit conditions. In case of non-compliance the competent authority will require the operator to take measures necessary to ensure that compliance is restored.

5. Following each site visit, the competent authority prepares a report describing the relevant findings regarding compliance of the installation with the permit conditions and conclusions on whether any further action is necessary.

6. The purpose of this document is to provide the necessary background information for inspectors on how they have to inspect various industrial operations in order to better conduct their in-plant inspections.

7. The Guide is structured in 2 parts: part 1 (general) gives background information on the elements to be considered when inspections are planned i.e. planning/execution of an environmental inspection, reporting after the on-site visit and performance monitoring (i.e. evaluation of inspections, follow-up actions taken for enforcement, inspection performance indicators) whereas part 2 is devoted to the presentation of some checklists which will be used as guidance for the conduction of inspections in selected industrial sectors.

1. General part

1.1. Planning of an environmental inspection
1.1.1. Types of inspection

8. Before embarking to conduct an inspection it must be clear for the inspectors the framework/context which defines its purpose and scope in order to avoid scattered and bad organized site visits which inevitably will cause wasting of resources (e.g. manpower/equipment) and, on the other hand, eventual complaints of plant owners and of the public. Therefore an inspection program has to be designed which will follow concrete purposes, priorities and targets. In table 1 the types of inspections are shown.

Table 30: Inspection types

Inspection type	Objectives
Program	
Geographic	• Checking of pollution sources to specific receiving media • Checking of pollution sources from facilities in a specific area
Sector specific	Checking of aspects relevant to specific sector
Site inspection	
Comprehensive	Evaluation of compliance of all facilities of one/more sectors in a geographic area
Specific	Investigation of compliance status of one or more facilities on the basis of complaints
Follow-up	Evaluation of implementation of compliance procedures (from previous inspections)

9. Therefore the inspections' coordinator has to define in advance (i.e. before starting the inspections) whether the inspections should be devoted to a geographic area e.g. a river basin or a coast line where many installations are located or to a specific sector (e.g. iron/steel production) which contains several installations which are located in one or more geographical areas. In doing so, a good input for deciding about the inspection program is the historical findings from previous inspections i.e. inspection results from the past, monitoring results i.e. self-monitoring reports (prepared by the operators of the installation), any past/current complaints from the public etc.; the permit conditions i.e. critical pollutants and the associated emission limit values (ELV), environmental quality standards (EQS) of the ambient environment in the area concerned form the framework for setting the inspection priorities for those installations which potentially endanger the quality of the related recipients (water bodies, soil, air).

1.1.2. Minimum inspection criteria

10. All inspection activities should be planned in advance, by having inspection plans that cover the entire territory of the country and those sectors/installations which can cause a potential harm to the environment.

11. The plans should be based on:

(i) The legal requirements to be complied with
(ii) A register of controlled installations (structured according to their size and environmental "importance"
(iii) A general assessment of major environmental issues in the area

(iv) A general appraisal of the state of compliance of the controlled installations so far: number/size of installations which showed deviations from set standards in the past and of those ones which generally comply with the set legal requirements.

12. Each inspection plan should as a minimum:

- Define the geographical area which it covers, which may be for all or part of the territory of a country
- Cover a defined time period (e.g. one year)
- Include specific provisions for its revision
- Identify the specific sites or types of controlled installations covered
- Prescribe the programmes for routine inspections, taking into account environmental risks; these programmes should include, where appropriate, the frequency of site visits for different types of specified controlled installations
- Devote additional time for random inspections which can occur in case of unforeseen circumstances (e.g. sudden release of pollutants, public complaints)
- Provide for coordination between the different inspecting authorities, where relevant.

1.1.3. The inspection cycle

13. A schematic picture of the whole inspection cycle is given in figure 1. This is an interactive process; that means that the reporting findings can lead to a review/modification of the inspection plan.

This cycle can be further described (figure 2):

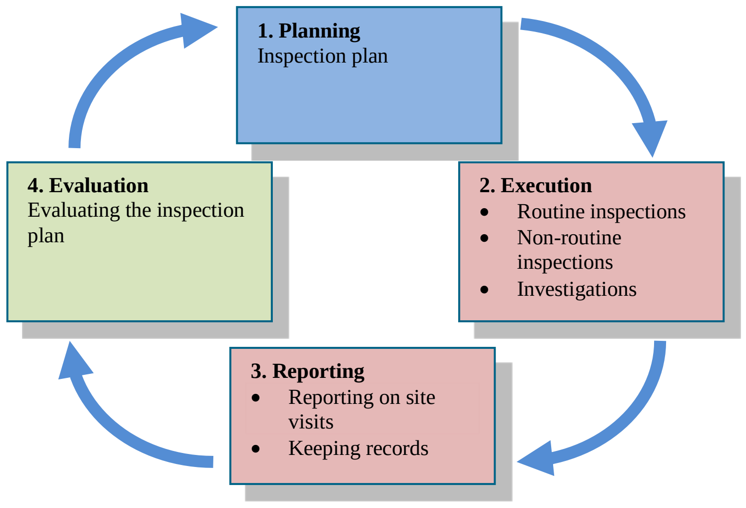

Figure 4: The inspection cycle

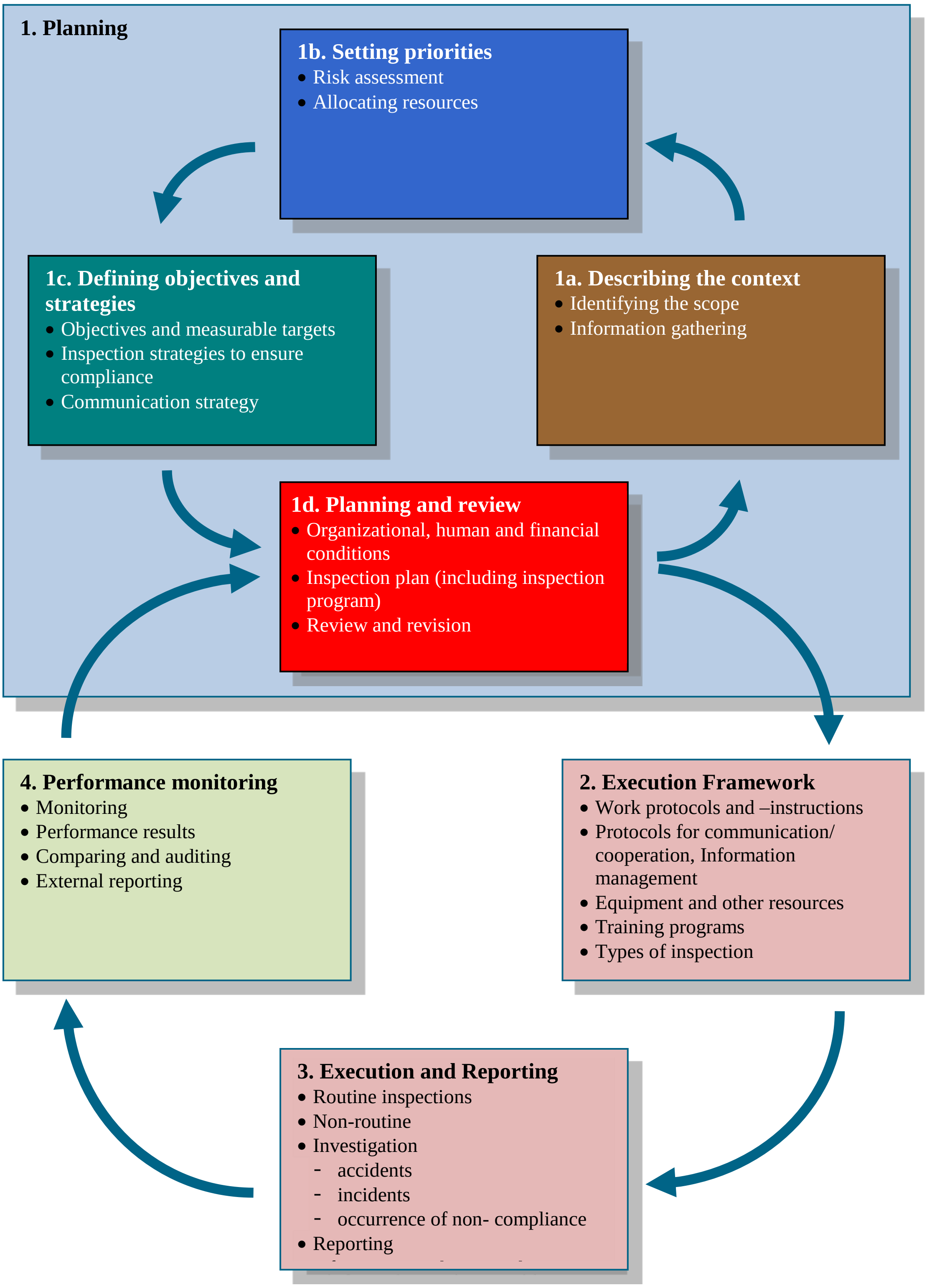

Figure 5: Inspection cycle – details

1.1.3.1. Context

14. Describing the context is a first step of the systematic approach for planning of inspections and a necessary input for identifying and analyzing the risks; it defines the scope and objectives of the inspection plan taking into consideration the country's environmental policies (as a whole or in a specific geographic area), the existing situation in the environmental recipients (water, air, soil), the available resources (i.e. financial means, manpower, equipment) so that a comprehensive, practical and targeted plan can be designed.

1.1.3.2. Setting priorities

15. Setting priorities starts with a risk assessment. The main goal of a risk assessment is to prioritize the workload of the inspectorate. The result of an assessment will result in an inspection frequency of site visits of inspection objects. The reason for prioritizing the workload is that inspecting authorities have limited resources (inspectors and finance), which should be distributed among the inspection objects in an accountable way. In a risk-based approach, most inspection effort should be expended on the objects with the highest risks (highest risk first).

16. Elements to be taken into consideration for the risk definition can be:

- Quantity/quality of air pollution
- Quantity/quality of water pollution
- Potential pollution of soil and ground water
- Waste production or waste management
- Amount of dangerous substances released
- Local nuisance (noise, odor)
- Local environmental conditions

1.1.3.3. Objectives/strategies

17. Based upon the priorities, the inspectorate should set targets and objectives. In order to establish whether these objectives and targets can be met, the outputs of the inspections must be monitored. This is generally done by using performance indicators. Examples of performance indicators that may be useful are:

- The amount of incidents or complaints occurring
- The level of compliance
- The actual achievement of reduction targets for certain pollutants
- Improvement of air, land and water quality through the actions of the inspectorate to improve compliance.

18. These indicators will be derived by analyzing historic monitoring/inspection data so that the strategy to be developed will not be too ambitious or too difficult to be implemented.

19. To determine the best inspection strategy it can be useful to assess the following 2 elements:
<u>Element 1</u>

20. Clearly define the target group (i.e. the installations) and the rules they have to comply with.

<u>Element 2</u>

21. How often and why the target group does not meet the standards set by the relevant permitting authorities.

22. The aim is to get an insight into the target group compliance behaviour and the motives for that behavior: in many cases the operators do not comply with the requirements due to:

- Increased costs
- Lack of qualified personnel for emissions monitoring
- Confidence that the inspections will rarely occur
- Bribing of inspectors

23. On the basis of these elements the inspection strategy will define the pathways to be followed in order to define the installations to be inspected according to the expected emitted pollution load, the installations' past behavior and the quality of the inspecting personnel.

1.1.3.4. Planning/review

24. Based upon the previous steps, the inspecting authority should then develop its inspection program and plan. The inspection program can be seen as a strategic reference document which will act as guidance throughout the whole inspection cycle.

25. The program will describe:

- The objectives that the Inspecting authority, given its mission and tasks, wants to achieve
- The policy, environmental, legal, organizational, financial and other relevant conditions under which the inspecting authority has to perform its inspection activities
- The strategies which the inspecting authority has adopted for performing its inspection activities
- How priorities with regard to inspection activities are set, taking into account these objectives, conditions and strategies
- The priorities themselves.

26. When developing the inspection program and inspection plan it is necessary to consider the organizational, human and financial circumstances. Most importantly the inspection program and the inspection plan should be in balance with the available resources and budgets and should be in line with the organizational structure.

27. When the program and the plan for the forthcoming inspections are set it will define and prioritize:

➢ The regions and environmental recipients which potentially are in danger from pollution caused by certain installations
➢ The industrial sectors which show a greater potential to harm the environmental quality of these recipients
➢ The relevant installations which have to be inspected in a defined time interval.

28. It must be noted that, obviously, the larger installations of a specific sector (e.g. food processing industry) have to be tackled first; however and due to the fact that many smaller industrial units can cause a cumulative pollution load (in some cases comparable to a single large one), the plan should envisage the inspection of some of these installations as well. The available resources (manpower, equipment) should be distributed accordingly. As a rule of thumb:

✓ All large installations discharging in a single recipient (e.g. a coast line, a river) have to be inspected
✓ Approx. 30 – 40 % of the medium/small installations have at least to be investigated.

29. The review and revision of the inspection plan is also part of this step of the environmental inspection cycle: it is possible that, after execution of the initial plan, some findings can show that, due

to improved performance of the inspectors or compliance with the permit standards of high risk installations, the plan's objectives and/or content have to be revised.

30. The inspection program should be multi-annual and reviewed/modified annually. Its intermediate and final performance has to be communicated to other relevant authorities as well as to the public: this communication can provide information on the numbers and types of regular inspection supervision (which can be approx. 60% of the total number of inspections), extraordinary inspection supervision (which can be approx. 40% of the total number of inspections) to be carried out, including the frequency of site visits for different types of specified installations to be controlled and of course some crucial inspection results on the basis of required confidentiality (e.g. how many installations have met/not met the standards, which environmental recipients are in danger etc.).

1.2. Execution of an environmental inspection

1.2.1. Execution framework

31. As framework is meant the preparation of the necessary "infrastructure" for the implementation of the inspection program/plan: the absence of it will lead to badly prepared on-site inspections.

32. Within this step, training, protocols and working instructions are developed and conditions for realization of inspections are established. This step is necessary to make sure that inspection activities can be executed effectively, efficiently, professionally and consistently.

33. The execution framework should at least cover:

- Training program(s) for the inspectors (staff) based on a training needs assessment
- Protocols and working instructions for routine inspections
- Protocols and working instructions for non-routine inspections (how to react to incidents and accidents).
- Procedures/guides for imposing sanctions
- Development of inspection and enforcement handbooks
- Protocols for communication with the public (access to information) and with industry
- Information management (e.g. information systems) and information exchange (within the organization and with partner organizations)
- Provisions and memoranda of understanding for cooperation with relevant partners (other inspecting authorities).

34. For the realization of the inspection framework some crucial conditions have to be fulfilled namely:

- ➢ Clear authorizations and competencies (e.g. legal right of access to site and information)
- ➢ All necessary assistance from the operators to carry out any site visits, to take samples and to gather information necessary for the performance of their duties (described in the inspection legislation)
- ➢ System for planning, programming and monitoring
- ➢ Facilities and materials needed (e.g. computers, transport, and means of communication).
- ➢ Maintenance and calibration of equipment.

1.2.1.1. Training

35. Inspectors in principle should be well trained persons on a continuous basis. This is a precaution as BAT are evolving and so does the law (e.g. issuing of permits, new inspection authorities etc.). The trainings should be twofold:

- Focused on administrative issues and legal aspects of inspections
- Focused on technical aspects of inspections.
- Focussed on information/communications issues.

The first type of training must include the following aspects:
- Administrative preparation of inspections, including planning issues
- Legal acts on inspections
- Interpretation of legal acts.

36. Training does not have to mean a group of inspectors gathered together in one room with a lecturer. It might be realized on an individual basis, even weekly e.g. professional duties can include the reading of a case-law of a court or the examination of a received complaint from an installation's neighborhood.

37. The second type of training should be focused on technical aspects that an inspector may encounter on site. This should be co-ordinated with the way inspectors are assigned to installations/sectors of industry.

38. Two solutions for this "technical" training are possible:

1. The inspectors focus on one aspect of the environment e.g. some inspectors concentrate themselves on wastewater issues, other on waste issues, etc. This enables achievement of a high level of competences in particular fields, however an integrated approach to installations might be lost.
2. The inspectors focus on particular branches of industry, where there are a lot of cross-media aspects in terms of environment e.g. one inspector might be well-trained in food industry, another one in metal processing industry.

39. The training can be conducted by experienced inspectors or by specialized external experts.

<u>Issues that can be addressed in a training program:</u>

40. Before developing a training programme for an inspector or a group of inspectors a training needs assessment must be performed. This assessment will show the gap(s) between the required and existing skills and qualifications for job. Based on this assessment a training programme may include the following issues:
Knowledge of:
- work and procedures in governmental organizations
- procedures, methods and systems in the field of environmental inspections
- respective industrial sectors
- the applicable legislation
- the procedures in court
- environmental management systems (i.e. ISO 14000, EMAS).

Specific skills required by an inspector:
- Basic inspection skills
- Sampling of emissions, soil and waste
- Assessment of administration and data management (e.g. maintenance, monitoring)
- Basic information technology
- Social skills, especially for dealing with difficult facilities' operators
- Communication skills to communicate with industry and the public
- Provision of administrative and/or criminal evidence.

1.2.1.2. Equipment

41. Equipment that an inspector should have during on-site inspections is:

- A camera (it should take pictures of a minimum quality)
- Clothes resistant to atmospheric conditions and difficult circumstances (e.g. water proof boots) as well as safety equipment
- Some basic measuring equipment such as pH-meter, conductivity meter, etc. that should be taken if needed
- Any equipment needed for taking complex samples if necessary.

1.2.1.3. Working documents

42. For the best possible implementation of the on-site visits some protocols (checklists) have to be prepared before the visits in order to achieve a targeted and well-focused visit. These checklists can be:

- ➢ General – horizontal i.e. dealing with issues such as the environmental management procedures, monitoring/reporting systems, end-of-pipe facilities (i.e. wastewater treatment plants, air pollution abatement devices), waste handling/storage management, noise/odor etc.
- ➢ Specific for the industrial sector concerned aiming at the assessment of the level of BAT installment and operation.

43. Types of these checklists will be listed (as examples) in the 2nd part of this Guide.

1.2.1.4. Authorization and competences

44. Each inspector should be formally authorized by the inspectorate to carry out environmental inspection. He/she should have an identification card while conducting inspections. At the beginning of inspection, the inspector should identify him/herself with his/her identity card to the subject of supervision or to the responsible or other authorized persons of the installation.

45. Obligations and authorizations of inspectors should be described in detail in the relevant law on inspections and in other legislative acts such as the framework law on environment and corresponding sectoral legislation (e.g. law on nature protection, law on waste etc.).

1.2.1.5. Cooperation with other institutions

46. The inspector has the right to request information from a state administration body or legal entity, as well as assistance from a state administration body for the purpose of completing the inspection supervision. The same applies to cooperation with other institutions: the inspector may, within the boundaries of the inspection procedure, request an opinion and cooperation from expert institutions, should that be necessary to properly assess the actual situation.

47. It is possible that a joint inspection is necessary e.g. when indications show that a freshwater reservoir is in danger and the expertise of the specialized drinking water authority is needed to assess the potential damage from a polluting activity. In terms of administering such cases, the corresponding inspectorates are obliged to:

- ✓ Consolidate the work plans and programs of both (or more) inspectorates and plan the joint inspections
- ✓ Exchange experiences and consolidate opinions on the means and methods of work and other issues;
- ✓ Hold joint meetings, consultations, councils and other forms of joint cooperation

- ✓ Inform other state bodies competent in the enforcement of the corresponding regulations, when the inspection services make some finding relevant to those regulations during the supervision.
- ✓ Inspectors should be aware of the existing protocols to implement such joint inspections and modify them if necessary.

1.2.1.6. Programs for routine/non-routine inspections

48. The regular (routine) inspection supervision is an announced supervision that is performed on the basis of the working program of the inspectorate and covers the inspection of the enforcement of the laws.

49. The routine/planned inspection is performed after the expiry of the term determined in the inspection report adopted by the inspector in the last prior inspection. During this inspection the inspector will verify the facts and the actual situation and will conclude whether the operator (in relation to the previous inspection findings):

- Took all the actions required
- Partially took the actions required
- Did not take any action.

50. In terms of routine inspections, there are two basic types:
- On-site inspection (as mentioned above)
- Desktop inspection which is a "paper" inspection based on the reports submitted by operators - focused mostly on checking whether monitoring and reporting obligations are fulfilled plus obtaining the knowledge on the fact whether emission limit values stated in environmental permits are not breached.

51. The extraordinary (non-routine) inspection is an unannounced inspection and is performed upon initiative submitted from state authorities and physical or legal persons.

1.2.2. Execution and reporting

52. In this step the inspections are actually carried out: the various inspection activities (aiming at compliance) are prepared and executed. Traditional inspection activities are the (physical) routine (site) inspections, non-routine (site) inspections and investigations of incidents. Many of these activities can and should be executed according to standard protocols and working instructions (see 1.2.1.3.).

1.2.2.1. What should be inspected?

53. Each inspection should at least cover:

A) Routine site visits:
   - o Examining the environmental impact
   - o Evaluating permits and authorizations
   - o Monitoring of emissions
   - o Checks of internal reports
   - o Verification of self-monitoring devices
   - o Checking of the BAT used
   - o Adequacy of the environmental management of the installation
   - o Additional inspection (follow-up/control inspection) in case an important non-compliance has been identified (within 6 months after the initial inspection).

B) Non-routine site visits:

- Complaints received
- Accidents and incidents occurred
- Occurrences of non-compliance (e.g. sudden discharge of pollution load into a river)
- The need for revising an existing permit or issuing a new permit.

54. In case of accidents/incidents:
    - To clarify the cause and its impact
    - Responsibilities, liabilities and consequences of the operator
    - Follow up that has to be taken:
        - Actions to mitigate / remedy the impact
        - Actions for prevention of such cases in the future
        - Actions of the operator.
        - Enforcement actions.

55. Needless to say that non-compliances identified during inspections need to be followed up. In the specific case of a serious non-compliance an additional inspection has to be executed within 6 months at the latest (to examine whether the remedial actions have been implemented).

1.2.2.2. What should be reported?

56. Reporting/data gathering after a site visit should at least cover:
    - Processed inspection data
    - Recommendations for further actions
    - Recorded reports (kept in an accessible database)
    - Notification to the operator
    - Publicly available information.

57. The audience of the inspection reports can be broad. Besides the inspectorate and the operator, also other competent authorities, ministries, public and the European Commission (for EU member states) could be interested in the results of the inspection. An inspection report should therefore be written in plain language and not too technical. Commercial confidentiality and national security are also issues to take into account before publishing the report. Because of this, it may be considered appropriate to make specific reports (i.e. a summary) excluding these issues to be accessible by the public.

58. In chapter 1.3.4., the rules/tips for the preparation of an inspection report are presented (EU practice).

1.2.3. Preparation of an inspection

1.2.3.1. Type of inspection, staff, equipment

59. This is an obligation of the head of the inspectors unit to decide on type of inspection and how many resources (including human resources and equipment) should be used for it. Some considerations that should be taken into account:

- Complexity of an installation - the more complex it is the more inspectors that may be directed to it;
- Time of inspection - for safety reasons it is recommended that at night two inspectors should conduct inspection;
- For non-routine inspection, especially conducted upon a complaint and problematic situation, it is advisable to direct two inspectors to it;
- Weather condition as well as the time of a year - some additional equipment might be needed (e.g. torches, protective clothes, etc.).

60. Having in mind that one of the inspection goals is to detect whether BAT have been introduced in an installation an integrated inspection has to be preferred. This type of inspection requires a well-qualified personnel and asks for a very good preparation before the inspection. A summary of the features of this inspection is summarized in table 2.

Table 31: Integrated inspection

Integrated inspection (process and prevention inspection)			
Objectives	Advantages	Disadvantages	Target facilities
• Improves overall efficiency and environmental performance • Promotes broader goals (e.g. pollution prevention, compliance assistance)	• Considers all relevant factors • Capable of improving overall process • Capable of promoting broader goals (e.g. pollution prevention, compliance assistance) • Appropriate for industry sector	• Requires development of in depth understanding of facility and processes • Training essential for the inspectors • Close cooperation with the operator is needed (not always feasible)	• Appropriate for any size company where the goal is to identify and address process-related causes of non-compliance

1.2.3.2. Desktop study/collection of information

61. The more an inspector is prepared for an inspection, the better. Therefore he/she should gather all the relevant information and data that can be found in the following documents:

- Reports of previous inspections
- Maps
- Checklists (see examples in part 2 of this Guide)
- Environmental Impact Assessment studies
- Application for the permit
- The permit
- Environmental reports submitted by the operators
- Complaints received
- BAT documents (e.g. BREF)
- PRTR and other register
- Information on the installation received from other competent authorities.

62. If the inspection should focus not only on the general performance of the installation but also to which extent BAT are operational, some more detailed information has to be gathered such as:

1. Permit(s) or other types of authorisation of the installation and details of the application process including site reports, self-monitoring programme, EMAS, and mass balance information
2. The permit application submitted by the operator to the permitting authorities where the features of each BAT are described in details
3. Reports already submitted from the operator to the authorities on regular basis (e.g. self-monitoring report)
4. Technical literature: existing process techniques, industry best practice, related BREF, equipment used in the treatment process, equipment for pollution control and monitoring, analytical methods for pollutants identification

5. New or changed regulations of relevance to the installation
6. Technical drawings of the installation
7. Description of changes in the process or installation modification that are proposed or have been implemented
8. Process flow diagram for the installation. The site management may be asked to provide a process flow diagram showing the main process unit operations, inputs and outputs
9. Letters, reports, correspondence from previous inspections, including non-compliance and follow-up actions taken
10. Seasonal or other circumstantial differences that are of importance for the outcome of the visit
11. Inputs/outputs of unit operations (UO):

- Which inputs should be assessed?
  - Raw materials (ton/day)
  - Chemicals/other additives (kg/ton of raw material)
  - Water consumption (m^3/day)
  - Energy usage (kWh/day)
- Which outputs should be assessed?
  - Air emissions (mg/Nm^3)
  - Wastewater (effluents) discharges (kg/ton of raw material or mg/l)
  - Waste (kg/ton)
  - Products (ton/day)
  - By-products (ton/day)

63. The balance of inputs/outputs should be also assessed

64. All the gathered information will lead to specific questions which have to be formulated in an extensive questionnaire which will act as guide for the site visit.

1.2.3.3. Before embarking for the site visit

- ✓ Map the spots to be checked in the installation: emission points, fugitive emission sources, energy production facilities, storage sites, raw material handling systems (loading/unloading devices, feeding systems, chemicals handling), waste collection and disposal points
- ✓ Select the team for the site visit and assign roles
- ✓ Discuss and prepare the site visit programme with the team
- ✓ Inform the operator about the visit, ask for the availability of the necessary documents
- ✓ Get all documentation (checklists, tables, questionnaires) and any sampling and other (e.g. safety) equipment ready.

1.2.4. Execution of an inspection

1.2.4.1. What to check?

65. The questionnaire and the checklists will guide the inspector throughout his/her inspection. In general the inspector has to check:

- The administrative part (names of responsible persons, structure of the environmental management unit, procedures applied for monitoring the environmental performance of the installation etc.)
- The vicinity of an installation (this may be done even before entering the area of the installation) to see if there are some traces of a possible impact of the installation (e.g. leftovers of waste, dust from air emissions, appearance of a river that is a recipient of discharges from the installation)
- Production lines to assess whether the installation is actually working during the visit and to what extent
- Emission points to air/water to check whether their number and positions are in line with the permit

- ➢ All the required equipment used to protect the environment (e.g. air filters, the installation's wastewater treatment plant, barriers built to prevent leakages from storage tanks etc.).
- ➢ Areas and buildings used for waste storage: in the case of hazardous waste all the safety measures protecting against leakages (if the barrels are closed, the waste is packed in a proper way) and uncontrolled disposal to the environment should be checked.
- ➢ Self-monitoring devices.

1.2.4.2. Sampling/laboratory analysis

66. The inspector has to take any samples he/she thinks necessary for counter-check of the self-monitoring results (taken by the operator). In doing so, the inspector has:

1) In the same conditions and at the same time to obtain 2 samples in the amount necessary for examination (the second sample at the request of the operator
2) To draft a report on the collection of the sample
3) To draft a chain of custody

4) To seal the samples and mark them properly
5) To submit without delay the sample for the first analysis to the appropriate expertise institution (prescribed by law).

67. To anticipate eventual discrepancy between the laboratory results derived from the two samples, a third one has to be taken in parallel (if possible) and be regarded as the "final/concluding" sample.

1.2.4.3. Additional documentation

68. Everything that can be found during inspections may be worth being collected and treated as evidence and must be attached to the report:

- Photographs
- Oral and written statements of the operator and the employees
- Reports from previous laboratory analysis results
- Notes/reports of visual inspection
- Documents such as environmental reports, registries, results of self-monitoring. In case of infringements it is worth making copies and attach them to the inspection report, as they will serve as a proof in case of later proceedings.

1.2.5. Closure of the inspection

69. Minutes of the inspection are crucial in terms of later actions that need to be followed. They have to be prepared by the inspector, signed by him/her and counter-signed by the operator.

70. The minutes have to be written in a "neutral" way; that means that personal opinions of the inspector and/or the operator should be avoided.

71. An outline of inspection minutes can look as follows:

- ✓ Each activity performed by the inspector should be mentioned. This includes taking samples and measurements as well as formal order to the operator to take the corresponding measures and activities in a certain period of time given by the inspector
- ✓ Findings from pictures, maps which show non-conformity
- ✓ Description of previous sampling results
- ✓ Short report of the sampling procedures (e.g. which samples/from where)

- ✓ Findings about BAT application (e.g. in which UO BAT have been operational, BAT performance, needed improvements etc.)
- ✓ Review of operator's statements
- ✓ Final conclusions.

1.3. Follow-up

1.3.1. Review of the inspection's findings

72. The inspector has to inform the head of the inspectorate and his/her colleagues about the overall execution of the inspection and the relevant findings namely:

- ➢ How the inspection has been performed: cooperation with the operator, accessibility of the installation's facilities, difficulties encountered (e.g. for taking samples, transport to the installation) etc.
- ➢ Overall appearance of the installation e.g. desolate machinery/equipment, modern facilities, level of BAT operation, existing end-of-pipe techniques etc.
- ➢ Findings → minutes
- ➢ Proposals for follow-up actions.

73. On the basis of this briefing the head of the inspectorate will propose the next steps to be undertaken e.g. fines/sanctions to be imposed.

1.3.2. Informing other competent authorities

74. In case that other institutions are also responsible for this installation (e.g. forestry department, water authorities) a short report has to be drafted and submitted to them in order to enable them to take the necessary follow-up steps. The permitting department has also to be informed, especially about the conformity of the findings with the permit conditions.

1.3.3. Fines/sanctions

75. In case of non-conformity the respective fines have to be discussed and agreed upon by the inspectorate. The following issues should be considered:

1. Level of environmental harm: this can be derived from the laboratory results and the endeavoured deviations from the prescribed permit conditions. In this context the consultation with those authorities which have defined the respective Environmental Quality Standards (EQS) is necessary
2. Frequency of deviations i.e. how often they happened (according to previous inspections' findings)
3. The size of the installation which inevitably can cause the emission/discharge of higher pollution loads
4. The legal framework defining the sanctions context.

76. In any case any level of flexibility (without breaking the law) for imposing the fines has to be explored in order to secure that the fines will lead to the installation's improvement of its environmental performance and that any lengthy legal procedures can be avoided: in case of very severe financial fines it is possible that the operator will consult lawyers and appeal the relevant decision.

1.3.4. Publication of the inspection report

77. The inspection report can be reported and published on the inspectorate's website according to various needs (authorities/public). The report's elements/content are described in chapter 1.2.2.2. In general the conclusions derived from the inspection should form the main part of this report. It is

possible that a consolidated report can be prepared i.e. containing findings from several inspections in one or more installations.

78. It must be noted that the report is part of the information provided to other authorities and to the public and justifies the inspectorate's activities and actions. Some tips about the structure and content of this report according to EU practice are presented in table 3.

Table 32: Inspection report - EU practice

EU practice When discussing reports that should be publicly available according to IED, the Directive states that the report should include the relevant findings regarding compliance of the installation with the permit conditions and conclusions on whether any further action is necessary. There are some tips on reports in the IMPEL Reference Book on Environmental Inspection: - General rules: (i) The purpose of the inspection report is to present a factual record of an inspection, from the time when the need for the inspection is perceived through the analysis of samples and other data collected during the inspection. (ii) The objective of an inspection report is to organize and co-ordinate all evidence gathered in an inspection in a comprehensive, useable manner. To meet this objective, information in an inspection report must be: − Accurate. All information must be factual and based on sound inspection practices. Enforcement personnel must be able to depend on the accuracy of all information. − Relevant. Information in an inspection report should be pertinent to the subject of the report. − Comprehensive. The subject of the report should be substantiated by as much factual, relevant information as is feasible. − Co-ordinated. All information pertinent to the subject should be organized into a complete package. Documentary support (photographs, statements, sample documentation, etc.) accompanying the report should be clearly referenced so that anyone reading the report will get a complete, clear overview of the subject. − Objective. Information should be objective and factual; the report should not draw conclusions. − Clear. The information in the report should be presented in a clear, well organized manner. − Neat and Legible. Adequate time should be taken to allow the preparation of a neat, legible report. Conclusions regarding compliance: Inspection reports should contain only the facts about the inspection. The report to the inspection management should be objective and complete. Clearly, the inspector's conclusions about the compliance of the facility are the critical factors to decide if a violation did or did not exist. When the inspection report is sent to the company, the personal opinion of the inspector must be omitted. Although the inspector may communicate to the company his view on certain matters, facts and figures should never be mixed with personal opinions. If the inspector has concluded that there has been non-compliance, this information should be mentioned in the report sent to the company. All inspection reports should preferably be read and discussed by more experienced inspector. Note that the above mentioned principles are also applicable to the minutes of the inspection. The report is more comprehensive as it also includes non-compliance issues. In most EU Member States, there are no minutes of inspection but reports only. Usually, the leader of the inspection team is responsible for the drafting of the final inspection report; it also includes suggestions to the operator for the improvement of the environmental performance of the plant and proposal of amendments to the permit to the Competent Authority.

1.4. Performance monitoring

79. Good performance monitoring is essential for the inspecting authority. It helps to show to the public, the policy makers and the operators the results of the efforts of the inspecting authority in a defined period. The inspecting authority should act on the basis of systematic monitoring of the inspection and enforcement process and its result and effects.

This monitoring can take place on different levels: not only the results of the performance of the inspecting authority as a whole but also the performance of the individual inspectors has to be measured.

1.4.1. Reports

80. The performance of the inspectorate can be published on regular intervals, usually annually or biannually.

81. A typical report outline can contain the following sections:

1. General part
    - Regulatory inspection framework i.e. the legislative acts governing the inspectorate's functioning/operation – mission of the inspectorate
    - International standards fulfilled/cooperating organizations (e.g. IMPEL for EU countries)
    - Organizational structure, manpower/equipment used
    - Profile of inspectors
    - Budget/financial resources

2. Inspections
    - Types of inspections
    - Subjects of inspections i.e. industrial installations, environmental facilities (e.g. landfills, wastewater treatment plants)
    - Number of inspections performed in the given time period (1/2 years)
    - Results achieved on the basis of indicators of performance of the inspectorate (see 1.4.2.)

1.4.2. Performance indicators

82. Regular checking of the inspectorate's performance is crucial to justify its mission and function. The best way for this checking is the close monitoring of some indicators which have to be comprehensive (well defined), simple and understandable.

83. Types of performance indicators can be:

- ✓ Total number of inspections performed/year
- ✓ Number of inspections allocated/inspector unit/individual inspector
- ✓ Number of installations allocated/inspector unit/individual inspector
- ✓ Number of complaints received/year
- ✓ Number of non-compliant facilities/year
- ✓ Number of samples taken/facility
- ✓ Number of administrative decisions issued/year
- ✓ Number of appearances in courts
- ✓ Number of fines/year
- ✓ Amount of collected fines (i.e. $/€/year).
- ✓ I_2 = <u>Number of environmental inspectors</u>
  Number of facilities
  I_5 = <u>Number of inspected facilities</u>
- ✓ Number of facilities

- ✓ I_6 = Number of non compliances
- ✓ Number of facilities
- ✓ I_7 = Number of judicial actions
  Number of non compliances
- ✓ **Optional indicators**
- ✓ I_9 = Number of inspectors with an operational plan
- ✓ Number of environmental inspectors
- ✓ I_{10} = Number of facilities with self monitoring or environmental management system
- ✓ Number of facilities
- ✓ I_{11} = Number of administrative sanctions
  Number of inspected facilities

2. Checklists

2.1. What is a checklist?

84. A good preparation of a site visit requires that the inspector knows in advance what/where to inspect. Therefore he/she needs a "pathway" which will guide him/her throughout the visit. The checklist is exactly this "pathway": it contains a sequence of issues to be addressed which will allow the inspector to assess the environmental performance of the installation.

85. Advantages of using checklists are:

- To ensure that all necessary aspects will be inspected
- A better organisation of the interview and site visit
- Time/resources rationalisation
- Fast assessment of the non-compliance situations.

86. The checklist consists of 2 parts: the first one contains some "horizontal" issues i.e. general information about the facility (names, location etc.), environmental management systems (EMS) applied, energy efficiency, storage/handling of raw materials/waste, end-of-pipe installations (wastewater, air emissions), monitoring devices, communication duties (i.e. self-monitoring and reporting), general resource management (i.e. water use, raw materials, chemicals), BAT application. The 2nd part refers to each specific sector (i.e. industry, landfills, wastewater treatment plant) and contains targeted questions on BAT application.

87. It must be kept in mind that checklists are an important tool but cannot replace the critical mind of an experienced inspector; that means that the checklists should not restrict the inspector from changing direction based on unexpected observations during the site visit. Additionally the checklists can be modified according to particular national/local situation, experiences gained from previous inspections and the inspector's personal judgement.

88. Before developing the checklists the inspector has also to prepare a **factsheet** for each sector he/she intends to inspect; the factsheet should contain in a "condensed" way the main permit's prescriptions (i.e. which BAT have to be implemented) and some basic findings about the production processes applicable in the sector: it is practically a summary about the sector and the available BAT.

89. Two examples of factsheets (iron/steel production, meat processing/slaughterhouses) are presented in annex 1.

2.2. "Horizontal" checklist

90. An example of a "horizontal" checklist is presented in annex 2.

2.3. Sectoral checklists

91. Two sectoral checklists (iron/steel production, meat processing/slaughterhouses) are presented in annex 3.

Annex I
Factsheets

1. Iron/steel production: Electric arc furnace (EAF)

1.1. Production process

1. The direct smelting of materials which contain iron, such as scrap is usually performed in electric arc furnaces (EAF): steel is produced by melting the steel scrap with the help of graphite electrodes. After refining process, liquid steel transferred from the ladle to the continuous casting machine is solidified and finally shaped as the desired size of semi-finished products.

2. The major feedstock for the EAF is ferrous scrap, which may be comprised of scrap from inside the steelworks, cut-offs from steel product manufacturers (e.g. vehicle builders) and capital or post-consumer scrap (e.g. end-of-life products). Direct reduced iron (DRI) is also increasingly being used as a feedstock due to its low gangue content, variable scrap prices and lower content of undesirable metals (e.g. Cu). Ferroalloys may be used as additional feedstock in greater or lesser quantities to adjust the desired concentrations of non-ferrous metals in the finished steel.

3. For the production of carbon steel and low alloyed steels (the common case in most EAF processes), the following main operations are performed:

- raw materials handling, pretreatment (if any) and storage
- furnace charging
- EAF scrap melting
- steel and slag tapping
- ladle furnace treatment for quality adjustment (secondary metallurgy)
- slag handling
- casting.

1.1.1. Raw materials handling

4. Scrap metal is stored normally outside on large, uncovered and often unpaved ground. The ferrous scrap metal is loaded into baskets by magnets or grabs. In house generated scrap can be cut into manageable sizes using oxygen lancing. The scrap may be loaded into charging baskets in the scrapyard or may be transferred to temporary scrap bays inside the melting shop. Other raw materials including fluxes in lump and powder, powdered lime and carbon, alloying additions, deoxidants and refractories are normally stored under cover. Powdered materials can be stored in sealed silos (lime should be kept dry) and conveyed pneumatically or kept and handled in sealed bags.

1.1.2. Scrap preheating

5. Over the past several years more and more new and existing EAFs have been equipped with a system for preheating the scrap by the off-gas in order to recover energy. Such preheating is performed either in the scrap charging baskets or in a charging shaft (shaft furnace) added to the EAF or in a specially designed scrap conveying system allowing continuous charging during the melting process.

1.1.3. Furnace charging

6. The scrap is usually loaded into baskets together with lime or dolomitic lime which is used as a flux for the slag formation. Carbon-bearing materials are also charged for the needs of the metallurgical work to be performed in the furnace. At some plants, lump coal is also charged in order to adjust the carbon content. A commercially available system is known as the shaft furnace which allows part of the scrap to be charged into a vertical shaft integrated into the furnace roof and thus prevents the opening of the furnace roof halfway through the melting process. The scrap present in the shaft is preheated by the hot gases coming from the furnace.

1.1.4. Electric arc furnace melting and refining

7. During the initial period of melting, the applied power is kept low to prevent damage from radiation to the furnace walls and the roof whilst allowing the electrodes to bore into the scrap. Once the arcs have become shielded by the surrounding scrap, the power can be increased to complete the melting. Fuels include natural gas and oil.
Oxygen in electric furnace steelmaking has become increasingly considered over the last 30 years not only for metallurgical reasons but also for increasing productivity requirements.

1.1.5. Steel and slag tapping

8. The furnace is tilted backwards towards the slagging door and the slag runs off or is raked into a pot or on the ground below the furnace resulting in dust and fume generation. For special steels, mainly alloyed steel, for metallurgic reason, the slag is tapped with the liquid steel into the ladle. Most of the slag is separated from the steel at a deslagging station into a slag pot. The fumes generated there should be captured by an exhaust system.

1.1.6. Ladle furnace treatment for quality adjustment (secondary metallurgy)

Carbon steel

9. Secondary metallurgy is carried out on the molten steel after the tapping of the primary steelmaking furnace up to the point of casting. It is typically carried out at ladle treatment stations while the molten steel stays in the ladle. These treatment stations are generally comprised of an arc-heating unit (a ladle furnace) which allows an adjustment of the final temperature of the liquid steel for the casting operation. The treatment includes the addition of deoxidizing agents and alloying elements in order to adjust the chemical composition of the finished steel. In some cases, vacuum treatment units are used for achieving special requirements regarding the concentration of elements such as hydrogen, nitrogen and oxygen of finished steel. In order to achieve a good homogenization, inert gases (Ar or N2) are injected into the ladle for stirring purpose. Some minor ladle treatment stations are based on inert gas or powder injection equipment.

Stainless steel

10. The secondary metallurgy of stainless steel may be performed either under vacuum in the ladle (VOD process – vacuum oxygen decarburization) or in a separate metallurgical vessel called an AOD (argon oxygen decarburization) converter and a subsequent ladle treatment. Depending on the s

11. teel grades to be produced, some operators apply a combination of both AOD and VOD.

Alloys steel

12. The secondary metallurgy of alloy steels which contain (besides carbon) substantial quantities of alloying elements but do not rank in the stainless steel category consist generally of a ladle furnace and, if required, a vacuum treatment, depending on the steel grades produced. During most of the processes of secondary metallurgy, slags are used to capture the non-metallic compounds generated during the treatment.

1.1.7. Slag handling and processing

13. If slag is collected in a slag pot at the EAF (or at secondary metallurgic plants like AOD or VOD) it needs to be poured into outside slag basins for solidification. The cooling of the slag may be enhanced by water sprays. Some sites operate a slag treatment during the liquid phase to improve the slag final quality and its dimensional stability, by adding silica, alumina, boron (colemanite or sodium borate) and checking the cooling duration. In some plants the slags from the different processes are mixed in the liquid phase to make them more suitable for further processing.

If the slag is poured on the floor, it is pre-crushed after solidification using excavators or shovel loaders and brought to an outside storage area. After a certain period of time, the slag is processed in crushing and screening devices in order to give it the desired consistency for its further use in construction. During this operation, any metallic particles contained in the slag are separated magnetically, manually or using digging, crushing and sieving in order to be recycled into the steelmaking process.

1.1.8. Casting

14. Once the final steel quality has been achieved, the steel is conveyed in a casting ladle to the casting machines. Some years ago, the standard method was to pour the molten steel into permanent moulds (permanent mould or ingot casting) by a discontinuous process. In ingot casting, the liquid steel is cast into casting moulds. Depending on the desired surface quality, degassing agents can be added during casting in the ingot mould. After cooling, the ingots are taken out of the casting mould and transported to the rolling mills. Subsequently, after preheating, the ingots are rolled into slabs, blooms or billets.

15. Today, the method of choice is continuous casting, whereby the steel is cast in a continuous strand (i.e. slabs of different sizes, thin strip): it is a process which enables the casting of one or a sequence of ladles of liquid steel into a continuous strand of billet, bloom, slab, beam blank or strip. The liquid steel is poured from the converter into a ladle which transports the steel after secondary metallurgy to the ‘tundish’ of the continuous casting machine. This is an intermediate ladle with a controllable outlet. The ladles are preheated prior to accepting a liquid steel charge in order to avoid temperature stratification in the tundish.

16. When the liquid steel has reached the desired temperature, it is poured into the tundish. From here, it passes to a short water-cooled copper mould where no air is present and which performs oscillating up and down movements to prevent the steel from sticking. The mould gives the metal the desired shape.

1.2. Key environmental issues/BAT

1.2.1. Air

1.2.1.1. Dust

17. BAT for dust abatement in electric arc furnishes are the following ones:

18. BAT for the electric arc furnace (EAF) primary and secondary dedusting (including scrap preheating, charging, melting, tapping, ladle furnace and secondary metallurgy) is to achieve an efficient extraction of all emission sources by using one of the techniques listed below and to use subsequent dedusting by means of a bag filter.

I. A combination of direct off-gas extraction (4th and 2nd hole) and hood systems

II. Direct gas extraction and doghouse systems.

III. Direct gas extraction and total building evacuation (low-capacity EAFs may not rquire direct gas extraction to achieve the same extraction efficiency).

The overall average collection efficiency associated with BAT is> 98 %.

The BAT associated emission level for dust is < 5 mg/Nm3, determined as a daily mean value.

19. BAT for on site slag processing is to reduce dust emissions by using one or a combination of the following techniques :

I. Efficient extraction of the slag crusher and screening devices with subsequent off gas cleaning, if relevant

II. Transport of untreated slag by shovel loaders

III. Extraction or wetting of conveyer transfer points for broken material

IV. Wetting of slag storage heaps

V. Use of water fogs when broken slag is loaded.

20. In the case of using BAT I the BAT associated emission level for dust is < 10-20 mg/Nm3, determined as the average over the sampling period (discontinuous measurement, spot samples for at least half an hour).

1.2.1.2. Pollutant substances

21. BAT for the electric arc furnace process is to prevent mercury emissions by avoiding, as much as possible, raw materials and auxiliaries which contain mercury.

BAT for the electric arc furnace (EAF) primary and secondary dedusting (including scrap preheating, charging, melting, tapping, ladle furnace and secondary metallurgy) is to prevent and reduce polychlorinated dibenzodioxins/furans (PCDD/F) and polychlorinated biphenyls (PCB) emissions by avoiding, as much as possible, raw materials that contain PCDD/F and PCB or their precursors and using one or a combination of the following techniques, in conjuction with an appropriate dust removal system:

I. Appropriate post-combustion

II. Appropriate rapid quenching

III. Injection of adequate absorption agents into the duct before dedusting.

1.2.2. Wastewater

22. BAT is to minimize the water consumption from the electric arc furnace (EAF) process by the use of closed loop water cooling systems for the cooling of furnace devices as much as possible unless once-through cooling systems are used.

BAT is to minimize the wastewater discharge from continuous casting by using the following techniques in combination:

I. The removal of solids by flocculation, sedimentation and/or filtration

II. The removal of oil in skimming tanks or in any other effective device

III. The recirculation of cooling water and water from vacuum generation as much as possible

23. The BAT associated emission levels for waste water from continuous casting machines, based on a qualified random sample or a 24-hour composite sample, are

- Suspended solids < 20 mg/l
- Iron < 5 mg/l
- Zinc < 2 mg/l
- Nickel < 0,5 mg/l
- Total chromium < 0,5 mg/l
- Total hydrocarbons <5 mg/l

1.2.3. Soil and groundwater

24. BAT is the appropriate storage and handling of input materials and production residues which can help to minimize the airborne dust emissions from stockyards and conveyer belts including transfer points and to avoid soil, groundwater and runoff water pollution.

1.2.4. Waste

25. BAT for solid residues is to use integrated techniques and operational techniques for waste minimization by internal use or by application of specialised recycling processes (internally or externally).

26. BAT is to maximise external use or recycling for solid residues which cannot be used or recycled according to previous BAT, wherever this is possible.

27. BAT is to use the best operational and maintenance practices for the collection, handling, storage and transport of all solid residues and for the hooding of transfer points to avoid emissions to air and water.

28. BAT is to prevent waste generation by using one or a combination of the following techniques:

I. Appropriate collection and storage to facilitate a specific treatment

II. Recovery and on-site recycling of refractory materials from the different processes and use internally, i.e. for the substitution of dolomite, magnesite and lime.

III. Use of filter dusts for the external recovery of non-ferrous metals such as zinc in the non – ferrous metals industry, if necessary, after the enrichment of filter dusts by recirculation to the electric arc furnace.

IV. Separation of scale from continuous casting in the water treatment process and recovery with subsequent recycling e.g. in the sinter/blast furnace or the cement industry.

V. External use of refractory materials and slag from the electric arc furnace process as a secondary raw material where market conditions allow for it.

2. Meat processing (Slaughterhouses)

2.1. Production process

2.1.1. Slaughtering of large animals

29. In slaughterhouses of cattle and sheep the hide is removed. Pig skins are usually retained, although the bristles are removed and the surface of the skin is singed. The basic processes are briefly described below.

2.1.1.1. Animal reception and lairage

30. The animals are unloaded via ramps and the lorries are cleaned. Most slaughterhouses have a dedicated vehicle wash area for this purpose. In some cases bedding, such as straw or sawdust, is used. The animals are often held in the lairage to allow them to recover from the stress of the journey.

2.1.1.2. Slaughtering/bleeding

31. Animals are taken from the lairage along a fenced or walled passageway constructed to allow them to walk in single file, or in small groups to where they are stunned and slaughtered. Carcasses are bled over a trough or tank to collect the blood. The blood trough is normally fitted with a double drain, one opening for the blood to be pumped to a tanker for disposal and the other for wash-water.

32. During bleeding blood coagulates on the base/walls of the trough. This is either hosed down or washed directly to the WWTP or in some slaughterhouses it is collected by shovels, squeegees or by vacuum suction and as much as possible is pumped to a blood tanker. Some slaughterhouses have traditionally allowed all or a significant proportion of the blood they collect to run to their WWTP. This has always been considered to be bad practice, due to the high COD and BOD and because it also removes the possibility of other routes for the use and/or disposal of blood being followed.

2.1.1.3. Hide and skin removal

33. Machines to remove hide and skin typically pull the hide/skin from the carcass. Two chains are hooked to the hide/skin and are then wound onto a drum to pull the hide/skin. Some sheepskins are removed manually, but automated removal is also common. The hides and skins are supplied to

tanneries for the production of leather goods. In some slaughterhouses, the hides and skins are salted to improve preservation. Pigs are washed before the skin is removed using a hide-puller.

2.1.1.4. Head and hoof removal for cattle and sheep

34. After the bleeding of cattle and sheep, the animals' forelegs, tail and udder/testicles are manually removed using knives. The tongue and cheeks may also be removed for human consumption. Cattle and sheep heads are washed, inspected and disposed of. Hooves are traditionally supplied for use in the manufacture of glue but may also be ground for use in pet food. They may also be used to produce horn meal fertilizer.

2.1.1.5. Pig scalding

35. Traditionally the pig carcase is passed through a static or rotary scalding tank filled with water between 58 ºC and 65 ºC for 3 – 6 minutes to loosen the bristles and toenails. Steam heating is normally used to maintain the temperature in the scalding tank and continuous make-up water is required to balance drag-out, which drips onto the floor and into the de-hairing machine. The scalding process produces some steam and odor.

2.1.1.6. Pig hair and toenail removal

36. An automatic de-hairing machine is used to remove bristles and toenails from pig carcases. In some de-hairing machines, the carcases are tumbled two at a time horizontally between two sets of rubber flails, with a water spray from above to wash the hair out of the bottom of the machine. The water spray is used to flume hair and toenails to a primary screen. In some slaughterhouses, toenails are collected dry and sent for rendering.

2.1.1.7. Pig singeing

37. Pig carcases are singed to remove residual hair which has not been removed by the de-hairer, to provide a firmer skin texture and to eliminate micro-organisms. The singeing unit commonly uses propane gas burners firing intermittently or alternatively oil burners, although this is becoming less common.

2.1.1.8. Evisceration

38. Evisceration involves manual removal of the respiratory, pulmonary and digestive organs. This is done by pulling out the bladder and the uterus, if it is present; the intestines and mesenteries; the rumen and other parts of the stomach; the liver and then, after cutting through the diaphragm, the plucks, i.e. the heart, lungs and trachea. The resulting offal is loaded into pans for inspection and transportation to the offal processing area. The heart, liver, kidneys and non– ruminant intestine may be sold for human consumption.

39. Offal, including the lungs and trachea for all animals and the first stomach for cattle and sheep, can be used in the production of pet food. For cattle and sheep, the first stomach is cut open on a table and the contents are removed using either a wet or dry process. In the wet process, it is cut open in a water flow to produce a slurry which is discharged over a screen and then pumped to a holding area.

40. In some slaughterhouses macerator equipment is used to chop, wash and spin-dry the remaining offal prior to supply to the rendering company. This can reduce the offal volume by over 50 %.It is not necessary to wash the carcases in the evisceration area, although it is sometimes undertaken if there is contamination present from damaged viscera.

2.1.1.9. Splitting

41. After evisceration, the cattle, mature sheep (not lamb, because it is not necessary to remove the spinal cord as a TSE precaution) and pig carcases are split along the spine using a saw. Water is

sprayed onto the blade to remove any bone dust which is generated. The spinal cords of the cattle and mature sheep are then removed from the carcase and disposed of. Some slaughterhouses use a vacuum system which sucks the spinal cord material to the SRM waste skip. In other slaughterhouses, the spinal cord is removed manually and the cavity is cleaned using a steam spray/suction device.

2.1.1.10. Chilling

42. The carcases are chilled to reduce microbiological growth. To reduce the internal temperature to less than 7 ºC, they are chilled in batch chillers with air temperatures between 0 ºC and 4 ºC. The carcases may then be held in a chilled meat store to further condition the meat prior to dispatch to cutting plants, wholesalers, or on to further processing.

2.1.1.11. Associated downstream activities – viscera and hide/skin treatment

Viscera treatment

43. If the intestines are destined for food use, after veterinary approval, the pancreas gland is cut off the intestine set. The intestine set is then conveyed to the casing cleaning area. It is then separated into the following parts: stomach, fat end (rectum), small intestine (duodenum, jejunum), large intestine (colon) and "blind" intestine (caecum). These are then cleaned and may be salted at the slaughterhouse or off-site. If the intestines are to be rendered, the contents may be removed first by, e.g., cutting followed by centrifugation.

Hide and skin treatment

44. Whether hides/skins are salted or not may depend on customer requirements. If hides/skins can be delivered to a tannery and processed within 8 – 12 hours after slaughter they generally don't require any treatment at the slaughterhouse. They need to be chilled if they are to be processed within 5 – 8 days. For longer storage times, e.g. if they have to be transported overseas, then salting is reported to be the preferred option, due to the weight of ice and the energy consumption required for ice production and for refrigeration. If sheep/lamb skins and cattle hides are to be salted, they may be cooled first with cold water or chilled prior to being stacked flat and then salted, using sodium chloride, or alternatively they may be salted directly. After approximately 6 days they are packed with additional salt and stored or transported to tanneries for leather production.

2.1.2. Slaughtering of poultry

2.1.2.1. Reception of birds

45. It is essential that crates, modules and vehicles used to transport birds are thoroughly cleaned between collections, to reduce the spread of any infection which may be present. The poultry processor generally provides separate facilities for cleaning and disinfecting the crates, modules and vehicles. In general, crate cleaning is a three-stage process, which offers considerable opportunities for re-using and recycling water. Many of the larger poultry processors have installed automated crate washing equipment to permit a thorough cleaning immediately following delivery of the birds.

2.1.2.2. Stunning and sleeping

46. After the birds have had time to settle they are removed from their crates/modules and put onto the killing line. They are required to be stunned, before being killed. A commonly used stunning system uses a water-bath, which constitutes one electrode and a bar which comes into contact with the shackles and forms the other electrode.
After stunning, the bird is bled for up to two minutes before being dressed.

2.1.2.3. Scalding

2.1.2.4. After stunning and bleeding, the birds are immersed in a scalding tank to loosen the feathers to facilitate de-feathering.

2.1.2.5. De-feathering

47. Feathers are removed mechanically, immediately after scalding, by a series of on-line plucking machines. The machines comprise banks of counter-rotating stainless steel domes or discs, with rubber fingers mounted on them. Rubber flails mounted on inclined shafts are sometimes used for finishing. Any feathers remaining on the bird after mechanical plucking, including pin feathers, are removed by hand.

48. Continuous water sprays are usually incorporated within the machines for flushing out feathers.

49. Feathers are commonly taken to a centralized collection point via a fast-flowing water channel located below the machine.

2.1.2.6. Evisceration

50. After de-feathering and head and feet removal the birds are eviscerated, i.e. the internal organs are removed. In the majority of production sites, evisceration is carried out mechanically, but manual evisceration is still practiced in some of the smaller companies.

2.1.2.7. Chilling

51. After evisceration and inspection, fresh poultry meat must be cleaned immediately and chilled in accordance with hygiene requirements to a temperature not exceeding 4 ºC. There are several designs of chilling equipment used; the most popular are immersion chillers, spray chillers and air-chillers.

2.1.2.8. Maturation

52. Where carcases require maturation after chilling, further conditioning using a refrigeration medium (air, ice, water or other food-safe process) can be used which may continue the cooling process of the carcases or parts of carcases.

2.1.2.9. By-products recovery from slaughtering

Storage

53. Arrangements for the storage of animal by-products vary between premises. To some extent they depend on the nature and characteristics of the by-product and its intended use or disposal route. Generally, the storage of materials can be undertaken within an enclosed area, operated under negative pressure, provided with extractive ventilation connected to a suitable odor abatement plant. Some slaughterhouses store animal by-products in open containers in the open air and rely on frequent removal from the site, e.g. once or twice a day, to prevent odour problems from putrescible materials.

Fat melting

54. The product of fat melting is generally for food use, so feedstocks are required to be fresh and consequently cause less odor problems during storage and processing.

Three methods of fat melting have been reported: batch wet fat melting, batch dry fat melting and continuous wet fat melting.

Rendering

55. The rendering process uses animal by-products from meat production. These originate from e.g. slaughterhouses, meat processing plants, butcher's shops, supermarkets and livestock rearing facilities. The by-products include carcases, parts of carcases, heads, feet, offal, excess fat, excess meat, hides, skins, feathers and bones.

56. The rendering process comprises a number of processing stages, as follows, although the order may vary between installations. The raw material is received at the installation and stored. Preparing the raw material for rendering generally involves size reduction. The material is then heated under pressure to kill micro-organisms and to remove moisture. The liquefied fat and the solid protein are separated by centrifugation and/or pressing. The solid product may then be ground into a powder to make animal protein meal. The final products are transferred to storage and dispatch. The waste solids, liquids and gases are then treated and disposed of, possibly with some intermediate storage.

Blood processing

57. Blood processing uses blood from animals which have been passed as fit for human consumption by an official veterinarian, after a post mortem inspection. The sequence of processes is as follows:
Blood collection (in the slaughterhouse), filtering and centrifugation (in the slaughterhouse) and plasma/red cell production.

Gelatine manufacture

58. Gelatine is natural, soluble protein, gelling or non-gelling, obtained by the partial hydrolysis of collagen produced from bones, hides and skins, tendons and sinews of animals. The raw materials used comprise bones, fresh or frozen hides and pig skins.

59. There are various unit operations for gelatine manufacture e.g. degreasing, demineralization, liming, neutralization, extraction, filtration, ion exchange, concentration, sterilization, drying, acid treatment.

2.2. Key environmental issues/BAT

2.2.1. Air

2.2.1.1. Dust

60. Dust emission arising during the unloading of poultry and the hanging of live birds on the slaughter-line is a key environmental issue at poultry slaughterhouses (during the unloading and hanging of birds up to and during slaughter and bleeding). The dust levels can be abated by the use of exhaust ventilation. The dust can be collected in a fabric filter or a wet scrubber or metal mesh.

2.2.1.2. Pollutant substances

61. Most emissions to air from slaughterhouses are water vapour from the boilers used to raise hot water and steam. There is also a potential for the release of refrigerant gases from chilling and freezing plants and CO2 from stunning equipment.
The replacement of the use of fuel oil with natural gas, where a natural gas supply is available is appropriate BAT to reduce the emission of sulphur compounds into the atmosphere.

2.2.2. Wastewater

62. “Process-integrated” BAT which minimise both the consumption and the contamination of water should be applied. The selection of wastewater treatment techniques can then be made, based on the capacity required to treat the waste water produced after BAT minimizing its quantity and load have been applied.

63. Wastewater treatment, an “end-of-pipe” technology, is always required because waste water is produced from various sources. These include water from vehicle, equipment and installation cleaning and from the washing of carcases and animal by-products.

A. There are several options considered as BAT – good housekeeping measures which, if applied, can substantially reduce water consumption and consequently wastewater generation. Some of them are listed below:

1. Apply dedicated metering of water consumption
2. Separate process and non-process waste water
3. Remove all running water hoses and repair dripping taps and toilets
4. Fit and use drains with screens and/or traps to prevent solid material from entering the waste water
5. Dry clean installations and transport by-products dry, followed by pressure cleaning using hoses fitted with hand-operated triggers and where necessary hot water supplied from thermostatically controlled steam and water valves
6. Fit and use floor drains with screens and/or traps to prevent solid material from entering the waste water
7. Dry clean installations and transport by-products dry.

B. For the treatment of wastewater from slaughterhouses and animal by-products installations, BAT is to do the following:

1. Prevent wastewater stagnation
2. Apply an initial screening of solids using sieves at the slaughterhouse or animal by-products installation
3. Remove fat from wastewater, using a fat trap
4. Use a flotation plant, possibly combined with the use of flocculants, to remove additional solids
5. Use a wastewater equalization tank
6. Provide a wastewater holding capacity in excess of routine requirements
7. Prevent liquid seepage and odor emissions from waste water treatment tanks, by sealing their sides and bases and either covering them or aerating them

8. Subject the effluent to a biological treatment process.

9. Remove the sludge produced and subject them to further animal by-product uses.

10. Subject the resulting effluent to tertiary treatment (in own or municipal wastewater treatment plant).

2.2.3. Waste

64. Any possibility to separate solid waste quantities generated from all production processes and to avoid any mixing with the various water/wastewater flows should be explored. This will lead to a smaller wastewater pollution load and on the other side it will avoid unnecessary solid waste treatment (e.g. drying). Available BAT to achieve this goal are the following:

1. Continuously collect by-products dry and segregated from each other, along the length of the slaughter-line

2. Collect floor waste dry, with e.g. shovels, avoiding usage of water

3. Dry clean the lairage floor and periodically clean it with water

4. Operate continuous, dry and segregated collection of animal by-products throughout animal by-products treatment

5. Dry clean installations and transport by-products dry

Annex II
"Horizontal" Checklist

GENERAL DATA	
Date of Inspection	
Type of Inspection	☐ Routine ☐ Non Routine ☐ Follow up
Field of inspection	☐ Integrated ☐ Sectorial - ☐ Water ☐ Air ☐ Soil ☐ Noise ☐ Waste ☐ Odor
Name of Company	
Location of the plant	
Address	
Industrial activity	
Permit (number, date and title)	
Permit holder	
Telephone	
E-mail	
Contact person for integrated permit-related issues	
Representative competent authority	

ENVIRONMENTAL MANAGEMENT SYSTEM					
Ref. to the permit (page)	**Topic**	**BAT**	**What to check**	**What has been observed**	**Compliance (YES/NO)**
	EMS	Commitment of senior management	Official company documents on the EMS		
	EMS	Establishment of environmental policy including continuous improvement of installations by management	Company documents on the EMS and most recent reporting on results		
	EMS	Planning, establishing and implementation of necessary procedures, objectives and targets	Company documents and reports on the EMS about targets and necessary investments		
	EMS	Implementation of structure, responsibility, training, communication and documentation	Reports on results of EMS implementation in the company		
	EMS	Performance and corrective action, monitoring and measurement and preventive action	How does the system work, how is the monitoring and measurement organized		
	EMS	Maintenance of records Independent internal and external auditing	The presence of auditing reports		
	EMS	Review EMS by senior management on adequacy and effectiveness	Is a regularly review organized?		
	EMS	Following development of cleaner technologies	Presence of knowledge about new developments in the industrial sector		
	EMS	Application of sectoral benchmarking on a regular basis	Is the operator aware of the environmental performance of other companies in the sector? What is the knowledge about international norms and standards		

ENVIRONMENTAL MANAGEMENT SYSTEM					
Ref. to the permit (page)	**Topic**	**BAT**	**What to check**	**What has been observed**	**Compliance (YES/NO)**
	EMS	Independent audits	Is the EMS and audit procedure examined and validated by an accredited certification body or an external EMS verifier?		
	EMS	EMAS and EN-ISO 14001:1996	Is there an implementation and adherence to an internationally accepted voluntary system such as EMAS and ISO 14001?		

COMMUNICATION					
Ref. to the permit (page)	**Topic**	**BAT**	**What to check**	**What has been observed**	**Compliance (YES/NO)**
	Self-monitoring report	Preparation of self-monitoring reports	Check the correct delivery to the competent authority of the self-monitoring report. Check results of the monitoring.		
	Incidents/Emission Limit Values (ELVs)		Check if the operator communicates incidents and exceedances of ELVs to the competent authority		
	Installation changes		Check that the operator asked for authorization for making changes to the installation, as specified in legislation.		

ENERGY EFFICIENCY					
Ref. to the permit (page)	**Topic**	**BAT**	**What to check**	**What has been observed**	**Compliance (YES/NO)**

ENVIRONMENTAL MANAGEMENT SYSTEM					
Ref. to the permit (page)	**Topic**	**BAT**	**What to check**	**What has been observed**	**Compliance (YES/NO)**
	Energy efficiency	Carrying out an audit	Check if the operator ever performed an audit. Check the content of the audit: - energy-using equipment, and the type and quantity of energy used in the installation; - detected possibilities to minimize energy use; - possibilities to use alternative sources or use of energy that is more efficient.		
	Energy efficiency	Establish energy efficiency indicators	Check if the operator identified suitable energy efficiency indicators for the installation, and measure their change over time or after the implementation of energy efficiency measures		
		Carry out maintenance at installations to optimize energy efficiency	Check if the operator applies the followings: - establishing a structured program for maintenance - supporting the maintenance program by appropriate record keeping systems and diagnostic testing		

STORAGE/HANDLING					
Ref. to the permit (page)	**Topic**	**BAT**	**What to check**	**What has been observed**	**Compliance (YES/NO)**
	Storage and handling	Ensuring that the storage area drainage infrastructure can contain all possible contaminated run-off and that drainage from incompatible wastes cannot come into contact with each other	Check the separation among wastes with different properties; check if rainwater can produce a leakage of the waste; check the drainage infrastructure. Check whether any hazardous wastes are		

STORAGE/HANDLING					
Ref. to the permit (page)	**Topic**	**BAT**	**What to check**	**What has been observed**	**Compliance (YES/NO)**
			stored properly (safety regulations)		
	Storage and handling	Collect the rainwater in a special basin for checking, treatment if contaminated and further use.	Check the separation among wastes with different properties; check if rainwater can produce a leakage of the waste.		
	Storage and handling	Handling odorous materials in fully enclosed or suitably abated vessels and storing them in enclosed buildings connected to abatement.	Check from the yearly report the presence of odorous wastes; check how they are stored.		
	Storage and handling	Equipping tanks and vessels with suitable abatement systems when volatile emissions may be generated, together with level meters and alarms.	Check from the yearly report the presence of waste that can produce volatile emissions; check how they are stored and the presence of abatement systems.		
	Storage and handling	Have a waste management plan	Check if they have procedures to manage existing waste streams; check if they maximize the re-use of generated waste (i.e. separation of waste streams, transport to waste recycling centers).		
	Liquid storage: soil protection around tanks	Provide secondary containment to aboveground and underground tanks containing flammable liquids or liquids that pose a risk for significant soil pollution or a significant pollution of adjacent watercourses. Install a liquid-tight reservoir that can contain all or a part of the dangerous liquids stored.	Check which secondary containment measures has been applied by operator (double wall tanks, monitored bottom discharge etc.).		
	Storage of packaged dangerous substances	Apply a storage building and/or an outdoor storage area covered with a roof.	Check where dangerous substances are stored.		

STORAGE/HANDLING					
Ref. to the permit (page)	**Topic**	**BAT**	**What to check**	**What has been observed**	**Compliance (YES/NO)**
	Transfer and handling of liquids and liquefied gases	For large storage facilities, according to the properties of the products stored, BAT is to apply a leak detection and repair program.	Check if the operator as a leak detection and repair program.		
	Storage of solids	BAT is to apply enclosed storage by using, for example, silos, bunkers, hoppers and containers, to eliminate the influence of wind and to prevent the formation of dust by wind.	Check the storage areas of materials likely producing dust.		
	Open storage of solids	BAT for open storage are: - moistening the surface - covering the surface - solidification of the surface - grassing-over of the surface	Check the measures undertaken by the operator.		

COMMON WASTEWATER AND WASTE GAS TREATMENT					
Ref. to the permit (page)	**Topic**	**BAT**	**What to check**	**What has been observed**	**Compliance (YES/NO)**
	Wastewater assessment	Checking and identifying relevant water-consuming processes and listing them according to their water usage. The resultant ranking is the basis for improvement of water consumption	Check whether any wastewater/ cooling water recirculation systems are applicable.		
	Wastewater and waste gas treatments	Treat contaminated waste water/waste gas streams at source in preference to dispersion and subsequent central treatment.	Check if the operator treats or pre-treats the effluents (water, gas) at source (not using a centralized treatment plant).		
	Wastewater	Using process water in a recycle mode whenever feasible for economic and quality reasons.	Check if the process foresees recycling measures of the process water.		

STORAGE/HANDLING					
Ref. to the permit (page)	**Topic**	**BAT**	**What to check**	**What has been observed**	**Compliance (YES/NO)**
	Wastewater	Segregate process water from uncontaminated rainwater and other uncontaminated water releases.	Check if the operator takes adequate measures to avoid rainwater to mix with process water.		
	Rainwater	Duct uncontaminated rainwater directly to a receiving water, by-passing the waste water sewerage system. Treat rainwater from contaminated areas.	Check the discharging of rainwater and the possibility to be contaminated. Check whether any possibilities for on-site treatment and reuse of rainwater from contaminated areas can be applied.		
	Wastewater discharge	BAT-associated emission levels for final waste water discharge into surface water	Compare the emission values of waste water discharge into surface water with BAT-associated emission levels		

	BAT PROCESS MANAGEMENT			
Ref. to the permit (page)	**Topic**	**What to check**	**What has been observed**	**Compliance (YES/NO)**
	Process design	Is the configuration of the process' modules arranged according to the manufacturer's instructions?		
		Have any design's modifications occurred? If YES, for which reasons?		
		Do any improvements result from these modifications?		
		Are there any corrective measures planned to overcome any malfunctions of the process? If YES, specify the achieved improvement of the process features (in environmental terms e.g. less use of water/ energy)		

STORAGE/HANDLING					
Ref. to the permit (page)	**Topic**	**BAT**	**What to check**	**What has been observed**	**Compliance (YES/NO)**
	Equipment	Has the equipment been installed/ operated according to its technical specifications?			
		Any changes/ modifications occurred? If YES, specify the achieved improvements			
		Is the equipment regularly checked for defects, leakages?			
		Is maintenance performed regularly according to the equipment's specifications?			
	Use of resources	Are the quantities of raw materials, water, chemicals, energy introduced in the production process **(inputs)** according to the technical prescriptions? If NO, specify the reasons and the achieved improvements in the production process			
		Are measured/ weighted quantities of raw materials, chemicals, water registered? If NO, specify why			
		Is the least polluting energy source used for the production e.g. natural gas? If NO, specify why			
		Is the energy input measured? If NO, specify why			
		Which process **outputs** (products, by-products, air emissions, effluents, waste) are measured? If NO, specify why			
		How is the heating/cooling system operated?			
		Are there any special precautions to avoid losses/leakages from the feeding devices of inputs (raw materials, chemicals)?			

STORAGE/HANDLING					
Ref. to the permit (page)	**Topic**	**BAT**	**What to check**	**What has been observed**	**Compliance (YES/NO)**
		If NO, specify why			
		Are there any special precautions to avoid losses/leakages from the storage devices for raw materials/chemicals needed? If NO, specify why			
		Are there any special precautions to avoid losses/leakages from the water feeding system? If NO, specify why			

Annex III
Sectoral Checklists

1. **Iron/steel production: Electric arc furnace (EAF)**

AIR EMISSIONS					
Topic	**What does the permit say**	**Which BAT are applicable**	**What to check**	**What has been observed**	**Compliance (YES/NO)**
Pollution abatement systems EAF steelmaking and casting		To prevent mercury emissions by avoiding, as much as possible, raw materials and auxiliaries which contain mercury	Check use of material with low or no mercury content		
Pollution abatement systems EAF steelmaking and casting		To achieve an efficient extraction of all emission sources by using one of the techniques listed below and to use subsequent dedusting by means of a bag filter A combination of direct off-gas extraction (4th and 2nd hole) and hood systems Direct gas extraction and doghouse systems. Direct gas extraction and total building evacuation (low-capacity EAFs may not require direct gas extraction to achieve the same extraction efficiency). The overall average collection efficiency associated with BAT is> 98 %.	Check if primary and secondary de dusting (incl. scrap preheating, charging, melting, tapping, ladle furnace and secondary metallurgy) is implemented by one of the techniques described in BAT and is followed by de dusting by means of a bag filter. Check the measurement reports of the BAT–AELs for dust and mercury The BAT-AEL for dust is < 5 mg/Nm^{3}as a daily mean average The BAT-AEL for mercury is < 0,05 mg/Nm^3 determined as the average of the sampling period (discontinuous measurement, spot samples for at least four hours.		

AIR EMISSIONS					
Topic	**What does the permit say**	**Which BAT are applicable**	**What to check**	**What has been observed**	**Compliance (YES/NO)**
		The BAT associated emission level for dust is < 5 mg/Nm3, determined as a daily mean value.			
Pollution abatement system EAF steelmaking and casting		To prevent and reduce polychlorinated dibenzodioxins/furans (PCDD/F) and polychlorinated biphenyls (PCB) emissions by avoiding, as much as possible, raw materials which contain PCDD/F and PCB and using one or a combination of the following techniques, in conjunction with an appropriate dust removal system: I. appropriate post-combustion II. appropriate rapid quenching III. injection of adequate adsorption agents into the duct before dedusting. The BAT-AEL for PCDD/F is < 0,1 ng I-TEQ/Nm^3 based on 6-8 hour random sample during steady-state conditions	Check the use of one (or a combination of) the 3 described techniques in the BAT to reduce the formation of PCDD/Fs and PCBs Check the measurement reports of the BAT-AEL for PCDD/Fs.		

AIR EMISSIONS					
Topic	**What does the permit say**	**Which BAT are applicable**	**What to check**	**What has been observed**	**Compliance (YES/NO)**
Pollution abatement systems EAF steelmaking and casting		To reduce dust emissions by using one or a combination of the following techniques: I. efficient extraction of the slag crusher and screening devices with subsequent off gas cleaning, if relevant II transport of untreated slag by shovel loaders III. extraction or wetting of conveyor transfer points for broken material IV. wetting of slag storage heaps V. use of water fogs when broken slag is loaded. The BAT-AEL for dust is < 10-20mg/Nm^3 when the extraction technique (I) with slag-crusher is used.	Check the use of one (or a combination of) the 5 emission reducing techniques for the reduction of dust emissions and check emission levels		

WASTEWATER					
Topic	**What does the permit /National law says**	**Which BAT are applicable**	**What to check**	**What has been observed**	**Compliance (YES/NO)**
Water and wastewater management		To prevent, collect and separate waste water types, maximising internal recycling and using an adequate treatment for each final flow. This includes techniques utilising, e.g. oil interceptors, filtration or sedimentation. In this context, the following techniques can be used where the prerequisites mentioned are present: • avoiding the use of potable water for production lines • increasing the number and/or capacity of water circulating systems when building new plants or modernising/revamping existing plants • centralising the distribution of incoming fresh water • using the water in cascades until single parameters reach their legal or technical limits • using the water in other plants if only single parameters of the water are affected and further usage is possible • keeping treated and untreated waste water separated; by this measure it is possible to dispose of waste water in different ways at a reasonable cost • using rainwater whenever possible.	Check if the use of potable water is avoided, if contaminated water streams are segregated, internal water recycling is maximized and if non-contaminated water streams are segregated/reused and if other measures stated in BAT are used		
Water and waste		To minimize the water consumption from the electric arc furnace (EAF) process by the use of	Check if water consumption of the EAF installation is minimized by the use of		

WASTEWATER					
Topic	**What does the permit /National law says**	**Which BAT are applicable**	**What to check**	**What has been observed**	**Compliance (YES/NO)**
water management		closed loop water cooling systems for the cooling of furnace devices as much as possible unless once-through cooling systems are used.	closed loop water cooling systems for the cooling of furnace devices.		
Pollution abatement systems for water emissions from EAF steelmaking		To minimise the wastewater discharge from continuous casting by using the following techniques in combination: The removal of solids by flocculation, sedimentation and/or filtration The removal of oil in skimming tanks or in any other effective device The recirculation of cooling water and water from vacuum generation as much as possible. The BAT-AEL for waste water from continuous casting machines based on a qualified random sample or a 24-hour composite sample are: Suspended solids < 20 mg/l Iron < 5 mg/l Zinc < 2 mg/l Nickel < 0,5 mg/l Total chromium < 0,5 mg/l Total hydrocarbons < 5 mg/l	Check if water discharge from continuous casting is minimized by the use of flocculation, sedimentation and/or filtration, oil removing by e.g. skimming and recirculation of cooling water and water from vacuum generation. Check the reporting on BAT-AELs and monitoring frequency.		

SOIL AND GROUNDWATER					
Topic	**What does the permit /National law says**	**Which BAT are applicable**	**What to check**	**What has been observed**	**Compliance (YES/NO)**
Rainwater		Process water should be segregated from rainwater and other water effluent, to allow reuse or recycling, as well as to minimize the amount of waste water which requires treatment, the installation of a roof over certain process areas, loading and unloading bays, etc. Prevention of uncontrolled effluents from the site, such as contaminated rainwater. Rainwater from production areas is collected either in sumps on the spot or in other central facilities (e.g. emergency storage tanks or lagoons) to allow inspection and then a decision is to be made on whether to discharge it directly to the receiving water or to a waste water treatment facility.	Existence of systems to separate and treat first flush rainwater from later rainfall.		
Tank bunds		Design a tank farm bund (or dike) to contain large spills, such as that caused by a shell rupture or a large overfill. The bund consists of a wall around the outside of the tank (or tanks) to contain any product in the unlikely event of a spill personnel both on and off-site. The volume is normally sized to accommodate the contents of the largest tank within the bund.	Presence of tank bunds to contain spills from storage tanks and drums of waste, to prevent soil contamination in case of leakage.		

WASTE					
Topic	**What does the permit /National law says**	**Which BAT are applicable**	**What to check**	**What has been observed**	**Compliance (YES/NO)**
Waste generation		To prevent waste generation by using one or a combination of the following techniques: I. appropriate collection and storage to facilitate a specific treatment II. recovery and on-site recycling of refractory materials from the different processes and use internally, i.e. for the substitution of dolomite, magnesite and lime III. use of filter dusts for the external recovery of non-ferrous metals such as zinc in the non-ferrous metals industry, if necessary, after the enrichment of filter dusts by recirculation to the electric arc furnace (EAF) IV. separation of scale from continuous casting in the water treatment process and recovery with subsequent recycling, e.g. in the sinter/blast furnace or cement industry V. external use of refractory materials and slag from the electric arc furnace (EAF) process	Check if waste generation is prevented according to one or a combination of the techniques that are described in BAT. Check if EAF residues that cαn not be voided or recycled are managed in a controlled manner.		

WASTE					
Topic	**What does the permit /National law says**	**Which BAT are applicable**	**What to check**	**What has been observed**	**Compliance (YES/NO)**
		as a secondary raw material where market conditions allow for it.			
Waste minimization by internal use or by application of specialized recycling processes		To use integrated techniques and operational techniques for waste minimization by internal use or by application of specialized recycling processes (internally or externally).	Check if integrated techniques for the recycling of iron-rich residues are used.		
Waste reuse		To maximize external use or recycling for solid residues which cannot be used or recycled wherever this is possible.	Check if there is maximum reuse or recycling for solid residues that cannot be recycled according to previous BAT; check if there is control and management for residues that cannot be avoided or recycled.		
Waste treatment		To use the best operational and maintenance practices for the collection, handling, storage and transport of all solid residues and for the hooding of transfer points to avoid emissions to air and water.	Check operational and maintenance practices for collection, handling, storage and transport of solid residues and the hooding of transfer points to avoid emissions to air and water.		

2. Meat processing (Slaughterhouses)

AIR EMISSIONS					
Topic	**What does the permit /National law say**	**Which BAT are applicable**	**What to check**	**What has been observed**	**Compliance (YES/NO)**
Pollution abatement systems			Air emissions collection Air emissions treatment		
Pollution abatement systems			Concentration and quantity of contaminants before and after the treatment. Duration of operation daily/annually.		
Air emission continuous monitoring			Check the program of maintenance and calibration of the air emission measurements equipment.		
Dust		Dust collection at poultry reception – fabric filter - wet scrubber - metal mesh.	Check which type (fabric filter, wet scrubber, metal mesh) is installed and operated. Check what is happening with the collected dust (e.g. transport to landfill?).		

WASTE WATER					
Topic	**What does the permit /National law say**	**Which BAT are applicable**	**What to check**	**What has been observed**	**Compliance (YES/NO)**
Pollution abatement systems		Apply an initial screening of solids using at the slaughterhouse or animal by-products facilities installation sieves Use a wastewater equalization tank Remove fat from waste water, using a fat trap	Check whether the relevant treatment facilities are in place: • Sieves • Equalization tank • Emergency lagoon • Fat trap • Flotation plant • Own biological WWTP		

AIR EMISSIONS					
Topic	**What does the permit /National law say**	**Which BAT are applicable**	**What to check**	**What has been observed**	**Compliance (YES/NO)**
		Use a flotation plant, possibly combined with the use of flocculants, to remove additional solids Subject the effluent to a biological treatment process Subject the resulting effluent to tertiary treatment (in own or municipal wastewater treatment plant)	Check the records (kept by operator) concerning the total waste water quantity (m^3/day) and the concentration of contaminants after final treatment (exit of own WWTP – entrance to municipal WWTP) Check the level of treatment applied in the municipal WWTP (tertiary treatment?)		
Water use conservation measures		Apply dedicated metering of water consumption Separate process and non-process waste water Dry clean installations and transport by-products dry followed by pressure cleaning using hoses fitted with hand-operated triggers and where necessary hot water supplied from thermostatically controlled steam and water valves.	Check whether metering devices are installed at the major water supply devices: cleaning of floors/ equipment, hot water supply Inspect whether the cooling water (closed loop system) is separated from the process water and whether it is eventually sometimes discharged into the WWTP (for dilution purposes) Inspect how the by-products are collected/ transported (dry collection/ transport?) and how frequent floors/devices are cleaned with water.		

SOIL AND GROUNDWATER					
Topic	**What does the permit /National law say**	**Which BAT are applicable**	**What to check**	**What has been observed**	**Compliance (YES/NO)**
Disposal of carcasses, sludge, by-products			Inspect the places where any solid residues are dumped/ disposed of:		

SOIL AND GROUNDWATER					
Topic	**What does the permit /National law say**	**Which BAT are applicable**	**What to check**	**What has been observed**	**Compliance (YES/NO)**
			Are these areas covered? Any underground sealing in place?		
WASTE					
Topic	**What does the permit /National law say**	**Which BAT are applicable**	**What to check**	**What has been observed**	**Compliance (YES/NO)**
Collection/ Storage		Segregation of collected by-products	Check where offal, feathers and any other non-usable by-products are separately collected and stored Check how manure from lairage is collected (dry collection?)		
Waste generated			Waste classification (according to national list of waste) Check the records (kept by the operator) concerning the quantity of each waste/by-product (kg/day)		
Disposal/ Recycling			Check the disposal/recycling route: Disposal (where are they disposed – municipal landfill?) Recycling (according to applicable national waste legislation) Are they recycled within the facility? Are they transported to other facilities for re-use/ recycling?		

Appendix 7
IMAP Common Indicator Guidance Facts Sheets (Pollution and Marine Litter)

Table of Contents

2. Common indicators Factsheet

Common Indicator 13 (EO5): Concentration of key nutrients in water column[15,16]

Indicator Title	13. Concentration of key nutrients in water column (EO5)	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
Concentrations of nutrients in the euphotic layer are in line with prevailing physiographic, geographic and climate conditions	Human introduction of nutrients in the marine environment is not conducive to eutrophication	1. Reference nutrients concentrations according to the local hydrological, chemical and morphological characteristics of the un-impacted marine region. 2. Decreasing trend of nutrients concentrations in water column of human impacted areas, statistically defined. 3. Reduction of BOD emissions from land based sources. 4. Reduction of nutrients emissions from land based sources
Rational		
Justification for indicator selector 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. The direct and indirect consequences of eutrophicationare undesirable when they degrade ecosystem health and/or the sustainable provision of goods and services, such as algal blooms, dissolved oxygen deficiency, declines in sea-grasses, mortality of benthic organisms and/or fish. Altough, these changes may also occur due to natural processes, the management concern begins when they are attributed to anthropogenic sources.		
Scientific References i. Brzezinski M.A., 1985. The Si:C:N ratio of marine diatoms: interspecific variability and the effect of some environmental variables. Journal of Phycology, Vo. 21, pp. 347–357. ii. Conley D.J., Schelske C.L., Stoermer E. F., 1993. Modification of the biogeochemical cycle of silica with eutrophication. Mar. Ecol. Prog. Ser. 101, 179-192.		

[15]Note that this builds upon a previous indicator factsheet developed under Horizon 2020. H2020 Indicators Fact Sheets. Regional meeting on PRTR and Pollution indicators, Ankara (Turkey), 16-17 June 2014. (UNEP(DEPI)/MED WG. 399/4)

[16]MSFD Descriptor 5: Human-induced eutrophication is minimized, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters.

Indicator Title	13. Concentration of key nutrients in water column (EO5)

iii. Devlin, M., Painting, S., Best, M., 2007. Setting nutrient thresholds to support an ecological assessment based on nutrient enrichment, potential primary production and undesirable disturbance. Mar. Poll., 55., 65-73.

iv. Carstensen, J., 2007. Statistical principles for ecological status classification of Water Framework Directive monitoring data. Mar. Poll., 55, 3-15.

Policy Context and targets

Policy context description

In the Mediterranean, the UNEP/MAP MED POL Monitoring programme included from its inception the study of eutrophication as part of its seven pilot projects approved by the Contracting Parties at the Barcelona meeting in 1975 (UNEP MAP, 1990a,b). The issue of a consistent monitoring strategy and assessment of eutrophication was first raised at the UNEP/MAP MED POL National Coordinators Meeting in 2001 (Venice, Italy) which recommended to the Secretariat to elaborate a draft programme for monitoring of eutrophication in the Mediterranean coastal waters (UNEP/MAP MED POL, 2003). In spite of a series of assessments reviewing the concept and state of eutrophication, there are important gaps in the capacity to assess the intensity of this phenomenon. Efforts have been devoted to define the concepts to assess the intensity and to extend experience beyond the initial sites in the Adriatic Sea, admittedly, the most eutrophic area in the entire Mediterranean Sea. In the context of the Mediterranean Sea, the Integrated Monitoring and Assessment Programe (UNEP/MAP, 2016) and the European Marine Strategy Framework Directive (2000/56/EC) are the two main policy tools for the eutrophication phenomenon.

Targets

For each considered marine spatial scale (region, sub-region, local water mass, etc.) the nutrient levels should be compared based on base reference levels and trends monitoring until commonly agreed thresholds have been scientifically assessed and agreed upon in the Mediterranean Sea.

Policy documents

General Policy documents

i. 19th COP to the Barcelona Convention, Athens, Greece, 2016. Decision IG.22/7 - Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Sea and Coast and Related Assessment Criteria (UNEP(DEPI)/MED IG.22/28)

ii. 19th COP to the Barcelona Convention,Athens, Greece, 2016.Draft Integrated Monitoring and Assessment Guidance (UNEP(DEPI)/MED IG.22/Inf.7)

iii. 18th COP to the Barcelona Convention, Istanbul, Turkey, 2013.Decision IG.21/3 - Ecosystems Approach including adopting definitions of Good Environmental Status (GES) and Targets. UNEP(DEPI)/MED IG.21/9

iv. Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy(Marine Strategy Framework Directive).

Nutrient/Eutrophication related Policy documents

Indicator Title	13. Concentration of key nutrients in water column (EO5)

v. UNEP/MAP MED POL (2003). Eutrophication Monitoring Strategy of UNEP/MAP MED POL. UNEP(DEPI)/MED WG.231/14. UNEP, Athens.

vi. Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.

vii. UNEP/FAO/WHO (1996). 'Assessment of the state of eutrophication in the Mediterranean Sea'. MAP Technical Reports Series No 106. UNEP, Athens, 211 pp.

viii. UNEP/MAP MED POL (1990a). Activity IV: Research on the effects of pollutants on Marine Organisms and their Populations (UNEP/MAP MED POL Phase I, 1975-1981).

ix. UNEP/MAP MED POL (1990b). Activity V: Research on the effects of pollutants on Marine Communities and Ecosystems (UNEP/MAP MED POL Phase I, 1975-1981).

Indicator analysis methods

Indicator Definition

Concentration of key (inorganic) nutrients in the water column:

Nitrate (NO_3-N)
Nitrite (NO_2-N)
Ammonium (NH_4-N)
Total Nitrogen (TN)
Orthophosphate (PO_4-P)
Total Phosphorus (TP)
Orthosilicate (SiO_4-Si)

Sub-Indicators: Nutrient ratios (molar) of silica, nitrogen and phosphorus where appropriate:
Si:N, N:P, Si:P

Methodology for indicator calculation

All: Spectrophotometry (manually or automated methods and instrumentation)

Indicator units

All: micromol per liter, that is micromolar concentration (μmol/L =μM)
Ratios: adimensional (simple mathematical derivation of ratios from nutrient concentrations)

List of Guidance documents and protocols available

i. OSPAR, 2012. OSPAR MSFD Advice Document on Eutrophication. Approaches to determining good environmental status, setting of environmental targets and selecting indicators for Marine Strategy Framework Directive descriptor 5.

ii. Piha, H., Zampoucas, N., 2011. Review of Methodological Standards Related to the Marine Strategy Framework Directive Criteria on Good Environmental Status. JRC Scientific and Technical Reports, EUR 24743 EN

Indicator Title	13. Concentration of key nutrients in water column (EO5)

iii. UNEP/MAP MED POL (2005). Sampling and Analysis Techniques for the Eutrophication Monitoring Strategy of UNEP/MAP MED POL. MAP Technical Reports Series No. 163. UNEP, Athens. 61pp.

iv. Durairaj, P., Sarangi, R.K., Ramalingam, S. *et al.* Seasonal nitrate algorithms for nitrate retrieval using OCEANSAT-2 and MODIS-AQUA satellite data. Environ Monit Assess (2015) 187: 176.

v. See also UNEP/MAP website (http://web.unep.org/unepmap)

Data Confidence and uncertainties

Despite the great variability born by the water layers subject to active hydrodynamic processes, monitoring the characteristics of the seawater is still the most direct way of assessing eutrophication. Inorganic nutrients may be determined either at the surface or at various depths.

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols

Traditional methods for eutrophication monitoring in coastal waters involve *in situ* sampling/measurements of commonly measured parameters such as nutrients concentration. Concerning available methods for *in situ* measurements, ships provide flexible platforms for eutrophication monitoring, while remote sensing provides opportunities for a synoptic view over regions or sub-regions. Besides traditional ship measurements, ferry-boxes and other autonomous measuring devices have been developed that allow high frequency and continuous measurements.

Sampling for the determination of *in vitro* fluorescence and nutrient analysis may be carried out with relatively little effort if a proper pump and hose are mounted on the ship. The measurements may be done at the surface or just below it with a water intake on the hull of the vessel or at fixed or varying depths with a towed "fish" and pumping system.

Available data sources

EMODNET Chemistry:
http://www.emodnet-chemistry.eu/data_access.html

EEA Waterbase - Transitional, coastal and marine waters:
http://www.eea.europa.eu/data-and-maps/data/waterbase-transitional-coastal-and-marine-waters-11

Spatial scope guidance and selection of monitoring stations

The first factor promoting eutrophication is nutrient enrichment. This explains why the main eutrophic areas are to be found primarily not far from the coast, mainly in areas receiving high nutrient loads, despite some natural symptoms of eutrophication can also be found, such as in upwelling areas. Additionally, the risk of eutrophication is linked to the capacity of the marine environment to confine growing algae in the well-lighted surface layer. The geographical extent of potentially eutrophic waters may vary widely, depending on:

(i) the extent of shallow areas, i.e. with depth $\leq$ 20 m;
(ii) the extent of stratified river plumes, which can create a shallow surface layer separated by a halocline from the bottom layer, whatever its depth;
(iii) extended water residence times in enclosed seas leading to blooms triggered to a large degree by internal and external nutrient pools; and

Indicator Title	13. Concentration of key nutrients in water column (EO5)

(iv) upwelling phenomena leading to autochthonous nutrient supply and high nutrient concentrations from deep water nutrient pools, which can be of natural or human origin.

Therefore, the geographical scale of monitoring for the assessment of GES for eutrophication will depend on the hydrological and morphological conditions of an area, particularly the freshwater inputs from rivers, the salinity, the general circulation, upwelling and stratification. The spatial distribution of the monitoring stations should, prior to the establishment of the eutrophication status of the marine sub-region/area, be risk-based and proportionate to the anticipated extent of eutrophication in the sub-region under consideration as well as its hydrographic characteristics aiming for the determination of spatially homogeneous areas. The eutrophication monitoring programes should pursue to assess the eutrophication phenomena, based on the differentiation of the scale and time dependant signals from human induced versus natural eutrophication.

Temporal Scope guidance

Flexibility should be incorporated into the design of the monitoring programme to take account of differences in each marine sub-region/area. At the Mediterranean Sea latitudes, in general terms, the pre-summer and Winter primary production bloom intensity peaks of natural eutrophication will define the strategy for the sampling frequency, altough year round measurements of nutrients may be more appropriate. The optimum frequency (seasonal 2 to 4 times per year or monthly 12 times per year) for the monitoring of nutrients at the selected stations should be choseen taking into account the necessity of both to control the deviations of the known natural cycles of eutrophication in coastal areas and the control of (decreasing) trends monitoring impacted areas, therefore, from low frequency (mínimum)to high frequency measurements.

Therefore, either for impacted or non-impacted coastal waters the optimal frequency per year and sampling locations needs to be selected at a local scales, whilst for open waters the sampling frequency to be determined on a sub-regional level following a risk based approach.

Mainly, in order to build a robust sampling frequency scale in future a sounded statistical approach has to be developed that take in account the discriminant limit between classes when the nutrient boundaries approach will be widely accepted.

Data analysis and assessment outputs

Despite the individual nutrient concentrations and nutrient ratios will be evaluated based on statistical analysis against known reference levels and known marine eutrophication processes, following the evaluation of information provided by a number of countries and other available information, it has to be noted that the Mediterranean countries are using different eutrophication non-mandatory assessment methods such as TRIX, UNTRIX, Eutrophication scale, EI, HEAT, OSPAR, etc. Nutrients concentratons are part of these tools and is very important to continue to be used at sub-regional or national levels because there is a long-term experience within countries which can reveal / be used for assessing eutrophication trends.

However, in order to increase coherency and comparability regarding eutrophication assessment methodologies is recommended that further efforts should be made to harmonize existing tools through workshops, dialogue and comparative exercises at regional/subregional/subdivision levels in Mediterranean with a view to further develop common assessment methods.

EXAMPLE: The trophic index (TRIX; Vollenweider *et al.*, 1998) may be used for a preliminary assessment of the trophic status of coastal waters in relation to eutrophication providing that its advantages and shortcomings are taken into account (Primpas and Karydis, 2011). The adopted UNEP/MAP MED POL short-term eutrophication monitoring strategy monitored parameters to support the TRIX. This Index is widely used to synthesize key eutrophication variables into a simple numeric expression to make information comparable over a wide range of trophic situations. For TRIX chlorophyll-a, Oxygen as absolute % deviation from saturation, Dissolved Inorganic Nitrogen, and Total Phosphorus data are required.

Expected assessments outputs

<table>
<tr><td>Indicator Title</td><td colspan="2">13. Concentration of key nutrients in water column (EO5)</td></tr>
<tr><td colspan="3">As sugested by the on line expert group on eutrophication established by the Contracting parties it is recommended that with regard to nutrient concentrations, until commonly agreed thresholds have been determinedand agreed upon, GES may be determined on a levels and trend monitoring basis.</td></tr>
<tr><td colspan="3">Known gaps and uncertainties in the Mediterranean

For a complete assessment of eutrophication and GES achievement, GES thresholds and reference conditions (natural background concentrations) are needed not only for chlorophyll a, but such values must be set in the near future, through dedicated workshops and exercises also for nutrients, transparency and oxygen as minimum requirements (see also related Common Indicator 14). This should include quality assurance schemes, as well as data quality control protocols.
Nutrient, transparency and oxygen thresholds and reference values may not be identical for all areas, since is recognized that area-specific environmental conditions must define threshold values. GES could be defined on a sub-regional level, or on a sub-division of the sub-region (such as the Northern Adriatic), due to local specificities in relation to the trophic level and the morphology of the area.</td></tr>
<tr><td colspan="3">Contacts and version Date</td></tr>
<tr><td colspan="3">http://www.unepmap.org</td></tr>
<tr><td>Version No</td><td>Date</td><td>Author</td></tr>
<tr><td>V.1</td><td>31.05.17</td><td>MEDPOL</td></tr>
</table>

Common Indicator 14 (EO5): Chlorophyll *a* concentration in water column[17]

Indicator Title	14. Chlorophyll *a* concentration in water column (EO5)	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
Natural levels of algal biomass, water transparency and oxygen concentrations in line with prevailing physiographic, geographic and weather conditions	Direct and indirect effects of nutrient over-enrichment are prevented	1. Chlorophyll *a* concentrations in high-risk areas below thresholds 2. Decreasing trend in chl-*a* concentrations in high risk areas affected by human activities
Rational		
Justification for indicator selector 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. The consequences of eutrophication are undesirable if they appreciably degrade ecosystem health and/or the sustainable provision of goods and services, such as excessive algal blooms, dissolved oxygen deficiency, declines in sea-grasses, mortality of benthic organisms and/or fish. Altough, these changes may also occur due to natural processes, the management concern begins when they are attributed to anthropogenic sources.		
Scientific References i. Boyer J.N. Kelble C.R., Ortner P.B., Rudnick D.T., 2009. Phytoplankton bloom status: Chlorophyll *a* biomass as an indicator of water quality condition in the southern estuaries of Florida, USA. Ecological Indicators 9s:s56- s67. ii. Primpas I., Karydis M., 2011. Scaling the trophic index (TRIX) in oligotrophic marine environments. Environmental Monitoring and Assessment July 2011, Volume 178, Issue 1-4, pp 257-269. iii. Vollenweider, R.A., Giovanardi F., Montanari, G., Rinaldi A., 1998. Characterization of the trophic conditions of marine coastal waters, with special reference to the NW Adriatic Sea: proposal for a trophic scale, turbidity and generalized water quality index. Environmetrics, 9, 329-357.		
Policy Context and targets		
Policy context description In the Mediterranean, the UNEP/MAP MED POL Monitoring programme included from its inception the study of eutrophication as part of its seven pilot projects approved by the Contracting Parties at the Barcelona meeting in 1975 (UNEP MAP, 1990a,b). The issue of a consistent monitoring strategy and assessment of eutrophication was first raised at the UNEP/MAP MED POL National Coordinators Meeting in 2001 (Venice, Italy) which recommended to the Secretariat to elaborate a draft programme for monitoring of eutrophication in the Mediterranean coastal waters (UNEP/MAP MED POL, 2003). In spite of a series of assessments reviewing the concept and state of eutrophication, there are important gaps in the capacity to assess the intensity of this phenomenon.		

[17] MSFD Descriptor 5: Human-induced eutrophication is minimized, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters.

Indicator Title	14. Chlorophyll *a* concentration in water column (EO5)

Efforts have been devoted to define the concepts to assess the intensity and to extend experience beyond the initial sites in the Adriatic Sea, admittedly, the most eutrophic area in the entire Mediterranean Sea. In the context of the Mediterranean Sea, the European Marien Strategy Framework Directive (200/56/EC) and the Integrated Monitoring and Assessment Programe (UNEP/MAP, 2016), are the two main policy tools for the eutrophication phenomenon.

Targets

For each defined marine spatial scale (region, sub-region, etc.) the levels should be compared against agreed threshold levels defining High/Good and Good/Medium environmental status based on the indicative thresholds and reference values of Chlorophyll *a*- in Mediterranean coastal water types, according to the Commission Decision of 20 September 2013 (2013/480/EU) establishing, pursuant to Directive 2000/60/EC (WFD), the values of the Member State monitoring system classifications as a result of the intercalibration exercise and repealing Decision 2008/915/EC, recalling on reference conditions (High/Good) and boundaries of good/moderate status (G/M).

Policy documents

General Policy documents

i. 19th COP to the Barcelona Convention, Athens, Greece, 2016. Decision IG.22/7 - Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Sea and Coast and Related Assessment Criteria (UNEP(DEPI)/MED IG.22/28)

ii. 19th COP to the Barcelona Convention,Athens, Greece, 2016.Draft Integrated Monitoring and Assessment Guidance (UNEP(DEPI)/MED IG.22/Inf.7)

iii. 18th COP to the Barcelona Convention, Istanbul, Turkey, 2013.Decision IG.21/3 - Ecosystems Approach including adopting definitions of Good Environmental Status (GES) and Targets. UNEP(DEPI)/MED IG.21/9

iv. Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive).

Nutrient/Eutrophication related Policy documents

v. UNEP/MAP MED POL (2003). Eutrophication Monitoring Strategy of UNEP/MAP MED POL. UNEP(DEPI)MED WG.231/14. UNEP, Athens.

vi. Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.

vii. UNEP/FAO/WHO (1996). ‘Assessment of the state of eutrophication in the Mediterranean Sea’. MAP Technical Reports Series No 106. UNEP, Athens, 211 pp.

viii. UNEP/MAP MED POL (1990a). Activity IV: Research on the effects of pollutants on Marine Organisms and their Populations (UNEP/MAP MED POL Phase I, 1975-1981).

ix. UNEP/MAP MED POL (1990b). Activity V: Research on the effects of pollutants on Marine Communities and Ecosystems (UNEP/MAP MED POL Phase I, 1975-1981).

Indicator Title	14. Chlorophyll *a* concentration in water column (EO5)
Indicator analysis methods	

Indicator Definition

Chlorophyll *a* concentration in the water column (State, Impact Indicator);

Sub-Indicators: Water Transparency (State, Impact Indicator) and Dissolved oxygen (State, Impact Indicator)

Methodology for indicator calculation

Chlorophyll *a*: Spectrophotometry.
ISO 10260 (1992) on spectrometric determination of the chlorophyll *a* concentration provides a standard method for quantification of chlorophyll *a*.
Water transparency: measured as Secchi disk depth or according to ISO 7027:1999 Water Quality-Determination of Turbidity
Dissolved Oxygen: Chemical methods, Oxygen sensors, etc. measured near the bottom (under the euphotic layer/oxycline)

Indicator units

microgram per liter (μg/L) - Chlorophyll *a*
meters – Secchi disk depth; NTU Turbidity Scale (Nephelometric Turbidity Units) – Water transparency
milligram per liter (mg/L) and % Saturation (if temperature and salinity is known) – Dissolved Oxygen

List of Guidance documents and protocols available

i. OSPAR, 2012. OSPAR MSFD Advice Document on Eutrophication. Approaches to determining good environmental status, setting of environmental targets and selecting indicators for Marine Strategy Framework Directive descriptor 5

ii. Piha, H., Zampoucas, N., 2011. Review of Methodological Standards Related to the Marine Strategy Framework Directive Criteria on Good Environmental Status. JRC Scientific and Technical Reports, EUR 24743 EN

iii. UNEP/MAP MED POL, 2005. Sampling and Analysis Techniques for the Eutrophication Monitoring Strategy of UNEP/MAP MED POL. MAP Technical Reports Series No. 163. UNEP, Athens. 61pp.

Data Confidence and uncertainties

Despite the great variability born by the water layers subject to active hydrodynamic processes, monitoring the characteristics of the seawater is still the most direct way of assessing eutrophication. A number of parameters have been identified as providing most information relative to eutrophication e.g. chlorophyll *a*, dissolved oxygen, inorganic nutrients, organic matter, suspended solids, light penetration, aquatic macro-phytes, zoo benthos, etc. They all may be determined either at the surface or at various depths.
If only limited means are available, determination of those parameters that synthesize the most information should be retained. Chlorophyll *a* determinations for example, although not very precise representations of the system, are data which provide a great deal of information. Turbidity may also be a good measure of eutrophication, except near the mouths of rivers where inert suspended solids may be extremely abundant. Dissolved oxygen is one parameter that integrates much information on the processes involved in eutrophication, provided it is measured near the bottom or, at least, below the euphotic zone where an oxycline usually appears.

Indicator Title	14. Chlorophyll *a* concentration in water column (EO5)
Methodology for monitoring, temporal and spatial scope	
Available Methodologies for Monitoring and Monitoring Protocols Traditional methods for eutrophication monitoring in coastal waters involve *in situ* sampling/measurements of commonly measured parameters such as nutrients concentration, chlorophyll *a* concentration, phytoplankton abundance and composition, transparency and dissolved oxygen concentration. Concerning available methods for *in situ* measurements, ships provide flexible platforms for eutrophication monitoring, while remote sensing provides opportunities for a synoptic view over regions or sub-regions. Besides traditional ship measurements, ferry-boxes and other autonomous measuring devices have been developed that allow high frequency and continuous measurements. Modelling and remote sensing should also be considered as area integrating in addition to *in situ* measurements, depending on the requirements with respect to data. In general, *in situ* measurements always remain necessary to validate and calibrate the models and data calculated from satellite measurements. However, satellite data need to be supported by ground truth data. A good strategy appears to be a combination of remote sensing and scanning of the area known or suspected to be affected with automatic measuring instruments such as thermo-salinometer, dissolved oxygen sensors and *in vivo* fluorometer and/or nephelometer. Sampling for the determination of *in vitro* fluorescence and nutrient analysis may be carried out with relatively little effort if a proper pump and hose are mounted on the ship. The measurements may be done at the surface or just below it with a water intake on the hull of the vessel or at fixed or varying depths with a towed “fish” and pumping system.	
Available data sources http://www.unepmap.org Satellite databases such as in EMIS http://mcc.jrc.ec.europa.eu/emis/	
Spatial scope guidance and selection of monitoring stations The extent of eutrophication shows spatial variation, for instance coastal regions versus the open sea. The frequency and spatial resolution of the monitoring programme should reflect this spatial variation in eutrophication status and pressures following a risk based approach and the precautionary principle. The geographical extent of potentially eutrophic waters may vary widely, depending on: (i) the extent of shallow areas, i.e. with depth ≤ 20 m; (ii) the extent of stratified river plumes, which can create a shallow surface layer separated by a halocline from the bottom layer, whatever its depth (iii) extended water residence times in enclosed seas leading to blooms triggered to a large degree by internal and external nutrient pools; and (iv) upwelling phenomena leading to autochthonous nutrient supply and high nutrient concentrations from deep water nutrient pools, which can be of natural or human origin. Therefore, the geographical scale of monitoring for the assessment of GES for eutrophication will depend on the hydrological and morphological conditions of an area, particularly the freshwater inputs from rivers, the salinity, the general circulation, upwelling and stratification. The spatial distribution of the monitoring stations should, prior to the establishment of the eutrophication status of the marine sub-region/area, be risk-based and proportionate to the anticipated extent of eutrophication in the sub-region under consideration as well as its hydrographic characteristics aiming for the determination of spatially homogeneous areas. The eutrophication monitoring programes should pursue to assess the eutrophication phenomena, based on the differentiation of the scale and time dependant signals from human induced versus natural eutrophication.	
Temporal Scope guidance	

Indicator Title	14. Chlorophyll *a* concentration in water column (EO5)
The current national eutrophication monitoring programme implemented so far by the Contracting Parties in the framework of the UNEP/MAP MED POL programme should be used as a sound basis for monitoring under the EcAp. It could be recommended: Chlorophyll *a*: For coastal stations minimum sampling 4/year, 6-12 /year recommended; For open waters sampling frequency to be determined on a sub-regional level following a risk based approach Water transparency: *id.* Chlorophyll *a* Dissolved Oxygen: *id.* Chlorophyll *a* AAdditionally, in order to build a robust sampling frequency scale in future a sounded statistical approach has to be developed that take in account the discriminant limit between classes when the class boundary approach will be widely accepted.	
Data analysis and assessment outputs	
Statistical analysis and basis for aggregation The classification scheme on chlorophyll *a* concentration developed by MEDGIG as an assessment method easily applicable by all Mediterranean countries based on the indicative thresholds and reference values adopted. Further, developments within the European MSFD and OSPAR Comission with regard eutrophication should also be taken into account. Further, it has to be noted that the Mediterranean countries are using different eutrophication non-mandatory assessment methods such as TRIX, UNTRIX, Eutrophication scale, EI, HEAT, OSPAR, etc. These tools are very important to continue to be used at sub-regional or national levels because there is a long-term experience within countries which can reveal / be used for assessing eutrophication trends. However, in order to increase coherency and comparability regarding eutrophication assessment methodologies is recommended that further efforts should be made to harmonize existing tools through workshops, dialogue and comparative exercises at regional/subregional/subdivision levels in Mediterranean with a view to further develop common assessment methods. EXAMPLE: The trophic index (TRIX, Vollenweider *et al.*, 1998) may be used for a preliminary assessment of the trophic status of coastal waters in relation to eutrophication providing that its advantages and shortcomings are taken into account (Primpas and Karydis, 2011). The adopted UNEP/MAP MED POL short-term eutrophication monitoring strategy monitored parameters to support the TRIX. This Index is widely used to synthesize key eutrophication variables into a simple numeric expression to make information comparable over a wide range of trophic situations. For TRIX chlorophyll-a, Oxygen as absolute % deviation from saturation, Dissolved Inorganic Nitrogen, and otal Phosphorus data are required.	
Expected assessments outputs GES thresholds and trends are recommended to be used in a combined way, according to data availability and agreement on GES threshold levels. In the framework of UNEP/MAP MED POL there is experience with regard to using quantitative thresholds. It is proposed that for the Mediterranean region, quantitative thresholds between “good” (GES) and “moderate” (non GES) conditions for coastal waters could be based as appropriate on the work carried out in the framework of the MEDGIG intercalibration process of the EU Water Framework Directive (WFD). The Contracting Parties are 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 of chlorophyll a in Mediterranean coastal water types (according to 2013/480/EU, see reference below), recalling on reference conditions and boundaries of good/moderate status (G/M). In this context regarding the definition of subregional thresholds for chlorophyll *a* water typology is very important for further development of classification schemes of a certain area. Within the MEDGIG exercise the recommended water types for applying eutrophication assessment is based on hydrological parameters characterizing a certain area dynamics and circulation.	

Indicator Title	14. Chlorophyll *a* concentration in water column (EO5)	
2013/480/EU: Commission Decision of 20 September 2013 establishing, pursuant to Directive 2000/60/EC of the European Parliament and of the Council, the values of the Member State monitoring system classifications as a result of the intercalibration exercise and repealing Decision 2008/915/EC		
Known gaps and uncertainties in the Mediterranean For a complete assessment of eutrophication and GES achievement, GES thresholds and reference conditions (natural background concentrations) are needed not only for chlorophyll *a*, but such values must be set, in the near future, through dedicated workshops and exercises also, water ransparency and oxygen as minimum requirements, where appropriate. This shoudl include quality assurance schemes, as well as data quality control protocols. Further, in order to increase coherency and comparability regarding eutrophication assessment methodologies is recommended that further efforts should be made to harmonize existing tools through workshops, dialogue and comparative exercises at regional/subregional/subdivision levels in Mediterranean with a view to further improve and develop common assessment methods.		
Contacts and version Date		
http://www.unepmap.org		
Version No	**Date**	**Author**
V.1	31.05.17	MEDPOL

Common Indicator 17 (EO9): Concentration of key harmful contaminants measured in the relevant matrix[18]

<table>
<tr><td>Indicator Title</td><td colspan="2">17. Concentration of key harmful contaminants measured in the relevant matrix (EO9)</td></tr>
<tr><td>Relevant GES definition</td><td>Related Operational Objective</td><td>Proposed Target(s)</td></tr>
<tr><td>Level of pollution is below a determined threshold defined for the area and species</td><td>Concentration of priority contaminants is kept within acceptable limits and does not increase</td><td>1. Concentrations of specific contaminants below Environmental Assessment Criteria (EACs) or below reference concentrations

2. No deterioration trend in contaminants concentrations in sediment and biota from human impacted areas, statistically defined

3. Reduction of contaminants emissions from land based sources</td></tr>
<tr><td colspan="3">Rational</td></tr>
<tr><td colspan="3">Justification for indicator selector

Environmental chemical pollution is directly linked with humankind activities and advancements. Marine environmental investigations have detected thousands of man-made chemicals (both inorganic and organic compounds) all over the world oceans, which have been shown to impair the health of the marine ecosystems and their ecosystem services. The study of the occurrence, transport, transformation and fate, through the different ecosystem compartments (seawater column, marine biota, sediment, etc.), as well as the study of their sources and entry routes (land-based, marine and atmospheric) are the first steps to understand and discover a growing environmental problem. The monitoring of the spatial and temporal scales of the harmful and noxious substances occurrence determines either a chronic or acute contamination/pollution episode. Currently, new man-made chemicals and emerging pollutants continue to enter the marine environment and interact with the different marine ecosystems (coastal, open ocean, deep-sea areas), increasing the complexity of the chemical pollution threats for the marine environment and their future sustainability to deliver its benefits.</td></tr>
<tr><td colspan="3">Scientific References

i. Clark, R.B., 1986. Marine Pollution, Oxford University Press.
ii. Neff, J.M., 1979. Polycyclic aromatic hydrocarbons in the aquatic environment. Sources, fates and biological effects. Applied Science Publishers, Ltd., London.
iii. Goldberg, E. D., 1975. The Musssel Watch - a first step in global marine monitoring. Mar.Poll.Bull., 6, 111.
iv. Bricker, S., Lauenstein, G., Maruya, K., 2014. NOAA’s Mussel Watch Program: Incorporating contaminants of emerging concern (CECs) into a long-term monitoring program. Mar.Poll.Bull., 81, 289–290.
v. Furdek, M., Vahcic, M., Šcancar, J., Milacic, R., Kniewald, G., Mikac, N., 2012. Organotin compounds in seawater and Mytilus galloprovincialis mussels along the Croatian Adriatic Coast. Mar.Poll.Bull., 64, 189–199</td></tr>
</table>

[18] MSFD Descriptor 8: Concentrations of contaminants are at levels not giving rise to pollution effects

Indicator Title	17. Concentration of key harmful contaminants measured in the relevant matrix (EO9)

vi. Nakata, H., Shinohara, R.I., Nakazawa, Y., Isobe, T., Sudaryanto, A., Subramanian, A., Tanabe, S., Zakaria, M.P., Zheng, G.J., Lam, P.K.S., Young Kim, E., Yoon Min, B., Wef, S.U., Hung Viet, P., Tana, T.S., Prudente, M., Donnell, F., Lauenstein, G., Kannan, K., 2012. Asia–Pacific mussel watch for emerging pollutants: Distribution of synthetic musks and benzotriazole UV stabilizers in Asian and US coastal waters. Mar. Pollut. Bull., 64, 2211–2218

vii. Richardson, S., 2004. Environmental Mass Espectrometry: Emerging contaminants and current issues. Anal. Chem., 76, 3337-3364.

viii. Schulz-Bull, D.E., Petrick, G., Bruhn, R., Duinker, J.C., 1998. Chlorobiphenyls (PCB) and PAHs in water masses of the northern North Atlantic. Mar. Chem., 61, 101-114.

Policy Context and targets

Policy context description

In most Mediterranean countries, the monitoring of a range of hazardous chemical substances in different marine ecosystem compartments are undertaken in response to the UNEP/MAP Barcelona Convention (1975) and its Land-Based Protocol, the UNEP/MAP MED POL Monitoring Program, as well as international, european (e.g. EU WFD or EU MSFD) or other national policy drivers. A considerable amount of founding actions are available through the pollution monitoring and assessment component of the UNEP/MAP MED POL Programme from the past decades. The environmental assessments have been used for the identification and confirmation of significant marine contaminants occurrence, distributions, levels and trends; as well as, for the continuous development of monitoring strategies and guidance. With respect to the Ecosystem Approach and IMAP, their implementation will continue under the benefits gained from this past knowledge and its policy framework built in the Mediterranean Sea.

Targets

Initial targets of GES under Common Indicator 17 will be focused on the control of environmental levels, trend improvements and the reduction of emissions at sources. The targets monitoring will be based upon data of a relatively small number of both legacy and ‘traditional’ chemicals reflecting the scope of current programmes and the availability of suitable agreed assessment criteria for them. The inclusion of emerging chemical compounds of environmental concern and their targets for GES within IMAP will be implemented as the scientific knowledge develops.

Policy documents

General Policy documents

i. 19th COP to the Barcelona Convention, Athens, Greece, 2016. Decision IG.22/7 - Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Sea and Coast and Related Assessment Criteria (UNEP(DEPI)/MED IG.22/28)

ii. 19th COP to the Barcelona Convention,Athens, Greece, 2016.Draft Integrated Monitoring and Assessment Guidance (UNEP(DEPI)/MED IG.22/Inf.7)

iii. 18th COP to the Barcelona Convention, Istanbul, Turkey, 2013.Decision IG.21/3 - Ecosystems Approach including adopting definitions of Good Environmental Status (GES) and Targets. UNEP(DEPI)/MED IG.21/9

iv. Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive).

v. Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.

Indicator Title	17. Concentration of key harmful contaminants measured in the relevant matrix (EO9)

Contaminants related Policy documents

vi. UNEP/MAP, 1987. Report of the Fifth Meeting of the Contracting Parties to the Convention for the Protection of the Mediterranean Sea against pollution and its Related Protocols. UNEP/IG. 74/5. UNEP/MAP, Athens.
vii. UNEP/MAP, 2005. Fact sheets on Marine Pollution Indicators. Meeting of the UNEP/MAP MED POL National Coordinators. Barcelona, Spain, 24-27 May 2005. UNEP (DEC)/MED/ WG.264/ Inf.14. UNEP, Athens.
viii. UNEP/MAP MED POL – Phase III, Programme for the Assessment and Control of Pollution in the Mediterranean Region. MAP Technical Report Series No. 120, UNEP, Athens, 1999.
ix. OSPAR Commission, 2013. Levels and trends in marine contaminants and their biological effects - CEMP Assessment Report 2012. Monitoring and Assessment Series, 2013.
x. EEA, 2003. Hazarous substances in the European marine environment: Trends in metals and persistent organic pollutants. Topic Report 2/2003. EEA, European Environmental Agency, Copenhagen, 2003. http://www.eea.eu.int
xi. EEA, 1999 State and pressures of the marine and coastal Mediterranean environment. Enivronmental issues series nº5. European Environmental Agency, Copenhagen, 1999. http://www.eea.eu.int

Indicator analysis methods

Indicator Definition

Concentrations of key contaminants in the following matrices (note this is a multicompoment pressure indicator):

BIOTA: In marine organisms, whole soft tissues or dissected parts according sampling and sample preparation protocols, and primarily in bivalve species and/or fish:
Trace/Heavy Metals (TM): Total mercury (HgT), Cadmium (Cd) and Lead (Pb)
Organochlorinated compounds (PCBs, Hexachlorobenzene, Lindane and ΣDDTs)
Polycyclic aromatic hydrocarbons

Lipid content, flesh fresh/dry weight ratio for normalisation purposes

SEDIMENTS: In coastal, platform and offshore sediments (< 2 mm particle size fraction):
Trace/Heavy Metals: Total mercury (HgT), Cadmium (Cd) and Lead (Pb)
Organochlorinated compounds (PCBs (at least, congeners 28, 52, 101, 118, 138, 153, 180, 105 and 156), aldrin, dieldrin, Hexachlorobenzene, Lindane and ΣDDTs)
Polycyclic aromatic hydrocarbons

Aluminium (Al), Total Organic Carbon (TOC) in the < 2mm particle size fraction for normalization purposes for TM and OCs, respectively. The < 63µm sediment fraction is recommended to be complementary for metals.
The liophilization ratio (dry/wet sediment ratio).

SEAWATER: the monitoring for environmental assessment purposes and the determination of contaminants in seawater presents specific challenges and higher costs. For the mid/long-term monitoring programes, such as IMAP, these are recommended to be carried out on a country decision basis.

Indicator Title	17. Concentration of key harmful contaminants measured in the relevant matrix (EO9)
Sub-indicators: other relevant chemicals (such as tributyltin, TBT, low molecular weight PAHs, etc.) and emerging pollutants are recommended to be carried out on a country decision basis until a firm COP Meeting Decision will be taken.	
Methodology for indicator calculation Trace/Heavy Metals (TM) and Aluminium: Spectrometry, Mass Spectrometry Organic compounds: Gas or Liquid Chromatography (GC/LC) coupled to a variety of detectors, such as Electron Capture Detectors or Mass Spectrometry, atomic adsorption. TOC: Elemental Analyser Particle fractions: in-house mesh validated methods (for < 2 mm) and/or geological sieving methods. Additional parameters to be recorded: biometrics (size/length, age), biological parameters such as condition index (mussels), condition factor.	
Indicator units Trace/Heavy Metals (TM) and Aluminium: mass/dry or wet weight mass of sample according MEDPOL Database Format Protocols. The dry/wet mass ratios should be calculated and reported. Organic compounds (OCs): mass/dry or wet weight mass of sample according MEDPOL Database Format Protocols. The dry/wet mass ratios should be calculated and reported. TOC: Elemental Analyser (as %) Particle fractions (as %)	
List of Guidance documents and protocols available Refer to UNEP Methods and Protocols for Marine Pollution, as well as from other recent documents from regional conventions (e.g. OSPAR) and European Guidelines, such as the Guidance Document No. 33 ON ANALYTICAL METHODS FOR BIOTA MONITORING UNDER THE WATER FRAMEWORK DIRECTIVE, Technical Report - 2014 – 084, ISBN 978-92-79-44679-5.	
Data Confidence and uncertainties Selected analytical methods are subject to Quality Assurance Protocols and interlaboratory exercises: QA/QC through UNEP/MAP MED POL/IAEA MESL, National QA/QC Procedures	
Methodology for monitoring, temporal and spatial scope	
Available Methodologies for Monitoring and Monitoring Protocols With regard the Ecosystem Approach and IMAP implementation, there are considerable benefits to be gained from taking advantage of previous knowledge and information developed through the UNEP/MAP MED POL. These actions include (1) the use of existing experience in the design of monitoring programmes, (2) the use of existing guidance on sampling and analytical methods to inform technical aspects of ecosystem approach monitoring, (3) the use of existing sampling station networks as a framework for the ecosystem approach monitoring networks, (4) the use of existing statistical assessment tools and work on assessment criteria as the basis for the assessments of	

Indicator Title	17. Concentration of key harmful contaminants measured in the relevant matrix (EO9)

ecosystem approach data, (5) the use of existing data to describe the distributions of contaminants in the sea, and (6) the use of existing time series as the basis of monitoring against a “no deterioration” target. The availability of quality assured data is of importance for the assessment of trends in pollutant concentrations.

Available data sources

i. UNEP(DEPI)/MED WG.365/Inf.5. Analysis of the trend monitoring activities and data for the MED POL Phase III and IV (1999-2010). Consultation Meeting to Review MED POL Monitoring Activities. Athens, 22-23 November 2011.

ii. UNEP(DEPI)/MED WG. 365/Inf.8. Development of assessment criteria for hazardous substances in the Mediterranean. Consultation Meeting to Review MED POL Monitoring Activities. Athens, 22-23 November 2011.

Spatial scope guidance and selection of monitoring stations

The spatial scope for monitoring should include long-term master stations, distributed spatially as relevant and include local spatial refinements, such as transect sampling (for sediment and/or active biomonitoring), and therefore, is a direct function of the assessment of risks and the monitoring purpose (long-term). The selection of the sampling sites for the monitoring of contaminants in the marine environment should consider:

• Areas of concern identified on the basis of the review of the existing information.
• Areas of known past and/or present release of chemical contaminants.
• Offshore areas where risk warrants coverage (aquaculture, offshore oil and gas activity, dredging, mining, dumping at sea).
• Sites representative in monitoring of other sea-based (shipping) and atmospheric sources.
• Reference sites: For reference values and background concentrations.
• Representative sensitive pollution sites/areas at sub regional scale.
• Deep-sea sites/areas of potential particular concern

The selected sites should allow the collection of a realistic number of samples over the years (e.g. be suitable for sediment sampling, allow sampling a sufficient number of biota for the selected species during the duration of the programme). It is essential that the monitoring strategies are being coordinated at regional and/or sub regional level. Coordination with monitoring for other Ecological Objectives is crucial for cost-effective and future integrated assessment.

Temporal Scope guidance

Sampling frequencies will be determined by the purpose and the status of the national marine monitoring.

INITIAL PHASE MONITORING, if required to identify key sampling stations can include: BIOTA (mussel yearly and fish, i.e. *Mullus barbatus* every 4 years) and SEDIMENTS (coastal every two years), and

ADVANCED PHASE MONITORING (fully completed and reported MED POL Phase III datasets): BIOTA (from 1 to 3 years according trends and chemicals) and SEDIMENTS (from 3 to 6 years depending on the characteristics of sedimentation areas and the chemical concerned).

The temporal scope may range from seasonally variable parameters up to large time scales, e.g. sediment core monitoring (years to decades). For trend determinations the sampling frequencies will depend on the ability to detect trends considering the environmental and the analytical variability (ca.

Indicator Title	17. Concentration of key harmful contaminants measured in the relevant matrix (EO9)	
total uncertainty). It can be possible to decrease the sampling frequencies and target chemicals in cases where established time trends and levels show concentrations well below levels of concern, and without any upward trend over a number of years.		
Data analysis and assessment outputs		
Statistical analysis and basis for aggregation Monitoring should allow the necessary statistical data treatments and long-term time-trend data analysis.		
Expected assessments outputs For chemical contaminants trends analysis and distribution levels for the assessment could be carried out on sub-regional and/or regional level, provided appropriate quality assured datasets are available. For the assessment of GES, it would be carried out using Mediterranean data from the MEDPOL database and applying a two level threshold classification (Background Assessment Criteria-BACs and Environmental Assessment Criteria-EACs), such as the OSPAR methodology. Therefore, the Meditarranean BACs and EACs for chemical contaminants, such as trace metals (mercury, cadmium and lead) and organic contaminants (chlorinated compounds and PAHs) in sediments and biota in the Mediterranean Sea should be applied.		
Known gaps and uncertainties in the Mediterranean Important development areas in the Mediterranean Sea over the next few years will include harmonization of monitoring targets (determinants and matrices) within assessment sub-regions, development of suites of assessment criteria integrated chemical and biological assessment methods, and review of the scope of the monitoring programmes to ensure that those contaminants which are considered to be important within each assessment area are included in 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 each GES assessment sub-region. It has been recognized that the open and deep sea is much less covered by monitoring efforts than coastal areas. There is a need to include within monitoring programmes also areas beyond the coastal areas in a representative and efficient way, where risks warrant coverage.		
Contacts and version Date		
http://www.unepmap.org		
Version No	**Date**	**Author**
V.2	31.05.17	MEDPOL

Common Indicator 18 (EO9): Level of pollution effects of key contaminants where a cause and effect relationship has been established[19]

Indicator Title	18. Level of pollution effects of key contaminants where a cause and effect relationship has been established (EO9)	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
Concentrations of contaminants are not giving rise to acute pollution events	Effects of released contaminants are minimized	Contaminants effects below threshold decreasing trend in the operational releases of oil and other contaminants from coastal, maritime and off-shore activities..
Rational		
Justification for indicator selector Upon exposure to certain dosis of harmful contaminants, marine organisms start manifesting a number of symptoms that are indicative of biological damage, the first ones appearing after a short while at the subcellular level. These 'sublethal' effects, when integrated, often converge to visible harm for the organisms and posibly to the whole population at a later stage, when it will be too late to limit the extent of biological damage resulting from environmental chemical exposure and ecosystems deterioration. Most of these symptoms have been reproducibly obtained in the laboratory (at high dosis) and the various biological mechanisms of response to major xenobiotics are now sufficiently well documented. In the latest decades, scientific research has been intensified towards these alternative cellular and subcellular methods for integrated pollution monitoring, despite it revealed a more complex panorama with samples exposed to environmental concentrations, which includes a number of confounding factors hindering the cost-effective and reliable determination of biological effects at cellular and sub-cellular levels. As a consequence, most of these methods (biomarkers), based on the chemical exposure to biological effects cause relationships, are envisaged to monitor hotpots stations, dredging materials assessments and local damage evaluations rather than for continuous long-term environmental monitoring (surveillance). Ongoing research (biomarkers, bioassays) and future research trends, suchs as 'omics' developments, will futher define the indicators and the methodologies for these common indicator for toxicological effects.		
Scientific References i. European Comission, 2014. Technical report on aquatic effect-based monitoring tools. Technical Report - 2014 – 077. ii. Davies, I. M. And Vethaak, A.D., 2012. Integrated marine environmetal monitoring of chemicals and their effects. ICESCoopérative Research Report N). iii. Moore, M.N. (1985), Cellular responses to pollutants. *Mar.Pollut.Bull.*, 16:134-139 iv. Moore, M.N. (1990), Lysosomal cytochemistry in marine environmental monitoring. *Histochem.J.*, 22:187-191 v. Scarpato, R., L. Migliore, G. Alfinito-Cognetti and R. Barale (1990), Induction of micronuclei in gill tissue of *Mytilus galloprovincialis* exposed to polluted marine waters *Mar.Pollut.Bull.*, 21:74-80		

[19] MSFD Descriptor 8: Concentrations of contaminants are at levels not giving rise to pollution effects

Indicator Title	18. Level of pollution effects of key contaminants where a cause and effect relationship has been established (EO9)

vi. Lowe, D., M.N. Moore and B.M. Evans (1992), Contaminant impact on interactions of molecular probes with lysosomes in living hepatocytes from dab *Limanda limanda. Mar.Ecol.Progr.Ser.*, 91:135-140

vii. Lowe, D.M., C. Soverchia and M.M. Moore (1995), Lysosomal membrane responses in the blood and digestive cells of mussels experimentally exposed to fluoranthene. *Aquatic Toxicol.*, 33:105-112

viii. George, S.G. and Per-Erik Olsson (1994), Metallothioneins as indicators of trace metal pollution in Biomonitoring of Coastal Waters and Estuaries, edited by J.M. Kees. Boca Raton, FL 33431, Kramer CRC Press Inc., pp.151-171

Policy Context and targets

Policy context description

In most Mediterranean countries, the monitoring of a range of hazardous chemical substances in different marine ecosystem compartments are undertaken in response to the UNEP/MAP Barcelona Convention (1975) and its Land-Based Protocol, the UNEP/MAP MED POL Monitoring Program, as well as international, european (e.g. EU WFD or EU MSFD) or other national policy drivers. A considerable amount of founding actions are available through the pollution monitoring and assessment component of the UNEP/MAP MED POL Programme from the past decades, including monitoring pilot programmes (ecotoxicological effects of contaminats). The environmental assessments have been used for the identification and confirmation of significant marine contaminants occurrence, distributions, levels and trends; as well as, for the continuous development of monitoring strategies and guidance. With respect to the Ecosystem Approach and IMAP, their implementation will continue under the benefits gained from this past knowledge and its policy framework built in the Mediterranean Sea.

Targets

Initial targets of GES under Common Indicator 18 will be based upon data of a selected biological effects parameters and biomarkers (reflecting the scope of current programmes and research, see Indicator Justification above) and the availability of suitable agreed assessment criteria.

Policy documents

General Policy documents

i. 19th COP to the Barcelona Convention, Athens, Greece, 2016. Decision IG.22/7 - Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Sea and Coast and Related Assessment Criteria (UNEP(DEPI)/MED IG.22/28)

ii. 19th COP to the Barcelona Convention,Athens, Greece, 2016.Draft Integrated Monitoring and Assessment Guidance (UNEP(DEPI)/MED IG.22/Inf.7)

iii. 18th COP to the Barcelona Convention, Istanbul, Turkey, 2013.Decision IG.21/3 - Ecosystems Approach including adopting definitions of Good Environmental Status (GES) and Targets. UNEP(DEPI)/MED IG.21/9

iv. Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive).

v. Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.

Indicator Title	18. Level of pollution effects of key contaminants where a cause and effect relationship has been established (EO9)

Contaminants related Policy documents

vi. UNEP (1997), The MED POL Biomonitoring Programme Concerning the Effects of Pollutants on Marine Organisms Along the Mediterranean Coasts. UNEP(OCA)/MED WG.132/3, Athens, 15 p.
vii. UNEP (1997), Report of the Meeting of Experts to Review the MED POL Biomonitoring Programme. UNEP(OCA)/MED WG.132/7, Athens, 19 p.
viii. Targets: UNEP(DEPI)/MED WG.421/Inf.9. Integrated Monitoring and Assessment Guidance. Agenda item 5.7: Draft Decision on Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Sea and Coast and Related Assessment Criteria. Meeting of the MAP Focal Points. Athens, Greece, 13-16 October 2015.

Indicator analysis methods

Indicator Definition

In marine bivalves (such as *Mytilus galloprovincialis*) and/or fish (such as *Mullus barbatus*)

Lysosomal Membrane Stability (LMS) as a method for general status screening.

Acetylcholinesterase (AChE) assay as a method for assessing neurotoxic effects in aquatic organisms.

Micronucleus assay as a tool for assessing cytogenetic/DNA damage in marine organisms.

<u>Sub-indicators:</u> complementary biomarkers, bioassays and histology techniques and methods are also recommended to be carried out on a country basis (such as, comet assay, hepatic pathologies assessment, reduction of survival in air by Stress on Stress (SoS), larval embryotoxicity assay). Metallothionnein in mussels and Ethoxyresorufin-O-deethylase (EROD) activity in fish as a biomarkers of chemical exposure s

Methodology for indicator calculation

Lysosomal Membrane Stability (LMS) : Biological techniques (neutral red retention), including microscopy

Acetylcholinesterase (AChE) assay: Biochemical techniques, including spectrophotometry

Micronucleus assay: Biochemical techniques, including microscopy

Additional parameters to be recorded: biometrics (size/length, age), biological parameters such as condition index (mussels), condition factor, gonadosomatic index, hepatosomatic index (fish) and data on temperature, salinity and oxygen dissolved.

Indicator units

(retention) minutes - Lysosomal Membrane Stability (LMS)

nmol/min mg protein in gills (bivalves) - Acetylcholinesterase (AChE) assay

Number of cases, ‰ in haemocytes - Micronucleus assay

List of Guidance documents and protocols available

Indicator Title	18. Level of pollution effects of key contaminants where a cause and effect relationship has been established (EO9)

i. European Commission, 2014. Technical report on effect-based monitoring tools. Technical Report 2014 – 077. European Commission, 2014.
ii. UNEP/RAMOGE: Manual on the Biomarkers Recommended for the UNEP/MAP MED POL Biomonitoring Programme. UNEP, Athens, 1999.
iii. UNEP/MAP, 2005. Fact sheets on Marine Pollution Indicators. Meeting of the UNEP/MAP MED POL National Coordinators. Barcelona, Spain, 24-27 May 2005. UNEP(DEC)/MED/ WG.264/ Inf.14. UNEP, Athens.
iv. ICES Cooperative Research Report. No.315. Integrated marine environmental monitoring of chemicals and their effects. I.M. Davies and D. Vethaak Eds., November, 2012.

Data Confidence and uncertainties

Selected analytical validated methods should be subject to Quality Assurance Protocols and interlaboratory exercises: QA/QC through UNEP/MAP MED POL intercalibration supported exercises in agreement with University of Piemonte Orientale (Italy).

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols

With regard the Ecosystem Approach and IMAP implementation, there are considerable benefits to be gained from taking advantage of previous knowledge and information developed through the UNEP/MAP MED POL. These actions include (1) the use of existing experience in the design of monitoring programmes, (2) the use of existing guidance on sampling and analytical methods to inform technical aspects of ecosystem approach monitoring, (3) the use of existing sampling station networks as a framework for the ecosystem approach monitoring networks, (4) the use of existing statistical assessment tools and work on assessment criteria as the basis for the assessments of ecosystem approach data, (5) the use of existing data to describe the distributions of contaminants and effects in the sea, and (6) the use of existing time series as the basis of monitoring against a "no deterioration" target. The availability of quality assured data is of importance for the assessment of trends. Therefore, based on the work already carried out, the results of the intercalibration exercises and the scientific and technical publications within the UNEP/MAP MED POL programme on biological effects monitoring, there is a network of laboratories in the Mediterranean region with the capacity to carry out biomonitoring activities, in line with the new monitoring requirements.

Available data sources

i. MED POL Database.
ii. UNEP/RAMOGE: Manual on the Biomarkers Recommended for the UNEP/MAP MED POL Biomonitoring Programme. UNEP, Athens, 1999.

Spatial scope guidance and selection of monitoring stations

The spatial scope for monitoring should include long-term master stations, distributed spatially as relevant and include local spatial refinements, such as transect sampling, and therefore, is a direct function of the assessment of risks and the monitoring purpose (long-term). The selection of the sampling sites for the monitoring of biological effects in the marine environment should consider:

Indicator Title	18. Level of pollution effects of key contaminants where a cause and effect relationship has been established (EO9)
• Areas of concern identified on the basis of the review of the existing information. • Areas of known past and/or present release of chemical contaminants. • Offshore areas where risk warrants coverage (aquaculture, offshore oil and gas activity, dredging, mining, dumping at sea). • Sites representative in monitoring of other sea-based (shipping) and atmospheric sources. • Reference sites: For reference values and background concentrations. • Representative sensitive pollution sites/areas at sub regional scale. • Deep-sea sites/areas of potential particular concern The selected sites should allow the collection of a realistic number of samples over the years (e.g. allow to sample sufficient number of biota for the selected species during the duration of the programme). It is essential that the monitoring strategies are being coordinated at regional and/or sub regional level, in particular with chemical monitoring. The coordination with monitoring for other Ecological Objectives is crucial for cost-effective and future integrated assessment.	
Temporal Scope guidance Sampling frequencies will be determined by the purpose and the status of the national marine monitoring. INITIAL PHASE MONITORING, if required to identify monitoring stations and can include: BIOTA (mussel yearly), as for chemical monitoring focusing on few locations (hotspots and reference stations) if biological effects will be determined for both. ADVANCED PHASE MONITORING (fully completed and reported MED POL Phase III datasets, including biological effects): At these stage the objective should be the integration of the chemical and biological monitoring on a efficient manner. Therefore, a refinement of the biological effects long-term monitoring should be implemented and maintained based on previous pilot monitoring activities (Initial Phase). For trend determinations the sampling frequencies will depend on the ability to detect trends considering the environmental and the analytical variability (ca. total uncertainty). It can be possible to decrease the sampling frequencies in cases where established time trends and levels show concentrations well below levels of concern, and without any upward trend over a number of years.	
Data analysis and assessment outputs	
Statistical analysis and basis for aggregation Monitoring should allow the necessary statistical data treatments and long-term time-trend analysis.	
Expected assessments outputs For biological effects, trends analysis and distribution levels could be carried out on sub-regional level, provided appropriate quality assured datasets are available. For the integrated assessment of GES, it would be carried out using Mediterranean data from the MEDPOL database and applying a two level threshold classification (such as the OSPAR methodology). Assessing biomarker responses against Background Assessment Criteria (BACs) and Environmental Assessment Criteria (EACs) 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.	
Known gaps and uncertainties in the Mediterranean	

Indicator Title	18. Level of pollution effects of key contaminants where a cause and effect relationship has been established (EO9)	
Important development areas in the Mediterranean Sea over the next few years will include harmonization of monitoring targets (determinants and matrices) within assessment sub-regions, development of suites of assessment criteria integrated chemical and biological assessment methods, and review of the scope of the monitoring programmes to ensure that those contaminants which are considered to be important within each assessment area are included in 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 each GES assessment sub-region. It has been recognized that the open and deep sea is much less covered by monitoring efforts than coastal areas. There is a need to include within monitoring programmes also areas beyond the coastal areas in a representative and efficient way, where risks warrant coverage.		
Contacts and version Date		
http://www.unepmap,org		
Version No	**Date**	**Author**
V.2	31.05.17	MEDPOL

Common Indicator 19 (EO9): Occurrence, origin (where possible), and extent of acute pollution events (e.g. slicks from oil, oil products and hazardous substances) and their impact on biota affected by this pollution

Indicator Title	19. Occurrence, origin (where possible), extent of significant acute pollution events (e.g. slicks from oil, oil products and hazardous substances) and their impact on biota affected by this pollution (EO9)	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
Occurrence of acute pollution events is reduced to the minimum.	Acute pollution events are prevented and their impacts are minimized.	1. Decreasing trend in the occurrences of acute pollution events.
Rational		
Justification for indicator selection Oil and Hazardous and Noxious Substances (HNS) products released at sea may impact an environment as follows: - physical smothering with an impact on physiological functions; - chemical toxicity giving rise to lethal or sub-lethal effects or causing impairment of cellular functions; - ecological changes, primarily the loss of key organisms from a community and the takeover of habitats by opportunistic species; and - indirect effects, such as the loss of habitat or shelter and the consequent elimination of ecologically important species. In addition, pollution by oil and HNS has socio-economic impact (recreational activities; fisheries, maricultures as well as other activities such as power plants, shipping, salt production or seawater desalination). Occurrence of acute pollution events involving oil or HNS needs to be measured and possible impacts monitored.		
Scientific References ITOPF. “Effect of oil pollution on the marine environment”. ITOPF, Technical Information Paper 13. GESAMP. Report n° 75: “Estimates of Oil Entering the Marine Environment from Sea-Based Activities”, IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (2007). Zeina G. Kassaify, Rana H. El Hajj, Shady K. Hamadeh, Rami Zurayk and Elie K. Barbour. “Impact of Oil Spill in the Mediterranean Sea on Biodiversified Bacteria in Oysters”, Journal of Coastal Research, Vol. 25, No. 2 (2009), pp. 469-473. Published by: Coastal Education & Research Foundation, Inc. Peterson CH, Rice SD, Short JW, Esler D, Bodkin JL, Ballachey BE, Irons DB. “Longterm ecosystem response to the Exxon Valdez oil spill”. Science 302:2082–2086(2003).		
Policy Context and targets		
Policy context description Acute pollution from oil and other hazardous substances, resulting either from maritime casualties or from ships’ routine operations, is addressed in a number of international conventions under the aegis of the International Maritime Organization (IMO), the United Nations specialized agency with responsibility for the safety and security of shipping and the prevention of marine pollution by ships,		

Indicator Title	19. Occurrence, origin (where possible), extent of significant acute pollution events (e.g. slicks from oil, oil products and hazardous substances) and their impact on biota affected by this pollution (EO9)

some of which provide for stricter regimes in the Mediterranean Sea, including discharges of oil and oily mixtures. At the regional level, the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean ("the Barcelona Convention") and 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") thereto are crucial instruments enabling cooperation and joint action to support all Mediterranean coastal States implementing and enforcing IMO Conventions on pollution prevention and preparedness and response to oil and HNS spills.

The Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC), administered by the IMO in cooperation with the Mediterranean Action Plan (MAP) of the United Nations Environment Programme (UN Environment), also referred to as UN Environment/MAP, is responsible for the implementation of the 2002 Prevention and Emergency Protocol. The Centre has maintained a database on alerts and accidents causing or likely to cause pollution of the sea by oil (since 1977) and by other harmful substances (since 1989) in the Mediterranean Sea. Furthermore, following the adoption by the Contracting Parties to the Barcelona Convention of the Protocol for the Protection of the Mediterranean Sea against Pollution Resulting from Exploration and Exploitation of the Continental Shelf and the Seabed and its Subsoil ("the Offshore Protocol"), Contracting Parties thereto should endeavour to ratify the said Protocol as well as develop and adopt monitoring procedures and programmes for offshore activities, which is envisaged to take place building on the Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assesment Criteria (IMAP) of the Ecosystem Approach (EcAp).

Targets

To measure the trend of occurrence of oil and HNS accidental pollution events, the following indicator can be used: number of pollution events (of 50 cubic metres or more) per year in the marine waters of each Contracting Party to the Barcelona Convention. A target could be a maximum of 1 occurrence per year per Contracting Party to the Barcelona Convention.

Regarding illicit discharges of oil and oily waters (Annex I to the International Convention for the Prevention of Pollution from Ships (MARPOL)), minimum tolerance (near to 0 events) could be considered.

Policy documents

General Policy documents

i. 19th COP to the Barcelona Convention, Athens, Greece, 2016. Decision IG.22/7 - Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria (UNEP(DEPI)/MED IG.22/28)

ii. 19th COP to the Barcelona Convention, Athens, Greece, 2016. Integrated Monitoring and Assessment Guidance (UNEP(DEPI)/MED IG.22/Inf.7)

iii. 18th COP to the Barcelona Convention, Istanbul, Turkey, 2013. Decision IG.21/3 - Ecosystems Approach including adopting definitions of Good Environmental Status (GES) and Targets (UNEP(DEPI)/MED IG.21/9)

Related Policy documents

Indicator Title	19. Occurrence, origin (where possible), extent of significant acute pollution events (e.g. slicks from oil, oil products and hazardous substances) and their impact on biota affected by this pollution (EO9)

iv. 18th COP to the Barcelona Convention, Istanbul, Turkey, 2013. Decision IG.21/9 - Establishment of a Mediterranean Network of Law Enforcement Officials relating to MARPOL within the framework of the Barcelona Convention (UNEP(DEPI)/MED IG.21/9)

v. 2002 Prevention and Emergency Protocol

vi. Offshore Protocol

vii. MARPOL, specifically its Annex I (Regulations for the prevention of pollution by oil), Annex II (Regulations for the control of pollution by noxious liquid substances in bulk) and Annex III (Regulations for the prevention of pollution by harmful substances carried by sea in packaged form)

viii. International Convention on Oil Pollution Preparedness, Response and Co-operation, 1990 (OPRC Convention) and Protocol on Preparedness, Response and Co-operation to Pollution Incidents by Hazardous and Noxious Substances, 2000 (OPRC-HNS Protocol)

Indicator analysis methods

Indicator Definition

In the case of oil and HNS acute pollution events, the indicator will be obtained from the information of oil and HNS pollution events recorded and submitted in the Mediterranean Sea each year.

Methodology for indicator calculation

Under the 2002 Prevention and Emergency Protocol, Contracting Parties thereto established a reporting procedure (Article 9) whereby the following information (see the format below) should be reported by masters or other persons having charge of ships flying their flags and to the pilots of aircraft registered in their territories:

(1) all incidents which result or may result in a discharge of oil or hazardous and noxious substances; and

(2) the presence, characteristics and extent of spillages of oil or hazardous and noxious substances, including hazardous and noxious substances in packaged form, observed at sea which pose or are likely to pose a threat to the marine environment or to the coast or related interests of one or more of the Contracting Parties.

Moreover, in accordance with Article 10 (Operational Measures) of the said Protocol, any Contracting Party thereto faced with a pollution incident shall, amongst others:

(1) immediately inform all Contracting Parties thereto likely to be affected by the pollution incident of their assessments and of any action which it has taken or intends to take, and simultaneously provide the same information to REMPEC, which shall communicate it to all other Contracting Parties thereto; and

(2) continue to observe the situation for as long as possible and report thereon in accordance with Article 9.

BCRS (Barcelona Convention Reporting System) format:

(a) accident location (latitude and longitude or closest shore location);

(b) accident type* (*cargo transfer failure, contact, collision, engine breakdown, fire/explosion, grounding, foundering/weather, hull structural failure, machinery breakdown, other);

(c) vessel IMO number or vessel name;

(d) vessel flag;

Indicator Title	19. Occurrence, origin (where possible), extent of significant acute pollution events (e.g. slicks from oil, oil products and hazardous substances) and their impact on biota affected by this pollution (EO9)

(e) whether any product has been released or not. If yes, the type of product released (Oil/Hazardous and Noxious Substances) should be specified; and
(f) whether any actions have been taken or not. If yes, the actions taken should be specified.

In addition to monitoring pollution events occurrences against the target (incidents involving oil or hazardous substances that are < or = 1 event per year in the waters of each Contracting Party to the Barcelona Convention), it is recommended to carry out a trend analysis in order to measure performance against the target. Data on actual pollution events from ships would be collected every year and compared to the data for the previous year, to calculate a % increase or a % decrease in occurrences yearly frequency.

Indicator units

The Guidelines for Co-operation in Combating Marine Oil Pollution in the Mediterranean (UNEP/IG.74/5, UNEP/MAP, 1987) recommended Contracting Parties to the Barcelona Convention to report to REMPEC all spillages or discharges of oil in excess of 100 cubic metres. To align with the revised reporting formats for a mandatory reporting system under MARPOL ("one-line" entry format) adopted by IMO in 1996 (see MEPC/Circ.318), the Joint Session of MED POL and REMPEC Focal Points Meetings, which was held in Attard, Malta on 17 June 2015, discussed the appropriate threshold and concluded that spills of 50 cubic metres should be reported, whereas countries could also opt to report on spillages of lower amounts.

List of guidance documents and protocols available

i. ITOPF. "*Aerial Observation of Marine Oil Spills*", Technical Information Paper 1.
ii. ITOPF. "*Recognition of Oil on Shorelines*", Technical Information Paper 6.
iii. ITOPF. "*Fate of Marine Oil Spills*", Technical Information Paper 2.
iv. ITOPF. "*Response to Marine Chemical Incidents*", Technical Information Paper 17.
v. Bonn Agreement. "*Bonn Agreement Oil Appearance Code*".
vi. IPIECA/IMO/IOGP/CEDRE. "*Aerial Observation of Oil Spills at Sea: Good practice guidelines for incident management and emergency response personnel*" (February 2015).
vii. CEDRE. "*Surveying Sites Polluted by Oil: An Operational Guide for Conducting an Assessment of Coastal Pollution*" (March 2006).
viii. REMPEC. "*Mediterranean Guidelines on Oiled Shoreline Assessment*" (September 2009).
ix. GESAMP. "*Revised GESAMP Hazard Evaluation Procedure for Chemical Substances Carried by Ships"* (2014).
x. IMO Codes:
- For packaged goods: International Maritime Dangerous Goods (IMDG) Code.
- For Bulk liquids: International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code).
- For Gases: International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code).
- For solids in bulk: International Maritime Solid Bulk Cargoes (IMSBC Code).

Data confidence and uncertainties

Although characterisation of impact of oil and oily products at sea and on shore is well documented and response strategies well defined, there has been much less investment in research for HNS spills. Chemical spills occur at a much lower frequency than spills of oil and involve a very large variety of products with different physical and toxicity properties. Therefore, the characterisation of impacts

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from HNS pollution due to maritime casualties is more complex and response strategies and indicators will vary according to the specific chemical product involved.

Methodology for monitoring, temporal and spatial scope

Available methodologies for monitoring and monitoring protocols

As oil and HNS accidental spills and discharges from ships take the form of acute pollution events, there are no specific pollution methodologies for systematic oil and HNS pollution surveillance in IMO Conventions and guidance documents, where monitoring is essentially addressed from the perspective of ships' compliance monitoring (flag State surveys; coastal State and port State controls) or in the context of pollution response operations. In this latter case, a monitoring protocol was developed to detect and survey pollution events.

Pollution events are monitored using the following methods/protocols:

- **Oil:**

- Expert human eye observation;
- Aerial observation (human eye observation and/or remote sensing equipment);
- Satellite imagery analysis; and
- Sampling and analysis.

Monitoring at sea will provide the following information:

- Volume of oil: use ITOPF guidance based on oil type and appearance to assess thickness (mm) and volume of oil (m^3/km^2) at sea, or the guidance of the Bonn Agreement Oil Appearance Code (BAOAC) identifying the following relations between oil appearances and oil volume:
    1. sheen, 0.15-0.3 m^3/km^2;
    2. rainbow, 0.3-5 m^3/km^2;
    3. metallic, 5-50 m^3/km^2;
    4. discontinuous true colour, 50-200 m^3/km^2; and
    5. continuous true colour, > 200 m^3/km^2.
- Location and coverage of slick at sea (latitude and longitude - GPS);
- Oil characteristics (persistent vs. non persistent / viscosity); and
- Origin of slick (if visible, ship name and IMO number, offshore installations ID number).

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

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involved chemical, its properties/toxicity, and its form (packaged/bulk) as well as identification of sensitive neighbouring areas and environment conditions.

Furthermore, Article 18 (Mutual Assistance in cases of Emergency) of the Offshore Protocol states that in cases of emergency, a Contracting Party thereto, which is also a Contracting Party to 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"), shall apply the pertinent provisions of the said Protocol.

Available data sources

Because pollution events originating from ships must lead to response operations and investigations, there are a number of reporting obligations and reporting protocols that are useful for the purpose of determining the frequency of occurrences and assess trends:

(1) Contents and forms of reports that ships must send following maritime casualties involving oil and other hazardous substances are detailed in MARPOL Annex I. In addition, IMO developed the "General Principles for Ship Reporting Systems and Ship Reporting Requirements, including Guidelines for Reporting Incidents Involving Dangerous Goods, Harmful Substances and/or Marine Pollutants", containing recommendations on reporting requirements (when to report, information required, whom to report to).

(2) At regional level, the standard pollution accidents reporting format (POLREP) and related procedures provided under MARPOL are used between Contracting Parties to the 2002 Prevention and Emergency Protocol and between these Contracting Parties and REMPEC for exchanging information when pollution of the sea has occurred or when a threat of such is present.

(3) With respect to illegal discharges of oil from ships, REMPEC organised pilot projects on surveillance and monitoring of oil discharges at sea in the past. These initiatives led to the establishment of the Mediterranean Network of Law Enforcement Officials relating to MARPOL within the framework of the Barcelona Convention (MENELAS). This network works as a forum where information is exchanged and it is expected that data on pollution incidents (as well as on investigation and prosecution as the case may be) will be collected. REMPEC acts as the MENELAS Secretariat and the possible development of a MENELAS database on illicit ship pollution discharges in the Mediterranean and related reporting format are being looked into.

(4) The BCRS also requests information on spill incidents that occurred during a biennium.

Databases available:

- Mediterranean Alerts and Accidents Database maintained by REMPEC, available in the following versions:

- On-line database (accidents can be sorted by: date; accident location (country); vessel type; release quantity and type);
- Report containing the data and statistical analysis; and
- A Geographical Information System (GIS).

Indicator Title	19. Occurrence, origin (where possible), extent of significant acute pollution events (e.g. slicks from oil, oil products and hazardous substances) and their impact on biota affected by this pollution (EO9)	
- Mediterranean Integrated Geographical Information System on Marine Pollution Risk Assessment and Response (MEDGIS-MAR) 2012-2015 (http://medgismar.rempec.org/) provides data (private access) on offshore, marine incidents, oil handling facilities, and response equipment. **- Global Integrated Shipping Information System (GISIS)** (http://gisis.imo.org) maintained by IMO, with a module on marine casualties and incidents.		
Spatial scope guidance and selection of monitoring stations REMPEC will continue to be the central organisation coordinating and maintaining data on oil and HNS acute events and pollution surveillance in the Mediterranean Sea. REMPEC has implemented pilot projects involving aerial surveillance exercises and satellite imagery analysis jointly with Mediterranean coastal States and this effort should be strengthened.		
Temporal Scope guidance As oil and HNS pollution incidents from ships occurs unexpectedly (as a consequence of maritime casualties) or are not systematic (MARPOL illicit discharges), it is expected that pollution monitoring will continue to essentially take place "in real time" when pollution incidents actually happen or are detected.		
Data analysis and assessment outputs		
Statistical analysis and basis for aggregation Frequencies and quantitative statistical analysis. The basis for aggregation would be a "nested approach" over a geographical scale. Trend analysis to calculate the percentage of occurrences for oil and HNS incidents over a period of time (yearly) in the Mediterranean Sea.		
Expected assessments outputs Temporal trends analysis and distribution maps. If possible, this trend should be related to the maritime traffic crossing the Mediterranean Sea.		
Known gaps and uncertainties in the Mediterranean While Contracting Parties to the Barcelona Convention and to the 2002 Prevention and Emergency Protocol have a pollution monitoring and reporting obligation, data submitted to REMPEC are still scarce. Thus the main aim during the initial phase of the IMAP will be to strengthen monitoring efforts towards this already existing obligation.		
Contacts and version Date		
http://www.rempec.org		
Version No	**Date**	**Author**
V.2	31.05.17	MED POL/REMPEC

Common Indicator 20 (EO9): Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in commonly consumed seafood[20]

<table>
<tr><td>Indicator Title</td><td colspan="2">20. Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in commonly consumed seafood (EO9)</td></tr>
<tr><td>Relevant GES definition</td><td>Related Operational Objective</td><td>Proposed Target(s)</td></tr>
<tr><td>Concentrations of contaminants are within the regulatory limits for consumption by humans.</td><td>Levels of known harmful contaminants in major types of seafood do not exceed established standards</td><td>1. Concentrations of contaminants are within the regulatory limits set by legislation.

2</td></tr>
<tr><td colspan="3">Rational</td></tr>
<tr><td colspan="3">Justification for indicator selector

One of the potential risks associated with the occurrence of harmful substances (chemicals, nanoparticles, microplastics, toxins) in the marine environment is the human exposure through commercial fish and shellfish species (primarily, from wild fisheries and aquaculture). These organisms are exposed to environmental contaminants which enter their organism through different mechanisms and pathways according their thropic level, which include from filter feeding to predatory strategies (crustaceans, bivalves, fish). Consequently, there exist both bioaccumulation and biomagnification processes of these chemicals released in the marine environment. Common examples are the well-known bioaccumulation of metals and organic compounds in commercial bivalve species (such as the Mytillus galloprovincialis in the Mediterranean Sea) or alkyl mercury compounds (methylmercury) in tuna fish, which should be increased by new and emerging contaminants in the near future.</td></tr>
<tr><td colspan="3">Scientific References

i. Vandermeersch, G. et al. 2015. Environmental contaminants of emerging concern in seafood – European database on contaminant levels. Environmental Research, 143B, 29-45.

ii. Maulvault, A.M. et al. 2015. Toxic elements and speciation in seafood samples from different contaminated sites in Europe. Environmental Research, 143B, 72-81.

iii. Molin, M. et al., 2015. Arsenic in the human food chain, biotransformation and toxicology – Review focusing on seafood arsenic. Journal of Trace Elements in Medicine and Biology, 31, 249-259.

iv. Bacchiocchi, S. et al. 2015. Two-year study of lipophilic marine toxin profile in mussels of the North-central Adriatic Sea: First report of azaspiracids in Mediterranean seafood. Toxicon, 108, 115-125.

v. Perello, G. et al., 2015. Human exposure to PCDD/Fs and PCBs through consumption of fish and seafood in Catalonia (Spain): Temporal trend. Food and Chemical Toxicology, 81, 28-33.</td></tr>
</table>

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

Indicator Title	20. Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in commonly consumed seafood (EO9)

vi. Zaza, S. *et al.* 2015. Human exposure in Italy to lead, cadmium and mercury through fish and seafood product consumption from Eastern Central Atlantic Fishing Area. Journal of Food Composition and Analysis, 40, 148-153.

vii. Cruz, R. Brominated flame retardants and seafood safety: A review. Environment International, 77, 116-131.

viii. Dellate, E. *et al.* 2014. Individual methylmercury intake estimates from local seafood of the Mediterranean Sea, in Italy. Regulatory Toxicology and Pharmacology, 69, 105-112.

ix. Spada, L. *et al.* 2014. Mercury and methylmercury concentrations in Mediterranean seafood and surface sediments, intake evaluation and risk for consumers. International Journal of Hygiene and Environmental Health, 215, 418-42.

Policy Context and targets

Policy context description

The understanding of the health risks to humans (maximum levels, intake, toxic equivalent factors, etc.) and the food safety prevention, including emerging contaminants, through the consumption of potentially poisoned seafood is a challenge and a priority policy issue for governments, as well as a major societal concern. There are different initiatives and regulations at national and international levels mainly for the fishery economic sector, which have established public health recommendations and maximum regulatory levels for different contaminants in numerous marine commercial target species. Methylmercury poisoning continues as a global priority policy issue and in 2013 the Global Legally Binding Treaty (Minamata Convention on Mercury) was launched by UNEP. Further, the US Food and Drugs Administration, the European Food Safety Authority and FAO are also national and international authorities with regard seafood safety.

Targets

Initial targets of GES under Common Indicator 20 will be to maintain the chemical contaminants of human health concern under regulatory levels in seafood set/recommended/agreed by national and/or international authorities and their trends with regard their occurrence should decrease pointing towards zero events.

Policy documents

General Policy documents

i. 19th COP to the Barcelona Convention, Athens, Greece, 2016. Decision IG.22/7 - Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Sea and Coast and Related Assessment Criteria (UNEP(DEPI)/MED IG.22/28)

ii. 19th COP to the Barcelona Convention,Athens, Greece, 2016.Draft Integrated Monitoring and Assessment Guidance (UNEP(DEPI)/MED IG.22/Inf.7)

iii. 18th COP to the Barcelona Convention, Istanbul, Turkey, 2013.Decision IG.21/3 - Ecosystems Approach including adopting definitions of Good Environmental Status (GES) and Targets. UNEP(DEPI)/MED IG.21/9

Indicator Title	20. Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in commonly consumed seafood (EO9)

iv. Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive).

v. Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.

Contaminants related Policy documents

vi. EU 1881/2006. Commission Regulation (EC) No 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs. European Commission.

vii. US FDA http://www.fda.gov/Food/FoodborneIllnessContaminants/Metals/ucm115644.htm

viii. Joint FAO/WHO Expert consultation on the risk and benefits of fish consumption. FAO Fisheries and Aquaculture Report No. 978. ISSN 2070-6987. Rome, January, 2010.

ix. List of maximum levels for contaminants in foods set by the FAO/WHO Codex Alimentarius Commission can be found at ftp://ftp.fao.org/codex/Meetings/cccf/cccf7/cf07_INFe.pdf

x. Global Legally Binding Treaty (Minamata Convention on Mercury) http://www.mercuryconvention.org/

Indicator analysis methods

Indicator Definition

Number of detected regulated contaminants* in commercial species.

Number of detected regulated contaminants* exceeding regulatory limits.

(*list of contaminants can be found in the links from the previous section)

Additional parameters required: sample identification, location, date and biometrics

Sub-indicators: other relevant chemicals and emerging pollutants are recommended to be carried out on a country decision basis.

Methodology for indicator calculation

Number of detected contaminants: monitoring by national regulatory and inspection bodies through statistics and databases

Number of detected contaminants exceeding regulatory limits: monitoring by national regulatory and inspection bodies through statistics and databases

Indicator units

(frequencies, %) - Number of detected contaminants in individual commercial species

Indicator Title	20. Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in commonly consumed seafood (EO9)
(frequencies, %) - Number of detected contaminants exceeding regulatory limits in appropriate units, for example, mg/kg fresh weight (parts per million, ppm, fresh weight) or µg/g fresh weight (part per billion, ppb, fresh weight).	
List of Guidance documents and protocols available Refer to UNEP Methods and Protocols for Marine Pollution, as well as from other regional conventions for the determination of contaminants in marine organisms (Note, pre-treatment of samples from marine organisms might differ between sample preparation and analytical methods and care should be taken when comparing the different reference values.	
Data Confidence and uncertainties The data confidence is directly related to the number of available tests performed to commercial species and their regularity, beyond the analytical quality assurance (QA/QC) related to the determination of contamiants in fish	
Methodology for monitoring, temporal and spatial scope	
Available Methodologies for Monitoring and Monitoring Protocols There are no directly-applicable monitoring protocols in order to fulfil the requirement of this Common Indicator. Risk-based public health methodologies to define the monitoring are recommend.	
Available data sources At present national databases (if available), research papers and environmental databases (the MED POL Database)	
Spatial scope guidance and selection of monitoring stations Risk-based methodologies to define monitoring are recommended. Guidance for monitoring stations: environmental monitoring, fish markets, aboard fishing fleets, sampling at regular inspections by national authorities	
Temporal Scope guidance Risk-based methodologies to define monitoring are recommended.The temporal scope is highly linked to the data confidence and uncertainty of the indicator. Yearly statistics would be the basic time period.	
Data analysis and assessment outputs	
Statistical analysis and basis for aggregation Monitoring should allow the necessary statistical data treatments and long-term time-trend evaluations. Geographic reporting scales (within IMAP implementation) should be also considered in terms of indictor aggregation: (1) Whole region (i.e. Mediterranean Sea); (2) Mediterranean sub-regions, as presented in the Initial Assessment of the Mediterranean Sea, UNEP(DEPI)/MED IG.20/Inf.8; (3) Coastal waters and other marine waters; (4) Subdivisions of coastal waters provided by Contracting Parties	
Expected assessments outputs Assessment outputs would be based on trend analysis and annual statistics	
Known gaps and uncertainties in the Mediterranean	

Indicator Title	20. Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in commonly consumed seafood (EO9)	
As this is a new Common Indicator within the context of marine environmental protection policy (*ca*. Ecosystem Approach and IMAP implementation) its applicability beyond food consumer protection and public health would need to be determined, although intuitively reflects the health status of the marine environment in terms of their delivery of benefits (e.g. fisheries industry). Thus, monitoring protocols, risk-based approaches, analytical testing and assessment methodologies would need to be further examined between Contracting Parties national food safety authorities, research orgnisations and/or environmental agencies.		
Contacts and version Date		
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V.2	31.05.17	MEDPOL

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

Indicator Title	21. Percentage of intestinal enterococci concentration measurements within established standards (EO9)	
Relevant GES definition	**Related Operational Objective**	**Proposed Target(s)**
Concentrations of intestinal enterococci are within established standards	Water quality in bathing waters and other recreational areas does not undermine human health	ncreasing trend in the percentage of intestinal enterococci concentration measurements within established standards
Rational		

Justification for indicator selector

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. The establishment of sewage treatment plants and the construction of submarine outfall structures have decreased the potential for microbiological pollution, despite major hotpots still exist. 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. Therefore, 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 also shown a correlation between elevated levels of enterococci and the risks of human gastroenteritis. It has been suggested and later on demonstrated that *enterococci sp*. might be more appropriate than traditional *Escherichia 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 entorococci as a surrogate of polluted recreational waters, and therefore, as a Common Indicator for GES

Scientific References

i. Cabelli VJ, Dufour AP, Levin MA, McCabe LJ, Haberman PW. 1979. Relationship of microbial indicators to health effects at marine bathing beaches. Am. J. Public Health, 69, 690–696

ii. Byappanahalli, MN. *et al.*, 2012. Enterococci in the environment. Microbiol. Mol. Biol.Rev., 76, 685-706

iii. Moellering RC Jr. 1992. Emergence of Enterococcus as a significant pathogen. Clin. Infect. Dis., 15, 58–62

iv. Mote BL, Turner JW, Lipp EK. 2012. Persistence and growth of the faecal indicator bacteria enterococci in detritus and natural estuarine plankton communities. Appl. Environ. Microbiol.,78, 2569–2577

v. Sadowsky MJ, Whitman RL (Ed). 2010. The faecal bacteria. ASM Press, Washington, DC.

vi. Kay D, *et al.* 1994. Predicting likelihood of gastroenteritis from sea bathing: results from randomised exposure. Lancet, 344, 905–909

Indicator Title	21. Percentage of intestinal enterococci concentration measurements within established standards (EO9)

vii. Prüss A. 1998. Review of epidemiological studies on health effects from exposure to recreational water. Int. J. Epidemiol., 27, 1–9

Policy Context and targets

Policy context description

The World Health Organisation has been concerned with health aspects of the management of water resources for many years and published various documents concerning the safety of the water environment, including marine waters, and its importance for health. Revised Mediterranean guidelines for bathing water quality were formulated in 2007 based on the WHO guidelines for "Safe Recreational Water Environments" and on the EC Directive for "Bathing Waters" (EU/2006/7). The proposal was made in an effort to provide updated criteria and standards that can be used in the Mediterranean countries and to harmonize their legislation in order to provide homogenous data. Therefore, the standards for bathing waters quality in the framework of the implementation of Article 7 of the LBS Protocol, could be further used to define GES for the indicator on pathogens in bathing waters.

Targets

Initial target of GES under Common Indicator 21 will be an increasing trend in measurements to test that levels of intestinal enterococci comply with established national or international standards and the methodological approach itself. Particularly, under the EU 2006/7 Directive, excellent (95^{th} percentile < 100 CFU/100 mL) or good (95^{th} percentile < 200 CFU/100 mL) quality categories for the "last assessment", the last four years (see document below, Directive 2006/7/EC)

Policy documents

General Policy documents

i. 19th COP to the Barcelona Convention, Athens, Greece, 2016. Decision IG.22/7 - Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Sea and Coast and Related Assessment Criteria (UNEP(DEPI)/MED IG.22/28)

ii. 19th COP to the Barcelona Convention,Athens, Greece, 2016.Draft Integrated Monitoring and Assessment Guidance (UNEP(DEPI)/MED IG.22/Inf.7)

iii. 18th COP to the Barcelona Convention, Istanbul, Turkey, 2013.Decision IG.21/3 - Ecosystems Approach including adopting definitions of Good Environmental Status (GES) and Targets. UNEP(DEPI)/MED IG.21/9

iv. Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive).

v. Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.

Contaminants related Policy documents

vi. UNEP(DEPI)/MED IG 20/8. Decision IG.20/9. Criteria and Standards for bathing waters quality in the framework of the implementation of Article 7 of the LBS Protocol. COP17, Paris, 2012.

Indicator Title	21. Percentage of intestinal enterococci concentration measurements within established standards (EO9)

vii. UNE/MAP MED POL, 2010. Assessment of the state of microbial pollution in the Mediterranean Sea. MAP Technical Reports Series No. 170 (Ammended).

viii. WHO, 2003. Guidelines for safe recreational water environments. VOLUME 1: Coastal and fresh waters. WHO Library. ISBN 92 4 154580. World Health Organisation, 2003.

ix. Directive 2006/7/EC of the European Parliament and of the council of 15 February 2006 concerning the management of bathing water quality and repealing Directive 76/160/EEC

http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32006L0007&from=EN

Indicator analysis methods

Indicator Definition

Percentage of intestinal enterococci concentration measurements within established standards.

Concentration (CFU) of intestinal enterococci in the sample (normalised to 100 mL)

Methodology for indicator calculation

An ISO methodology has been proposed by Directive 2006/7/EC with the following specification: Based upon percentile evaluation of the log10 normal probability density function of microbiological data acquired from the particular bathing water, the percentile value is derived as follows:
1) Take the log10 value of all bacterial enumerations in the data sequence to be evaluated. (If a zero value is obtained, take the log10 value of the minimum detection limit of the analytical method used instead)
2) Calculate the arithmetic mean of the log10 values (μ).
3) Calculate the standard deviation of the log10 values (σ).
The upper 90-percentile point of the data probability density function is derived from the following equation: upper 90-percentile = antilog (μ + 1,282 σ). The upper 95-percentile point of the data probability density function is derived from the following equation: upper 95-percentile = antilog (μ + 1,65 σ).

Indicator units

Percentage of intestinal enterococci (as %)

CFU (Colony Forming Units)/100 mL sample – Concentration of intestinal enterococci

List of Guidance documents and protocols available

i. ISO 7899-1[Water quality – Detection and enumeration of intestinal enterococci: Part 1: Miniaturized method (Most Probable Number) for surface and wastewater]

ii. ISO 7899-2 [Water quality – Detection and enumeration of intestinal enterococci: Part 2: Membrane filtration method].

Data Confidence and uncertainties

ISO 7899-2 describes the isolation of intestinal enterococci (*Enterococcus faecalis*, *E. faecium*, *E. durans* and *E. hirae*). In addition, other Enterococcus species and some species of the genus Streptococcus (namely *S. bovis* and *S. equinus*) may occasionally be detected. These Streptococcus species do not survive long in water and are probably not enumerated quantitatively. For purposes of water examination, *enterococci sp.* can be regarded as indicators of faecal pollution, despite it should be mentioned that some enterococci found in water can occasionally also originate from other habitats.

Indicator Title	21. Percentage of intestinal enterococci concentration measurements within established standards (EO9)
Methodology for monitoring, temporal and spatial scope	
Available Methodologies for Monitoring and Monitoring Protocols Revised Mediterranean guidelines for bathing waters were formulated in 2007 based on the WHO guidelines for "Safe Recreational Water Environments" and on the EC Directive for "Bathing Waters" (EU/2006/7). The proposal was made in an effort to provide updated criteria and standards that can be used in the Mediterranean countries and to harmonize their legislation in order to provide homogenous data.	
Available data sources Directive 2006/7/EC of the European Parliament and of the council of 15 February 2006 concerning the management of bathing water quality and repealing Directive 76/160/EEC http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32006L0007&from=EN	
Spatial scope guidance and selection of monitoring stations Sampling should be performed in recreational waters where microbiological pollution could threat the recreational uses.	
Temporal Scope guidance According Annex IV (EU Directive 2006/7EC), the temporal scope guidance is as follows: 1. One sample is to be taken shortly before the start of each bathing season. Taking account of this extra sample and subject to paragraph 2 (below), no fewer than four samples are to be taken and analysed per bathing season. 2. However, only three samples need be taken and analysed per bathing season in the case of a bathing water that either: (a) has a bathing season not exceeding eight weeks; or (b) is situated in a region subject to special geographical constraints. 3. Sampling dates are to be distributed throughout the bathing season, with the interval between sampling dates never exceeding one month. 4. In the event of short-term pollution, one additional sample is to be taken to confirm that the incident has ended. This sample is not to be part of the set of bathing water quality data. If necessary to replace a disregarded sample, an additional sample is to be taken seven days after the end of the short-term pollution.	
Data analysis and assessment outputs	
Statistical analysis and basis for aggregation Monitoring should allow the necessary statistical data treatments, as well as time-trend evaluations In order to comply with the stated Common Indicator within IMAP the geographic reporting scales (nested approach) should be taken into account. However, the balance between data, location and spatial resolution should be carefully considered for coherence in areas (1) and (2), as this Common Indicator is largely (if not entirely) evaluated in coastal waters (3): (1) Whole region (i.e. Mediterranean Sea); (2) Mediterranean sub-regions, as presented in the Initial Assessment of the Mediterranean Sea, UNEP(DEPI)/MED IG.20/Inf.8; (3) Coastal waters and other marine waters; (4) Subdivisions of coastal waters provided by Contracting Parties	
Expected assessments outputs For pathogenic microorganisms in bathing water, monitoring for the assessment of GES could be carried out on a sub-regional and/or local level due to the nature of microbiological contamination	

Indicator Title	21. Percentage of intestinal enterococci concentration measurements within established standards (EO9)	
(the impact is restricted to a relatively short distance from the pollution source due to the short survival time of microorganisms in seawater and dilution effects). Distribution maps and temporal trend assessment (short periods) are also envisaged.		
Known gaps and uncertainties in the Mediterranean Within the context of Ecosystem Approach and IMAP implementation its applicability beyond bathing waters (recreational waters) protection and management would need to be determined, although intuitively reflects the health status of the coastal environment in terms of their delivery of benefits (e.g. tourism).		
Contacts and version Date		
http://www.unepmap.org		
Version No	**Date**	**Author**
V.2	31.05.17	MEDPOL

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).

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment	
Indicator Title	*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).*	
Relevant GES definition	**Related Operational Objective**	**Target(s)**
Number/amount of marine litter items on the coastline do not have negative impact on human health, marine life and ecosystem services.	10.1 The impacts related to properties and quantities of marine litter in the marine environment and coastal environment are minimized	Decreasing trend in the number of/amount of marine litter (items) deposited on the coast.
Rationale		
Marine litter found on the coastlines (washed ashore and/or deposited) is one of the most obvious signs of marine litter pollution. Beach marine litter originates from major land-based (tourism, recreation, illegal fly tipping, waste disposal sites,) and sea-based (commercial shipping, fisheries activities, pleasure crafts and off-shore installations) sources following very diverse pathways to reach the marine environment (e.g. input from rivers, sewage and storm water outflows, etc.). Beach marine litter items may range from very large items (metres) down to smaller pieces and fragments i.e. macro-litter (≥25 mm), meso-litter (5-25 mm), micro-litter (≤5 mm), and nano-litter (< 1000 μm) (GESAMP 2017). Surveys of litter stranded on the coastline are a primary tool for monitoring the load of litter in the marine environment and have been used world-wide to quantify and describe marine litter pollution (JRC, 2011). The results of the surveys, in a later stage, shall be used to assess the effectiveness of management or mitigation measures, identify the sources and activities leading to pollution from marine litter and determine threats to marine biota and ecosystems (Cheshire et al., 2009). The overviews by UN Environment (Cheshire et al. 2009) and the National Oceanic and Atmospheric Administration (NOAA) (Opfer et al., 2012), are the most comprehensive and useful overviews for monitoring methods on the coast. The UN Environment overview includes a comprehensive comparison of existing marine litter survey and monitoring methods and protocols in which beach surveys were assessed (Cheshire et al., 2009). The European Commission through its Marine Strategy Framework Directive (MSFD), Technical Group on Marine Litter (TGML) published the Guidance Document on Monitoring of Marine Litter in European Seas (2013) which proposes a common implementation strategy for the MSFD on several aspects of marine litter. Recently the IPA-Adriatic DeFishGear[21] project has also developed comprehensive guidelines for monitoring marine litter in the Adriatic-Ionian macro- region while a marine litter assessment is already available for the Adriatic and Ionian Seas (Vlachogianni et al., 2017). When designing marine litter surveys it is necessary to differentiate between standing-stock surveys, where the total load of litter is assessed during a one-off count, and the assessment of accumulation and loading rates during regularly repeated surveys of the same stretch of beach with initial and subsequent removal of litter. Both types of survey provide information on the amount and types of marine litter, however, only the accumulation surveys provide information on the rate of deposition of litter and trends in litter pollution. The type of survey selected i.e. strandline surveys, cleaning and regular surveys depends on the objectives of the assessment and on the magnitude of the pollution on the coastline (UNEP(DEPI)/MED WG.417/Inf.15Part2[22]). A single survey method has been recommended by		

[21] http://www.defishgear.net/
[22] 2nd Report of the Informal Online Working Group on Marine Litter

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*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).*

TGML with different spatial parameters for light to moderately polluted coastline and for heavily polluted coastlines.

Scientific References

- Cheshire, A. C., Adler, E., Barbière, J., Cohen, Y., Evans, S., Jarayabhand, S., Jeftic, L., Jung, R.T., Kinsey, S., Kusui, E.T., Lavine, I., Manyara, P., Oosterbaan, L., Pereira, M.A., Sheavly, S., Tkalin, A., Varadarajan, S., Wenneker, B., Westphalen, G., 2009. UNEP/IOC Guidelines on Survey and Monitoring of Marine Litter. UNEP Regional Seas Reports and Studies 186 (IOC Technical Series No. 83): 120.

- GESAMP (2016). “Sources, fate and effects of microplastics in the marine environment: part two of a global assessment” (Kershaw, P.J., and Rochman, C.M., eds). (IMO/FAO/UNESCO-IOC/UNIDO/WMO/IAEA/UN/UNEP/UNDP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection). Rep. Stud. GESAMP No. 93, 220 p.

- IPA-Adriatic DeFishGear project, 2014. Methodology for Monitoring Marine Litter on Beaches (Macro-Debris >2.5 cm).

- IPA-Adriatic DeFishGear project, 2014. Methodology for Monitoring Marine Litter on the Sea Surface-Visual observation (> 2.5 cm).

- IPA-Adriatic DeFishGear project, 2014. Methodology for Monitoring Marine Litter on the Seafloor (continental shelf) - bottom trawl surveys.

- IPA-Adriatic DeFishGear project, 2014. Methodology for Monitoring Marine Litter on the Seafloor (Shallow coastal waters 0 - 20 m) - Visual surveys with SCUBA/snorkelling.

- JRC, 2011. Marine Litter Technical Recommendations for the Implementation of MSFD Requirements. European Commission, Joint Research Centre, Institute for Environment and Sustainability EUR 25009 EN, pp. 66. doi: 10.2788/92438.

- JRC, 2013. Guidance on Monitoring of Marine Litter in European Seas. JRC Scientific and Policy Reports EUR 26113 EN, pp. 126. doi: 10.2788/99475.

- Opfer, S., Arthur, C. and Lippiatt, S., 2012. NOAA Marine Debris Shoreline Survey Field Guide. National Oceanic and Atmospheric Administration.Vlachogianni, Th., Zeri, Ch., Ronchi, F., Fortibuoni, T., Anastasopoulou, A., 2017. Marine Litter Assessment in the Adriatic and Ionian Seas. IPA-Adriatic DeFishGear Project, MIO-ECSDE, HCMR and ISPRA. pp. 180 (ISBN: 978-960-6793-25-7)

Policy Context and targets (other than IMAP)

Policy context description

The UN Environment / Mediterranean Action Plan Barcelona Convention Regional Plan on Marine Litter Management in the Mediterranean Region is the first ever legally binding regional plan

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*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).*

adopted by a Regional Sea Convention (Decision IG. 21/7) that addresses marine litter management in regional level in a coherent manner and sets out legally binding measures at regional and national level, and implementation timetables. The main objective of the Regional Plan on Marine Litter Management in the Mediterranean is to prevent and reduce marine litter generation and its impact on marine and coastal environment in order to achieve good environmental status (GES) as per the relevant Mediterranean ecological objectives and ecosystem approach based Marine Litter related targets adopted by UN Environment / Mediterranean Action Plan in 2012 and 2013 during the 17th and 18th Meeting of the Contracting Parties of the Barcelona Convention consecutively. Moreover, through its Articles: 11 “Assessment of Marine Litter in the Mediterranean” and 12 “Mediterranean Marine Litter Monitoring Programme”, the Regional Plan on Marine Litter includes a series of specific provisions for the countries for monitoring and assessment of marine litter i.e. assess the state of marine litter, the impact to marine and coastal environment and human health, the socio-economic aspects of marine litter management, the development of marine litter data banks, the development of national monitoring programmes on marine litter etc.

The EU MSFD (2008/56/EC) requires European Member States to develop strategies that should lead to programmes of measures to achieve or maintain GES in European Seas. MSFD sets the framework for Member States to achieve by 2020 GES for their marine waters, considering 11 descriptors. Descriptor 10 focuses on marine litter, stating that GES is achieved only when "Properties and quantities of marine litter do not cause harm to the coastal and marine environment".

Indicator/Targets

UN Environment / Mediterranean Action Plan Decision IG.21/3 of the 18th Meeting of the Contracting Parties of the Barcelona Convention on the Ecosystem Approach including adopting definition of GES and targets proposes as target for Indicator 10.1.1: Decreasing trend in the number of/amounts of marine litter (items) deposited on the coast.

Moreover, in the framework of the UN Environment / Mediterranean Action Plan Barcelona Convention, Regional Plan on Marine Litter Management in the Mediterranean (Decision IG.21/7 - 18th Meeting of the Contracting Parties), a series of Marine Litter Baseline Values and Environmental Targets have been adopted by the 19th Meeting of the Contracting Parties) (Decision IG.22/10):

Baseline Values for Beach Marine Litter:
- Minimum value: 11 items/100m
- Maximum value: 3600 items/100m
- Mean value: 920 items/100m
- Proposed Baseline: 450-1400 items/100m

Environmental Targets for Beach Marine Litter:
- Types of Target: % of decrease
- Minimum: Significant
- Maximum: 30%
- Reduction Targets: 20% by 2024

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*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).*
Indicator analysis methods	
Indicator Definition GES Definition: Number/amount of marine litter items on the coastline do not have negative impacts on human health, marine life and ecosystem services.	
Methodology for indicator calculation All items found on the survey unit (i.e. one or two 100m transects) should be entered on survey forms. On the survey forms, each item is given a unique identification number. Data should ideally be entered on the survey form while picking up the litter. Collecting the litter first and identifying it later may alter numbers as collected litter tends to get more entangled or broken. A standard list of marine litter items should be used including all possible marine litter items. Several relevant lists exist. A master list of litter categories and items has been also developed by EU MSFD TGML. This master list includes a list of categories and items to be recorded during beach litter surveys. Based on this Master list, the UN Environment /Mediterranean Action Plan, Mediterranean Pollution Assessment and Control Programme (MED POL) as part of the Integrated Monitoring and Assessment Programme (IMAP) has elaborated a reduced list including the items more frequently found on the Mediterranean beaches, avoiding those that are found rarely. The MSFD derived MED POL list merge some types of beach litter (e.g. different types of plastic drink bottles or different types of caps/lids and rings, etc), split glass and ceramic items categories, consider the sanitary and medical wastes as a separate category and not to include several specific items that have not appeared in the running Mediterranean countries monitoring programmmes. In order to homogenize and harmonize the information collected in the Contracting Parties Monitoring Programmes, this reduced MED POL list should be used. It has been strongly recommended to produce regional photo guides including pictures of all litter items on the survey protocol. This will assist in the correct identification and allocation of recorded items. Attentions should be also given on size limits and classes of the surveyed marine litter items. There are no upper size limits to litter recorded on beaches. The IMAP guidance document (UNEP(DEPI)/MED IG.22/Inf.7) suggest a lower limit of 0.5 cm in the longest dimension is recommended for litter items monitored during beach surveys. However in many other cases the lower size limit, which is considered in such cases is 2.5 cm[23]. Special attention should be drawn upon the environmental sound waste disposal of the collected litter from the Mediterranean coastlines. The removal of the beach marine litter ítems should be done according to specific rules and guidelines, also the proper waste disposal taking into account several factors, as for example that the weathered marine litter ítems cannot be recycled. <u>In that extent there is a need to develop of a corresponding document in the future.</u> There are some projects lead by NOAA where they focus on the removal of the collected marine litter items[24]	
Indicator units Counts of items per item type per survey unit are recommended as the standard unit of litter to be assessed on the coastline.	

[23] http://publications.jrc.ec.europa.eu/repository/bitstream/JRC83985/lb-na-26113-en-n.pdf
[24] https://marinedebris.noaa.gov/current-efforts/removal

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
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urvey unit is a fixed section of beach covering the whole area between the water edges (where possible and safe) or from the strandline to the back of the beach (IMAP Integrated Monitoring and Assessment Guidance document).

- At least 1 section of 100m on the same beach, optimum 2 sections, are recommended for monitoring purposes on lightly to moderately littered beaches;

- At least 2 sections of 100 m for heavily littered beaches (exceptionally 50m section with a normalization factor of up to 100m to ensure coherence).

For assessing trends on marine litter, the percent (%) of decrease should be assessed. OSPAR recommends a minimum of 6 years monitoring in order to assess trends. The information on items/km^2 should be coupled with information on weight per different category. In cases where more than one section is selected, then a 50m separation zone, between the two transects, should be selected.

List of Guidance documents and protocols available

- UN Environment / Intergovernmental Oceanographic Commission, Guidelines on Survey and Monitoring of Marine Litter (2009).

- UN Environment /Mediterranean Action Plan, Integrated Monitoring and Assessment Programme Guidance document (2016) (UNEP(DEPI)/MED_IG.22/Inf.7)

- EU MSFD TGML, Guidance on Monitoring of Marine Litter in European Seas (2013).

- DeFishGear project, Methodology for Monitoring Marine Litter on Beaches Macro-debris (<2.5cm) (2015).

Data Confidence and uncertainties

Most beach marine litter surveys are organized by NGOs with a focus on cleaning. Moreover, small fragments measuring less than 2.5 cm are often buried and may not be targeted by clean-up campaigns or monitoring surveys. Stranding fluxes are also difficult to assess. Moreover, the majority of studies performed show a high variability in the density of litter depending on the use or characteristics of each beach. More work has also to be done on informing volunteer groups about the necessity to submit standardized research data for statistical purposes. In that respect clean-up programmes shall increase public knowledge of the scientific relevance of information and information sharing.

Quality Assessment and Quality Control for beach marine litter data is considered of primary importance. Based on UN Environment Guidelines (Cheshire et al., 2009), any long-term marine litter assessment programme will require a specific and focussed effort to recruit and train field staff and volunteers. Consistent, high quality training and standard data reporting are essential to ensure data quality and needs to explicitly include the development of operational (field based) skills. Standard data reporting sheets (i.e. IMAP Reporting Sheets) including a standardized list of marine litter items and also additional information (weather conditions, etc) commonly used at regional level should be promoted in order to maximize homogeneity on the collected data, make comparison possible, come up with most commonly observed items at regional and sub-regional level and thus assess the problem at regional level. Moreover, all the available training material like

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the UN Environment Massive Open Online Course (MOOC[25]) should be used to train beach marine litter surveyors on surveying, monitoring and on general aspects of marine litter. Staff education programmes should incorporate specific information on the results and outcomes from the work so that staff and volunteers can understand the context of the litter assessment programme.

Quality assurance and quality control should be primarily targeted at education of the field teams to ensure that litter collection and characterization is consistent across surveys. Investment in communication and the training of the country/regional and local survey coordinators and managers is thus critical to survey integrity.

The quality assurance protocol of Ocean Conservancy's National Marine Debris Monitoring Program (USA) required a percentage of all locations to be independently re-surveyed immediately following the scheduled assessment of litter (Sheavly, 2007). The collected litter from the follow-up survey could then be added to that of the main collection and could be used to provide an estimate of the error level associated with the survey.

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols

The selection of survey sites should be based on the following criteria:

- A minimum length of 100m;
- Clear access to the sea (not blocked by breakwaters or jetties) such that marine litter is not screened by anthropogenic structures;
- Accessible to survey teams year round, although some consideration needs to be;
- Ideally the site should not be subject to any other litter collection activities, although it is recognized that in many parts of Europe large scale maintenance cleaning is carried out periodically; in such cases the timing of non-survey related beach cleaning must be known such that litter flux rates (the amount of litter accumulation per unit time) can be determined.
- Survey activities should be conducted so as not to impact on any endangered or protected species such as sea turtles, sea birds or shore birds, marine mammals or sensitive beach vegetation; in many cases this would exclude national parks but this may vary depending on local management arrangements.

Within the above constraints, the location of survey sites within each zone should be stratified such that counts are obtained from beaches subject to different litter exposures, including:

- Urban coasts may better reflect the contribution of land-based inputs;
- Rural coasts may better reflect background values for litter pollution levels
- Coasts close to major rivers, if downstream from the prevailing drift, may better reflect the contribution of riverine input to coastal litter pollution.

At least two surveys per year in winter and summer are recommended and ideally 4 surveys in spring, summer, autumn and winter. However, because of the large seasonal variation in amounts of litter washed ashore, initially a higher frequency of surveys may be necessary in order to identify significant seasonal patterns, which can then be considered when treating raw data for long-term

[25] http://www.unep.org/gpa/gpml/MOOC.asp

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
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trend analyses. Preferably, the surveys for all participating beaches in a given region should be carried out within the shortest timeframe possible within a survey period. Coordinators within these regions should try and coordinate the survey dates between beaches. Furthermore a given beach should be surveyed on roughly the same day each year if possible.

It is very important to document and characterise the survey sites. As surveys should be repeated on exactly the same site the coordinates of the site should be documented. Permanent reference points must be used to ensure that exactly the same site will be monitored for all surveys. The start and end points of each survey unit can be identified by different methods. For example numbered beach poles could be installed at the site or easily identifiable landmarks could be used. Coordinates obtained by GPS are useful for identifying the reference beaches especially where easily identifiable landmarks are lacking.

Counts of items per item type are recommended as the standard unit of litter to be assessed on the coastline. Once a beach is chosen survey units can be identified. A survey unit is a fixed section of beach covering the whole area between the water edges (where possible and safe) or from the strandline to the back of the beach:

- At least 1 section of 100m on the same beach, optimum 2 sections, are recommended for monitoring purposes on lightly to moderately littered beaches
- At least 2 sections of 100 m for heavily littered beaches (exceptionally 50m section with a normalisation factor of up to 100m to ensure coherence)

All items found on the survey unit should be entered on survey forms. On the survey forms, each item is given a unique identification number. Data should ideally be entered on the survey form while picking up the litter. Collecting the litter first and identifying it later may alter numbers as collected litter tends to get more entangled or broken. Unknown litter or items that are not on the survey form should be noted in an appropriate “other item box”. A short description of the item should then be included on the survey form. If possible, digital photos should be taken of unknown items so that they can be identified later and, if necessary, be added to the survey form.
There are no upper size limits to litter recorded on beaches. A lower limit of 0.5 cm in the longest dimension is recommended for litter items monitored during beach surveys. This would ensure the inclusion of caps & lids and cigarette butts in any counts. This lower limit was agreed in the IMAP Guidance presented at COP 19. However a revised higher limit in line with MSFD and other Regional Seas of 2.5 cm may be discussed with experts and Contracting Parties in the future.

Removal of litter should be carried out at the same time as monitoring the litter. Coupling removal with monitoring ensures better accuracy of reporting and enables comparison of litter accumulation over time; It also has the added advantage of leaving a clean beach. It is important to note that only the 100m ref section(s) need to be monitored and cleaned. Further areas of a beach can be cleaned without monitoring if surveyors/volunteers wish to do so. The litter collected should be disposed of properly. Regional or national regulations and arrangements should be followed. If these do not exist local municipalities should be informed. Larger items that cannot be removed (safely) by the surveyors should be marked, with for example paint spray (for marking trees) so they will not be counted again at the next survey.

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Available data sources

- National Monitoring Programmes
- European Environment Agency (EEA) Marine LitterWatch (MLW) Smartphone Application: http://www.eea.europa.eu/themes/coast_sea/marine-litterwatch
- Hellenic Marine Environment Protection Association (HELMEPA): http://www.helmepa.gr/en/home.php
- Legambiente International: http://international.legambiente.it/
- IPA Adriatic DeFishGear Project: http://www.defishgear.net/
- Ocean Conservancy, International Coastal Clean-up (ICC): http://www.oceanconservancy.org/our-work/international-coastal-cleanup/?referrer=https://www.google.gr/
- Surfers Against Sewage: https://www.sas.org.uk/
- Surfrider Foundation Europe: https://www.surfrider.org/

Spatial scope guidance and selection of monitoring stations

Ideally the selected sites should represent litter abundance and composition for a given region. Not any given coastal site may be appropriate, as they may be limited in terms of accessibility, suitability to perform a survey (sand or rocks/boulders) and beach cleaning activities. If possible the same criteria as the ones considered during the selection of the survey sites should be applied.
The location of survey sites should be selected in such a way that samples are obtained from beaches subject to different litter exposures, including:

- Urban coasts may better reflect the contribution of land-based inputs;
- Minimum settlement sites may better reflect background values for litter pollution levels \
- Coasts close to major rivers, if downstream from the prevailing drift, may better reflect the contribution of riverine input to coastal litter pollution.

Temporal Scope guidance

At least two surveys per year in spring and autumn are recommended and ideally 4 surveys in spring, summer, autumn and winter. However, because of the large seasonal variation in amounts of litter washed ashore, initially a higher frequency of surveys may be necessary in order to identify significant seasonal patterns, which can then be considered when treating raw data for long-term trend analyses.

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Preferably, the surveys for all participating beaches in a given region should be carried out within the shortest timeframe possible within a survey period. Coordinators within these regions should try and coordinate the survey dates between beaches. Furthermore a given beach should be surveyed on roughly the same day each year if possible.

It should be kept in mind that circumstances may lead to inaccessible and unsafe situations for surveyors: heavy winds, slippery rocks and hazards such as rain, snow or ice, etc. The safety of the surveyors must always come first. Dangerous or suspicious looking items, such as ammunition, chemicals and medicine should not be removed. Inform the police or authorities responsible. If working on remote beaches it is recommended to work with a minimum of two people.

Data analysis and assessment outputs

Statistical analysis and basis for aggregation

Basic analysis involves spreadsheet development, aggregations per category and type of marine litter items, mean values and corresponding standard deviation. Since there are no available long-term data at the moment, there is no statistical method recommended. Six years of monitoring is considered as the minimum to assess trends. Moreover, at present there is no agreed statistical method for recommending a minimum number of sites that may be representative for a certain length of coast. This depends greatly on the purpose of the monitoring, on the geomorphology of the coast and how many sites that meet the criteria described above are available. The representativeness of survey sites should be assessed in pilot studies, where initially a large numbers of beaches are surveyed. Subsequently, selection of representative beaches from these sites should be made on the basis of a statistical analysis.

Expected assessments outputs

- Abundance of beach marine litter with detailed information on densities (items/100m transect and items/m^2), different types of material and/or use;
- Temporal and spatial distribution;
- Identify sources;
- Most frequent items list found at regional and national level.

Known gaps and uncertainties in the Mediterranean The lack of harmonized monitoring methods and the use of a common list of marine litter items found on beaches leads in several data uncertainties mainly attributed to the lack of comparison among sub-regions and also to give a complete view at basin scale. Comparison is difficult if different methods, different spatial and temporal scales, different size scales of litter items and different lists or categorisation of litter items recorded on beaches are used. Moreover, data collection and data management are considered crucial towards minimizing data uncertainties. Data collation should be undertaken through dedicated database management systems, preferably in regional level, under the control and direction of the local data managers. The EU MSFD TGML Guidance Document (2013), highlights that the existence of such databases would ensure a high level of consistency within each region as well as create a hierarchy of quality assurance on data acquisition. Such a database should be developed and maintained for the Mediterranean.		
Contacts and version Date: *UNEP/MAP 16 January 2017*		
Key contacts within UN Environment for further information - Mr Christos Ioakeimidis, Marine Litter MED Project Expert, Mediterranean Pollution Assessment and Control Programme (MED POL) (Christos.Ioakeimidis@unep.org) - Ms Virginie Hart, Programme Officer, UN Environment/Mediterranean Action Plan, Mediterranean Pollution Assessment and Control Programme (MED POL) (Virginie.Hart@unep.org) - Ms Tatjana Hema, Deputy Coordinator, UN Environment/Mediterranean Action Plan (Tatjana.Hema@unep.org)		
Version No	**Date**	**Author**
V.1	31.05.17	MEDPOL

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

[A] Seafloor Marine Litter

<table>
<tr><td></td><td colspan="2">Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment</td></tr>
<tr><td>Indicator Title</td><td colspan="2">Common Indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor</td></tr>
<tr><td>Relevant GES definition</td><td>Related Operational Objective</td><td>Target(s)</td></tr>
<tr><td>Number/amount of marine litter items in the water surface and the seafloor do not have negative impacts on human health, marine life, ecosystem services and do not create risk to navigation</td><td>10.1. The impacts related to properties and quantities of marine litter in the marine and coastal environment are minimized</td><td>Decreasing trend in the number/amount of marine litter items in the water surface and the seafloor</td></tr>
<tr><td colspan="3">Rationale</td></tr>
<tr><td colspan="3">Justification for indicator selection

The seafloor has been identified as an important sink for marine litter. From the existing information marine litter can be found in varying depths and places, showing considerable spatial variability. 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. Marine litter items may range from very large items (metres) down to smaller pieces and fragments i.e. macro-litter (≥25 mm), meso-litter (5-25 mm), micro-litter (≤5 mm), and nano-litter (< 1000 µm) (GESAMP 2016).The Mediterranean Sea is a special case, as its shelves are not extensive and its deep sea environments can be influenced by the presence of coastal canyons. However there are several studies investigating the abundance of marine litter on the seafloor of 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).

The geographical distribution of litter on the seafloor is strongly influenced by hydrodynamics, geomorphology and human factors. Litter that reaches the seafloor may already have been transported considerable distance, only sinking when weighted down by entanglement and fouling by a wide variety of bacteria, algae, animals and fine-grained accumulated sediments, and litter can then sink to the seafloor. 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). 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). Taking also into account the persistence of most of litter materials (i.e. plastics) and thus the fact that many of the recorded marine litter may be present on the seafloor for year or even decades, then the monitoring of seafloor marine litter becomes extremely important information regarding the abundance of small plastic particles accumulating in the deep-sea sediments is still very limited as only few studies exist on this field (Van Cauwenberghe et al., 2013; Woodall et al., 2014) and further work should be encouraged.</td></tr>
<tr><td colspan="3">Scientific References

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</table>

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Common Indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*

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	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Common Indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*

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Policy Context and targets (other than IMAP)

Policy context description

The UN Environment / Mediterranean Action Plan Barcelona Convention Regional Plan on Marine Litter Management in the Mediterranean Region is the first ever legally binding regional plan adopted by a Regional Sea Convention (Decision IG. 21/7) that addresses marine litter management in regional level in a coherent manner and sets out legally binding measures at regional and national level, and implementation timetables. The main objectives of the ML Management Regional Plan are to prevent and reduce marine litter generation and its impact on marine and coastal environment in order to achieve good environmental status (GES) as per the relevant Mediterranean ecological objectives and ecosystem approach based Marine Litter related targets adopted by UN Environment / Mediterranean Action Plan in 2012 and 2013 during the 17th and 18th Meeting of the Contracting Parties of the Barcelona Convention consecutively. Moreover, through its Articles 11 “Assessment of marine litter in the Mediterranean” and 12 “Mediterranean Marine Litter Monitoring Programme”, the Regional Plan on Marine Litter includes a series of specific provisions for the countries for monitoring and assessment of marine litter i.e. assess the state of marine litter, the impact to marine and coastal environment and human health, the socio-economic aspects of marine litter management, the development of marine litter data banks, the development of national monitoring programmes on marine litter etc.

The EU Marine Strategy Framework Directive (MSFD) (2008/56/EC) requires European Member States to develop strategies that should lead to programmes of measures to achieve or maintain Good Environmental Status (GES) in European Seas. MSFD sets the framework for Member States to achieve by 2020 GES for their marine waters, considering 11 descriptors. Descriptor 10 focuses on marine litter, stating that GES is achieved only when "Properties and quantities of marine litter do not cause harm to the coastal and marine environment".

Indicator/Targets

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Common Indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*

UN Environment / Mediterranean Action Plan Decision IG.21/3 adopted by the 18th Meeting of the Contracting Parties of the Barcelona Convention on the Ecosystem Approach including adopting definition of GES and targets proposes as target for Indicator 10.1.2: Decreasing trend in the number of/amounts of marine litter items in the water surface and the seafloor.

Moreover, in the framework of the UN Environment / Mediterranean Action Plan Barcelona Convention Regional Plan on Marine Litter Management in the Mediterranean (Decision IG.21/7 - 18th Meeting of the Contracting Parties), a series of Marine Litter Baseline Values and Environmental Targets have been adopted by the 19th Meeting of the Contracting Meeting (Decision IG.22/10):

Baseline Values for Seafloor Marine Litter:

- Minimum value: 0 items/km^2
- Maximum value: 7,700 items/ km^2
- Mean value: 179 items/ km^2
- Proposed Baseline: 130 – 230 items/ km^2

Environmental Targets for Seafloor Marine Litter:

- Types of Target: % of decrease
- Minimum: Stable
- Maximum: 10% in 5 years
- Reduction Targets: Statistically Significant (15% in 15 years is possible

Policy documents

- UN Environment / Mediterranean Action Plan, Regional Plan on Marine Litter Management in the Mediterranean, Decision IG.21/7 (2013)[26].
- UN Environment / Mediterranean Action Plan, Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria, Decision IG 22/7 (2016)[27].
- UN Environment, Marine Litter Legislation Toolkit for Policymakers (2016)[28].
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- European Commission, Decision on criteria and methodological standards on good environmental status of marine waters (2010)[30].

Indicator analysis methods

Indicator Definition

[26] https://wedocs.unep.org/rest/bitstreams/8222/retrieve (ENG)/ https://wedocs.unep.org/rest/bitstreams/8223/retrieve (FR)
[27] https://wedocs.unep.org/rest/bitstreams/8385/retrieve
[28] http://www.unep.org/stories/Ecosystems/Marine-Litter-Legislation-A-toolkit-for-Policymakers.asp
[29] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0056&from=EN
[30] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010D0477(01)&from=EN

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Common Indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*

GES Definition: Number/amount of marine litter items in the water surface and the seafloor do not have negative impacts on human health, marine life, ecosystem services and do not create risk to navigation.

Methodology for indicator calculation

General strategies for the investigation of seabed marine litter are similar to those used to assess the abundance and type of benthic species. The most common approaches to evaluate sea-floor litter distribution is to use perform opportunistic surveys often coupled with regular fisheries surveys (marine reserve, offshore platforms, etc.) and programmes on biodiversity, These methods for determining seafloor litter distributions (e.g. trawling, diving, video) are similar to those used for benthic and biodiversity assessments. The use of submersibles or Remotely Operated Vehicles (ROVs) is a possible approach for deep sea areas although this requires expensive equipment. 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 ECAP requirements.

<u>Shallow sea-floor (<20m):</u>
The most commonly used method to estimate marine litter density in shallow coastal areas is to conduct underwater visual surveys with SCUBA/snorkelling. These surveys are best based on line transect surveys of litter on the sea-floor, which is derived from UN Environment (Cheshire, 2009). The protocol is actually in use for evaluation of benthic fauna. It requires SCUBA equipment and trained observers. Only litter items above 2.5 cm are considered, between 0 and 20 m (to 40 meters with skilled divers).

Individual litter within 4 m of the line (half of the width –Wt - of the line transects) are recorded. For each observed litter item, when possible, the corresponding line segment of occurrence and its perpendicular distance from the line (yi - for the estimation of detection probability, measured with the use of a 2 m plastic rod), and litter size category (wi) are recorded. The nature of the bottom/habitat is also recorded. The length of the line transects vary between 20 and 200 m, depending on the depth, the depth gradient, the turbidity, the habitat complexity and the litter density (Katsavenakis, 2009). Results on litter density are often expressed in items/m^2, items/100 m^2, and/or items/100m transect.
In surveys using the distance-sampling method, detectability is used to correct marine litter abundance estimations (Katsavenakis, 2009). The standard software for modelling detectability and estimating density/abundance, based on surveys using distance-sampling method, is DISTANCE (Thomas et al., 2006).

<u>Monitoring the Sea-floor (20-800m):</u>
From all the methods assessed, trawling (otter trawl) has been shown to be the most suitable for large scale evaluation and monitoring (Goldberg, 1995, Galgani et al., 1995, 1996, 2000). Nevertheless there are some restrictions in rocky areas and in soft sediments, as the method may be restricted and/or underestimate the quantities present. This approach is however reliable, reproducible, allowing statistical processing and comparison of sites. As recommended by UN Environment (Cheshire, 2009), sites should be selected to ensure that they:

i. Comprise areas with uniform substrate (ideally sand/silt bottom);

ii. Consider areas generating/accumulating litter;

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iii. Avoid areas of risk (presence of munitions), sensitive or protected areas;

iv. Do not impact on any endangered or protected species.

Units should be stratified relative to sources (urban, rural, close to riverine inputs) and impacted offshore areas (major currents, shipping lanes, fisheries areas, etc.). General strategies to investigate seabed litter are similar to methodology for benthic ecology and place more emphasis on the abundance and nature of items (e.g. bags, bottles, pieces of plastics) rather than their mass. The occurrence of international bottom trawls surveys such as MEDITS (Mediterranean) provide useful and valuable means for monitoring marine litter. These are using common gears depending on region (MEDITS net in the Mediterranean with their stratification scheme) and provide standardized and harmonized survey conditions (20 mm mesh, 30-60 min tows, large survey surface covered) and hydrographical and environmental information (priority: surface & bottom temperature, surface & bottom salinity, Optional: surface & bottom current direction & speed, wind direction & speed, swell direction and height).

Indicator units

- Litter on the seafloor shallow coastal waters(0-20m): visually surveyed litter items size above 2.5cm expressed on items/m^2
- Litter on the seafloor 20-800m: (items/ha or) items/km^2 of litter collected in bottom trawl surveys and if possible to be coupled with dry weight information (kg/km^2)

List of Guidance documents and protocols available

- UN Environment / Intergovernmental Oceanographic Commission, Guidelines on Survey and Monitoring of Marine Litter" (2009).
- UN Environment / Mediterranean Action Plan, Integrated Monitoring and Assessment Programme Guidance document (2016) (UNEP(DEPI)/MED_IG/22/Inf7).
- EU MSFD TGML, Guidance on Monitoring of Marine Litter in European Seas (2013).
- International bottom trawl survey in the Mediterranean, Instructional Manual, MEDITS Working Group (2016).
- IPA-Adriatic DeFishGear project, 2014. Methodology for Monitoring Marine Litter on the Sea Surface-Visual observation (> 2.5 cm).
- IPA-Adriatic DeFishGear project, 2014. Methodology for Monitoring Marine Litter on the Seafloor (continental shelf) – bottom trawl surveys.
- IPA-Adriatic DeFishGear project, 2014. Methodology for Monitoring Marine Litter on the Seafloor (Shallow coastal waters 0 – 20 m) - Visual surveys with SCUBA/snorkelling.

Data Confidence and uncertainties

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
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Several Contracting Parties from UN Environment / Mediterranean Action Plan and its Mediterranean Pollution Assessment and Control Programme (MED POL) have indicated they will use their fish stock surveys for seafloor litter monitoring. This is considered to be an adequate approach although quantities of litter might be underestimated, given restrictions in some areas. The adoption of a common protocol will lead to a significant level of standardization among the Contracting Parties countries that apply this type of survey strategy.

Data on litter in shallow sea-floor are collected through protocols already validated for benthic species. Until now, no quality assurance programme has been considered for litter monitoring on the sea-floor. This process may also support quality insurance for data on litter. Currently, there are on-going discussions on how to organize and harmonize a specific system to collect, validate and organize data through a common platform, enabling the review and validation of data. MEDITS has included litter data to be analysed within a specific sub-group.

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols

Monitoring the shallow sea-floor (<20m):

Recreational and professional scuba divers can provide valuable information on litter they see underwater and they are uniquely positioned to support seafloor litter monitoring efforts. They can access, have the skills and the equipment needed to collect, record, and share information about litter they encounter underwater. Many dive clubs organize underwater clean-ups, often in partnerships with NGOs or local governments. Many of these events, when managed, can be a valuable source of information and possibly be a part of a regular survey, monitoring or even assessment efforts while using volunteers.

For some Contracting Parties use of volunteer divers might be a good opportunity for shallow-water litter monitoring but standardization and conformity with common methodologies and tools such as those proposed by the EU MSFD Technical Group on Marine Litter (TGML) should be achieved. Fixed sites, common frequency and survey methodology can be easily established by each Contracting Party and training, material distribution etc. can be achieved relatively easily when partner NGOs or research institutions are involved.

Monitoring the Sea-floor (20-800m):

Templates for data recording have been integrated in the 2016 MEDITS Instruction Manual (v.8)[31]. Data on litter should be collected on these templates using items categories such as those listed for Sea-floor prepared by TGML. Other elements from the haul operations should be also recorded (see the 2016 MEDITS Instruction Manual v.8) for the Mediterranean. Data on litter should be reported as items/ha or items/km^2 before further processing and reporting.

A standardized litter classification system has been defined for monitoring the sea floor by the EU MSFD TGML. The categories were defined in accordance with types of litter found at regional level, enabling common main categories for all regions. The main categories have a hierarchical system including sub categories. It considers 4 main categories of material for the Mediterranean (wood, paper/cardboard, other, unspecific). There are various subcategories for a more detailed description of litter items. Other specific categories may be added by Contracting Parties and additional description of the item may provide added-value, as long as the main categories and sub-

[31] http://www.sibm.it/MEDITS%202011/docs/Medits_Handbook_2016_version_8_042016.pdf

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categories are maintained. Furthermore, the weight, picture and note of potential attached organisms may further complement the classification of items.

Site information and trawling survey characteristics such as date, position, type of trawl, speed, distance, sampled area, depth, hydrographical and meteorological conditions should be recorded. Data-sheets should be filled out for each trawl and compiled by survey. If multiple counts (transects/observers) are run at any given site then a new sheet should be used for each trawl shot. After each survey data must be aggregated for analysis and reporting.

Towed video camera for shallow waters (Lundqvist, 2013) or ROVs for deeper areas are simpler and generally cheaper and must be recommended for litter surveys. There are some available protocols where litter is counted on routes and expressed as item/km, especially when using submersibles/ROVs at variable depths above the deep sea floor (Galgani et al., 1996) however technology enables the evaluation of densities trough video-imagery using a standardized approach especially for shallow waters.

Available data sources

- DeFishGear Project: http://www.defishgear.net/
- Hellenic Centre for Marine Research (HCMR): www.hcmr.gr
- Institut français de recherche pour l'exploitation de la mer (IFREMER): http://wwz.ifremer.fr/
- International Bottom Trawl Surveys in the Mediterranean (MEDITS): http://www.sibm.it/SITO%20MEDITS/principaleprogramme.htm
- Laboratory of Marine Geology and Physical Oceanography, Department of Geology, University of Patras: http://www.oceanus.upatras.gr/?q=node/15

Spatial scope guidance and selection of monitoring stations

Monitoring the shallow sea-floor (<20m):
Surveys are conducted through 2 line transects for each site. Unbiased design-based inference requires allocating the transects randomly in the study area or on a grid of systematically spaced lines randomly superimposed. However, with a model-based approach like density surface modelling (DSM), it is not required that the line transects are located according to a formal and restrictive survey scheme, although good spatial coverage of the study area is desirable. Line transect are defined with a nylon line, marked every 5 meters with resistant paints, that is deployed using a diving reel while SCUBA diving.

Monitoring the Sea-floor (20-800m):
UN Environment (Cheshire, 2009) recommends that at least 20 survey units will be selected at regional level although a higher level of redundancy (i.e. replication) in survey units within each region is highly recommended.

Moreover, the protocol of the EU MSFD TGML for surveying and trawling margins (20-800m) has been standardized for each region. For the Mediterranean Region, the protocol is derived from the MEDITS protocol (see the 2016 MEDITS Instruction Manual v.8[32]). The hauls are positioned following a depth stratified surveying scheme with random drawing of the positions within each stratum. The number of positions in each stratum is proportional to the surface of these strata and the hauls are made in the same position from year to year. The following depths (10 – 50; 50 – 100; 100 – 200; 200 – 500; 500 - 800 m) are fixed in all areas as strata limits. The total number of hauls

[32] http://www.sibm.it/MEDITS%202011/docs/Medits_Handbook_2016_version_8_042016.pdf

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for the Mediterranean Sea is 1260; covering the shelves and slopes from 10 countries in the Mediterranean.

Temporal Scope guidance

Monitoring the shallow sea-floor (<20m):
The minimum surveying frequency for any site should be annually. Ideally it is recommended that locations are surveyed every three months (allowing an interpretation in terms of seasonal changes).

Monitoring the Sea-floor (20-800m):
The haul duration is fixed at 30 minutes on depths less than 200m and at 60 minutes at depths over 200m (defined as the moment when the vertical net opening and door spread are stable), using the same GOC 73 trawl with 20 mm mesh nets (Bertran et al, 2007) and surveying between May and July, at 3 knots between 20 and 800 m depth.

Data analysis and assessment outputs

Statistical analysis and basis for aggregation

Basic statistics may be applied during the analysis and aggregation of the results. The coefficient of variation (i.e. Standard deviation) should be included in the processed data for seafloor marine litter, to couple the abundance/density figures (e.g. items/km^2).

Expected assessments outputs

- Assess marine litter found on the seafloor of the Mediterranean sea at basin, sub-basin and or national scale;
- Assess abundance, density (items/ha or items/km^2), spatial and temporal distribution and types;
- Identify sources to target prevention and reduction measures;
- Map existing information in order to assess marine litter accumulation areas on the seafloor of the Mediterranean Sea

Known gaps and uncertainties in the Mediterranean

More than 50 studies were conducted worldwide between 2000 and 2015, but until recently very few covered extensive geographical areas or considerable depths. While there is sufficient knowledge on seafloor marine litter for the Northern part of the Mediterranean sea, however more information shall be acquired for the Southern part of the Mediterranean. Moreover, accumulation areas shall be assessed with priority on the convergence zones and deep-sea canyons.

Contacts and version Date: *UNEP/MAP 16 January 2017*

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	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
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Version No	**Date**	**Author**
V.2	31.05.17	MEDPOL

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

[B] Floating Marine Litter

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment	
Indicator Title	*Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*	
Relevant GES definition	**Related Operational Objective**	**Target(s)**
Number/amount of marine litter items in the water surface and the seafloor do not have negative impact on human health, marine life, ecosystem services and do not create risk to navigation	The impacts related to properties and quantities of marine litter in the marine and coastal environment are minimized (10.1)	Decreasing trend in the number/amount of marine litter in the water surface and the seafloor.
Rationale		

Justification for indicator selection

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. Floating marine litter comprises the mobile fraction of debris in the marine environment, as it is less dense than seawater. Marine litter items may range from very large items (metres) down to smaller pieces and fragments i.e. macro-litter (≥25 mm), meso-litter (5-25 mm), micro-litter (≤5 mm), and nano-litter (< 1000 µm) (GESAMP 2016). 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 debris, 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.

Floating marine litter items of different size (nano-, micro- to macro-litter) may be found floating at sea. The transportation of floating litter particles (especially microplastics) can be considered passive, mainly subject to surface currents. Beyond vertical mixing, waves and wind also affect the horizontal transport of microplastics (GESAMP, 2016). A 30-year circulation model using various input scenarios showed the accumulation of floating debris in ocean gyres and closed seas, such as the Mediterranean Sea, made up 7-8% of the total debris expected to accumulate (Lebreton et al., 2012). Locations that are particularly susceptible to litter accumulation are as follows: i) coastal areas; ii) areas close to terrestrial sources (e.g. sewage wastewater, river); iii) depressions in the seabed; and iv) low-energy environments (low currents, weak circulation) (IMO, 2016).

Visual assessment approaches include the use of research vessels, marine mammal surveys, commercial shipping carriers, and dedicated litter observations. Aerial surveys are now being employed for larger items. Although the basic principle of floating debris monitoring through visual observation is very simple, there are few datasets available for the comparable assessment of debris abundance, and monitoring is only performed occasionally.

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	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*

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Policy Context and targets (other than IMAP)

Policy context description

The UN Environment / Mediterranean Action Plan Barcelona Convention Regional Plan on Marine Litter Management in the Mediterranean Region is the first ever legally binding regional plan adopted by a Regional Sea Convention (Decision IG. 21/7) that addresses marine litter management in regional level in a coherent manner and sets out legally binding measures at regional and national level, and implementation timetables. The main objective of the Regional Plan on Marine Litter Management in the Mediterranean is to prevent and reduce marine litter generation and its impact on marine and coastal environment in order to achieve good environmental status (GES) as per the relevant Mediterranean ecological objectives and ecosystem approach based Marine Litter related targets adopted by UN Environment / Mediterranean Action Plan in 2012 and 2013 during the 17th and 18th Meeting of the Contracting Parties of the Barcelona Convention consecutively. Moreover, through its Articles 11 "Assessment of marine litter in the Mediterranean" and 12 "Mediterranean Marine Litter Monitoring Programme", the Regional Plan on Marine Litter includes a series of specific provisions for the countries for monitoring and assessment of marine litter i.e. assess the

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state of marine litter, the impact to marine and coastal environment and human health, the socio-economic aspects of marine litter management, the development of marine litter data banks, the development of national monitoring programmes on marine litter etc.

The EU Marine Strategy Framework Directive (MSFD) (2008/56/EC) requires European Member States to develop strategies that should lead to programmes of measures to achieve or maintain Good Environmental Status (GES) in European Seas. MSFD sets the framework for Member States to achieve by 2020 GES for their marine waters, considering 11 descriptors; descriptor 10, focuses on marine litter, stating that GES is achieved only when "properties and quantities of marine litter do not cause harm to the coastal and marine environment".

Indicator/Targets

UN Environment / Mediterranean Action Plan Decision IG.21/3 of the 18th Meeting of the Contracting Parties of the Barcelona Convention on the Ecosystem Approach including adopting definition of GES and targets proposes as target for Indicator 10.1.2: Decreasing trend in the number of/amounts of marine litter items in the water surface and the seafloor.

Moreover, in the framework of the UN Environment / Mediterranean Action Plan Barcelona Convention Regional Plan on Marine Litter Management in the Mediterranean, adopted by the 18th Meeting of the Contracting Parties (Decision IG.21/7), a series of Marine Litter Baseline Values and Environmental Targets have been adopted by the 19th Meeting of the Contracting Parties (Decision IG.22/10):

Baseline Values for Floating Marine Litter:

- Minimum value: 0 items/km^2
- Maximum value: 195 items/ km^2
- Mean value: 3.9 items/ km^2
- Proposed Baseline: 3-5 items/ km^2

Environmental Targets for Floating Marine Litter:

- Types of Target: % of decrease
- Minimum: -
- Maximum: -
- Reduction Targets: Statistically Significant

Baseline Values for Floating Microplastics:

- Minimum value: - items/km^2
- Maximum value: 4,860,000 items/ km^2
- Mean value: 340,000 items/ km^2

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- Proposed Baseline: 200,000 – 500,000 items/ km^2

Environmental Targets for Floating Microplastics:
- Types of Target: % of decrease
- Minimum: -
- Maximum: -
- Reduction Targets: Statistically Significant

Policy documents

- UN Environment / Mediterranean Action Plan, Regional Plan on Marine Litter Management in the Mediterranean, Decision IG.21/7 (2013)[33].
- UN Environment / Mediterranean Action Plan, Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria, Decision IG.22/7 (2016)[34].
- UN Environment, Marine Litter Legislation Toolkit for Policymakers (2016)[35].
- European Commission, Marine Strategy Framework Directive, Directive 2008/56/EC (2008)[36].
- European Commission, Decision on criteria and methodological standards on good environmental status of marine waters (2010)[37].

Indicator analysis methods

Indicator Definition

GES Definition: Number/amount of marine litter items in the water surface and the seafloor do not have negative impacts on human health, marine life, ecosystem services and do not create risk to navigation.

Methodology for indicator calculation

The reporting of monitoring results requires the grouping into categories of material, type and size of litter object. The approach for categories of floating litter is linked with the development of a “master list” with the categories (Artificial Polymer Materials, Rubber, Cloth/Textile, Paper/Cardboard, Processed/Worked Wood, Metal, Glass/Ceramics) for other environmental compartments such as the “master list” prepared by the EU MSFD TGML. This allows cross comparisons. For the practical use during the monitoring the list has to be arranged by object occurrence frequency so that the data acquisition can be done in the required short time. As floating litter items will be observed but not collected, the size is the only indicative parameter of the amount of plastic material that it contains. The size of an object is defined here as its largest dimension, width or length, as visible during the observation.

The lower size limit for the observations is determined by the observation conditions. A lower size limit that appears to be reasonable for observation from “ships-of-opportunity” and is in line with

[33] https://wedocs.unep.org/rest/bitstreams/8222/retrieve (ENG) / https://wedocs.unep.org/rest/bitstreams/8223/retrieve (FR)
[34] https://wedocs.unep.org/rest/bitstreams/8385/retrieve
[35] http://www.unep.org/stories/Ecosystems/Marine-Litter-Legislation-A-toolkit-for-Policymakers.asp
[36] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0056&from=EN
[37] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010D0477(01)&from=EN

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the size for beach litter surveys is probably the 2.5 cm. This denotes that observations not achieving this minimum size limit cannot be recommended. For reporting purposes size range classes must be introduced as visual observation will not permit the correct measuring of object sizes. Only the estimation of size classes is feasible. The size determination/reporting scheme should enclose the following classes: 2.5 – 5 cm, 5 - 10 cm, 10 – 20 cm, 20 – 30 cm, 30 – 50 cm. While also wider size range classes (e.g. 2.5–10cm, 10–30cm, 30–50 cm) could be utilized, it will be important that a common approach is used, as the data will be combined in common data bases. The upper size limit will have to be determined by statistical calculations regarding the density of the object occurrence in comparison to transect width, length and frequency. In coherence with the beach litter surveys an upper limit of 50 cm is here provisionally proposed. It has to be evaluated in experiments and from initial data sets if items larger than 50 cm should be reported, as their relevance in the statistical evaluation of data from short and narrow coastal transects might be questionable.

Indicator units

For floating marine litter the unit of reporting will be items of floating litter, 2.5 to 50 cm per km^2. The data will be available for the different categories and size classes.

List of Guidance documents and protocols available

- UN Environment / Intergovernmental Oceanographic Commission, Guidelines on Survey and Monitoring of Marine Litter (2009).

- UN Environment / Mediterranean Action Plan, Integrated Monitoring and Assessment Programme Guidance document (2016) (UNEP(DEPI)/MED_IG.22/Inf.7).

- EU MSFD TGML, Guidance on Monitoring of Marine Litter in European Seas (2013).

IPA-Adriatic DeFishGear project, 2014. Methodology for Monitoring Marine Litter on the Sea Surface-Visual observation (> 2.5 cm).

Data Confidence and uncertainties

The observation of floating marine litter from ships is subject to numerous variables in the observation conditions. They can be divided into operational parameters, related to the ship properties and observation location. Protocols should be developed where the processing of the collected information, starting from the documentation on board, its compilation, elaboration and further use would be part of the protocol in order to derive comparable final results. The format should allow a compilation across different observing institutes and areas or regions. This would allow a plotting of floating litter distribution over time and thus finally allow the coupling with oceanographic current models.

The widespread acquisition of monitoring data will need some kind of inter-comparison or calibration in order to ensure comparability of data between different areas and over time, for trend assessments. Approaches for this should be developed and implemented. This can be hands (eyes)–on training courses with comparisons of observations. Such events should be organized at Regional level with further implementation at national scale. A methodology for calibrating observation quality by artificial targets may be devised through research efforts.

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
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A harmonized approach for the quantification of floating marine litter by ship-based observers has been developed by the EC MSFD Technical Group on Marine Litter (TGML). It has the scope to harmonize the monitoring of floating marine litter:

- In the size range from 2.5 to 50 cm;
- Observation width needs to be determined according to observation set-up;
- It is planned for use from ships of opportunity;
- It is based on transect surveys;
- It should cover short transects; and
- Also record necessary metadata.

The observation from ships-of-opportunity (i.e. volunteer merchant and passenger ships which routinely transit strategic shipping routes) should ensure the detection of litter items at 2.5 cm size. The observation transect width will therefore depend on the elevation above the sea, the ship speed and the observation conditions. Typically a transect width of 10 m can be expected, but a verification should be made and the width of the observation corridor chosen in a way that all items in that transect and within the target size range, can be seen. Table below provides a preliminary indication of the observation corridor width, with varying observation elevation and speed of vessel (kn = knot = nautical mile/h). The parameters need to be verified prior to data acquisition.

Observation elevation above sea	Ship speed 2 knots = 3.7 km/h	6 knots =11.1 km/h	10 knots = 18.5 km/h
1 m	6m	4m	3m
3m	8m	6m	4m
6m	10m	8m	6m
10m	15m	10m	5m

The ideal location for observation will often be in the bow area of the ships. If that area is not accessible, the observation point should be selected so that the target size range can be observed, eventually reducing the observation corridor, as ship induced waves might interfere with the observations. An inclinometer can be used to measure distances at sea (Doyle, 2007).

The protocol will have to go through an experimental implementation phase during which it is applied in different sea regions by different institutions, its practicality is tested and feedback for definition of observation parameters is provided.
The observation, quantification and identification of floating litter items must be made by a dedicated observer who does not have other duties contemporaneously. Observation for small items and surveying intensively the sea surface leads to fatigue and consequently to observation errors. The transect lengths should therefore be selected in a way that observation times are not too long. Times of 1 h for one observer could be reasonable, corresponding to a length of a few kilometres.

Available data sources

- IPA Adriatic DeFishGear Project: http://www.defishgear.net/
- Hellenic Marine Environment Protection Association (HELMEPA): http://www.helmepa.gr/en/home.php\

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor*

Spatial scope guidance and selection of monitoring stations

The monitoring of floating marine litter by observers is a methodology indicated for short transects in selected areas. In a region with little or no information about floating marine litter abundance it might be advisable to start by surveys in different areas in order to understand the variability of litter distribution. The selected areas should include expected low density areas (e.g. open sea) as well as expected high density areas (e.g. close to ports). This will help to obtain maximum/minimum conditions and train the observers. Other selected areas (e.g. in estuaries), in the vicinity of cities, in local areas of touristic or commercial traffic, incoming currents from neighbouring areas or outgoing currents should be considered. Based on the experience obtained in this initial phase, a routing programme including areas of interest should then be established.

Temporal Scope guidance

The observation of floating marine litter is much depending on the observation conditions, in particular on the sea state and wind speed. The organization of monitoring must be flexible enough to take this into account and to re-schedule observations in order to meet appropriate conditions. Ideally the observation should be performed after a minimum duration of calm sea, so that there is no bias by litter objects which have been mixed into the water column by recent storms or heavy sea.
The initial, investigative monitoring should be performed with a higher frequency in order to understand the variability of litter quantities in time. Even burst surveying, i.e. high surveying frequency over short period, might be appropriate in order to understand the variability of floating marine litter occurrence.

For trend monitoring the timing will depend on the assumed sources of the litter, this can be e.g. monitoring an estuary after a rain period in the river basin, monitoring a touristic area after a holiday period. The timing of the surveys will also depend on the schedule of the observation platforms. Regular patrols of coast guard ships, ferry tracks or touristic trips may offer frequent opportunities which thus also allow the use during the needed calm weather conditions.

Data analysis and assessment outputs

Statistical analysis and basis for aggregation

No specific statistical tool is required for the analysis of the observed floating marine litter items. However, it is not uncommon that floating marine litter items appear grouped, either because they have been released together or because they accumulate on oceanographic fronts. The reporting system should acknowledge this and foresee a way to report such groups. The occurrence of such accumulation areas needs to be considered when evaluating the data. Along with the litter occurrence data, a series of metadata should be recorded, including geo-referencing (coordinates) and wind speed (m/s). This accompanying data shall allow the evaluation of the data in the correct context.

Expected assessments outputs

- Assess accumulation zones for floating marine litter items;
- Assess abundance, density and types of floating marine litter items in a more precise way;
- Comparison with marine litter found in other sea compartments.

Known gaps and uncertainties in the Mediterranean

Only a few studies have been published on the abundance of floating macro debris in Mediterranean waters (Aliani et al., 2003; UNEP, 2009; Topcu et al., 2010, Gerigny et al., 2011, Suaria and Aliani,

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2015, Vlachogianni et a; 2017), and the reported quantities measuring over 2 cm range widely from 0 to over 600 items per square kilometer. So the abundance of floating marine litter in the Mediterranean Sea cannot be estimated with accuracy. Moreover we still have no information on the accumulation zones for floating marine litter items.

Contacts and version Date: *UNEP/MAP 16 January 2017*

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V.2	31.05.17	MEDPOL

Candidate Common indicator 24: Trends in the amount of litter ingested by or entangling marine organisms, especially mammals, marine birds and turtles

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment	
Indicator Title	*Candidate Common indicator 24: Trends in the amount of litter ingested by or entangling marine organisms, especially mammals, marine birds and turtles*	
Relevant GES definition	**Related Operational Objective**	**Target(s)**
	Impacts of litter on marine life are controlled to the maximum extent practicable (10.2)	Decreasing trend in the cases of entanglement or/and a decreasing trend in the stomach content of the sentinel species.
Rationale		

Justification for indicator selection

As marine litter affects different ecological compartments, the study of its impact on marine biota of all trophic levels on the same temporal and spatial scale is of increasing importance. More than 800 marine and coastal species are affected by marine debris through ingestion, entanglement, ghost-fishing and dispersal by rafting as well as habitat effects. More than 500 marine and coastal species are affected by ingestion of, or entanglement in, marine debris, which includes the effects of ghost fishing. The number of seabird and marine mammal species affected by marine debris ingestion or entanglement is steadily rising. Moreover, microplastics are present in all marine habitats and from the ocean surface to the seabed, and are available to every level of the food web, from primary producers to higher trophic levels (GESAMP, 2015). Microplastics are also providing a new habitat in the oceans for microbial communities, although the effects on ocean ecosystems and processes are not yet understood (CBD, 2016).

With regard to biodiversity, it is essential to focus research on sensitive species such as turtles, marine mammals, seabirds, and filter feeders, invertebrates or fish that may be ingest micro plastics. Protocols also have to be developed in order to assess early warning effects on key species and key habitats (CIESM Workshop Monographs, 2014). The effect of marine litter on marine populations is difficult to quantify, as an unknown number of marine animals die at sea and may quickly sink or be consumed by predators, eliminating them from potential detection. New methods for the unbiased estimation of mortality rates and the effects on the population dynamics of many affected species are urgently needed.

In the North Sea, an indicator is available, which expresses the impact of marine litter (OSPAR EcoQO). It measures ingested litter in Northern Fulmar and it is used to assess temporal trends, regional differences and compliance with a set target for acceptable ecological quality in the North Sea area (Van Franeker et al., 2011). A combined protocol is also proposed by the EU Marine Strategy Framework Directive (MSFD) Technical Group on Marine Litter (TGML) which can be used for seabirds in general. However alternative tools are needed for the Mediterranean Sea. Moreover, in the Adriatic Sea, fish have been found ingesting marine litter particles at a rate of 2.6% in the North Adriatic, 25.9% South Adriatic, and 2.7% in the northeastern Ionian Sea (Vlachogianni et al., 2017)

On the basis of available information and expertise, a monitoring protocol for marine litter in sea turtles with focus on relevant parameters for application in the Mediterranean Sea is proposed by the EU MSFD TGML. The loggerhead sea turtle (*Caretta caretta*) is the most abundant chelonian in the Mediterranean (Camedda et al., 2014; Casale and Margaritoulis, 2010) and may ingest plastic bags mistaken for jellyfishes (Mrosovsky et al., 2009) when they feed in neritic and offshore habitats. This is a very sensitive species to marine litter and one of the most studied. Despite the fact that the loggerhead is able to ingest any kind of waste, plastic items seem to be more significant than other kinds of marine litter. Different studies in the Mediterranean Sea (Lazar and

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Gracan, 2011; Campani et al., 2013, Camedda et al., 2014), as well as for other seas and oceans, demonstrated that plastic is the most frequently ingested anthropogenic debris. There is no difference in litter found in stranded sea turtles when compared with those excreted by hospitalized ones (Cameda et al., 2014), with analyses showing homogeneity in relation of the total abundance, weight, and composition among alive and dead individuals.

Entanglement in beached animals, entanglement in live animals (others than in relation to seabird nests), ingestion of litter by marine mammals, ingestion of litter by marine invertebrates and research on food chain transfer are reflected in the final report of the EU MSFD TGML. However only ingestion of and entanglement in marine litter by marine mammals are considered by the EU MSFD TGML for further development whereas the other aspects are crucial issues for research but not suitable to be recommended for wide monitoring application at this stage.

Scientific References

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- Vlachogianni, Th., Anastasopoulou, A., Fortibuoni, T., Ronchi, F., Zeri, Ch., 2017. Marine Litter Assessment in the Adriatic and Ionian Seas. IPA-Adriatic DeFishGear Project, MIO-ECSDE, HCMR and ISPRA. pp. 168 (ISBN: 978-960-6793-25-7).

Policy Context and targets (other than IMAP)

Policy context description

The UN Environment / Mediterranean Action Plan Barcelona Convention Regional Plan on Marine Litter Management in the Mediterranean Region is the first ever legally binding regional plan adopted by a Regional Sea Convention (Decision IG. 21/7) that addresses marine litter management in regional level in a coherent manner and sets out legally binding measures at regional and national level, and implementation timetables. The main objectives of the ML Management Regional Plan are to prevent and reduce marine litter generation and its impact on marine and coastal environment in order to achieve good environmental status (GES) as per the relevant Mediterranean ecological objectives and ecosystem approach based Marine Litter related targets adopted by UN Environment / Mediterranean Action Plan in 2012 and 2013 during the 17th and 18th Meeting of the Contracting Parties of the Barcelona Convention consecutively.

The EU MSFD (2008/56/EC) requires European Member States to develop strategies that should lead to programmes of measures to achieve or maintain Good Environmental Status (GES) in European Seas. MSFD sets the framework for Member States to achieve by 2020 GES for their marine waters, considering 11 descriptors. Descriptor 10 focuses on marine litter, stating that GES is achieved only when "Properties and quantities of marine litter do not cause harm to the coastal and marine environment".

Indicator/Targets

UN Environment / Mediterranean Action Plan Decision IG.21/3 of the 18th Meeting of the Contracting Parties of the Barcelona Convention on the Ecosystem Approach including adopting definition of GES and targets proposes as target for Indicator 10.2: Decreasing trend in the cases of entanglement or/and a decreasing trend in the stomach content of the sentinel species.

Moreover, in the framework of the UN Environment / Mediterranean Action Plan Barcelona Convention Regional Plan on Marine Litter Management in the Mediterranean, adopted by the 18th Meeting of the Contracting Parties (Decision IG.21/7), a series of Marine Litter Baseline Values and Environmental Targets have been adopted by the 19th Meeting of the Contracting Parties (Decision IG.22/10):

Baseline Values for Affected Sea Turtles (%):
- Minimum value: 14%
- Maximum value: 92.5%
- Mean value: 45.9%
- Proposed Baseline: 40-60%

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Environmental Targets for Affected Sea Turtles (%):

- Types of Target: % of decrease in the rate of affected animals
- Minimum: -
- Maximum: -
- Reduction Targets: Statistically Significant

Baseline Values for Ingested Marine Litter (gr):

- Minimum value: 0 gr
- Maximum value: 14 gr
- Mean value: 1.37 gr
- Proposed Baseline: 1-3 gr

Environmental Targets for Ingested Marine Litter (gr):

- Types of Target: % decrease in quantity of ingested weight (gr)
- Minimum: -
- Maximum: -
- Reduction Targets: Statistically Significant

Policy documents

- UN Environment / Mediterranean Action Plan, Regional Plan on Marine Litter Management in the Mediterranean, Decision IG.21/7 (2013)[38].
- UN Environment / Mediterranean Action Plan, Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria, Decision IG.22/7 (2016)[39].
- UN Environment, Marine Litter Legislation Toolkit for Policymakers (2016)[40].
- European Commission, Marine Strategy Framework Directive, Directive 2008/56/EC (2008)[41].
- European Commission, Decision on criteria and methodological standards on good environmental status of marine waters (2010)[42].

Indicator analysis methods

Indicator Definition

Methodology for indicator calculation

Seabirds:

[38] https://wedocs.unep.org/rest/bitstreams/8222/retrieve (ENG) / https://wedocs.unep.org/rest/bitstreams/8223/retrieve (FR)
[39] https://wedocs.unep.org/rest/bitstreams/8385/retrieve
[40] http://www.unep.org/stories/Ecosystems/Marine-Litter-Legislation-A-toolkit-for-Policymakers.asp
[41] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0056&from=EN
[42] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010D0477(01)&from=EN

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The methodology of the tool proposed by the EU MSFD TGML follows the OSPAR Ecological Quality Objective (EcoQO) methods for monitoring litter particles in stomachs of northern fulmars (*Fulmarus glacialis*). The stomach contents of birds beached or otherwise found dead are used to measure trends and regional differences in marine litter. Background information and the technical requirements are described in detail in documents related to the fulmar EcoQO methodology. A pilot study evaluating methods and potential sources of bias was conducted by Van Franeker & Meijboom (2002). Bird dissection procedures including characters for age, sex, cause of death etc. have been specified in Van Franeker (2004). Further OSPAR EcoQO details were given in OSPAR (2008, 2010a, b) and in Van Franeker et al., (2011a, 2011b).

<u>Sea Turtles:</u>
The digestive tract contents of stranded Loggerhead sea turtles *Caretta caretta* (Linnaeus, 1758) are used to measure trends and regional differences in marine litter. In many case the stranded animals are stored into freezers and when the adequate number of speciments is collected then the analysis is performed. A recent pilot study evaluating methods and potential sources of bias was conducted during 2012 by ISPRA, CNR-IAMC Oristano, Stazione Zoologica Napoli; University of Siena, University of Padova, ArpaToscana. Caretta caretta feeds in the water column and at the seafloor. Therefore these two marine compartments are addressed when quantifying litter in the stomachs of stranded Loggerhead sea turtles.

<u>Entanglement rates among beached animals:</u>
Direct harm or death is more easily observed and thus more frequently reported for entanglement than for ingestion of litter. This applies to all sorts of organisms, marine mammals, birds, turtles, fishes, crustaceans etc. It is, however, difficult from simply looking at the outside appearance of an animal to identify whether a particular individual has died because of entanglement in litter rather than from other causes, mainly entanglement in active fishery gear (by-catch). Nevertheless it is possible to differentiate between animals that have died quickly due to entanglement and sudden death in active fishing gear and those suffering a long drawn out death after entanglement in pieces of nets, string or other litter items, because entangled birds, which have been entangled for a time before death are emaciated.

Proportions of sea birds found dead with actual remains of litter attached as evidence for the cause of mortality are extremely low. The possible use of entangled beached birds as an indication of mortality due to litter will be further investigated by the EU MSFD TGML.

In marine mammals, numbers of beached animals and especially cetaceans are often high and many have body marks suggesting entanglement, although remains of ropes or nets on the corpses are mostly rare. Given that in a number of places well working stranding networks are already in place, dead marine mammals should, whenever possible, become subject to pathologic investigations which need to include an assessment for the cause of disease and death and the relevance of marine litter in this connection.

This issue will be further investigated and the development of a dedicated monitoring protocol for the entanglement of marine mammals in marine litter will be considered in the next report of the EU MSFD TGML.

<u>Ingestion of litter by marine mammals and entanglement:</u>
Ingestion of litter by a wide range of whales and dolphins is known. Although known rates of incidences of ingested litter are generally low to justify a standard ECAP monitoring

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recommendation at this point, it can also be argued that the number of pathologically studied animals is low as well. Dead marine mammals should, whenever possible, become subject to pathologic investigations which need to include an assessment for the cause of disease and death and the relevance of ingested marine macro- and microlitter in this connection.

The development of a monitoring protocol for the ingestion of marine litter in the different size categories by marine mammals will therefore be considered in the next report of the TSG ML. Opportunistic monitoring of marine mammals is envisaged under the population demographic characteristics component of the EcAp biodiversity common indicators.\

Indicator units

- For sea turtles: Abundance by mass (weight in grams, accurate to 3th decimal) is the main information useful for the monitoring programme.

List of Guidance documents and protocols available

- UN Environment / Intergovernmental Oceanographic Commission, Guidelines on Survey and Monitoring of Marine Litter (2009).
- UN Environment / Mediterranean Action Plan, Integrated Monitoring and Assessment Programme Guidance document (2016) (UNEP(DEPI)/mED_IG.22/Inf.7).
- EU MSFD TGML, Guidance on Monitoring of Marine Litter in European Seas (2013).

Data Confidence and uncertainties

Seabirds:
The methodology referred to in this tool is based on an agreed OSPAR methodology which has been developed over a number of years with ICES and OSPAR and which has received full quality assurance by publication in peer reviewed scientific literature (Van Franeker et al., 2011a). The EcoQO methodology has been fully tested an implemented on Northern *Fulmars Fulmarus glacialis*, including those from Canadian Arctic and northern Pacific areas. All methodological details can be applied to other tubenosed seabirds (Procellariiformes) with no or very minor modifications. Trial studies are being conducted using shearwaters from the more southern parts of the north Atlantic and Mediterranean. In other seabird families, methods may have to be adapted as stomach morphology, foraging ecology, and regurgitation of indigestible stomach contents differ and can affect methodological approaches.

Sea turtles:
There is a lack of quality assurance/quality control (QA/QC) due to lack of long-term monitoring programmes. More publications in peer reviewed scientific literature are required.

Methodology for monitoring, temporal and spatial scope

Available Methodologies for Monitoring and Monitoring Protocols

Seabirds:
Bird corpses are stored frozen until analysis. Standardized dissection methods for Fulmar corpses have been published in a dedicated manual (Van Franeker, 2004) and are internationally calibrated during annual workshops. Stomach content analyses and methods for data processing and presentation of results were described in full detail in Van Franeker & Meijboom (2002) and

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updated in later reports (van Franeker et al., 2011a, b). At dissections, a full series of data is recorded to determine sex, age, breeding status, likely cause of death, origin, and other issues. Age, the only variable found to influence litter quantities in stomach contents, is largely determined on the basis of development of sexual organs (size and shape) and presence of Bursa of Fabricius (a gland-like organ positioned near the end of the gut which is involved in immunity systems of young birds; it is well developed in chicks, but disappears within the first year of life or shortly after). After dissection, stomachs of birds are opened for analysis. Stomachs of Fulmars have two 'units': initially food is stored and starts to digest in a large glandular stomach (the proventriculus) after which it passes into a small muscular stomach (the gizzard) where harder prey remains can be processed through mechanical grinding. For the purpose of most cost-effective monitoring, the contents of proventriculus and gizzard are combined, but optional separate recordings should be considered where possible.

Stomach, contents are carefully rinsed in a sieve with a 1mm mesh and then transferred to a petri dish for sorting under a binocular microscope. The 1 mm mesh is used because smaller meshes become easily clogged with mucus from the stomach wall and with food-remains. Analyses using smaller meshes were found to be extremely time consuming and particles smaller than 1 mm seemed rare in the stomachs, contributing little to plastic mass.

If oil or chemical types of pollutants are present, these may be sub-sampled and weighed before rinsing the remainder of stomach content. If sticky substances hamper further processing of the litter objects, hot water and detergents are used to rinse the material clean as needed for further sorting and counting under a binocular microscope.

In the Fulmar EcoCO, stomach contents are sorted into categories, and this categorisation is followed for marine biota monitoring ingestion in seabirds, marine turtles and fish. The fulmar categorisation of stomach contents is based on the general ‘morphs’ of plastics (sheet-like, filament, foamed, fragment, other) or other general rubbish or litter characteristics. This is because in most cases, particles cannot be unambiguously linked to particular objects. But where such is possible, under notes in datasheets, the items should be described and assigned a litter category number using as master list, such as the “Master List” developed by the EU MSFD TGML group. For each litter category/subcategory an assessment is made of:

i. Incidence (percentage of investigated stomachs containing litter);

ii. Abundance by number (average number of items per individual), and

iii. abundance by mass (weight in grams, accurate to 4th decimal)

In the fulmar monitoring scheme, stomach contents are rinsed over a sieve with mesh 1 mm prior to further categorisation, counting and weighing. The size range of plastics monitored is thus ≥ 1 mm. Unpublished data on particle size details in stomachs of fulmars show that a smaller mesh size would not be of use because smaller items have passed into the gut.

Sea Turtle:

The Loggerhead sea turtle *Caretta caretta* is a protected species (CITES), therefore only authorized people can handle them. Upon finding the animal, its discovery should be reported to the main authorities and the operation of coordinated with the local authorities (depending on national law). Based on initial observations and if possible still at the place of discovery, some data should be recorded on an “Identification Data” Sheet. The animal should be transported to an authorized service centre for necropsy. In case the body is too decomposed, the integrity of the digestive tract

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should be assessed before disposal at the licensed contractor. If the necropsy cannot be carried out immediately after recovery, the carcass should be frozen at -16 ° C, in the rehabilitation facility.

Before the necropsy operation, morphometric measurements should be collected and recorded on an appropriate Data Sheet. External examination of the animal should be conducted, including inspecting the oral cavity for possible presence of foreign material. The methodology suggested in the EU MSFD TGML report could be followed to carry out a dissection of the animal to expose the gastrointestinal system (GI). The following sampling procedure of GI contents can be applied to any section of the GI: the section of the GI should be placed in a graduated beaker of adequate size, pre-weighed on electronic balance (accuracy of ± 1g). The section of GI should be open and the contents emptied into the beaker with the help of a spatula, followed by the record of the net weight and volume of the content. The section of the GI should be observed and any ulcers or any lesions caused by hard plastic items should be recorded.

The contents should be inspected for the presence of any tar, oil, or particularly fragile material that must be removed and treated separately. The liquid portion, mucus and the digested unidentifiable matter should be removed, by washing the contents with freshwater through a filter mesh 1 mm, followed by a rinse of all the material collected by the filter 1mm in 70% alcohol and finally again in freshwater. The retained content should be enclosed in plastic bags or pots, labelled and frozen, not forgetting the sample code and corresponding section of the GI. Finally, the contents can then be sent for analysis. If the contents are stored in liquid fixative, note of the compound and the percentage of dilution should be noted and communicated to the staff in charge of further analysis.

For the analysis of the contents of the GI, the organic component should be separated from any other items or material (marine litter). The fraction of marine litter should be analysed and categorised with the help of a stereo-microscope, following the approach used in the protocol for ingestion in birds (Van Franeker et al., 2005; 2011b; Matiddi et al., 2011) and using a Standard Data-Sheet.

The fraction of marine litter should be dried at room temperature and the organic fraction at 30°C. Both fractions should be weighted, including the different categories of items identified within the marine litter fraction. The volume of the litter found should also me measured, through the variation of water level in a graduated beaker, when the items are immersed without air. If possible, different categories of "food" should also be identified. Otherwise, the dry contents should be kept in labelled bags and sent to an expert taxonomist. An optional methodology for application for sampling litter excreted by live sea-turtles (faecal pellet analysis) in case of finding a specimen alive is recommended by the EU MSFD TGML.

For turtle analyses, stomach contents are sorted into the same categories as for birds. Following the method for seabirds, abundance by mass (weight in grams, accurate to 3th decimal) is the main information useful for the monitoring programme. Other information such as the colour of items, volume of litter, different type of litter, different incidence of litter in oesophagus, intestine and stomach, incidence and abundance by number per litter category, are useful for research and impact analysis. The size range should be ≥1 mm (stomach contents are rinsed over 1 mm mesh sieve).

Available data sources

- Mediterranean Association to Save the Sea Turtles (MEDASSET): http://www.medasset.org

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- Rescue centres and stranding networks

Spatial scope guidance and selection of monitoring stations

Seabirds:
Dead birds are collected from beaches or from accidental mortalities such as long-line victims; fledgling road kills etc. (for methodology see Van Franeker, 2004). The tool is applicable to the regions where fulmars occur; for similar seabird species such as any of the family of the tubenoses, the methodology can follow this approach. This could for example be applied to shearwater species occurring in the Mediterranean Sea.

Sea turtles:
Dead sea turtles are collected from beaches or at sea from accidental mortalities such as victims of fishing gear (by catch) or of boat collisions. The tool is applicable to the Mediterranean Sea region.

Temporal Scope guidance

Seabirds:
Continuous sampling is required. A sample size of 40 birds or more is recommended for a reliable annual average for a particular area. However, also years of low sample size can be used in the analysis of trends as these are based on individual birds and not on annual averages. For reliable conclusions on change or stability in ingested litter quantities, data over periods of 4 to 8 years (depending on the category of litter) is needed.

Sea turtles:
Continuous sampling is required. Minimum sample population size for year and period of sampling must be established for reliable conclusions on change or stability in ingested litter quantities.

Data analysis and assessment outputs

Statistical analysis and basis for aggregation

Seabirds:
Because of potential variations in annual data, it is recommended to describe ‘current levels’ as the average for all data from the most recent 5-year period, in which the average is the ‘population average’ which includes individuals that were found to have zero litter in the stomach.
As indicated, EcoQO data presentation for Northern Fulmars is for the combined contents of glandular (proventriculus) and muscular (gizzard) stomachs. Results of age groups are combined except for chicks or fledglings which should be dealt with separately. Potential bias from age structure in samples should be checked regularly.

In the Fulmar EcoQO, statistical significance of trends in ingested litter, i.e. plastics, is based on linear regression of ln-transformed data for the mass of litter (of a chosen category) in individual stomachs against their year of collection. ‘Recent’ trends are defined as derived from all data over the most recent 10-year period. The Fulmar EcoQO focuses on trend analyses for industrial plastics, user plastics, and their combined total.

Sea turtles:
Specific long-term monitoring programmes are required in order to assess trends.

Expected assessments outputs

	Related Ecological Objective: (EO 10) Marine and coastal litter do not adversely affect the coastal and marine environment
Indicator Title	*Candidate Common indicator 24: Trends in the amount of litter ingested by or entangling marine organisms, especially mammals, marine birds and turtles*

- Develop an Ecological Quality Objective (ECOQ) for the ingestion of litter in indicator species suitable for monitoring (sea turtles) and support implementation of the monitoring of this indicator (capacity building, technology transfer).
- Identify new indicator species for impact (entanglement, ingestion, microplastics,) through laboratory and field evaluation, and define thresholds for harm.

Known gaps and uncertainties in the Mediterranean

- A better understanding of entanglement (lethal or sub lethal) under different environmental conditions and of how litter is ingested by marine organisms is necessary;
- For ingestion of litter by sea turtles, the precise definition of target (GES) and the identification of parameters/biological constrains and possible bias sources should be better exploited;
- Work on top-predator and "sentinel" species (fishes and invertebrates) should be promoted to provide additional protocols supporting the measurement of impacts;
- New approaches and new metrics to assess entanglement, or ingestion, in marine litter should be developed which may also open new perspectives in the context of monitoring.

Contacts and version Date: *UNEP/MAP 16 January 2017*

Key contacts within UN Environment for further information
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Version No	Date	Author
V.2	31.05.17	

Appendix 8
Quality Status Report (QSR) Fact Sheet Assessment (Marine Litter)

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).

Content	Actions [43]	Guidance
General		
Reporter	Underline appropriate	UNEP/MAP/MED POL SPA/RAC REMPEC PAP/RAC Plan Bleu (BP)
Geographical scale of the assessment	Select as appropriate	Regional: Mediterranean Sea
Contributing countries	Text	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	Select as appropriate	1-Land and Sea Based Pollution
Ecological Objective	Write the exact text, number	Ecological Objective 10 (EO10): Marine and coastal litter do not adversely affect the coastal and marine environment.
IMAP Common Indicator	Write the exact text, number	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	Text	EO10CI22
Rationale/Methods		
Background (short)	Text (250 words)	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.

[43] The Column of “Actions” will be removed from the final revised version of the assessment factsheet and is only kept in this document for information purposes.

Content	Actions [43]	Guidance
Background (*extended*)	Text (no limit), images, tables, references	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.

Content	Actions [43]	Guidance
		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	Text (200-300 words), images, formulae, URLs	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 characterisation 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.

<table>
<tr><th colspan="3">Results</th></tr>
<tr>
<td>Results and Status, including trends (brief)</td>
<td>Text (500 words), images</td>
<td>

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.

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

<table>
<tr><th>Source (Literature)</th><th>Items/Consistency (beaches; top five)</th><th>Type of material</th><th>Sources</th></tr>
<tr><td>IPA Adriatic DeFishGear (2016)</td><td>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%</td><td>Plastics: 91%</td><td>Recreational & tourism:40%
Households(combined): 40%
Coastal tourism: 32,3%
Toilet/sanitary: 26,2%
Household: 11,2%
Waste collection: 6%
Recreational: 5,6%</td></tr>
</table>

</td>
</tr>
</table>

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)	Text(no limit), figures, tables	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	

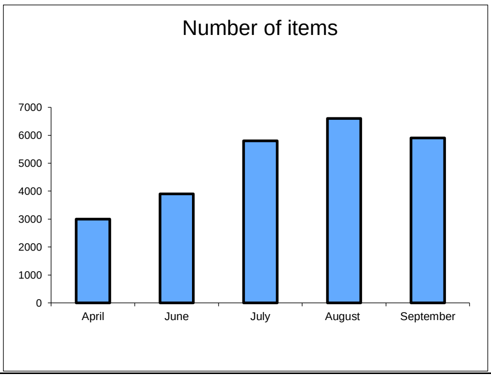
Marine litter items cannot always be linked to a specific source as several marine litter items can be attributed to more than one sources, means of release, geographic origin, pathways and transport mechanism (Veiga et al., 2016). We often categorize the origin of marine litter into land-based and sea-based 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).



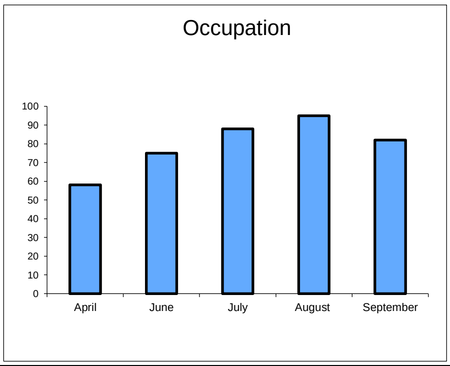


Figure 1: Monthly variation of litter items (A) and percentage of hotel occupation for the corresponding date (B) in the Balearic Islands (Source Martinez-Ribes et al., 2007).

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[44]							5			
Malta		2					1			
Morocco	7	13	1	23	5	7	10	5	13	3

[44] 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.

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.

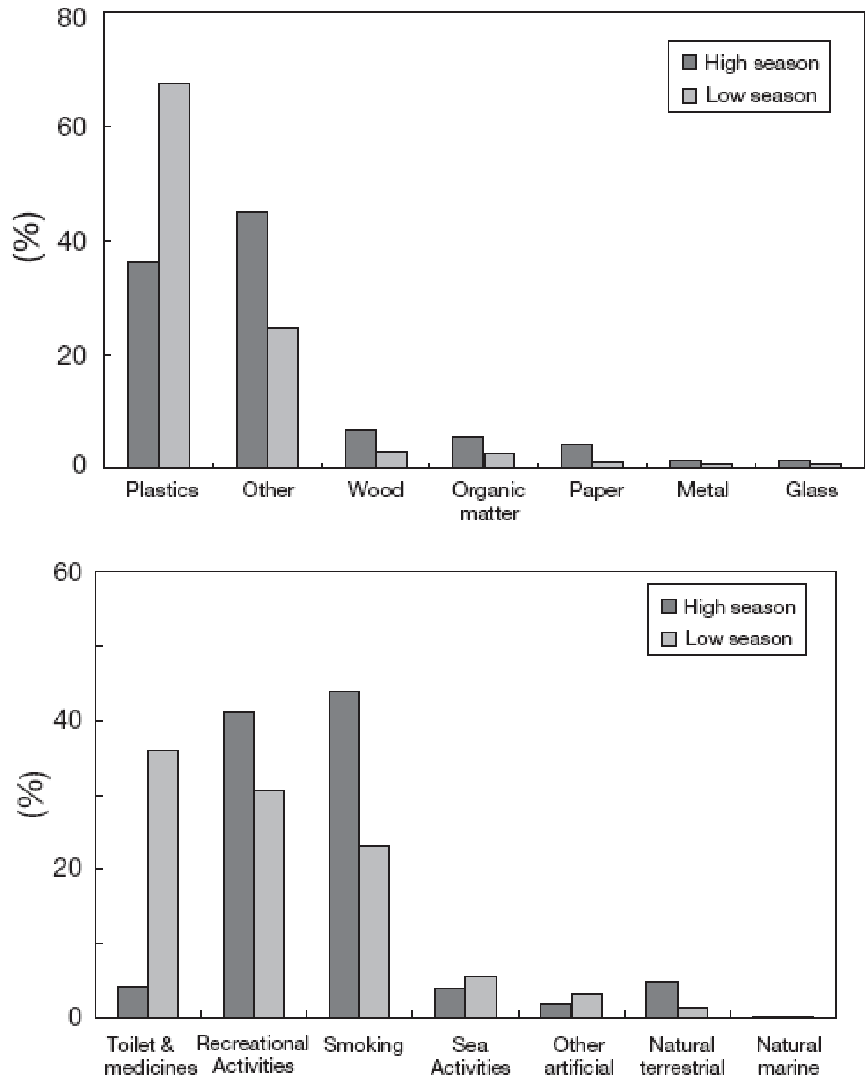
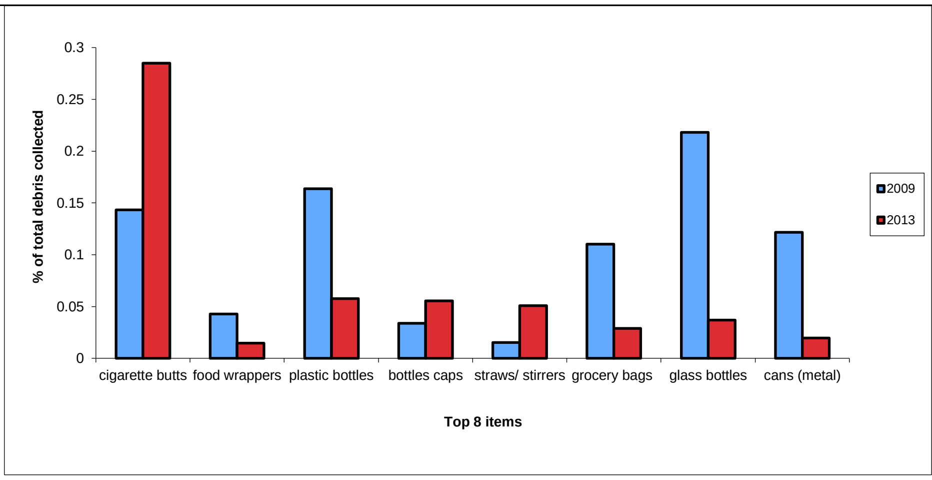


Figure 2: Litter composition (A) and estimated origin (B) of the litter collected in low and high tourist season in Balearic Islands (source Martinez-ribes et al., 2007)

Conclusions		
Conclusions (brief)	Text (200 words)	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)	Text (no limit)	. 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 3:** 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	Text (2-3 sentences or maximum 50 words)	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	Text (200-300 words)	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.
List of references	Text (10 pt, Cambria style)	**References included in the UNEP/MAP (2015). Marine Litter Assessment in the Mediterranean 2015.** UN Environment / Mediterranean Action Plan. ISBN: 978-92-807-3564-2. • Arcadis (2014) Marine litter study to support the establishment of an initial headline reduction target- SFRA0025? European commission / DG ENV, project number BE0113.000668, 127 pages. • Galgani, F., Hanke, G., Werner, S., De Vrees, L. (2013). Marine litter within the European marine strategy framework directive. ICES J. Mar. Sci. 70 (6): 1055-1064. • Interwies E., Görlitz S., Stöfen A., Cools J., Van Breusegem W., Werner S., L. de Vrees (2013) Issue Paper to the "International Conference on Prevention and Management of Marine Litter in European Seas", Final Version, 16th May

		2013 (http://www.marine-litter-conference-berlin.info/downloads.php), 111 pages. • JRC (2013). Guidance on Monitoring of Marine Litter in European Seas. • Martinez-Ribes L., Basterretxea G., Palmer M., J.Tintore (2007). Origin and abundance of beach debris in the Balearic Islands. Sci. Mar. 71: 305–314. • Ocean conservancy /International Coastal Cleanup (ICC, 2014), (http://www.oceanconservancy.org/) • Oko institut (G.Mehlhart & M. Blepp, 2012) Study on Land sourced Litter in the Marine Environment. Review of sources and literature Olko Institut report http://www.kunststoffverpackungen.de/show.php?ID=5262), 128 pages • UNEP (2009), Marine Litter A Global Challenge, Nairobi: UNEP. 232 pp. • UNEP (2011) Assessment of the status of marine Litter in the Mediterranean Sea. UNEP(DEPI)/MED WG.357/Inf.4 12 April 2011, 55 pages • UNEP (2013) Regional Plan on Marine litter Management in the Mediterranean in the Framework of Article 15 of the Land Based Sources Protocol (Decision IG.21/7). 18th Meeting of the Contracting Parties of the Barcelona Convention. **Additional references** Brouwer R., Hadzhiyska D., Ioakeimidis C., Ouderdorp H. (2017). The social costs for marine litter along the European coasts. Ocean & Coastal Management 138: 38-49. Ghermandi, A., Nunes, P.A.L.D. (2013). A global map of coastal recreation values: results from a spatially explicit meta-analysis. Ecol. Econ. 86: 1-15. González, D., Hanke,G., Tweehuysen, G., Bellert, B., Holzhauer, M., Palatinus, A., Hohenblum, P., and Oosterbaan, L. 2016. Riverine Litter Monitoring - Options and Recommendations. MSFD GES TG Marine Litter Thematic Report; JRC Technical Report; EUR 28307; doi:10.2788/461233 JRC, 2016. Marine beach litter in Europe – Top Items. A short summary. JRC Technical Reports, JRC 103929. Ryan P.G., Moore C.J., van Franeker J.A., Moloney C.L. (2009). Monitoring the abundance of plastic debris in the marine environment. Phil. Trans. R. Soc. B 364, 1999–2012 (doi:10.1098/rstb.2008.0207). Veiga, J.M., Fleet, D., Kinsey, S., Nilsson, P., Vlachogianni, T., Werner, S., Galgani, F., Thompson, R.C., Dagevos, J., Gago, J., Sobral, P. and Cronin, R.; 2016; Identifying Sources of Marine Litter. MSFD GES TG Marine Litter Thematic Report; JRC Technical Report; EUR 28309; doi:10.2788/018068 Vlachogianni, Th., Zeri, Ch., Ronchi, F., Fortibuoni, T., Anastasopoulou, A., 2017. Marine Litter Assessment in the Adriatic and Ionian Seas. IPA-Adriatic DeFishGear Project, MIO-ECSDE, HCMR and ISPRA. pp. 180 (ISBN: 978-960-6793-25-7)

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

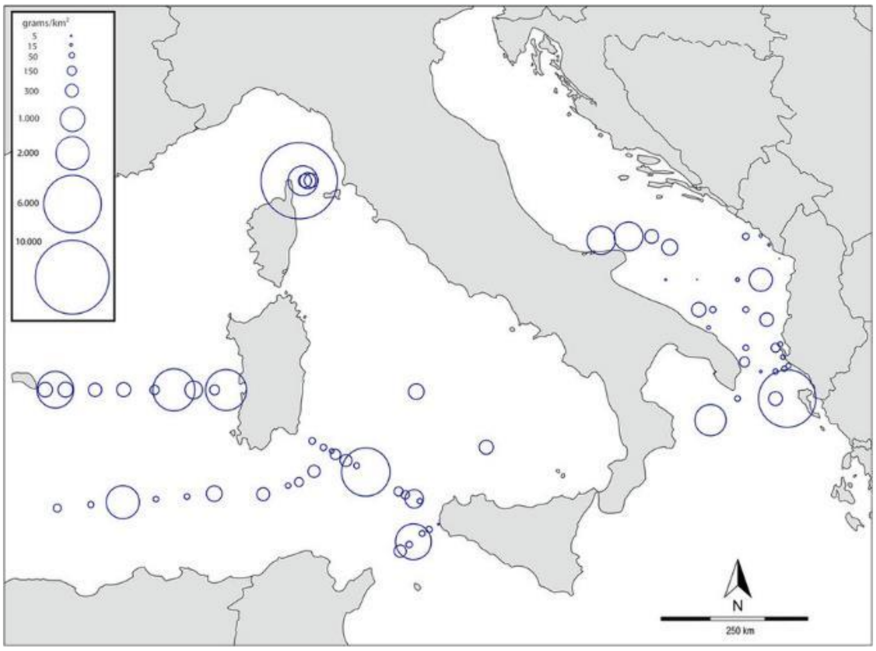
Content	Actions[45]	Guidance
General		
Reporter	Underline appropriate	UNEP/MAP/MED POL SPA/RAC REMPEC PAP/RAC Plan Bleu (BP)
Geographical scale of the assessment	Select as appropriate	Mediterranean Sea
Contributing countries	Text	Mediterranean assessment based on existing regional and national surveys, research and publications and as appropriate data from national monitoring programmes of the Contracting Parties.
Mid-Term Strategy (MTS) Core Theme	Select as appropriate	1-Land and Sea Based Pollution
Ecological Objective	Write the exact text, number	Ecological Objective 10 (EO10): Marine and coastal litter do not adversely affect the coastal and marine environment
IMAP Common Indicator	Write the exact text, number	Common Indicator 23 (CI23): Trends in the amount of litter in the water column including microplastics and on the seafloor
Indicator Assessment Factsheet Code	Text	EO10CI23
Rationale/Methods		
Background (short)	Text (250 words)	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/km^2 (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.

[45] The Column of "Actions" will be removed from the final revised version of the assessment factsheet and is only kept in this document for information purposes.

		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*	Text (no limit), images, tables, references	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 The 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	Text (200-300 words), images, formulae, URLs	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)	Text (500 words), images	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)

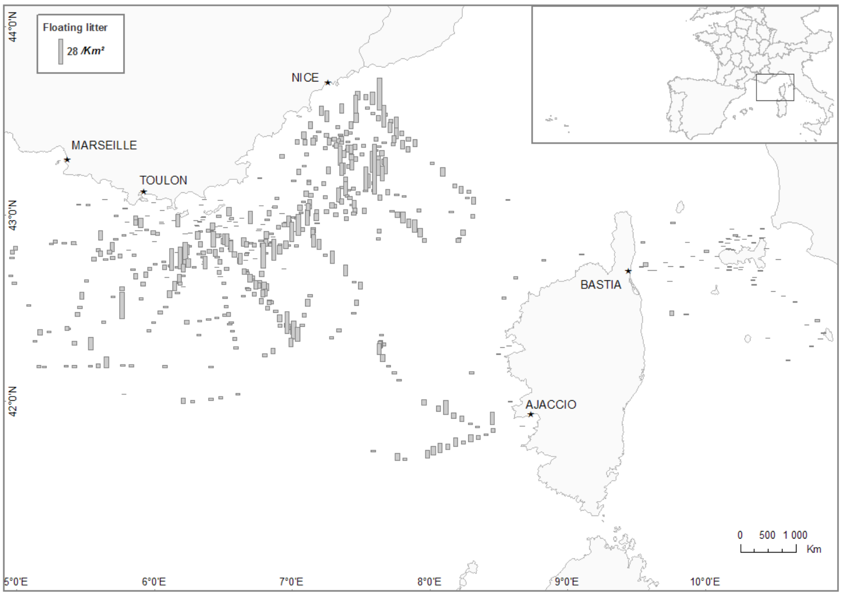


Figure 2: Distribution of floating litter in the northwestern Mediterranean Sea (2006-2008) (visual observations). IFREMER/SHOM map using data from the Ecocean/ParticipeFutur project for initial MSFD assessment (Gerigny et al., 2011).

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.

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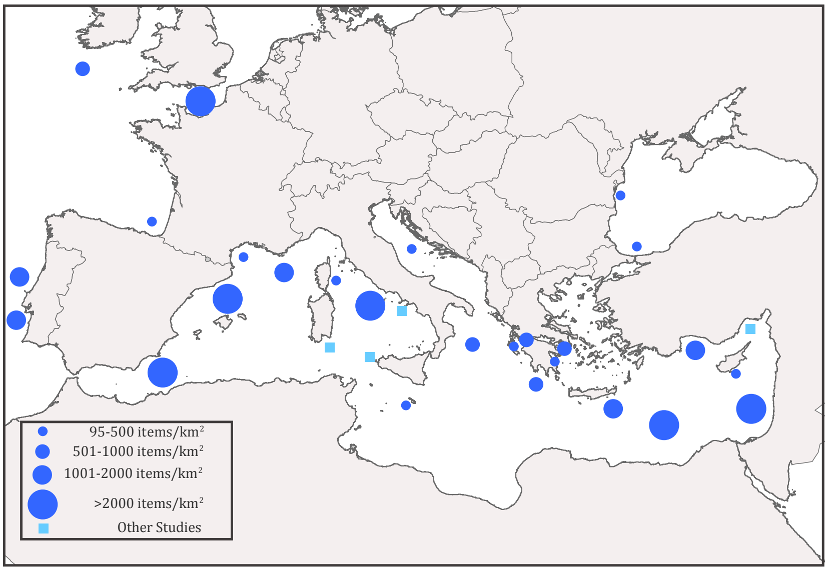
<tr><td></td><td></td><td>

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.</td></tr>
<tr><td>Results and Status, including trends (extended)</td><td>Text(no limit), figures, tables</td><td>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/km^2 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</td></tr>
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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).

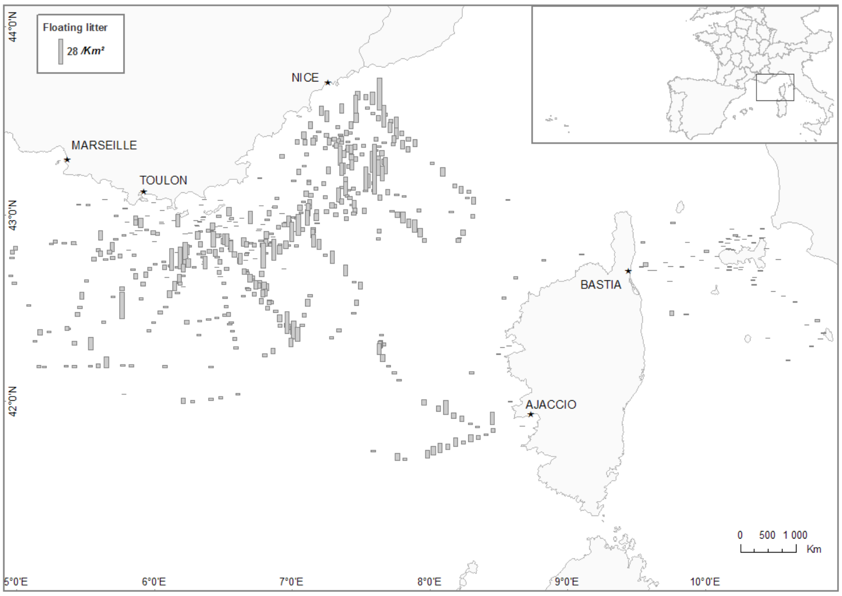

Figure 4: Distribution of floating litter in the northwestern Mediterranean Sea (2006-2008) (visual observations). IFREMER/SHOM map using data from the Ecocean/ParticipeFutur project for initial MSFD assessment (Gerigny et al., 2011).

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.

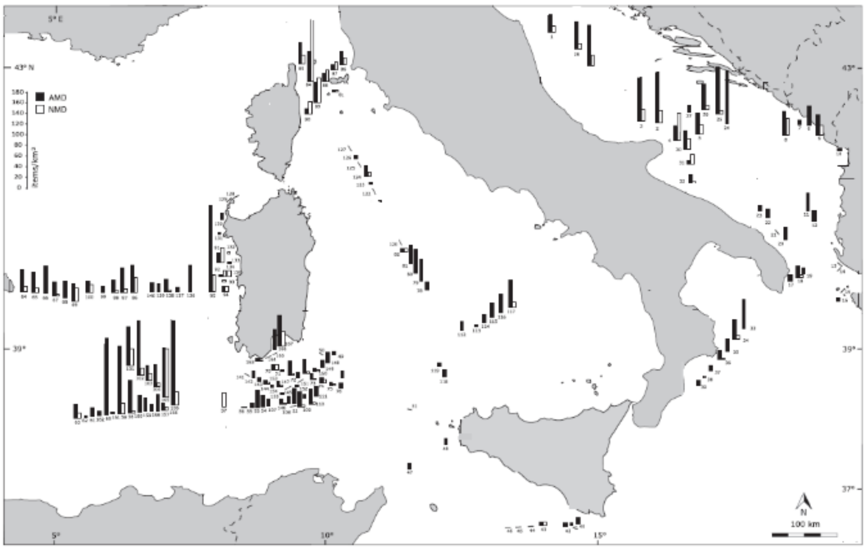

Figure 5: Anthropogenic (black bars) and Natural (white bars) Marine Litter densities (items/km2) in the Western, Adriatic and Northern Ionian basins of the Mediterranean Sea (From Suaria and Aliani, 2014)

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.

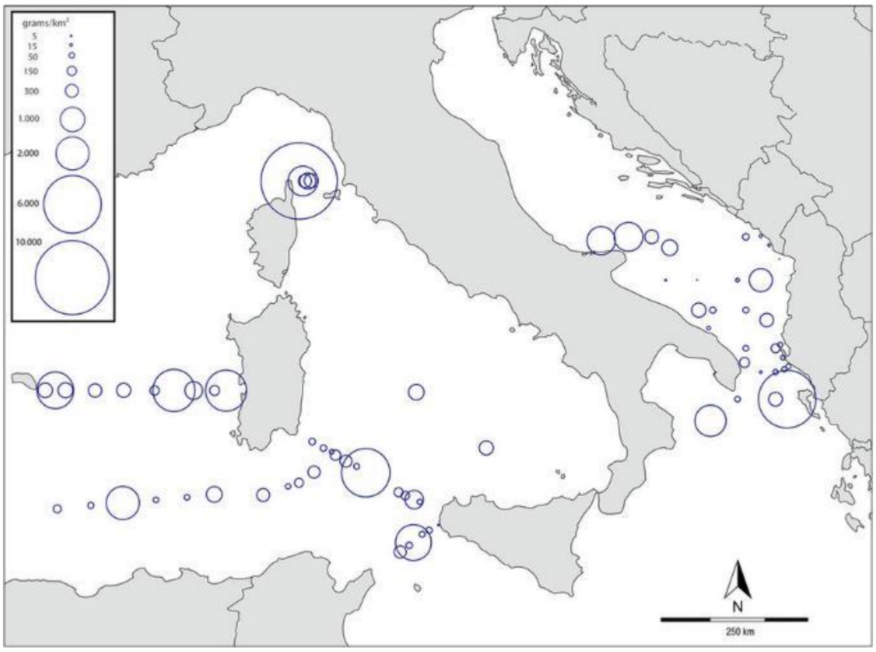

Figure 6: Map of the central-western Mediterranean Sea showing the distribution of plastic densities expressed as grams of plastic per km^2 (after Suaria et al., 2016)

Table 33: 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).

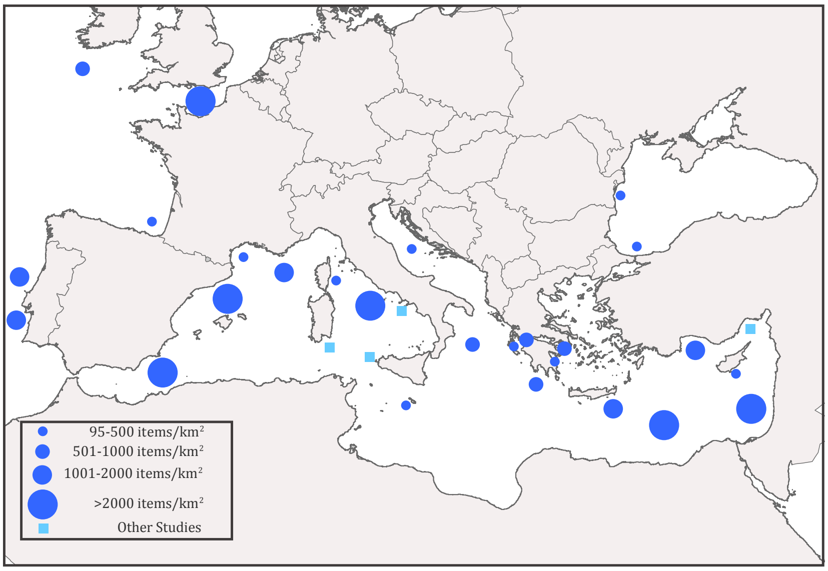

Figure 7: Seafloor marine litter distribution in the Mediterranean and other European Seas (Ioakeimdis, 2015).

Counts from 7 surveys and 295 samples in the Mediterranean Sea and Black Sea (2,500,000 km², 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)	Text (200 words)	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)	Text (no limit)	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	Text (3-6 sentences or maximum 200 words)	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)	Text (100 words)	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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Appendix 9

Meta Data Templates for Pollution and Marine Litter IMAP Indicators

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1. Pollution revised meta-data and data templates

1. The MED POL excel database reporting formats have not been revised since 2002. The proposal is for a simple revision of the guidelines (see Annex 1) revision and update of the data reporting format guidelines and the associated Excel file templates. Both the data formats and Excel templates have been revised and updated when necessary without modifying the reporting structure of the Excel sheets but adding two more sheets (3 in total) to provide more flexibility in terms of reporting for Contracting Parties (CPs) of the Barcelona Convention. Therefore, this new Excel template versions to include designed space for CPs to report on additional associated information ("metadata") under the MED POL monitoring activities, as the needs and requirements of the monitoring have changed overtime.

2. To summarize, the major categories of checks and changes are listed below:

a. Parameter units and format revisions and verifications, including geographical coordinates
b. Clarification on Mandatory and Additional parameter requirements by matrix type
c. Inclusion of relevant or missing parameters (mainly in the sediment reporting templates), including mismatches between guidelines and templates.
d. In depth revision of the CRM template to report the quality assurance data.

3. This document with the corresponding Excel files should serve to clarify the reporting obligations of the Contracting Parties with regard to the monitoring activities within the MED POL Programme. As mentioned, it gives also an opportunity to the CPs to contribute by including additional data from monitoring (metadata) or relevant new information as they deem appropriate. Therefore, this will be a starting point for the future amendments and revisions to the UNEP/MAP Databases, in line with the Integrated Monitoring and Assessment Programme (IMAP).

4. Table 1 compares the IMAP Indicators with the current reporting templates for EO 5 (Eutrophication) and EO 9 (Contaminants). As can be seen the two indicators on eutrophication are reported currently in Table 1, 2, 3, 4 and 6 on trace metals and organics in biota, sediments and water. Common Indicator 18 is addressed partially in Table 5 on bio-effects and Indicators 19, 20 and 21 require new reporting templates to be developed in 2018-2019.

5. Further work will be required to develop revised and new reporting formats in line with IMAP indicators in 2018-2019. However, based on the review of existing Phase IV MEDPOL reporting templates revised in Annex 1 and the IMAP Guidance Factsheets (UNEP(DEPI)/MED WG. WG.439/12), it is recommended that the following revisions are considered by the MEDPOL Focal Points, and are highlighted in Annex 1:

i. For metals in biota (Table 1) Cd, Cu, Pb, are reported as mandatory rather than as additional;
ii. For organic contaminants in biota (Table 2), PAH and HH[46](PCBs, Hexachlorobenzene, Lindane and DDTs), analysis date, method(s) and concentrations are reported as mandatory rather than as additional;
iii. For trace metals in sediments (Table 3), Cu, Pb along with information on the analysis date and methods are reported as mandatory rather than additional
iv. For organic contaminants in sediments (Table 4) PAH and HH analysis date, method(s) and concentrations are reported as mandatory rather than as additional;
v. For sea water data reporting (Table 6), that all fields related to sample ID, station, year, country date time, location etc., as well as chlorophyll-a and nutrient fields are reported as mandatory rather than as additional;

Table 1. Comparison of IMAP Indicators with the MEDPOL Reporting formats

[46] Halogenated Hydrocarbons

IMAP Indicators	**MEDPOL templates based on MEDPOL Phase IV (Annex 1)**
Common Indicator 17: Concentration of key harmful contaminants measured in the relevant matrix (EO9, related to biota, sediment, seawater) Common Indicator 13: Concentration of key nutrients in water column (EO5); Common Indicator 14: Chlorophyll-a concentration in water column (EO5)	Table 1. Biota / trace metals data reporting format
	Table 2. Biota / organic contaminants data reporting format
	Table 3. Sediment / trace metals data reporting format
	Table 4. Sediment / organic contaminants data reporting format
	Table 6. Seawater data reporting format
Common Indicator 18: Level of pollution effects of key contaminants where a cause and effect relationship has been established (EO9)	Table 5. Bio-effects data reporting format. *Note needs revision to be further aligned in 2018-2019*
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);	*Note: Contracting Parties report to REMPEC, and with the adoption of the Offshore Action Plan in 2016, work is currently underway to further elaborate an offshore monitoring program*
Common Indicator 20: Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in commonly consumed seafood (EO9);	*Note: Currently no reporting format and suggests to be developed I 2018-2019*
Common Indicator 21: Percentage of intestinal enterococci concentration measurements within established standards (EO9)	Some bathing water quality data submitted to MEDPOL based on basic template. *Note: Further revision and development to be developed in 2018-2019 in line with WHO guidelines*
Not in IMAP but to remain as integral part of MEDPOL monitoring programme	Table 7. Atmospheric dry deposition data reporting format
	Table 8. Atmospheric wet deposition data reporting format
Overall for all data	Table 9. Certified reference material (CRM) / quality control data

2. Marine Litter Meta Data Templates

6. In order to implement the IMAP Decision in terms of marine litter data reporting, a common approach to the collection and reporting of quality assured data is required. The past year several attempts have been done by projects and initiatives to develop corresponding marine litter databases. The IPA-Adriatic DeFishGear47 project, the European Environment Agency (EEA) Marine LitterWatch48 (MLW) smartphone application, the FP7 MARLISCO project49, and the International Bottom Trawl Surveys in the Mediterranean (MEDITS)50 project are some of the examples of the developed databases and information systems on marine litter. The OSPAR Commission for protecting and conserving the North-East Atlantic and its recourses, has developed a good example of a regional database on beach marine litter51. The OSPAR beach litter database stores marine litter data collected on references beaches using the standardized OSPAR beach litter monitoring guidelines. The online

[47]http://defishgear.izvrs.si/PassAuth/AutoAuth.aspx?ReturnUrl=/defishgear
[48]http://www.eea.europa.eu/themes/coast_sea/marine-litterwatch/data-and-results/marine-litterwatch-data-viewer-1
[49]http://www.marlisco.eu/marine-litter-database.el.html
[50] http://www.sibm.it/MEDITS%202011/docs/Medits_Handbook_2016_version_8_042016.pdf
[51] http://www.mcsuk.org/ospar/

database has been developed to manage that data and allow it to be interrogated at the regional, sub-regional and beach level.

7. The Meeting of the Ecosystem Approach Correspondence Group (CORMON) on Marine Litter Monitoring held in Madrid, Spain, 28 February – 2 March 2017 reviewed a proposal by MED POL on the main elements to build data and metadata reporting on Marine Litter in the Mediterranean. It was agreed that further work was needed to develop a proposal of data and meta-data and that those members of the Marine Litter online working group present (France, Spain and Italy) would lead in the development of a proposal for consideration by the MED POL Focal points meeting. Below are the elements presented and agreed in principle during the Marine Litter CORMON based on which France, Spain and Italy further elaborated the proposed data and meta data templates presented in Annex 2a and 2b and Annex III for the consideration of the MED POL Focal Points Meeting

A. Beach Litter

1. The Beach ID Form is proposed to include the following elements/features:

- Name of the beach;
- National beach ID;
- Country;
- Date;
- Name and contact information (phone, e-mail, etc.)
- Beach width (m);
- Total length of the beach (m);
- Back of the beach (e.g. dunes);
- GPS coordinates start 100m;
- GPS coordinates end 100m;
- Prevailing currents at the beach: N/E/S/W;
- Prevailing winds: N/E/S/W;
- Direction towards the beach is facing: N/E/S/W;
- Type of beach (e.g. pebble, sand, rocky, mixed, etc.);
- Any objects in the sea influencing the currents;
- Major beach usage (e.g. local people, swimming, sunbathing, fishing, surfing, etc.);
- Access to the beach (e.g. public transportation, private vehicle, on foot, boat, etc.);
- Nearest town;
- Distance from the nearest town;
- Developments behind the beach (Y/N);
- Specify developments;
- Food and/or drink outlets on the beach (Y/N);
- Distance of the food/drink outlets from the survey areas (m/km);
- Period over the year where the food/drinks are open (specify months);
- Distance of the beach to the nearest shipping lane (km);
- Estimated traffic density (number of ships/year);
- Distance of the beach to the nearest harbor (km);
- Is the harbor entrance facing the survey area (Y/N);
- Distance of the beach to the nearest river mouth (km);
- Name of the river;
- Distance of the beach to the nearest discharge or discharges of waste water (km);
- Beach clean-ups on the selected beach (Y/N);
- Frequency of the beach clean-ups (specify months);
- Map of the beach
- Additional comments and observations;

8. The Beach Litter Survey Form (see Annex 2b) is proposed to include the following elements/features:

- Name of the Beach;
- National beach ID;
- Country;
- Date of survey;
- Surveyor information (name, phone number, e-mail);
- Previous conducted survey (dd/mm/yy);
- Did you divert from the pre-determined 100 metres (Y/N; give new coordinates);
- Weather conditions (wind, rain, sand storm, fog, high tide, etc);
- Stranded animals (Y/N);
- Describe the stranded animal;
- Stranded animal dead or alive (D/A);
- Stranded animal entangled in litter (Y/N, specify litter item);
- Any factors influencing the survey (specify; e.g. track/vehicles on the beach, etc.);
- Any unusual marine litter items and/or marine litter loads (specify);
- Master list of categories agreed for beaches (IMAP Marine Litter Master List Categories: UNEP(DEPI)/MED IG.22/Inf.7 – Annex VII), including UNEP Code, General Name, and total number of recorded items (per category and sub-category), listed per different Material (Level 1);
- Any pellets observed (Y/N);
- Additional comments and observations.

9. It should be noted that Annex 2b contains the reduced master list of marine litter items agreed during the meeting of the Meeting of the Informal Online Working Group on Marine Litter in Athens in May 2014(UNEP(DEPI)/MED WG.417/Inf.15)

B. Seafloor Marine Litter

- Country;
- Date (dd/mm/yy);
- Surveyor information (name, phone, e-mail, etc.);
- Area (EcAp Code);
- Campaign name;
- Vessel name;
- Haul number;
- Gear (e.g. bottom trawl, etc.);
- Speed (knot);
- Opening of the net (m) (e.g. SCANMAR Trawl Sensor or SIMRAD);
- Cod-end mesh size (mm);
- Latitude (Start and End);
- Longitude (Start and End);
- Depth (Start and End);
- Haul duration (minutes);
- Distance covered (km);
- Weight (total) of litter per haul (kg);
- Weight (total) per category and sub-category (kg);
- Master list of categories agreed for seafloor (IMAP Marine Litter Master List Categories: UNEP(DEPI)/MED IG.22/Inf.7 – Annex VII), including UNEP Code, General Name, and total number of recorded items (per category and sub-category), listed per different Material (Level 1);
- Additional comments and observations (e.g. any unusual marine litter items).

Annex 1
MEDPOL Monitoring Data Reporting Guidelines and Excel

MEDPOL MONITORING DATA REPORTING GUIDELINES AND EXCEL TEMPLATES

TABLE 1. BIOTA / TRACE METALS DATA REPORTING FORMAT

	Fields	Requisite	Description	Format	Units
1	SAMPLE_ID	Mandatory	Individual sample code given to each sample by the laboratory		
2	YEAR	Mandatory	Monitoring Year	NUM (4)	
3	COUNTRY	Mandatory	Country Code (MED POL Codes)	CHAR (3)	
4	AREA	Mandatory	Area Code	CHAR (6)	
5	STATION	Mandatory	Station Code	CHAR (6)	
6	STATION_TYPE	Mandatory	for Hot Spots (H), Coastal (C), Reference (R)	CHAR (2)	
7	SAMP_DATE	Mandatory	Date of Sampling (dd/mm/yy)	DATE	
8	LON_DEG	Mandatory	Longitude in degrees	NUM (2)	Degree
9	LON_MIN	Mandatory	Longitude minute, seconds (In case of GPS application use this field for minutes and seconds in decimals, otherwise use only for minutes)	NUM (5,2)	Minute
10	LON_SEC	Mandatory	Longitude seconds (Use this field only when GPS is not used for positioning)	NUM (2)	Second
11	LON_HEMIS	Mandatory	Longitude hemisphere (codes: W=west, E=east)	CHAR (1)	
12	LAT_DEG	Mandatory	Latitude degree	NUM (2)	Degree
13	LAT_MIN	Mandatory	Latitude minute, seconds (In case of GPS application use this field for minutes and seconds in decimals, otherwise use only for minutes)	NUM (2,2)	Minute
14	LAT_SEC	Mandatory	Latitude seconds (Use this field only when GPS is not used for positioning)	NUM (2)	Second
15	BOT_DEPTH	Mandatory	Bottom depth of the sampling station	NUM (5,1)	meters
16	SAM_DEPTH	Mandatory	Sampling depth	NUM (5,1)	meters
17	SAM_TEMP	Mandatory	Temperature at the sampling station and depth	NUM (5,2)	ºC
18	SAM_SALIN	Mandatory	Salinity at the sampling station and depth (indicate exact unit)	NUM (5,2)	mS
19	SAM_DO	Additional	Dissolved oxygen at the sampling station and depth	NUM (5,2)	mg/L
20	SPECY	Mandatory	Selected Specie for analysis (MED POL codes)	CHAR (2)	
21	TISSUE	Mandatory	Selected Tissue for analysis (MED POL codes)	CHAR (2)	
22	SAM_NO	Mandatory	Sample no. (1,n) (“n” as used in trend objectives of the programme)	NUM (2)	
23	NS	Mandatory	Number of specimens (=number of pooled organisms in a sample)	NUM (2)	
24	LENGTH_AVG	Mandatory	Average length of specimens in a pool (Important: Use “fork length” for fish and “shell length” for mussels)	NUM (7,2)	cm
25	LENGTH_STD	Mandatory	Standard deviation of average length of specimens in a pool	NUM (6,2)	cm
26	LENGTH_UNIT	Mandatory	Unit given for length of organisms	CHAR (5)	“cm”
27	WEIGHT_AVG	Mandatory	Average weight of specimens in a pool	NUM (8,1)	g
28	WEIGHT_STD	Mandatory	Standard deviation of average weight of specimens in a pool	NUM (7,1)	g
29	WEIGHT_UNIT	Mandatory	Unit given for weight of organisms	CHAR (5)	“g”
30	EOM	Additional	Extractable Organic Matter	NUM (5,2)	mg/g
31	EOM_UNIT	Additional	Extractable Organic Matter	CHAR (5)	“mg/g”
32	DW / FW	Additional	Ratio of dry weight to fresh weight (dried to constant temperature)	NUM (5,2)	
33	INST_CODE_TM	Mandatory	Trace Metal Institude code (Country code+institute no. given in the MEDPOL Phase III Agreement)	CHAR(5)	

	Fields	Requisite	Description	Format	Units
34	ANALY_DATE_TM	Mandatory	TM Analysis Date (day/mn/yr)	DATE	
35	ANALY_METH_TM	Mandatory	TM Analysis method (MED POL codes)	CHAR (5)	
36	FW_DW	Mandatory	Mention if concentrations are based on fresh or dry weight (code as "**F**" for fresh weight and "**D**" for dry weight	CHAR (1)	
37	AS_CONC	Additional	Arsenic concentration	NUM (7,3)	µg/kg
38	AS_BDL	Additional	enter **BDL** if As conc. is below detection limit or level of determination	CHAR (3)	
39	AS_DL	Additional	Detection limit value	NUM (7,3)	µg/kg
40	AS_UNIT	Additional	Unit for As_conc	CHAR (5)	
41	CD_CONC	Mandatory	Cadmium Concentration	NUM (7,3)	µg/kg
42	CD_BDL	Mandatory	Enter BDL if Cd conc. is below detection limit or level of determination	CHAR (3)	
43	CD_DL	Mandatory	Detection limit value	NUM (7,3)	µg/kg
44	CD_UNIT	Mandatory	Unit for Cd_conc	CHAR (5)	
45	CR_CONC	Additional	Chromium Concentration	NUM (7,3)	µg/kg
46	CR_BDL	Additional	enter BDL if Cr conc. Is below detection limit or level of determination	CHAR (3)	
47	CR_DL	Additional	Detection limit value	NUM (7,3)	µg/kg
48	CR_UNIT	Additional	Unit for Cr_conc	CHAR (5)	
49	CU_CONC	Mandatory	Cupper concentration	NUM (7,3)	µg/kg
50	CU_BDL	Mandatory	Enter BDL if Cu conc. Is below the detection limit or level of determination	CHAR (3)	
51	CU_DL	Mandatory	Detection limit value	NUM (7,3)	µg/kg
52	CU_UNIT	Mandatory	Unit for Cu_conc	CHAR (5)	
53	HGT_CONC	Mandatory	Total Hg concentration	NUM (7,3)	µg/kg
54	HGT_BDL	Mandatory	enter BDL if HgT conc. is below detection limit or level of determination	CHAR (3)	
55	HGT_DL	Mandatory	Detection limit value	NUM (7,3)	µg/kg
56	HGT_UNIT	Mandatory	Unit for Hgt_conc	CHAR (5)	
57	PB_CONC	Mandatory	Lead Concentration	NUM (7,3)	µg/kg
58	PB_BDL	Mandatory	enter BDL if Pb conc. Is below detection limit or level of determination	CHAR (2)	
59	PB_DL	Mandatory	Detection limit value	NUM (7,3)	µg/kg
60	PB_UNIT	Mandatory	Unit for Pb_conc	CHAR (5)	
61	ZN_CONC	Additional	Zinc concentration	NUM (7,3)	µg/kg
62	ZN_BDL	Additional	Enter **BDL** if Zn conc. Is below the detection limit or level of determination	CHAR (3)	
63	ZN_DL	Additional	Detection limit value	NUM (7,3)	µg/kg
64	ZN_UNIT	Additional	Unit for Zn_conc	CHAR (5)	
	Other Trace Metals	**Additional**	**to be included by the laboratories depending on the country agreements**		

TABLE 2. BIOTA / ORGANIC CONTAMINANTS DATA REPORTING FORMAT

	Fields	Requisit	Description	Format	Units
1	SAMPLE_ID	Mandatory	Individual sample code given to each sample by the laboratory		
2	YEAR	Mandatory	Monitoring Year	NUM (4)	
3	COUNTRY	Mandatory	Country Code (MED POL Codes)	CHAR (3)	
4	AREA	Mandatory	Area Code	CHAR (6)	
5	STATION	Mandatory	Station Code	CHAR (6)	
6	STATION_TYPE	Mandatory	for Hot Spots (H), Coastal (C), Reference (R)	CHAR (2)	
7	SAMP_DATE	Mandatory	Date of Sampling (day/mn/yr)	DATE	
8	LON_DEG	Mandatory	Longitude in degrees	NUM (2)	Degree
9	LON_MIN	Mandatory	Longitude minute, seconds (In case of GPS application use this field for minutes and seconds in decimals, otherwise use only for minutes)	NUM (5,2)	Minute
10	LON_SEC	Mandatory	Longitude seconds (Use this field only when GPS is not used for positioning)	NUM (2)	Second
11	LON_HEMIS	Mandatory	Longitude hemisphere (codes: W=west, E=east)	CHAR (1)	
12	LAT_DEG	Mandatory	Latitude degree	NUM (2)	Degree
13	LAT_MIN	Mandatory	Latitude minute, seconds (In case of GPS application use this field for minutes and seconds in decimals, otherwise use only for minutes)	NUM (5,2)	Minute
14	LAT_SEC	Mandatory	Latitude seconds (Use this field only when GPS is not used for positioning)	NUM (2)	Second
15	BOT_DEPTH	Mandatory	Bottom depth of the sampling station	NUM (5,1)	meters
16	SAM_DEPTH	Mandatory	Sampling depth	NUM (5,1)	meters
17	SAM_TEMP	Mandatory	Temperature at the sampling station and depth	NUM (5,2)	ºC
18	SAM_SALIN	Mandatory	Salinity at the sampling station and depth	NUM (5,2)	mS
19	SAM_DO	Additional	Dissolved oxygen at the sampling station and depth	NUM (5,2)	mg/L
20	SPECY	Mandatory	Selected Specie for analysis (MED POL codes)	CHAR (2)	
21	TISSUE	Mandatory	Selected Tissue for analysis (MED POL codes)	CHAR (2)	
22	SAM_NO	Mandatory	Sample no. (1,.n) ("n"as used in trend objectives of the programme)	NUM (2)	
23	NS	Mandatory	Number of specimens (=num.Of pooled organisms in a sample)	NUM (2)	
24	LENGTH_AVG	Mandatory	Average length of specimens in a pool (Important: Use "fork length" for fish and "shell length" for mussels)	NUM (7,2)	cm
25	LENGTH_STD	Mandatory	Standard deviation of average length of specimens in a pool	NUM (6,2)	cm
26	LENGTH_UNIT	Mandatory	Unit given for length of organisms	CHAR (5)	"cm"
27	WEIGHT_AVG	Mandatory	Average weight of specimens in a pool	NUM (8,1)	g
28	WEIGHT_STD	Mandatory	Standard deviation of average weight of specimens in a pool	NUM (7,1)	g
29	WEIGHT_UNIT	Mandatory	Unit given for weight of organisms	CHAR (5)	"g"
30	EOM	Mandatory	Extractable Organic Matter	NUM (5,2)	mg/g
31	EOM_UNIT	Additional	Extractable Organic Matter	CHAR (5)	"mg/g"
32	DW / FW	Mandatory	Ratio of dry weight to fresh weight (dried to constant temperature)	NUM (5,2)	"mg/g"
33	INST_CODE_OC	Mandatory	Institude code for organic contaminant analysis (Country code+institute no. given in the MEDPOL Phase III Agreement)	CHAR(5)	
34	FW_DW	Mandatory	Mention if concentrations are based on fresh or dry weight (code as "**F**" for fresh weight and "**D**" for dry weight	CHAR (1)	
35	ANALY_DATE_PAH	Mandatory	Analysis Date (day/mn/yr)	DATE	

	Fields	Requisit	Description	Format	Units
36	ANALY_METH_PAH	Mandatory	Analysis method(s) for PAH (MED POL codes)	CHAR (5)	
37	PAH_CONC	Mandatory	PAH+ concentration	NUM (7,3)	µg/g
38	PAH_BDL	Mandatory	enter BDL if PAH conc. is below detection limit or level of determination	CHAR (3)	
39	PAH_DL	Mandatory	Detection limit value	NUM (7,3)	µg/kg
40	PAH_UNIT	Mandatory	Unit for PAH_conc	CHAR (5)	
41	ANALY_DATE_HH	Mandatory	Analysis Date (day/mn/yr)	DATE	
42	ANALY_METH_HH	Mandatory	Analysis method(s) for halogenated hydrocarbons (MED POL codes)	CHAR (5)	
43	HH_CONC	Mandatory	HH+ concentration	NUM (7,3)	µg/g
44	HH_BDL	Mandatory	enter BDL if HH+ conc. is below detection limit or level of determination	CHAR (3)	
45	HH_DL	Mandatory	Detection limit value	NUM (7,3)	µg/g
46	HH_UNIT	Mandatory	Unit for HH_conc	CHAR (5)	
	Other Organics	Additional	to be included by the laboratories depending on the country agreements		

***NOTE 1: PAH compounds should include the congeners: fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo[a]anthracene, chrysene, benzo[e]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, benzo[g,h,i]perylene, dibenzo[a,h]anthracene and indeno[1,2,3-c,d]pyrene. Therefore, rows from 37-40 should be duplicated for each individual congener determined.

***NOTE 2: HH compounds should include the following compounds: PCBs (at least congeners 28, 52, 101, 118, 138, 153, 180, 105 and 156); Hexachorobenzene, Lindane, Aldrin, Dieldrin and ΣDDTs). Therefore, rows from 43-46 should be duplicated for each compounds or congener determined within groups.

TABLE 3. SEDIMENT / TRACE METALS DATA REPORTING FORMAT

	Fields	Requisite	Description	Format	Unit
1	SAMPLE_ID	Mandatory	Individual sample code given to each sample by the laboratory		
2	YEAR	Mandatory	Monitoring Year	NUM (4)	
3	COUNTRY	Mandatory	Country Code (MED POL codes)	CHAR (3)	
4	AREA	Mandatory	Area Code	CHAR (6)	
5	STATION	Mandatory	Station Code	CHAR (6)	
6	STATION_TYPE	Mandatory	for Hot Spots (H), Coastal (C), Reference (R)	CHAR (2)	
7	SAMP_NO	Mandatory	Sample no.(1) (as used in trend objectives of the programme)	NUM (2)	
8	SAMP_DATE	Mandatory	Date of Sampling (day/mn/yr)	DATE	
9	LON_DEG	Mandatory	Longitude in degrees	NUM (2)	
10	LON_MIN	Mandatory	Longitude minute, seconds (In case of GPS application use this field for minutes and seconds in decimals, otherwise use only for minutes)	NUM (5,2)	
11	LON_SEC	Mandatory	Longitude seconds (Use this field only when GPS is not used for positioning)	NUM (2)	
12	LON_HEMIS	Mandatory	Longitude hemisphere (codes: W=west, E=east)	CHAR (1)	
13	LAT_DEG	Mandatory	Latitude degree	NUM (2)	
14	LAT_MIN	Mandatory	Latitude minute, seconds (In case of GPS application use this field for minutes and seconds in decimals, otherwise use only for minutes)	NUM (5,2)	
15	LAT_SEC	Mandatory	Latitude seconds (Use this field only when GPS is not used for positioning)	NUM (2)	
16	BOT_DEPTH	Mandatory	Bottom depth of the sampling station	NUM (5,1)	m
17	BOT_TEMP	Mandatory	Temperature value at the bottom of the sediment sampling station	NUM (5,2)	Deg C
18	BOT_SALIN	Mandatory	Salinity value at the bottom of the sediment sampling station	NUM (5,2)	
19	BOT_DO	Additional	Dissolved Oxygen value at the bottom of the sampling station	NUM (5,2)	mg/L
20	SAMP_LAYER	Mandatory	Sampling layer to be provided (e.g. 0-2 cm, 1 cm etc.)		cm
21	SAMP_FRAC	Mandatory	Sample size fraction to be provided (e.g. > 60 μm etc.)		μm
22	DW / WW	Additional	Ratio of dry weight to wet weight (dried to constant temperature)	NUM (5,2)	
23	INST_CODE_TM	Mandatory	Trace Metal Institude code (Country code+institute no. given in the MEDPOL Phase III Agreement)	CHAR(5)	
24	ANALY_DATE_TM	Mandatory	TM Analysis Date (day/mn/yr)	DATE	
25	ANALY_METH_TM	Mandatory	TM Analysis method (MED POL codes)	CHAR (5)	
26	WW_DW	Mandatory	Mention if concentrations are based on wet or dry weight (code as "**W**" for wet weight and "**D**" for dry weight	CHAR (1)	
27	AS_CONC	Additional	Arsenic concentration	NUM (7,3)	µg/kg
28	AS_BDL	Additional	enter **BDL** if As conc. Is below detection limit or level of determination	CHAR (2)	
29	AS_DL	Additional	Detection limit value	NUM (7,3)	µg/kg
30	AS_UNIT	Additional	Unit for As_conc	CHAR (5)	
31	**CD_CONC**	**Mandatory**	**Cadmium concentration**	**NUM (7,3)**	µg/kg
32	**CD_BDL**	**Mandatory**	**enter BDL if Cd conc. is below detection limit or level of determination**	**CHAR (2)**	
33	**CD_DL**	**Mandatory**	**Detection limit value**	NUM (7,3)	µg/kg
34	**CD_UNIT**	**Additional**	**Unit for Cd_conc**	**CHAR (5)**	
35	CR_CONC	Additional	Chromium Concentration	NUM (7,3)	µg/kg
36	CR_BDL	Additional	enter **BDL** if Cr conc. Is below detection limit or level of determination	CHAR (2)	

	Fields	Requisite	Description	Format	Unit
37	CR_DL	Additional	Detection limit value	NUM (7,3)	µg/kg
38	CR_UNIT	Additional	Unit for Cr_conc	CHAR (5)	
39	CU_CONC	Mandatory	Cupper concentration	NUM (7,3)	µg/kg
40	CU_BDL	Mandatory	Enter **BDL** if Cu conc. Is below the detection limit or level of determination	CHAR (2)	
41	CU_DL	Mandatory	Detection limit value	NUM (7,3)	µg/kg
42	CU_UNIT	~~Additional~~ Mandatory	Unit for Cu_conc	CHAR (5)	
43	**HGT_CONC**	**Mandatory**	**Total Hg concentration**	**NUM (7,3)**	µg/kg
44	**HGT_BDL**	**Mandatory**	**enter BDL if HgT conc. is below detection limit or level of determination**	**CHAR (2)**	
45	**HGT_DL**	**Mandatory**	**Detection limit value**	NUM (7,3)	µg/kg
46	**HGT_UNIT**	**Additional**	**Unit for HgT_conc**	**CHAR (5)**	
47	PB_CONC	Mandatory	Lead Concentration	NUM (7,3)	µg/kg
48	PB_BDL	Mandatory	enter **BDL** if Pb conc. Is below detection limit or level of determination	CHAR (2)	
49	PB_DL	Mandatory	Detection limit value	NUM (7,3)	µg/kg
50	PB_UNIT	Mandatory	Unit for Pb_conc	CHAR (5)	
51	ZN_CONC	Additional	Zinc concentration	NUM (7,3)	µg/kg
52	ZN_BDL	Additional	Enter **BDL** if Zn conc. Is below the detection limit or level of determination	CHAR (2)	
53	ZN_DL	Additional	Detection limit value	NUM (7,3)	µg/kg
54	ZN_UNIT	Additional	Unit for Zn_conc	CHAR (5)	
55	AL_CONC	Additional	Aluminium concentration	NUM (7,3)	g/kg
56	AL_BDL	Additional	enter **BDL** if Al conc. Is below detection limit or level of determination	CHAR (2)	
57	AL_DL	Additional	Detection limit value	NUM (7,3)	µg/kg
58	AL_UNIT	Additional	Unit for As conc. (indicate g/Kg or the reported unit, eg. %)	CHAR (5)	
55	LI_CONC	Additional	Arsenic concentration	NUM (7,3)	µg/kg
56	LI_BDL	Additional	enter **BDL** if As conc. Is below detection limit or level of determination	CHAR (2)	
57	LI_DL	Additional	Detection limit value	NUM (7,3)	µg/kg
58	LI_UNIT	Additional	Unit for As_conc	CHAR (5)	
59	ANALY_DATE	Mandatory	Elemental composition Analysis Date (dd/mm/yy)	DATE	
60	ANALY_METH	Mandatory	Elemental composition Analysis Method	CHAR (5)	
61	TC	Additional	Total carbon content (unit %)	NUM (2,2)	
62	TOC	Additional	Total organic carbon (unit %)	NUM (2,2)	
63	TIC	Additional	Total inorganic carbon (unit %)	NUM (2,2)	
64	TN	Additional	Total nitrogen content (unit %)	NUM (2,2)	
65	TON	Additional	Total organic nitrogen (unit %)	NUM (2,2)	
66	TIN	Additional	Total inorganic nitrogen (unit %)	NUM (2,2)	
	Other Trace Metals	Additional	to be included by the countries depending on their parameter settings		

TABLE 4. SEDIMENT / ORGANIC CONTAMINANTS DATA REPORTING FORMAT

	Fields	Requisite	Description	Format	Unit
1	SAMPLE_ID	Mandatory	Individual sample code given to each sample by the laboratory		
2	YEAR	Mandatory	Monitoring Year	NUM (4)	
3	COUNTRY	Mandatory	Country Code (MED POL codes)	CHAR (3)	
4	AREA	Mandatory	Area Code	CHAR (6)	
5	STATION	Mandatory	Station Code	CHAR (6)	
6	STATION_TYPE	Mandatory	for Hot Spots (H), Coastal (C), Reference (R)	CHAR (2)	
7	SAMP_NO	Mandatory	Sample no.(1,...) (as used in trend objectives of the programme)	NUM (2)	
8	SAMP_DATE	Mandatory	Date of Sampling (day/mn/yr)	DATE	
9	LON_DEG	Mandatory	Longitude in degrees	NUM (2)	
10	LON_MIN	Mandatory	Longitude minute, seconds (In case of GPS application use this field for minutes and seconds in decimals, otherwise use only for minutes)	NUM (5,2)	
11	LON_SEC	Mandatory	Longitude seconds (Use this field only when GPS is not used for positioning)	NUM (2)	
12	LON_HEMIS	Mandatory	Longitude hemisphere (codes: W=west, E=east)	CHAR (1)	
13	LAT_DEG	Mandatory	Latitude degree	NUM (2)	
14	LAT_MIN	Mandatory	Latitude minute, seconds (In case of GPS application use this field for minutes and seconds in decimals, otherwise use only for minutes)	NUM (5,2)	
15	LAT_SEC	Mandatory	Latitude seconds (Use this field only when GPS is not used for positioning)	NUM (2)	
16	BOT_DEPTH	Mandatory	Bottom depth of the sampling station	NUM (5,1)	m
17	BOT_TEMP	Mandatory	Temperature value at the bottom of the sediment sampling station	NUM (5,2)	Deg C
18	BOT_SALIN	Mandatory	Salinity value at the bottom of the sediment sampling station	NUM (5,2)	
19	BOT_DO	Additional	Dissolved Oxygen value at the bottom of the sampling station	NUM (5,2)	mg/L
20	SAMP_LAYER	Mandatory	Sampling layer to be provided (e.g. 0-2 cm, 1 cm etc.)		cm
21	SAMP_FRAC	Mandatory	Sample size fraction to be provided (e.g. >60 µm etc.)		µm
22	DW / WW	Additional	Ratio of dry weight to wet weight (dried to constant temperature)	NUM (5,2)	
23	INST_CODE_OC	Mandatory	Institute code for organic contaminant analysis (Country code+institute no. given in the MEDPOL Phase III Agreement)	CHAR(5)	
24	WW_DW	Mandatory	Mention if concentrations are based on wet or dry weight (code as "**W**" for wet weight and "**D**" for dry weight	CHAR (1)	
25	ANALY_DATE_PAH	Mandatory	PAH+ Analysis Date (day/mn/yr)	DATE	
26	ANALY_METH_PAH	Mandatory	PAH+ Analysis method (MED POL codes)	CHAR (5)	
27	PAH_CONC	Mandatory	PAH+ concentration	NUM (7,3)	µg/g
28	PAH_BDL	Mandatory	enter BDL if PAH+ conc. is below detection limit or level of determination	CHAR (2)	
29	PAH_DL	Mandatory	Detection limit value	NUM (7,3)	µg/kg
30	PAH_UNIT	Mandatory	Unit for PAH_conc	CHAR (5)	
31	ANALY_DATE_HH	Mandatory	HH+ Analysis Date (day/mn/yr)	DATE	
32	ANALY_METH_HH	Mandatory	HH+ Analysis method (MED POL codes)	CHAR (5)	
33	HH_CONC	Mandatory	HH+ concentration	NUM (7,3)	µg/g
34	HH_BDL	Mandatory	Enter BDL if HH+ conc. is below detection limit or level of determination	CHAR (2)	
35	HH_DL	Mandatory	Detection limit value	NUM (7,3)	µg/g

	Fields	Requisite	Description	Format	Unit
36	HH_UNIT	Mandatory	Unit for HH_conc	CHAR (5)	
59	ANALY_DATE	Additional	Elemental composition Analysis Date (dd/mm/yy)	DATE	
60	ANALY_METH	Additional	Elemental composition Analysis Method	CHAR (5)	
61	TC	Additional	Total carbon content (unit %)	NUM (2,2)	
62	TOC	Additional	Total organic carbon (unit %)	NUM (2,2)	
63	TIC	Additional	Total inorganic carbon (unit %)	NUM (2,2)	
64	TN	Additional	Total nitrogen content (unit %)	NUM (2,2)	
65	TON	Additional	Total organic nitrogen (unit %)	NUM (2,2)	
66	TIN	Additional	Total inorganic nitrogen (unit %)	NUM (2,2)	
	Other Organics	Additional	to be included by the countries depending on their parameter settings		

***NOTE 3: PAH compounds should include the congeners: fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo[a]anthracene, chrysene, benzo[e]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, benzo[g,h,i]perylene, dibenzo[a,h]anthracene and indeno[1,2,3-c,d]pyrene. Therefore, rows from 27-30 should be duplicated for each individual congener determined.

***NOTE 4: HH compounds should include the following compounds: PCBs (at least congeners 28, 52, 101, 118, 138, 153, 180, 105 and 156); Hexachorobenzene, Lindane, Aldrin, Dieldrin and ΣDDTs). Therefore, rows from 33-36 should be duplicated for each compounds or congener determined within groups.

TABLE 5. BIOEFFECTS DATA REPORTING FORMAT

	Fields	DESCRIPTION	Format	Units
1	SAMPLE_ID	Individual sample code given to each sample by the laboratory		
2	YEAR	Monitoring Year	NUM (4)	
3	COUNTRY	Country Code (existing coding)	CHAR (3)	
4	AREA	Area Code	CHAR (6)	
5	STATION	Station Code	CHAR (6)	
6	STATION_TYPE	for Hot Spots (H), Coastal (C), Reference (R)	CHAR (2)	
7	SAMP_DATE	Date of Sampling (day/mn/yr)	DATE	
8	LON_DEG	Longitude in degrees	NUM (2)	
9	LON_MIN	Longitude minute, seconds (In case of GPS application use this field for minutes and seconds in decimals, otherwise use only for minutes)	NUM (5,2)	
10	LON_SEC	Longitude seconds (Use this field only when GPS is not used for positioning)	NUM (2)	
11	LON_HEMIS	Longitude hemisphere (codes: W=west, E=east)	CHAR (1)	
12	LAT_DEG	Latitude degree	NUM (2)	
13	LAT_MIN	Latitude minute, seconds (In case of GPS application use this field for minutes and seconds in decimals, otherwise use only for minutes)	NUM (5,2)	
14	LAT_SEC	Latitude seconds (Use this field only when GPS is not used for positioning)	NUM (2)	
15	BOT_DEPTH	Bottom depth of the sampling station	NUM (5,1)	m
16	SAMP_DEPTH	Sampling depth	NUM (5,1)	m
17	SAM_TEMP	Temperature at the sampling station and depth	NUM (5,2)	Deg C
18	SAM_SALIN	Salinity at the sampling station and depth	NUM (5,2)	
19	SAM_DO	Dissolved oxygen at the sampling station and depth	NUM (5,2)	mg/L
20	SPECY	Species Name (MEDPOL code list)	CHAR (2)	
21	TISSUE	Selected Tissue (MEDPOL code list)	CHAR (2)	
22	WILD/CAGED	If the selected organism is wild enter *'w'*, if caged use *'c'*	CHAR (1)	
23	CAGE_DUR	Caging duration	NUM (2)	Days
24	INS_CODE_BIOMON	Institute Code for bio-monitoring (Country code+institute no. given in the MEDPOL Phase III Agreement)	CHAR (5)	
25	SAMPLE_NO	Sample no. (1,)	NUM (2)	
26	ANALY_DATE_DNAx	Analysis Date (day/mn/yr)	DATE	
27	ANALY_METH_DNAx	DNAx Analysis Methods (MEDPOL Code list)	CHAR (7)	
28	DNAx_ELUTION RATE_VOL	Fraction of DNA retained / volume	NUM (5,3)	Arbitrary units
29	DNAx_ELUTION RATE_TIME	Fraction of DNA retained / time	NUM (5,3)	Arbitrary units
30	DNAx_SSF	Strand Scission Factor	NUM (5,3)	unitless
31	DNAx_MICRONUCLEI	Micronuclei Frequency	NUM (5,1)	%
32	ANALY_DATE_EROD	Analysis Date (day/mn/yr)	DATE	
33	ANALY_METH_EROD	EROD Analysis Method (MEDPOL code list)	CHAR (7)	
34	EROD_ACT	EROD Activity = pmol resofurin per mg-protein per minute	NUM ( )	
35	ANALY_DATE_LMS	Analysis Date (day/mn/yr)	DATE	

	Fields	DESCRIPTION	**Format**	**Units**
36	ANALY_METH_LMS	Methods of LMS Analysis (MEDPOL code list)	CHAR (7)	
37	LMS_LP	The average Labilization Period	NUM (2)	min
38	LMS_NRR	Neutral Red Retention	NUM (2)	min
39	ANALY_DATE_MT	Analysis Date (day/mn/yr)	DATE	
40	ANALY_METH_MT	MT Analysis Method (MEDPOL code list)	CHAR (7)	
41	MT_LEVEL	MT Level in wet Tissue (w/w)	NUM (7,2)	µg/g
	Other Organics	Additional to (be included by the countries depending on their parameter settings)		

TABLE 6. SEAWATER DATA REPORTING FORMAT

	Fields	Requisite	Description	Format	Units
1	SAMPLE_ID	Mandatory	Individual sample code given to each sample by the laboratory		
2	YEAR	Mandatory	Monitoring Year	NUM (4)	
3	COUNTRY	Mandatory	Country Code (MED POL codes)	CHAR (3)	
4	AREA	Mandatory	Area Code (as used in Phase III Agreement)	CHAR (6)	
5	STATION	Mandatory	Station Code (as used in Phase III Agreement)	CHAR (6)	
6	STATION_TYPE	Mandatory	for Hot Spots (H), Coastal (C), Reference (R)	CHAR (2)	
7	SAMP_DATE	Mandatory	Date of Sampling (day/mn/yr)	DATE	
8	SAMP_TIME	Mandatory	Sampling Time	TIME	
9	LON_DEG	Mandatory	Longitude in degrees	NUM (2)	
10	LON_MIN	Mandatory	Longitude minute, seconds (In case of GPS application use this field for minutes and seconds in decimals, otherwise use only for minutes)	NUM (5,2)	
11	LON_SEC	Mandatory	Longitude seconds (Use this field only when GPS is not used for positioning)	NUM (2)	
12	LON_HEMIS	Mandatory	Longitude hemisphere (codes: W=west, E=east)	CHAR(2)	
13	LAT_DEG	Mandatory	Latitude degree	NUM (2)	
14	LAT_MIN	Mandatory	Latitude minute, seconds (In case of GPS application use this field for minutes and seconds in decimals, otherwise use only for minutes)	NUM (5,2)	
15	LAT_SEC	Mandatory	Latitude seconds (Use this field only when GPS is not used for positioning)	NUM (2)	
16	BOT_DEPTH	Mandatory	Bottom depth of the sampling station	NUM (5,1)	m
17	SAMP_DEPTH	Mandatory	Sampling depth	NUM (5,1)	m
18	SAM_TEMP	Mandatory	Temperature at the sampling depth	NUM (5,2)	Deg C
19	SAM_SALIN	Mandatory	Salinity at the sampling depth	NUM (5,2)	
20	SAM_DO	Additional	Dissolved oxygen at the sampling depth	NUM (5,2)	mg/L
21	INST_CODE_SW	Additional	Institude code for analysis of nutrients, chlorophyll-a, TRIX etc (Country code+institute no. given in the MEDPOL Phase III Agreement)	CHAR (5)	
22	PO4-P_CONC	Mandatory	PO4-P concentration	NUM (6,2)	µmol/L
23	PO4-P _BDL	Mandatory	Enter BDL if PO4-P conc. is below detection limit or level of determination	CHAR (2)	
24	PO4-P _DL	Mandatory	Detection limit value	NUM (6,2)	µmol/L
25	PO4-P_UNIT	Mandatory	Unit for PO4-P_conc	CHAR (6)	
26	TP_CONC	Mandatory	Total Phosphorus concentration	NUM (6,2)	µmol/L
27	TP _BDL	Mandatory	Enter BDL if TP conc. is below detection limit or level of determination	CHAR (2)	
28	TP _DL	Mandatory	Detection limit value	NUM (6,2)	µmol/L
29	TP_UNIT		Unit for TP_conc	CHAR (6)	
30	NH4-N_CONC	Mandatory	NH4-N concentration	NUM (6,2)	µmol/L
31	NH4-N _BDL	Mandatory	Enter BDL if NH4-N conc. is below detection limit or level of determination	CHAR (2)	
32	NH4-N _DL	Mandatory	Detection limit value	NUM (6,2)	µmol/L
33	NH4-N_UNIT		Unit for NH4-N_conc	CHAR (6)	
34	NO2-N_CONC	Mandatory	NO2-N concentration	NUM (6,2)	µmol/L

	Fields	Requisite	Description	Format	Units
35	NO2-N _BDL	Mandatory	Enter BDL if NO2-N conc. is below detection limit or level of determination	CHAR (2)	
36	NO2-N _DL	Mandatory	Detection limit value	NUM (6,2)	µmol/L
37	NO2-N_UNIT		Unit for NO2-N_conc	CHAR (6)	
38	NO3-N_CONC	Mandatory	NO3-N concentration	NUM (6,2)	µmol/L
39	NO3-N _BDL	Mandatory	Enter BDL if NO3-N conc. is below detection limit or level of determination	CHAR (2)	
40	NO3-N _DL	Mandatory	Detection limit value	NUM (6,2)	µmol/L
41	NO3-N_UNIT		Unit for NO3-N_conc	CHAR (6)	
42	NO3-2-N_CONC	Mandatory	NO3+NO2-N concentration	NUM (6,2)	µmol/L
43	NO3-2-N_BDL	Mandatory	Enter BDL if NO3-2-N conc. is below detection limit or level of determination	CHAR (2)	
44	NO3-2-N_DL	Mandatory	Detection limit value	NUM (6,2)	µmol/L
45	NO3-2-N_UNIT		Unit for NO3-N_conc	CHAR (6)	
46	TN_CONC	Mandatory	Total Nitrogen concentration	NUM (6,2)	µmol/L
47	TN_BDL	Mandatory	Enter BDL if TN conc. is below detection limit or level of determination	NUM (6,2)	µmol/L
48	TN_DL	Mandatory	Detection limit value	NUM (6,2)	µmol/L
49	TN_UNIT		Unit for TN_conc	CHAR (6)	
50	SIO4_CONC	Mandatory	Silicic acid concentration	NUM (6,2)	µmol/L
51	SIO4_BDL	Mandatory	Enter BDL if SIO4 conc. is below detection limit or level of determination	NUM (6,2)	µmol/L
52	SIO4_DL	Mandatory	Detection limit value	NUM (6,2)	µmol/L
53	SIO4_UNIT		Unit for SIO4_conc	CHAR (6)	
54	CHL-A_CONC	Mandatory	Chlorophyll-a concentration	NUM (6,2)	µg/L
55	CHL-A_BDL	Mandatory	Enter BDL if Chl-a is below detection limit or level of determination	NUM (6,2)	µg/L
56	CHL-A_DL	Mandatory	Detection limit value	NUM (6,2)	µg/L
57	CHL-A_UNIT	Mandatory	Unit for Chl-a_conc	CHAR (6)	
58	TRIX INDEX	Additional	Trophic Index	NUM (5,2)	
	Others		**Other parameters could be included depending on the country agreements.**		

TABLE 7. ATMOSPHERIC DRY DEPOSITION DATA REPORTING FORMAT

	Fields	Requisite	Description	Format	Units
1	SAMPLE_ID	Mandatroy	Individual sample code given to each sample by the laboratory		
2	YEAR	Mandatory	Monitoring Year	NUM (4)	
3	COUNTRY	Mandatory	Country Code (MED POL codes)	CHAR (3)	
4	AREA	Mandatory	Area Code (as used in Phase III Agreement)	CHAR (6)	
5	STATION	Mandatory	Station Code (as used in Phase III Agreement)	CHAR (6)	
6	STATION_ID	Mandatory	Station identity ('R' for reference and 'I' for Impact=hot spot)	CHAR (1)	
7	HEIGHT	Mandatory	Height of station from the ground	NUM (5,1)	m
8	ALTITUDE	Mandatory	Altitude/Elevation of st. ground level above sea level	NUM (6,1)	m
9	DISTANCE_SHORE	Mandatory	Distance of atmospheric station to shore	NUM (7,1)	m
10	METEO_DIST	Mandatory	Distance to nearest meteorological station	NUM (7,1)	m
11	LAT_DEG	Mandatory	Latitude degree	NUM (2)	
12	LAT_MIN	Mandatory	Latitude minute	NUM (5,2)	
13	LAT_SEC	Mandatory	Latitude seconds	NUM (2)	
14	LON_DEG	Mandatory	Longitude in degrees	NUM (2)	
15	LON_MIN	Mandatory	Longitude minute	NUM (5,2)	
16	LON_SEC	Mandatory	Longitude seconds	NUM (2)	
17	LON_HEMIS	Mandatory	Longitude hemisphere (codes: W=west, E=east)	CHAR(2)	
18	SAMP_START_DATE	Mandatory	Start Date of Sampling (day/mn/yr)	DATE	
19	SAMP_START_HOUR	Mandatory	Start Hour of Sampling	NUM (2)	
20	SAMP_END_DATE	Mandatory	End Date of Sampling (day/mn/yr)	DATE	
21	SAMP_END_HOUR	Mandatory	End Hour of Sampling	NUM (2)	
22	SAMP_TIME-TOT	Mandatory	Total Sampling Hours	NUM (2)	
23	AIR_VOLUME	Mandatory	Total Air volume filtered during the total sampling time	NUM (7,2)	m3
24	SAMP_INST_CODE	Mandatory	Sampling Institute Code	NUM (9)	
25	INST_CODE_DUST		Institude code for dust analysis	CHAR(9)	
26	ANALY_DATE_DUST		Dust Analysis Date (day/mn/yr)	DATE	
27	ANALY_METH_DUST		Dust Analysis method	CHAR (5)	
28	DUST_CONC		Dust Concentration	NUM ( )	
29	DUST_UNIT		Unit for dust_conc	CHAR (5)	
30	INST_CODE_TM	Mandatory	Trace Metal Institude code	CHAR(9)	
31	ANALY_DATE_TM	Mandatory	TM Analysis Date (day/mn/yr)	DATE	
32	ANALY_METH_TM	Mandatory	TM Analysis	CHAR (5)	
33	CD_CONC		Cadmium concentration	NUM (7,3)	
34	CD_BDL		enter BDL if Cd conc. is below detection limit or level of determination	CHAR (2)	
35	CD_DL		Detection limit value	NUM (7,3)	µg/kg
36	CD_UNIT		Unit for Cd_conc	CHAR (5)	
	Other Trace Metals	As specified in the programme			
	Organic contaminants	As specified in the programme			

TABLE 8. ATMOSPHERIC WET DEPOSITION DATA REPORTING FORMAT

	Fields	**Requisite**	**Description**	**Format**	**Units**
1	SAMPLE_ID	Mandatroy	Individual sample code given to each sample by the laboratory		
2	YEAR	Mandatory	Monitoring Year	NUM (4)	
3	COUNTRY	Mandatory	Country Code (MED POL codes)	CHAR (3)	
4	AREA	Mandatory	Area Code (as used in Phase III Agreement)	CHAR (6)	
5	STATION	Mandatory	Station Code (as used in Phase III Agreement)	CHAR (6)	
6	STATION_ID	Mandatory	Station identity ('R' for reference and 'I' for Impact=hot spot)	CHAR (1)	
7	HEIGHT	Mandatory	Height of station from the ground	NUM (5,1)	m
8	ALTITUDE	Mandatory	Altitude/Elevation of station ground level above sea level	NUM (6,1)	m
9	DISTANCE_SHORE	Mandatory	Distance of atmospheric station to shore	NUM (7,1)	m
10	METEO_DIST		Distance to nearest meteorological station	NUM (7,1)	m
11	LAT_DEG	Mandatory	Latitude degree	NUM (2)	
12	LAT_MIN	Mandatory	Latitude minute	NUM (5,2)	
13	LAT_SEC	Mandatory	Latitude seconds	NUM (2)	
14	LON_DEG	Mandatory	Longitude in degrees	NUM (2)	
15	LON_MIN	Mandatory	Longitude minute	NUM (5,2)	
17	LON_SEC	Mandatory	Longitude seconds	NUM (2)	
16	LON_HEMIS	Mandatory	Longitude hemisphere (codes: W=west, E=east)	CHAR(2)	
17	SAMP_START_DATE		Start Date of Sampling (day/mn/yr)	DATE	
18	SAMP_START_HOUR		Start Hour of Sampling	NUM (2)	
19	SAMP_END_DATE		End Date of Sampling (day/mn/yr)	DATE	
20	SAMP_END_HOUR		End Hour of Sampling	NUM (2)	
21	SAMP_TIME-TOT		Total Sampling Hours	NUM (2)	
22	PRECIPITATION_NG		Precipitation (National gauge)	NUM (5)	mm
23	SAMP_INST_CODE		Sampling Institute Code	NUM (9)	
24	INST_CODE_TM		Trace Metal Institude code	CHAR(9)	
25	ANALY_DATE_TM		TM Analysis Date (day/mn/yr)	DATE	
26	ANALY_METH_TM		TM Analysis method	CHAR (5)	
27	**CD_CONC**		Cadmium concentration	NUM (7,3)	µg/kg
28	**CD_BDL**		enter BDL if Cd conc. is below detection limit or level of determination	CHAR (2)	
29	**CD_DL**		Detection limit value	NUM (7,3)	µg/kg
30	**CD_UNIT**		Unit for Cd_conc	CHAR (5)	
	Other Trace Metals				
	Other fields		organic contaminants		

TABLE 9. CERTIFIED REFERENCE MATERIAL (CRM) / QUALITY CONTROL DATA REPORTING FORMAT

	Fields	Description	Format	Units
1	SAMPLE_ID (linked to CRM)	Individual sample code given to each sample linked to the following CRM information (by rows)		
2	YEAR	Monitoring Year	NUM (4)	
3	COUNTRY	Country Code	CHAR (3)	
BLOCK 1: TRACE METALS QUALITY CONTROL RESULTS IN BIOTA SAMPLES				
4	**INST_CODE_TM_BIO**	**Institude code for trace metal analysis in biota**	**CHAR (5)**	
5	CRM_BIO_TM_CD	Name of the certified reference material used for Cadmium analysis in biota (will be coded)	CHAR (10)	
6	CRM_BIO_CD_VALUE	The expected concentration value for Cd in CRM	NUM (7,3)	µg/kg
7	CRM_BIO_CD_SAMPLE NO	Number of sample (1,n**)	NUM (2)	
8	CRM_BIO_CD_CONC	Concentration of cadmium measured in each CRM sample (1,n) * Pls don't submit average values	NUM (7,3)	µg/kg
9	CRM_BIO_CD_UNIT	Unit for both expected and measured Cd_conc in CRM	CHAR (5)	
10	ANALY_DATE_CD_BIO	Cd Analysis Date (day/mn/yr)	DATE	
11	ANALY_METH_CD_BIO	Cd Analysis method (MED POL codes)	CHAR (5)	
12	CRM_BIO_TM_xxx	Name of the certified reference material used for total Mercury analysis in biota (will be coded)	CHAR (10)	
13	CRM_BIO_xxx_VALUE	The expected concentration value for total Hg in CRM	NUM (7,3)	µg/kg
14	CRM_BIO_xxx_SAMPLE NO	Number of sample (1,n**)	NUM (2)	
15	CRM_BIO_xxx_CONC	Concentration of total mercury in each CRM sample (1,n) * Pls don't submit average values	NUM (7,3)	µg/kg
16	CRM_BIO_xxx_UNIT	Unit for both expected and measured HgT_conc in CRM	CHAR (5)	
17	ANALY_DATE_xxx_BIO	Hgt Analysis Date (day/mn/yr)	DATE	
18	ANALY_METH_xxx_BIO	Hgt Analysis method (MEDPOL codes)	CHAR (5)	
BLOCK 2: TRACE METALS QUALITY CONTROL RESULTS IN SEDIMENT SAMPLES				
19	**INST_CODE_TM_SED**	**Institude code for trace metal analysis in sediment** (Country code+institute no. given in the MEDPOL Phase III Agreement)	**CHAR (5)**	
20	CRM_SED_TM_CD	Name of the certified reference material used for Cadmium analysis in sediment (will be coded)	CHAR (10)	
21	CRM_SED_CD_VALUE	The expected concentration value for Cd in CRM	NUM (7,3)	µg/kg
22	CRM_SED_CD_SAMPLE NO	Number of sample (1,n**)	NUM (2)	
23	CRM_SED_CD_CONC	Concentration of Cd in each CRM sample (1n) * Pls don't submit average values	NUM (7,3)	µg/kg
24	CRM_SED_CD_UNIT	Unit for both expected and measured Cd_conc in CRM	CHAR (5)	
25	ANALY_DATE_CD_SED	Cd Analysis Date (day/mn/yr)	DATE	
26	ANALY_METH_CD_SED	Cd Analysis method (MED POL codes)	CHAR (5)	
27	CRM_SED_TM_xxx	Name of the certified reference material used for t- Mercury analysis in sediment (will be coded)	CHAR (10)	
28	CRM_SED_xxx_VALUE	The expected concentration value for total Hg in CRM	NUM (7,3)	µg/kg
29	CRM_SED_xxx_SAMPLE NO	Number of sample (1,n)	NUM (2)	
30	CRM_SED_xxx_CONC	Concentration of xxx in each CRM sample (1,n) * Pls don't submit average values	NUM (7,3)	µg/kg
31	CRM_SED_xxx_UNIT	Unit for both expected and measured HgT_conc in CRM	CHAR (5)	
32	ANALY_DATE_xxx_SED	Hgt Analysis Date (day/mn/yr)	DATE	

	Fields	Description	Format	Units
33	ANALY_METH_xxx_SED	Hgt Analysis method (MED POL codes)	CHAR (5)	
BLOCK 3: ORGANIC COMPOUNDS QUALITY CONTROL IN BIOTSAMPLES				
34	INST_CODE_OC_BIO	Institude code for organic contaminants analysis in biota (Country code+institute no. given in the MEDPOL Phase III Agreement)	CHAR (5)	
35	CRM_BIO_HH	Name of the certified reference material for halogenated hydrocarbons in biota (will be coded)	CHAR (10)	
36	CRM_BIO_HH_VALUE	Expected concentration value of HH+ compound in CRM	NUM (7,3)	µg/kg
37	CRM_BIO_HH_SAMPLE NO	Number of sample (1,n**)	NUM (2)	
38	CRM_BIO_HH_CONC	Concentration of HH+ in each CRM sample (1,n) * Pls don't submit average values	NUM (7,3)	µg/kg
39	CRM_BIO_HH_UNIT	Unit for both expected and measured HH_conc in CRM	CHAR (5)	
40	ANALY_DATE_HH_BIO	HH+ Analysis Date (day/mn/yr)	DATE	
41	ANALY_METH_HH_BIO	HH+ Analysis method (MED POL codes)	CHAR (5)	
42	CRM_BIO_OC_PAH	Name of the certified reference material for PAH in biota (will be coded)	CHAR (10)	
43	CRM_BIO_PAH_VALUE	Expected concentration value of PAH in CRM	NUM (7,3)	µg/kg
44	CRM_BIO_PAH_SAMPLE NO	Number of sample (1,n**)	NUM (2)	
45	CRM_BIO_PAH_CONC	Concentration of PAH in each CRM sample (1,n) * Pls don't submit average values	NUM (7,3)	µg/kg
46	CRM_BIO_PAH_UNIT	Unit for both expected and measured PAH_conc in CRM	CHAR (5)	
47	ANALY_DATE_PAH_BIO	PAH Analysis Date (day/mn/yr)	DATE	
48	ANALY_METH_PAH_BIO	PAH Analysis method (MED POL codes)	CHAR (5)	
BLOCK 4: ORGANIC COMPOUNDS QUALITY CONTROL RESULTS IN SEDIMENT SAMPLES				
49	INST_CODE_OC_SED	Institude code for organic contaminant analysis in sediments (Country code+institute no. given in the MEDPOL Phase III Agreement)	CHAR (5)	
50	CRM_SED_HH	Name of the certified reference material used for the analysis of halogenated hydrocarbons in sediment (will be coded)	CHAR (10)	
51	CRM_SED_HH_VALUE	Expected concentration value of HH+ compound in CRM	NUM (7,3)	µg/kg
52	CRM_SED_HH_SAMPLE NO	Number of sample (1,n**)	NUM (2)	
53	CRM_SED_HH_CONC	Concentration of HH+ of each sample (1,n) * Pls don't submit average values	NUM (7,3)	µg/kg
54	CRM_SED_HH_UNIT	Unit for both expected and measured HH_conc in CRM		
55	ANALY_DATE_HH_SED	HH+ Analysis Date (day/mn/yr)	DATE	
56	ANALY_METH_HH_SED	HH+ Analysis method (MED POL codes)	CHAR (5)	
57	CRM_SED_PAH	Name of the certified reference material used for PAH analysis in sediment (will be coded)	CHAR (10)	
58	CRM_SED_PAH_VALUE	Expected concentration value of PAH in CRM	NUM (7,3)	µg/kg
59	CRM_SED_PAH_SAMPLE NO	Number of sample (1,n**)	NUM (2)	
60	CRM_SED_PAH_CONC	Concentration of PAH of each sample (1,n) * Pls don't submit average values	NUM (7,3)	µg/kg
61	CRM_SED_PAH_UNIT	Unit for both expected and measured PAH_conc in CRM	CHAR (5)	
62	ANALY_DATE_PAH_SED	PAH Analysis Date (day/mn/yr)	DATE	
63	ANALY_METH_PAH_SED	PAH Analysis method (MED POL codes)	CHAR (5)	

Annex IIa
MEDPOL Marine Litter Beach ID Form

Mediterranean Action Plan
Barcelona Convention

MEDPOL Marine Litter Beach ID Form

<table>
<tr><td colspan="2">Name of the beach:</td><td colspan="3"></td></tr>
<tr><td colspan="2">National beach ID:</td><td colspan="3"></td></tr>
<tr><td colspan="2">Contracting Party:</td><td colspan="3"></td></tr>
<tr><td>①Beach width at mean low spring tide (m):</td><td></td><td colspan="2">②Beach width at mean high spring tide (m):</td><td></td></tr>
<tr><td>③Total length of beach (m)</td><td></td><td colspan="2">④Back of the beach (example dunes):</td><td></td></tr>
<tr><td>⑤GPS coordinates start 100 m
(wgs84 – dd mm ss.ss)</td><td></td><td colspan="2">⑥GPS coordinates end 100 m
(wgs84 – dd mm ss.ss)</td><td></td></tr>
<tr><td>⑤GPS coordinates start 100 m (IF REPLICATE)
(wgs84 – dd mm ss.ss)</td><td></td><td colspan="2">⑥GPS coordinates end 100 m (IF REPLICATE)
(wgs84 – dd mm ss.ss)</td><td></td></tr>
<tr><td>Prevailing currents off the beach:</td><td>N E
S W</td><td colspan="2">Prevailing winds:</td><td>N E S W</td></tr>
<tr><td colspan="4">When you look from the beach to the sea, what direction is the beach facing?:</td><td>N E S W</td></tr>
<tr><td colspan="3">Type of beach material (% coverage): (e.g. sand 60%, pebbles 40%)</td><td colspan="2"></td></tr>
<tr><td colspan="3">Beach topography: (e.g. slope 20%)</td><td colspan="2"></td></tr>
<tr><td colspan="3">Are there any objects in the sea (e.g. a pier) that influence the currents (If YES, specify)</td><td colspan="2"></td></tr>
<tr><td colspan="5">Major beach usage (local people, swimming and sunbathing, fishing, surfing, sailing etc):
1. seasonal or whole year round:
2. seasonal or whole year round:
3. seasonal or whole year round:</td></tr>
<tr><td colspan="5">Access to the beach:
Pedestrian ☐ Vehicle ☐ Boats ☐</td></tr>
<tr><td colspan="5">Nearest town:
Name: Distance to the beach: Population:</td></tr>
</table>

Is there any development behind the beach?:	No	Yes, please describe:
Are there food and/or drink outlets on the beach?: Distance from the survey area (m): Present all year round: Position of food and/or drink outlet in relation to the survey area: N E S W	No Yes	Yes No, please specify in month:
Distance from the beach to the nearest shipping lane (km): What is the estimated traffic density: *(number of ships/year):* Is it used mainly by merchant ships, fishing vessels or all kinds: Position of shipping lane in relation to survey area: N E S W		
Distance from the beach to the nearest harbour (km): Name of the harbour: Is the harbour entrance facing the survey area?: Yes No Position of harbour in relation to survey area: N E S W Type of harbour: Size of harbour (number of ships):		

Distance from the beach to the nearest river mouth (km): Name of the river: What is the position of river mouth in relation to survey area: N E S W				
Distance from the beach to the nearest discharge or discharges of waste water (km): Position of discharge points in relation to survey area: N E S W				
How often is the beach cleaned:				
All year round:	Daily ☐	Weekly ☐	Monthly ☐	Other:
Seasonal, *please specify in months:*	Daily ☐	Weekly ☐	Monthly ☐	Other:
What method is used:	Manual ☐	Mechanical ☐		
Who is responsible for the cleaning:				

Additional comments and observations about this beach:
Please include: 1. A map of the beach 2. A map of the beach and the local surroundings. When relevant please mark on this map the following: Nearest town — Food/drink outlets — Nearest shipping lane Nearest harbour — Nearest river mouth — Discharge or discharges of waste water 3. A regional map
Is this an amendment to an existing questionnaire: Yes No Date questionnaire is filled in: / / (d/m/y) Name: Phone number: E-mail:

Annex IIb
MEDPOL Beach Litter Survey Form

Mediterranean Action Plan Barcelona Convention	**MEDPOL Beach Litter Survey Form**
Name of the beach:	
National beach ID:	
Contracting Party:	
Date of survey *(dd/mm/yy)*	
Number of surveyors:	
Responsible of this survey:	Name: Phone number: Email address:
Previous conducted survey *(dd/mm/yy)*	

Additional Information	
Did you divert from the predetermined 100 metres:	No Yes, please specify new GPS coordinates

Did any of the following weather conditions affect the data of the survey:

Wind ☐ Rain ☐ Sand storm ☐ Fog ☐

Snow ☐ Exceptionally high tide ☐

Did you find stranded or dead animals?

Yes ☐ No ☐ If so how many:

Describe the animals, or note the species name if known:

Stranded animals Dead ☐ Alive ☐

Is the animal entangled in litter? Yes ☐ No ☐ If so, specify litter item

Were there any circumstances that influenced the survey? For example tracks on the beach (cleaning or other), recent replenishment of the beach or other.
Please specify:

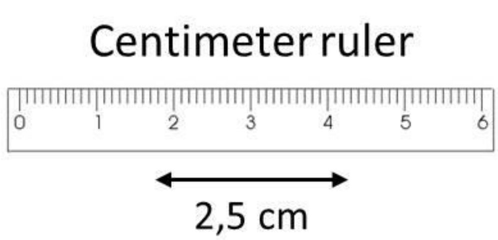
Were there any unusual marine litter items and/or marine litter loads?
Please specify:

MEDPOL Beach Litter Survey Form

Mediterranean Action Plan
Barcelona Convention

ID (See note)	PLASTIC/POLYSTYRENE	Nº units
G1	4/6-pack yokes, six-pack rings	
G3	Shopping bags incl. pieces	
G4	Small plastic bags, e.g. freezer bags incl. pieces	
G5	Plastic bag collective role; what remains from rip-off plastic bags	
G7/G8	Drink bottles	
G9	Cleaner bottles & containers	
G10	Food containers incl. fast food containers	
G11	Beach use related cosmetic bottles and containers, e.g. Sunblocks	
G14	Engine oil bottles & containers <50 cm	
G15	Engine oil bottles & containers >50 cm	
G16	Jerry cans (square plastic containers with handle)	
G17	Injection gun containers (including nozzles)	
G13	Other bottles & containers	
G18	Crates and containers / baskets	
G19	Car parts	
G21/24	Plastic caps and lids (including rings from bottle caps/lids)	
G26	Cigarette lighters	
G28	Pens and pen lids	
G29	Combs/hair brushes/sunglasses	
G30/31	Crisps packets/sweets wrappers/ Lolly sticks	
G32	Toys and party poppers	
G33	Cups and cup lids	
G34/35	Cutlery and trays/Straws and stirrers	
G36	Fertiliser/animal feed bags	
G37	Mesh vegetable bags	
G40	Gloves (washing up)	
G41	Gloves (industrial/professional rubber gloves)	
G42	Crab/lobster pots and tops	
G43	Tags (fishing and industry)	
G44	Octopus pots	

G45	Mussels nets, Oyster nets including plastic stoppers	
G46	Oyster trays (round from oyster cultures)	
G47	Plastic sheeting from mussel culture (Tahitians)	
G49	Rope (diameter more than 1cm)	
G50	String and cord (diameter less than 1 cm)	
G53	Nets and pieces of net < 50 cm	
G54	Nets and pieces of net > 50 cm	
G56	Tangled nets/cord	
G57/58	Fish boxes - plastic or polystyrene	
G59	Fishing line/monofilament (angling)	
G60	Light sticks (tubes with fluid) incl. Packaging	
G62/63	Floats for fishing nets/ Buoys	
G65	Buckets	
G66	Strapping bands	
G67	Sheets, industrial packaging, plastic sheeting	
G68	Fibre glass/fragments	
G69	Hard hats/Helmets	
G70	Shotgun cartridges	
G71	Shoes/sandals	
G73	Foam sponge	
G75	Plastic/polystyrene pieces 0 - 2.5 cm	
G76	Plastic/polystyrene pieces 2.5 cm - 50 cm	
G77	Plastic/polystyrene pieces > 50 cm	
G91	Biomass holder from sewage treatment plants	
G124	Other plastic/polystyrene items (identifiable) including fragments	
Please specify the items included in G124		



Note: The allocated codes may be revised in the near future.

ID	RUBBER	Nº units
G125	Balloons and balloon sticks	
G127	Rubber boots	
G128	Tyres and belts	
G134	Other rubber pieces	
Please specify the items included in G134		
ID	**CLOTH**	Nº units
G137	Clothing / rags (clothing, hats, towels)	
G138	Shoes and sandals (e.g. Leather, cloth)	
G141	Carpet & Furnishing	
G140	Sacking (hessian)	
G145	Other textiles (incl. rags)	
Please specify the items included in G145		
ID	**PAPER / CARDBOARD**	Nº units
G147	Paper bags	
G148	Cardboard (boxes & fragments)	
G150	Cartons/Tetrapack Milk	
G151	Cartons/Tetrapack (others)	
G152	Cigarette packets	
G27	Cigarette butts and filters	
G153	Cups, food trays, food wrappers, drink containers	
G154	Newspapers & magazines	
G158	Other paper items, including fragments	
Please specify the items included in G158		
ID	**PROCESSED / WORKED WOOD**	Nº units
G159	Corks	
G160/161	Pallets / Processed timber	
G162	Crates	
G163	Crab/lobster pots	
G164	Fish boxes	
G165	Ice-cream sticks, chip forks, chopsticks, toothpicks	
G166	Paint brushes	
G171	Other wood < 50 cm	
Please specify the items included in G171		
G172	Other wood > 50 cm	
Please specify the items included in G172		

ID	METAL	Nº units
G174	Aerosol/Spray cans industry	
G175	Cans (beverage)	
G176	Cans (food)	
G177	Foil wrappers, aluminium foil	
G178	Bottle caps, lids & pull tabs	
G179	Disposable BBQ's	
G180	Appliances (refrigerators, washers, etc.)	
G182	Fishing related (weights, sinkers, lures, hooks)	
G184	Lobster/crab pots	
G186	Industrial scrap	
G187	Drums, e.g. oil	
G190	Paint tins	
G191	Wire, wire mesh, barbed wire	
G198	Other metal pieces < 50 cm	
Please specify the items included in G198		
G199	Other metal pieces > 50 cm	
Please specify the items included in G199		
ID	**GLASS**	Nº units
G200	Bottles incl. pieces	
G202	Light bulbs	
G208	Glass fragments >2.5cm	
G210a	Other glass items	
Please specify the items included in G210a		
ID	**CERAMICS**	Nº units
G204	Construction material (brick, cement, pipes)	
G207	Octopus pots	
G208	Ceramic fragments >2.5cm	
G210b	Other ceramics items	
Please specify the items included in G210b		
ID	**SANITARY WASTE**	Nº units
G95	Cotton bud sticks	
G96	Sanitary towels/panty liners/backing strips	
G97	Toilet fresheners	
G98	Diapers/nappies	

G133	Condoms (incl. packaging)	
G144	Tampons and tampon applicators	
--	Other sanitary waste	
Please specify the other sanitary items		
ID	**MEDICAL WASTE**	Nº units
G99	Syringes/needles	
G100	Medical/Pharmaceuticals containers/tubes	
G211	Other medical items (swabs, bandaging, adhesive plaster etc.)	
Please specify the items included in G211		
ID	**FAECES**	Nº units
G101	Dog faeces bag	
ID	**PARAFFIN/WAX PIECES**	Nº units
G213	Paraffin/Wax	
Presence of industrial pellets?	☐ YES ☐ NO	
Presence of oil tars?	☐ YES ☐ NO	
ADDITIONAL COMMENTS:		

Annex III
MEDPOL Working Sheet -- Sea floor Litter

Mediterranean Action Plan
Barcelona Convention

MEDPOL WORKING SHEET FOR SEAFLOOR MARINE LITTER

Country :	
Date (dd/mm/yy) :	
Surveyor information : **(name, phone, e-mail, etc.)**	
Area (EcAp Code) :	
Campaign name :	
Vessel name :	
Haul number :	
Gear (e.g. bottom trawl, etc.) :	
Speed (knot) :	
Opening of the net (m) : **(e.g. SCANMAR Trawl Sensor or SIMRAD)**	
Cod-end mesh size (mm) :	
Latitude (Start and End) :	
Longitude (Start and End) :	
Depth (Start and End) :	
Haul duration (minutes) :	
Distance covered (km) :	

LITTER_CATEGORY	Number	Weight	OBSERVATIONS
L0 No litter			
L1a. Plastic Bags			
L1b. Plastic Bottles			
L1c. Plastic Food wrappers			
L1d. Plastic sheets			
L1e. Hard plastic objects			
L1f. Fishing nets (polymers)			
L1g. Fishing lines (polymers)			
L1h. Other synthetic fishing related			
L1i. Synthetic ropes/strapping bands L1j Others plastic			
L1 TOTAL PLASTIC			
L2a. Tyres			
L2b. Other rubber (gloves, floats, etc.)			
L2 TOTAL RUBBER			
L3a. Beverage cans (metal)			
L3b. Other food cans/wrappers			
L3c. Middle size containers (paint, etc.)			
L3d. Large metalic objects			
L3e. Cables			
L3f. Fishing related (hooks, spears, etc.) L3g. remnant from the war			
L3 TOTAL METAL			
L4a. Glass/ceramic Bottles L4b. Pieces of glass L4c. Ceramic jars			

L4d. Large objects			
L4 TOTAL GLASS/ CERAMIC			
L5a. Clothing (other than polymers) L5b. Large pieces (carpets, etc.) L5c. Natural fishing ropes L5d. Sanitaries (non polymers)			
L5 TOTAL TEXTILS / NATURAL FIBERS			
L6 TOTAL Wood processed			
L7 TOTAL Paper and cardboard			
L8 TOTAL Other			
L9 TOTAL UNSPECIFIED			
TOTAL LITTER			
TOTAL FISHING GEARS (L1 f to i; L3f, L5c)			
START POSITIONS :			
END POSITIONS			