Monitoring Factsheet

Eutrophication

1. Subject: Eutrophication

Increased levels of nutrients in the marine environment can lead to enhanced primary or biomass production resulting in changes in light penetration in the marine environment and increased carbon fixation, algal blooms, and changes to the taxonomic composition of algae and plants.

'Eutrophication' is the term used to describe the process of nutrient enrichment, especially compounds of nitrogen and/or phosphorous[1] leading to the effects described above. The consequences of eutrophication are undesirable if they appreciably degrade ecosystem health and/or the sustainable provision of goods and services.

Increased levels of organic matter in the marine environment are also associated with negative effects on the marine environment. The decay of organic matter often leads to a stimulation of microbial decomposition and oxygen consumption, depleting bottom-water oxygen concentrations and potentially bringing about anoxic conditions especially in stratified water bodies.

[1] Definition extracted from Ferreira, J.G.; Andersen, J.H.; Borja, A.; Bricker, S.B.; Camp, J. ; Cardoso da Silva, M.; Garces, E.; Heiskanen, A.S.; Humborg, C.; Ignatiades, L.; Lancelot, C.; Menesguen, A.; Tett, P.; Hoepffner, N. & Claussen, U. Marine Strategy Framework Directive Task Group 5 report on Eutrophication. Joint Report Prepared under the Administrative Arrangement between JRC and DG ENV (no 31210 ² 2009/2010), the Memorandum of Understanding between the European Commission and ICES managed by DG MARE and JRC's own institutional funding; Editor: N. Zampoukas.

2. Monitoring Requirements

2.1. Water Framework Directive – WFD (2000/60/EC)

The Water Framework Directive establishes requirements for good surface water quality. The Directive requires the assessment of chemical and physico-chemical elements supporting the Biological Quality Elements (BQE/s) which need to be assessed for the classification of ecological status.

For coastal waters, such physico-chemical elements include:

- Thermal conditions
- Oxygenation conditions
- Salinity
- Acidification status
- Nutrient conditions

There are three types of monitoring for surface waters described in Annex V of the WFD:

- surveillance monitoring: parameters indicative of all the biological, hydromorphological, general and specific physico-chemical quality elements and the priority list of pollutants which are discharged in significant quantities into the water body;
- operational monitoring: parameters indicative of the biological and hydromorphological quality elements most sensitive to the pressures to which the water body is subject and all priority substances discharged and other substances discharged in significant quantities; and
- investigative monitoring: targeted at identification of causes of degradation of state.

For the purposes of monitoring water bodies at risk because of nutrient enrichment, Member States must monitor parameters indicative of the Biological Quality Element (BQE/s)[2] most sensitive to the effects of nutrient enrichment as well as the nutrients that are being discharged into the water body in significant quantities.

2.2. Marine Strategy Framework Directive – MSFD (2008/56/EC)

2.2.1. Annex III characteristics/pressures/impacts

The MSFD calls for an assessment of the environmental status based on a list of characteristics listed in Table 1 of Annex III to the Directive, and pressures and impacts listed in Table 2 of the same Annex.

[2] Biological Quality Elements for coastal waters under the WFD (2000/60/EC) are phytoplankton, macroalgae, benthic invertebrates and angiosperms.

Implementation of this monitoring factsheet will enable a description of physical and chemical features as listed in Table 1 of Annex III including:

- annual and seasonal temperature regime;
- spatial and temporal distribution of salinity;
- spatial and temporal distribution of nutrients (DIN, TN, DIP, TP, TOC) and oxygen;
- pH

The monitoring factsheet also enables assessment of 'Nutrient and Organic Matter Enrichment' as a pressure on the marine environment as listed in Table 2 of Annex III to the Directive, including:

- Inputs of fertilisers and other nitrogen- and phosphorous-rich substances (e.g. from point and diffuse sources, including agriculture, aquaculture and atmospheric deposition)
- Inputs of organic matter (e.g. sewers, mariculture, riverine inputs).

2.2.2. Annex I Good Environmental Status Descriptors

MSFD Annex I descriptors of Good Environmental Status and the associated criteria and indicators established by MSFD Commission Decision 2010/477/EU for assessment of progress towards the achievement of GES in terms of eutrophication and which are addressed by this monitoring factsheet are listed hereunder:

Descriptor 5: Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters

- Criterion 5.1: Nutrient Levels
  - Nutrients concentration in the water column (5.1.1)
  - Nutrient ratios (silica, nitrogen and phosphorous), where appropriate (5.1.2)

- Criterion 5.2: Direct effects of nutrient enrichment
  - Chlorophyll concentration in the water column (5.2.1)
  - Water transparency related to increase in suspended algae, where relevant (5.2.2)
  - Abundance of opportunistic macroalgae (5.2.3)
  - Species shift in floristic composition such as diatom to flagellate ratio, benthic to pelagic shifts, as well as bloom events of nuisance/toxic algal blooms (e.g. cyanobacteria) caused by human activities (5.2.4)

- Criterion 5.2: Indirect effects of nutrient enrichment
  - Abundance of perennial seaweeds and seagrasses (e.g. fucoids, eelgrass and Neptune grass) adversely impacted by decrease in water transparency (5.3.1)
  - Dissolved oxygen, i.e. changes due to increased organic matter decomposition and size of the area concerned (5.3.2)

2.3. Urban Waste Water Treatment Directive (91/271/EEC)

This Directive, which aims at protecting the environment from adverse effects of urban waste water discharges and discharges from certain industrial sectors, requires monitoring of the composition of the effluents as outlined below:

- Discharges from urban waste water treatment plants should be monitored to verify compliance with the requirements of the Directive in terms of Biochemical Oxygen Demand, Chemical Oxygen Demand and Total Suspended Solids, and for discharges to sensitive areas, total phosphorous and total nitrogen as additional parameters.

and monitoring of receiving waters as per below:

- Waters subject to discharges from urban waste water treatment plants and direct discharges[3] in cases where it can be expected that the receiving environment will be significantly affected;
- In case of discharge to less sensitive areas, relevant monitoring shall be carried out in order to verify that the discharge does not adversely affect the environment.

2.4. Nitrates Directive (91/676/EEC)

The Nitrates Directive deals with the diffuse nature of nitrate contamination from agricultural sources. Sites that are prone or potentially prone to nitrate contamination are designated as 'Nitrate Vulnerable Zones' and action programmes should be set up to combat nitrate contamination in such areas. Member States shall draw up and implement suitable monitoring programmes to assess the effectiveness of the action programmes. Should the designation of 'Nitrate Vulnerable Zone' cover the national territory, monitoring of nitrate content should be made at selected measuring points which make it possible to establish the extent of nitrate pollution in the waters from agricultural sources.

2.5. Barcelona Convention, Land-Base Protocol and MEDPOL

The Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention) and its protocols aim at reducing pollution in the Mediterranean Sea and protecting and improving the marine environment in the area.

[3] Direct discharges in this case refer to biodegradable industrial waste water from plants belonging to the sectors listed in this note, which does not enter urban waste water treatment plants before discharge to receiving waters. These sectors, listed in Annex III of the Directive are as follows: milk-processing, manufacture of fruit and vegetable products, manufacture and bottling of soft drinks, potato-processing, meat industry, breweries, production of alcohol and alcohol beverages, manufacture of animal feed from plant products, manufacture of gelatine and glue from hides, skin and bones, malt-houses and fish-processing industry.

The Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources and Activities (LBS Protocol) identifies a list of substances of which control should be sought through action plans, programmes and measures. This list includes substances which have directly or indirectly an adverse effect on the oxygen content of the marine environment, especially those which may cause eutrophication.

The Programme for the Assessment and Control of Marine Pollution in the Mediterranean region (MEDPOL) is the environmental assessment component of the Mediterranean Action Plan (MAP) of the Barcelona Convention. MEDPOL Phase III identifies mandatory and recommended parameters for monitoring in effluents (input loads), water, sediment and biota. The mandatory parameters include the Total Suspended Solids, Biological Oxygen Demand, Chemical Oxygen Demand, Total Phosphorous and Total Nitrogen for effluents. Monitoring of nutrients, dissolved oxygen, chlorophyll-a and phytoplankton is recommended in seawater.

In recent years, the Mediterranean Action Plan has identified both a short-term and long term monitoring strategy for eutrophication[4]. The aim of the short term strategy was to monitor those parameters that support the TRIX index[5]. This strategy identifies additional mandatory parameters to be monitored by each country in seawater.

The Barcelona Convention/MAP are working towards an Integrated Monitoring Programme and an Integrated Policy of Assessments to be established by 2015. The Integrated Monitoring Programme should be able to provide all the data needed to assess whether Good Environmental Status defined through the ECAP process[6] has been achieved or maintained. The essential technical groundwork to develop the integrated monitoring programme (such as the development of methodological, technical issues, scope, feasibility, quality control, cost-effectiveness, common indicators) will be undertaken in 2014-2015. The integrated monitoring and assessment programme is to run on a 2 year initial basis in order to assess the effectiveness of the programmes, perform further gap analysis and establish needs for adaptation.

[4] UNEP. 2007. Eutrophication Monitoring Strategy for the Mediterranean Action Plan, Review meeting of MED POL monitoring activities and the use of indicators. UNEP (DEPI)/MED WG.321/Inf.5

[5] The TRIX index or Trophical Index for Marine systems is an index developed by Vollenweider *et al*. 1998 based on chlorophyll-a, oxygen saturation, total nitrogen and total phosphorus to characterise the trophic state of coastal and marine waters. Such an index assesses the trophic potential of a water body but does not inform on the actual state and changes in the biological community.

[6] Ecosystem-based approach undertaken as part of the Barcelona Convention.

2.6. E-PRTR Regulation (Regulation 166/2006)

The regulation concerning the establishment of a European Pollutant Release and Transfer Register calls for reporting by the operators of the facilities listed in Annex I to the regulation, of releases of pollutants. Such reporting should include:

- the annual amount of releases to air, water and land of any pollutant specified in Annex II for which the applicable threshold value specified in this Annex is exceeded; and
- the annual amount of off-site transfers of the same pollutants in waste water destined for waste-water treatment for which the threshold value specified in Annex II is exceeded.

Pollutants of relevance to nutrient enrichment include total nitrogen (threshold for reporting releases to water column 50 000kg/year), total phosphorus (threshold for reporting releases to water column 5 000kg/year) and total organic carbon (TOC) (threshold for reporting releases to water column 50 000kg/year).

2.7. Industrial Emissions Directive (2010/75/EU)

This Directive applies to industrial activities and lays down the rules on integrated prevention and control of pollution arising from such activities. Member States shall take the necessary measures to provide that industrial installations listed in Annex I to the Directive are operated in a manner that includes all the appropriate preventive measures against pollution. Application for permits to operate the installations should include measures planned to monitor emissions into the environment, and the list of polluting substances includes those which contribute to eutrophication in particular nitrates and phosphates, and substances which have an unfavourable influence on the oxygen balance (and can be measured using parameters such as BOD, COD, etc.). The frequency of the periodic monitoring shall be determined by the competent authority in a permit for each individual installation or in general binding rules.

The competent authority shall also set emission limit values and ensure that, under normal operating procedures, emissions do not exceed the emission levels associated with the best available technologies.

2.8. Bathing Water Quality Directive (**2006/7/EC)**

The Bathing Water Directive (BWD) is mainly concerned with the use of beaches by bathers and the management of water quality to standards that are safe for human health. In Malta the BWD is implemented through LN 125 of 2008[7] as amended by LN 237 of 2011[8].

[7] Public Health Act (CAP. 465) Management of Bathing Water Quality Regulations, 2008 (L.N. 125 of 2008)

[8] Public Health Act (CAP. 465) Management of Bathing Water Quality (Amendment) Regulations, 2008 (L.N. 237 of 2011)

As part of the requirements of the Directive, bathing water profiles have been prepared for all 87 designated bathing waters on the Maltese Islands. Each bathing water profile gives information about the bathing water quality, including the potential pollution risks at the site. Although not directly related to monitoring for nutrient enrichment, the bathing water profiles may provide information with respect potential sources of pollution including nutrients.

3. Targets

This section includes targets set by policies in relation to eutrophication.

Implementation of this monitoring factsheet would enable assessment of progress towards the achievement of targets adopted by Malta as part of the EU Marine Strategy Framework Directive. Such monitoring may also apply in assessing progress towards targets articulated through other processes.

Policy	Status to be achieved	Targets
Water Framework Directive	For good status, physico-chemical conditions must be such as to support the required biological quality element values associated with a good classification.	
Marine Strategy Framework Directive	Good Environmental Status Nutrient levels (or ratios as applicable) and chlorophyll-a levels in the marine environment do not depart significantly from natural levels of the Mediterranean Sea.	Long-term data on nutrient levels in the marine environment, or on direct or indirect effects of nutrient enrichment (as relevant), in relation to the main sources of nutrient input, is indicative of the effectiveness of existing mechanisms addressing nutrient input in the marine environment.
	Good Environmental Status Biological communities (assessed at relevant scales) are indicative of either undisturbed conditions or of slight or localised changes associated with nutrient enrichment.	
Barcelona Conventi	Operational Objective: *Human introduction of nutrients in the marine environment is not conducive to eutrophication*	Reference nutrients concentrations according to the local hydrological, chemical and morphological characteristics of the un-impacted marine

		region
	Common Indicator[9]*:* ▪ *Concentration of key nutrients in the water column (5.1.1)* Good Environmental Status defined as 'Concentrations of nutrients in the euphotic layer are in line with prevailing physiographic, geographic and climate conditions'	Decreasing trend of nutrients concentrations in water column of human impacted areas, statistically defined
		Reduction of BOD emissions from land based sources
		Reduction of nutrients emissions from land based sources
	Operational Objective: Human introduction of nutrients in the marine environment is not conducive to eutrophication *Indicator:* ▪ *Nutrient ratios (silica, nitrogen and phosphorous) where appropriate* Good Environmental Status defined as 'Natural ratios of nutrients are Kept'	No specific targets.
	Operational Objective: Direct effects of nutrient over-enrichment are prevented. *Common Indicator*[10]*:* ▪ *Chlorophyll-a concentration in the water column* Good Environmental Status defined as 'Natural levels of algal biomass in line with prevailing physiographic, geographic and weather conditions'	Chl-a concentrations in high-risk areas below thresholds (thresholds still to be set)
		Decreasing trend in chl-a concentrations in high risk areas affected by human activities
	Operational Objective: Direct effects of nutrient over-enrichment are prevented. *Indicator:* ▪ *Water transparency where relevant*	Index of turbidity behind threshold in high risk areas
		Increasing trend of transparency in areas impacted by human activities

[9] UNEP/MAP 2014.Working document on Common Indicators for the Mediterranean. Integrated Correspondence Groups of GES and Targets Meeting, Athens (Greece), 17-19 February 2014 , UNEP(DEPI)/MED WG.390/3

[10] UNEP/MAP 2014.Working document on Common Indicators for the Mediterranean. Integrated Correspondence Groups of GES and Targets Meeting, Athens (Greece), 17-19 February 2014 , UNEP(DEPI)/MED WG.390/3

	Good Environmental Status defined as 'Water transparency in line with prevailing physiographic, geographic and climate Conditions'.	
	Operational Objective: Indirect effects of nutrient over- enrichment are prevented *Indicator:* ▪ *Dissolved oxygen near the bottom i.e. changes due to increased organic matter decomposition, and size of the area concerned.* Good Environmental Status defined as 'Bottom water fully oxygenated in line with prevailing physiographic, geographic and climate conditions'.	Dissolved oxygen concentrations in high-risk areas above local threshold Increasing trend in dissolved oxygen concentrations in areas impacted by human activities
Urban Waste Water Treatment Directive	Biochemical oxygen demand (BOD), Chemical Oxygen Demand (COD) and Total Suspended Solids in urban wastewater treated effluents are in line with the requirements of the Directive.	Thresholds (for effluents): BOD: 25mg/l O_2 ; Minimum percentage of reduction[11]: 70-90% COD: 125mg/l O_2; Minimum percentage of reduction: 75% Total Suspended Solids: 35mg/l (more than 10 000p.e.) with a minimum percentage reduction of 90%; or 60mg/l (2 000-10 000p.e.) with a minimum percentage reduction of 70%
	The Directive calls for the identification of areas or water bodies that are eutrophic, or are at risk of becoming so if mitigation action is not taken, as 'sensitive areas'. Within these areas, higher thresholds for quality of marine discharges from urban waste water treatment plants apply.	Total Phosphorous: ▪ 2mg/l P (10 000 – 100 000p.e.); minimum percentage reduction: 80%; OR ▪ 1mg/l P (more than 100 000p.e.); minimum percentage reduction: 80% Total Nitrogen: ▪ 15mg/l N (10 000 – 100 000p.e.); minimum percentage reduction: 70-80%; or ▪ 10mg/l N (more than 100 000p.e.); minimum percentage reduction: 70-80%

[11] Reduction in relation to the load of the influent

4. Competent Authorities

Policy	Competent Authority
WFD	Malta Environment and Planning Authority (coastal waters, transitional waters and inland surface waters)
MSFD	Office of the Prime Minister (delegation of technical implementation to the Malta Environment and Planning Authority)
Urban Waste Water Treatment Directive	Malta Environment and Planning Authority
Nitrates Directive	Malta Environment and Planning Authority & Department of Agriculture
Barcelona Convention	Malta Environment and Planning Authority
E-PRTR regulations & Industrial Emissions Directive	Malta Environment and Planning Authority

5. Spatial Extent of monitoring requirements

Policy	Extent of marine waters
WFD	12 nautical miles
MSFD	Extent of waters to be monitored depends on relevance and established GES and targets.
Barcelona Convention	Regional
Urban Waste Water Treatment Directive	Areas affected by discharge of wastewaters
E-PRTR and Industrial Emissions Directive	Effluent monitoring

6. Monitoring Approach

This monitoring factsheet includes five monitoring subprogrammes listed hereunder:

Monitoring sub-programme	Title	Monitoring Purpose
1	Nutrient Levels in Water Column and Phytoplankton	Pressure
2	Water Column – Physical and chemical characteristics	State
3	Organic Matter in Sediment	Pressure
4	Direct and Indirect effects of Eutrophication	State/impacts
5	Nutrient inputs – land-based and	Pressure

	sea-based sources	

Implementation of the monitoring sub-programmes will provide data in relation to the level of nutrients in the water column and enable assessment of any direct and indirect effects of nutrient and organic matter enrichment on the physical, chemical and biological characteristics of the water column and on seabed habitats. The monitoring sub-programmes will also be providing information on the input of nutrients/organic matter in the marine environment through anthropogenic activities, by building on relevant mechanisms already in place.

Monitoring for the purposes of 'eutrophication' should apply a risk-based approach and should be flexible on the choice of parameters to be monitored, the frequency of monitoring as well as the location of monitoring stations. Following the first monitoring year, the parameters to be monitored, the location of monitoring stations and the frequency of monitoring as listed in this document will be revised on the basis of a risk-based approach following further knowledge on:

- the status of each station in terms of nutrient and organic enrichment;
- links between activities and impacts on the marine environment;
- links between nutrient and organic enrichment and the status of water column habitat types

7. Assessment of status

The spatial and temporal extent of the data which is currently available is insufficient to define links between the status of the marine environment (or biological quality elements) in terms of nutrient and organic matter enrichment and relevant pressures. This scenario does not allow the establishment of thresholds. Furthermore, setting thresholds on the basis of one-year baseline data could be premature and any set thresholds could be misleading. Within this context, for the first monitoring years, assessment of status in terms of 'eutrophication' is based on trends in the monitored parameters.

8. Monitoring sub-programme 1: *Nutrient Levels in Water Column and Phytoplankton*

8.1. Monitoring Parameters

8.1.1. Nutrient Levels

Table 1: List of nutrients to be monitored in water

Parameter	Unit	WFD	MSFD	MEDPOL[12]
Dissolved Nitrates (NO_3-N)	NO_3-N µmol/L, µg/L	×	×	×
Dissolved Nitrites (NO_2-N)	NO_2-N µmol/L, µg/L	×	×	×
Ammonium ions (NH_4-N)	NH_4-N µmol/L, µg/L	×	×	×
Dissolved Phosphates (PO_4-P)	PO_4-P µmol/L, µg/L	×	×	×
Silicate (SiO_2)	SiO_2 µmol/L		×	×
Total Nitrogen	N µmol/L, µg/L	×	×	×
Total Phosphorous	P µmol/L, µg/L	×	×	×
N:P:Si ratio			×	

8.1.2. Phytoplankton[13]

Table 2: List of parameters for phytoplankton to be monitored in water

Parameter/Indicator	Unit	WFD	MSFD	MEDPOL[14]
Chlorophyll-a	µg/L	×	×	×
Phytoplankton abundance	cells per litre	×	×	×
Phytoplankton composition including:		×	×	×
- Percentage abundance of blooming species[15]			×	×
- Diatom to flagellate ratio			×	

[12] The list of parameters is in line with the 'Eutrophication Monitoring Strategy for MED POL' UNEP(DEPI)/MED WG.321/Inf.5 listing the mandatory parameters to be monitored by each country, which parameters support the adoption of the TRIX index.

[13] Monitoring processes for phytoplankton reflect those adopted by the 'Water Column Habitats' monitoring factsheet

[14] The list of parameters is in line with the 'Eutrophication Monitoring Strategy for MED POL' UNEP(DEPI)/MED WG.321/Inf.5 listing the mandatory parameters to be monitored by each country, which parameters support the adoption of the TRIX index.

[15] Ferreria *et al.* (2010) distinguish three types of harmful blooms: (i) those due to toxic algae (e.g. *Alexandrium*, *Dinophysis* and *Pseudonitzschia*) which can poison fish and shellfish even at low algal abundance; (ii) potentially toxic algae (e.g. *Pseudonitzschia*); and (iii) high-biomass blooms that cause problems mainly because of the high biomass itself. High-biomass blooms are sometimes called "red tides" but may in fact be brown, green or white discolourations of the sea. Some organisms (e.g. *Alexandrium*) occur in more than one category. Links between HABs and nutrient enrichment have been much debated. HABs should be treated as part of the undesirable consequences of eutrophication only if their frequency or amplitude increases in correspondence with increased nutrient input.

8.2. Supporting Parameters

Parameter	Related Monitoring Factsheet
Hydrographical Conditions namely surface and sub-surface currents, bathymetry, water stratification	Hydrographical Changes

8.3. Monitoring methodologies

This section briefly outlines methodologies for monitoring of nutrient levels in the water column and phytoplankton. Adherence to methodological standards as listed in Section 14 of this factsheet should be ensured at all times. With respect to nutrient and phytoplankton, monitoring methodologies should primarily be in line with those stipulated in UNEP/MAP/MED POL (2005)[16].

8.3.1. Sampling

- Water sampling will take place at monitoring stations at surface (0m) and at one sub-surface depth (between 1 and 5m from surface) for analysis of nutrients, chlorophyll-a levels and phytoplankton profiles.

- Water sampling along specified transects (Section 8.4.4) will take place at three depths: surface, medium depth and bottom as required by the 'Eutrophication Monitoring Strategy of MEDPOL'[17].

- Samples are collected using Van-Dorn vertical all-plastic sampler or Niskin bottles[18]. For chlorophyll-a analysis, samples are collected in dark glass containers and filtered either immediately on board the vessel, or else in the laboratory within 8 hours from collection.

- Samples will be appropriately preserved and stored in agreement with the accredited laboratory performing the chemical analyses. Different preservation methods should be used for samples taken for analysis of phytoplankton. Samples intended for identification of major groups should be preserved in Lugol's Iodine, while samples intended for detailed species identification should be preserved using both Lugol's Iodine and formalin (2 aliquots)

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16 UNEP/MAP/MED POL (2005). Sampling and Analysis Techniques for the Eutrophication Monitoring Strategy of MED POL. MAP Technical Reports Series No. 163. UNEP/MAP, Athens, 2005.

17 UNEP(DEC)/MED WG. 231/14

18 Phytoplankton nets, which are useful in collecting samples over a relatively large area to assess the different species of phytoplankton that are present, may be used in offshore stations (only) to collect semi-quantitative data to be combined with quantitative data from samples collected in Niskin bottles. A conical net of diameter 20 – 30 cm, having a mesh size of 100µm or smaller (30 – 80 µm), is deployed at a specific depth between 1 and 5m from surface. The towing speed should be relatively constant between 1 and 2 knots and horizontal tows should be of 5-10 minutes duration. The net is rinsed thoroughly between hauls so as to remove any species that might have adhered to its sides.

8.3.2. Analysis

8.3.2.1. Limits of Detection and Limits of Quantification

Limits of Detection and/or Limits of Quantification to be applied for nutrient and chlorophyll-a analysis are listed in Table 3.

Table 3: Limits of Detection and Limits of Quantification to be used in sample analysis

Parameter	Limit of Detection		Limit of Quantification	
	µmol	µg	µmol	µg
Dissolved nitrates	0.01µmol-N/L	0.14µg N/L	0.03µmol-N/L	0.46µg N/L
Dissolved nitrites	0.01µmol-N/L	0.14µg N/L	0.05µmol-N/L	0.7µg N/L
Ammonium ions	0.01µmol-N/L	0.14µg N/L	0.03µmol-N/L	0.46µg N/L
Dissolved phosphates	0.005µmol-P/L	0.15µg P/L	0.01µmol-P/L	0.31µg P/L
Total Nitrogen	0.1µmol-N/L	1.4µg N/L	0.17µmol-N/L	2.4µg N/L
Total Phosphorous	0.01µmol-P/L	0.3µg P/L	0.02µmol-P/L	0.62µg P/L
Dissolved silicates	0.01µmol-Si/L	0.28µg Si/L	0.02µmol-Si/L	0.56µg Si/L
Chlorophyll a[19]		0.05µg/L		0.1µg /L

8.3.2.2. Nutrient ratios

Nutrient ratios are to be determined for each sample, by determining the atomic elemental ratio of total nitrogen to total phosphorous to silicates.

8.3.2.3. Phytoplankton[20]

The following analysis will be carried out with respect to phytoplankton:

- *Full species composition and Abundance*: involving concentration of samples followed by enumeration and identification to genus or species level on an inverted optical microscope. The cells being randomly distributed, would be viewed along transects within the field of view or else, if a significant amount of cells are present, they would be viewed in random fields. The cells on the transect or in a field are identified to species level and counted in a tally chart. The number of cells recorded in a subsample is then calculated as a function of the volume of sample and the magnification used, to arrive at the estimate of 'number of cells per litre'. This value would be used to calculate percentage abundances for other parameters.
- *Total Abundance of major groups*: identification of individuals down to the major groups: diatoms, dinoflagellates, and other phytoplankton. Diatom to flagellate ratios to be determined.
- *Percentage abundance of blooming species*: Species known to have a tendency to bloom are specifically counted and their percentage abundance is calculated

[19] Chlorophyll a concentration is determined through spectrophotometry (SPFT)

[20] Monitoring processes for phytoplankton reflect those adopted by the 'Water Column Habitats' monitoring factsheet

from the total abundance. Species to be considered: diatoms *Skeletonema costatum*, *Chaetoceros* spp., *Pseudonitzschia* spp., and dinoflagellates *Dinophysis* spp., *Ceratium* spp., *Prorocentrum* spp.

8.4. Monitoring area

8.4.1. Monitoring stations: Inshore

Inshore monitoring stations for assessing nutrient levels and phytoplankton for the purpose of 'eutrophication' are listed in Table 4. All parameters listed in Table 1 and Table 2 will be monitored at these stations.

Table 4: Inshore Monitoring Stations

Mon. Site Ref. Code	Monitoring Network	Coordinates (Full UTM ED50)	
		Longitude	Latitude
Operational Monitoring Stations			
CP04-1[21]	Operational	453769,71	3977836,62
CP04-2	Operational	449013,07	3979914,24
CP05	Operational - Harbour	457169,68	3973252,05
CP06-1[22]	Operational	461078,41	3971492,15
CP06-2	Operational	460522,84	3970960,01
CP07	Operational - Harbour	459771,77	3964111,98
Surveillance Monitoring Stations			
CS01[23]	Surveillance	425781,39	3992303,97
CS02[24]	Sur + Reference Site	435571,14	3992063,13
CS03[25]	Sur + Reference Site	442502,54	3984741,51
CS08[26]	Surveillance	453654,59	3962794,34
CS09[27]	Sur + Protected area	439697,26	3976129,46
National Monitoring Stations of relevance to 'Eutrophication'			
CN01-1	Protected Area	426700,89	3990134,58
CN02-1	Op – Diffuse sources	433397,15	3992518,78
CN03-1	Op – Sewage Outfall	435420,03	3986084,12
CN03-2	Op - Harbour	437057,14	3987236,76
CN03-3	Op-Harbour	440130,02	3983083,45
CN03-6	Op-Minor Sewage Outfall	441540,34	3985079,15
CN04-1[28]	Op - diffuse sources	442596,44	3981355,59
CN04-3[29]	Op - bunkering site	445500,41	3984462,78

[21] Station located beyond 500m therefore can be considered to be nearshore.
[22] Station located beyond 500m therefore can be considered to be nearshore.
[23] Station located beyond 500m therefore can be considered to be nearshore.
[24] Station located beyond 500m therefore can be considered to be nearshore.
[25] Station located beyond 500m therefore can be considered to be nearshore.
[26] Station located beyond 500m therefore can be considered to be nearshore.
[27] Station located beyond 500m therefore can be considered to be nearshore.
[28] Station located beyond 500m therefore can be considered to be nearshore.
[29] Nutrients were not assessed within this station during the first WFD monitoring surveys. Station retained for monitoring to be representative of bunkering sites. Station located beyond 500m therefore can be considered to be nearshore.

Mon. Site Ref. Code	Monitoring Network	Coordinates (Full UTM ED50)	
		Longitude	Latitude
CN04-5	Nitrates Directive	454162,08	3976206,21
CN04-6	Nitrates Directive	454528,54	3975162,74
CN05-1	Op - Harbour	455167,45	3973034,62
CN06-1	Op - diffuse sources	460815,92	3969206,43
CN07-1	Op - Thermal effluent	460712,08	3966044,50
CN07-3	Op – Harbour	458110,28	3965070,20
CN08-1	Op – Desalination Plant	447163,40	3965389,58
CN09-1	Op – Sewage Outfall	440099,89	3979621,63

8.4.2. Monitoring stations: nearshore (500m-1500m)

Sampling of nutrients and chlorophyll-a from additional nearshore stations shall be carried out for one monitoring year to enable WFD intercalibration of chlorophyll-a. Additional inshore stations to be sampled at a distance of >500m - <1500m perpendicular to the shoreline for parameters listed in Table 1 (nutrients) and chlorophyll-a are listed in Table 5.

Table 5: Additional nearshore stations for monitoring of nutrients and chlorophyll-a

Mon. Site Ref. Code	Monitoring Network	Coordinates (Full UTM ED50)	
		Longitude	Latitude
CP04-2	Operational	449013,07	3979914,24
CP05	Operational - Harbour	457169,68	3973252,05
CP06-2	Operational	460522,84	3970960,01
CP07	Operational - Harbour	459771,77	3964111,98
CN01-1	Protected Area	426700,89	3990134,58
CN03-1	Op – Sewage Outfall	435420,03	3986084,12
CN03-6	Op-Minor Sewage Outfall	441540,34	3985079,15
CN09-1	Op – Sewage Outfall	440099,89	3979621,63

8.4.3. Monitoring stations: territorial waters

Nine of the inshore stations will be sampled at a distance of 6 nautical miles from the baselines where the breadth of the territorial waters is measured with a view to provide data between the 1nm and the 12nm extent of Malta's territorial waters. These stations are listed in Table 6 together with additional stations in bunkering areas. Dissolved Nitrates (NO_3-N) and phytoplankton parameters as listed in Table 2 will be monitored at these stations.

Table 6: Monitoring Stations to **be sampled at a distance of 6 nautical miles from the baselines where the breadth of the territorial waters is measured and additional monitoring stations in bunkering areas, for monitoring of dissolved nitrates and phytoplankton parameters**[30]

Mon. Site Ref. Code	Monitoring Network	Coordinates (Full UTM ED50)	
		Longitude	Latitude
CS01	Surveillance	425781,39	3992303,97
CS02	Sur + Reference Site	435571,14	3992063,13
CS03	Sur + Reference Site	442502,54	3984741,51
CP04-1	Operational	453769,71	3977836,62
CP05	Operational - Harbour	457169,68	3973252,05
CP06-1	Operational	461078,41	3971492,15
CP07	Operational - Harbour	459771,77	3964111,98
CS08	Surveillance	453654,59	3962794,34
CS09	Sur + Protected area	439697,26	3976129,46
Bunkering Area 2		463215,69	3970468,46
Bunkering Area 3		480042,40	3971974,31
Bunkering Area 4		463310,71	3964577,20
Bunkering Area 6		439080,51	3978830,25
Waiting Area		470247,20	3967047,73

8.4.4. Transects

In accordance with the 'Eutrophication Monitoring Strategy of MEDPOL'[31] sampling along a transect perpendicular to the coastline should be sought for the purposes of applying the TRIX index, and to assess the vertical and horizontal profiles of phytoplankton. For this purpose monitoring stations listed in Table 7 will be supplemented by adjacent monitoring stations along a transect. These transects will span from inshore areas to nearshore areas (between 500m and 1500m from shoreline) to also cater for the WFD intercalibration process through correlation of inshore and nearshore data.

As per MEDPOL's eutrophication monitoring strategy, three stations should be sampled for each transect in accordance with bottom typology (*vide* UNEP(DEC)/MED/WG.231/14).

Table 7: Monitoring stations to be supplemented by monitoring stations along a transect.

Mon. Site Ref. Code	Monitoring Network	Coordinates (Full UTM ED50)	
		Longitude	Latitude
CN01-2	Op – Diffuse Sources	429492,88	3987775,43
CN05-2	Op - Harbour	456279,18	3972594,26
CN07-2	Op – Harbour	459413,96	3965607,40
	Innermost part of Salini	448260,79	3978712,49

[30] Bunkering Area 1 is covered by monitoring station CN04-3 hence not included in this table

[31] UNEP(DEC)/MED WG.231/14

8.5. Monitoring frequency

Frequency of monitoring will be revised on the basis of the data generated during the first monitoring year. In particular, monitoring frequency for monitoring stations with good status in terms of nutrient and organic matter enrichment will be reduced in subsequent years.

Parameters	Monitoring Stations	Monitoring Frequency
Nutrient levels	Inshore Monitoring stations	3-monthly[32]
	Additional nearshore stations	3-monthly (first monitoring year)
	Transects	3-monthly
Nitrates	Stations at 6 nautical miles; bunkering areas	6-monthly
Chlorophyll-a	Inshore monitoring Stations	Monthly
	Additional nearshore stations	Monthly (first monitoring year)
	Stations at 6 nautical miles; bunkering areas	6-monthly
	Transects	3-monthly
Phytoplankton: Species composition and abundance	Inshore monitoring stations	3-Monthly
	Stations at 6 nautical miles; bunkering areas and transects	6-monthly
	Transects	3-monthly

[32] Except for monitoring station CN05-1 for which monthly sampling will be sought.

8.6. Assessment of status

8.6.1. Nutrient Status

For the first monitoring years, assessment of status is based on trends in the monitored parameters. Broad definitions of high, good and moderate status as qualitatively defined by the WFD for nutrients are listed in Table 8.

Table 8: WFD high, good and moderate status definitions for nutrient concentrations.

High Status	Good Status	Moderate Status
Nutrient concentrations remain within the range normally associated with undisturbed conditions; Temperature, oxygen balance and transparency do not show signs of anthropogenic disturbance and remain within the ranges normally associated with undisturbed conditions.	Nutrient concentrations do not exceed the levels established so as to ensure the functioning of the ecosystem and the achievement of the values specified for the biological quality elements; Temperature, oxygenation conditions and transparency do not reach levels outside the ranges established so as to ensure the functioning of the ecosystem and the achievement of values specified for the biological quality elements.	Conditions consistent with the achievement of values specified for the biological quality elements.

8.6.2. Phytoplankton: Chlorophyll-a

Ecological Quality Ratios have been determined for High-Good and Good-Moderate ecological status in terms of Chlorophyll-a as a parameter indicative of phytoplankton biomass for Type IIIE waters in Greece and Cyprus (as per Commission Decision 2013/480/EU).

On the basis of the assumption that Maltese waters constitute Type IIIE coastal waters as defined by Commission Decision 2013/480/EU, the eutrophication scale provided in Simboura *et al*. (2005)[33] is being adopted for the purposes of determining ecological status in terms of chlorophyll-a concentrations (Table 9). Parameter values are expressed in µg/l of Chlorophyll-a, for the 90th percentile calculated over the year in at least a five year period.

[33] Simboura, N., Panayotidis, P. & Papathanassiuo, E. (2005) A synthesis of the biological quality elements for the implementation of the European Water Framework Directive in the Mediterranean ecoregion: the case of Saronikos Gulf. *Ecological Indicators* **5**: 253-266

The boundaries proposed need to be updated once the typology of Maltese coastal waters is defined and the WFD intercalibration exercise is finalised.

Table 9: Eutrophication scale defined by Simboura et al. (2005) to be used for assessment of status in terms of chlorophyll-a

Eutrophication Scale	Chlorophyll-a (µg/l)	Ecological Quality Status
Oligotrophic	<0.1	High
Lower mesotrophic	0.1-0.4	Good
Lower mesotrophic	0.4-0.6	Moderate
Higher mesotrophic	0.6-2.21	Poor
Eutrophic	>2.21	Bad

8.6.3. Eutrophication: TRIX Index

The TRIX index shall be calculated for the monitoring stations along transects stipulated in Section 8.4.4 as follows:

$TRIX = [Log_{10}(PO_4 * TN * Chla * D\%O_2) + 1.5]/1.2$

where

- Chl a = Chlorophyll *a* as µg/L
- $D\%O_2$ = the % deviation of the oxygen concentration from saturation conditions
- TN = Mineral Nitrogen; dissolved inorganic nitrogen, DIN = N (as $N\text{-}NO_3$ + $N\text{-}NO_2$ + $N\text{-}NH_4$) as µg/L
- P = Total inorganic phosphorous as $P\text{-}PO_4$ µg/L

The TRIX Index will only be used for the purposes of assessment of status once its applicability is verified through long-term series data.

9. Monitoring sub-programme 2: *Water Column – Physical and chemical characteristics*

9.1. Monitoring Parameters

Table 10: List of physical and chemical parameters to be monitored in water

Parameter	Unit	WFD	MSFD	MEDPOL[34]
Temperature	°C	×	×	×
Salinity	psu	×	×	×
pH		×	×	×
Water Transparency	Secchi depths, NTU	×	×	×
Dissolved Oxygen	% saturation & mg/L	×	×	×

9.2. Monitoring methodologies

- Multiparametric probes are used for *in situ* measurements of physical parameters as follows:
  - Salinity
  - Temperature
  - Turbidity (through Transmissometer or Optical Black-Scatter System[35])
  - Dissolved Oxygen
  - pH
- Depth profiles of these parameters are recorded.
- Secchi depths are measured to provide an indication of transparency.
- Measurement of physical parameters are undertaken under the same meteo-marine conditions throughout the monitoring years;
- Measurements of salinity and pH are repeated in the laboratory.

Adherence to methodological standards as listed in Section 14 of this factsheet should be ensured at all times

9.3. Monitoring area

9.3.1. Monitoring stations

Monitoring stations for physical and chemical parameters reflect those for monitoring of nutrient levels and phytoplankton (Section 8.4.1 - 8.4.3).

[34] The list of parameters is in line with the 'Eutrophication Monitoring Strategy for MED POL' UNEP(DEPI)/MED WG.321/Inf.5 listing the mandatory parameters to be monitored by each country, which parameters support the adoption of the TRIX index.

[35] The OBS is the preferred instrument in areas where the total suspended material concentration in the water column exceeds ~200 ppm, whereas a transmissometer usually is the more effective instrument in locations with low total suspended material concentration

9.3.2. Transects

Physical and chemical parameters will also be monitored along transects perpendicular to the coastline as described in 8.4.4.

9.4. Monitoring frequency

Parameters	Monitoring Stations	Monitoring Frequency
Physical and chemical parameters	Inshore Monitoring stations	monthly
	Nearshore stations	Monthly (first monitoring year)
	Stations at 6 nautical miles; bunkering areas	6-monthly
	Transects	3-monthly

9.5. Assessment of Status

For the first monitoring years, assessment of status is based on trends in the monitored parameters.

10. Monitoring sub-programme 3: *Organic Matter in Sediment*

10.1. Monitoring Parameters

Table 11: Parameters to be monitored in sediment

Parameter	Unit	WFD	MSFD	MEDPOL
Total Organic Carbon	%weight		×	

10.2. Monitoring methodologies

Adherence to methodological standards as listed in Section 14 of this factsheet should be ensured at all times

- Sediment samples are collected using van veen grabs. Sub-samples labelled and frozen.
- 5g of the sediment sub-samples are weighted and analysed for organic carbon in accordance with Walkley & Black method (Buchanan, 1984)[36]. Samples are pre-treated with acid prior to the analysis to remove any inorganic carbon.

10.3. Monitoring area

Table 12: Monitoring Stations (total Organic Carbon)

Mon. Site Ref. Code	Monitoring Network	Coordinates (Full UTM ED50)	
		Longitude	Latitude
Operational Monitoring Stations			
CP04-1	Operational	453769,71	3977836,62
CP04-2	Operational	449013,07	3979914,24
CP05	Operational - Harbour	457169,68	3973252,05
CP06-1	Operational	461078,41	3971492,15
CP06-2	Operational	460522,84	3970960,01
CP07	Operational - Harbour	459771,77	3964111,98
Surveillance Monitoring Stations			
CS01	Surveillance	425781,39	3992303,97
CS02	Sur + Reference Site	435571,14	3992063,13
CS03	Sur + Reference Site	442502,54	3984741,51
CS08	Surveillance	453654,59	3962794,34
CS09	Sur + Protected area	439697,26	3976129,46
National Monitoring Stations of relevance to 'Eutrophication'			
CN01-1	Protected Area	426700,89	3990134,58
CN02-1	Op – Diffuse sources	433397,15	3992518,78
CN03-1	Op – Sewage Outfall	435420,03	3986084,12

[36] Buchanan J.B. (1984). Sediment analysis. In: N.A. Holme & A.D. McIntyre [eds] *Methods for the study of marine benthos*; pp. 41-65. Oxford: Blackwell Scientific Publications

Mon. Site Ref. Code	Monitoring Network	Coordinates (Full UTM ED50)	
		Longitude	Latitude
CN03-2	Op - Harbour	437057,14	3987236,76
CN03-3	Op-Harbour	440130,02	3983083,45
CN03-6	Op-Minor Sewage Outfall	441540,34	3985079,15
CN04-1	Op - diffuse sources	442596,44	3981355,59
CN04-3[37]	Op - bunkering site	445500,41	3984462,78
CN04-5	Nitrates Directive	454162,08	3976206,21
CN04-6	Nitrates Directive	454528,54	3975162,74
CN05-1	Op - Harbour	455167,45	3973034,62
CN06-1	Op - diffuse sources	460815,92	3969206,43
CN07-1	Op - Thermal effluent	460712,08	3966044,50
CN07-3	Op – Harbour	458110,28	3965070,20
CN08-1	Op – Desalination Plant	447163,40	3965389,58
CN09-1	Op – Sewage Outfall	440099,89	3979621,63

10.4. Monitoring frequency

Monitoring frequency for the first monitoring year is indicated hereunder. This monitoring frequency is subject to changes following the first monitoring year.

Parameters	Monitoring Stations	Monitoring Frequency
Organic matter (sediment)	Inshore Monitoring stations	yearly

10.5. Assessment of status

Assessment of status is based on trends in the monitored parameters.

[37] Nutrients were not assessed within this station during the first WFD monitoring surveys. Station retained for monitoring to be representative of bunkering sites.

11. Monitoring sub-programme 4: *Direct and Indirect effects of Eutrophication*

11.1. Monitoring Parameters

Table 13: Features to be assessed for the purpose of monitoring direct and indirect effects of eutrophication

Feature to be assessed	Methodology	WFD	MSFD	MEDPOL
Macroalgae	CARLIT	×	×	
Posidonia oceanica	PREI	×	×	

11.2. Monitoring methodologies

For the purposes of monitoring MSFD indicators 5.2.3 'Abundance of opportunistic macroalgae' and 5.3.1 'Abundance of perennial seaweeds and seagrasses (e.g. fucoids, eelgrass and Neptune grass) adversely impacted by decrease in water transparency (5.3.1)', data generated through the application of the CARLIT index as stipulated in Ballesteros *et al*. (2007)[38] and the PREI index as described by Gobert *et al*. (2009)[39] will be assessed in terms of potential contribution to these indicators.

Methodologies reflect those adopted by the 'Seabed Habitats' monitoring factsheet.

[38] Ballesteros, E.; Torras, X; Pinedo, S.; Garcia, M.; Mangialajo, L. & deTorres, M. 2007. A new methodology based on littoral community cartography dominated by macroalgae for the implementation of the European Water Framework Directive. *Marine Pollution Bulletin* **55**: 172-180.

[39] Gobert, S., Sartoretto, S., Rico-Raimondino, V., Andral, B., Chery, A., Lejeune P., Boissery, P. 2009. Assessment of the ecological status of Mediterranean French coastal waters as required by the Water Framework Directive using the *Posidonia oceanica* Rapid Easy Index: PREI. *Marine Pollution Bulletin* **58**: 1727-1733

11.3. Monitoring area

The CARLIT methodology is applied at a National scale i.e. along the whole stretch of Malta's coastline. Data interpretation for the purpose of status assessment is carried out on the basis of WFD water bodies. Therefore CARLIT indices for the stretches of coastlines within WFD water bodies will be calculated.

Inshore monitoring stations for applying PREI index are listed in Table 14.

Table 14: Inshore monitoring stations

Mon. Site Ref. Code	Monitoring Network	Coordinates (Full UTM ED50)	
		Longitude	Latitude
CP04-1	Operational	453769,71	3977836,62
CP04-2	Operational	449013,07	3979914,24
CP06-1	Operational	461078,41	3971492,15
CP06-2	Operational	460522,84	3970960,01
CP07	Operational - Harbour	459771,77	3964111,98
CS02	Sur + Reference Site	435571,14	3992063,13
CS03	Sur + Reference Site	442502,54	3984741,51
CS09	Sur + Protected area	439697,26	3976129,46
CN01-1	Protected Area	426700,89	3990134,58
CN01-2	Op – Diffuse Sources	429492,88	3987775,43
CN02-1	Op – Diffuse sources	433397,15	3992518,78
CN03-1	Op – Sewage Outfall	435420,03	3986084,12
CN03-3	Op - Harbour	440130,02	3983083,45
CN03-6	Op – Minor Sewage Outfall	441540,34	3985079,15
CN04-1	Op - diffuse sources	442596,44	3981355,59
CN04-3	Op - bunkering site	445500,41	3984462,78
CN04-4	Op - diffuse sources	444937,85	3978614,21
CN04-5	Nitrates Directive	454162,08	3976206,21
CN04-6	Nitrates Directive	454528,54	3975162,74
CN06-1	Op - diffuse sources	460815,92	3969206,43
CN07-1	Op - Thermal effluent	460712,08	3966044,50
CN07-2	Op – Harbour	459413,96	3965607,40
CN07-3	Op – Harbour	458110,28	3965070,20
CN08-1	Op – Desalination Plant	447163,40	3965389,58
CN09-1	Op – Sewage Outfall	440099,89	3979621,63
/	Mgarr ix-Xini MPA	434555,04	3986240,65

11.4. Monitoring frequency

Monitoring frequency for the first monitoring year is indicated below. A risk-based approach will be applied in subsequent years.

Parameters	Monitoring Frequency
Macroalgae	Yearly: early summer season (May - June)
Posidonia	Yearly (September – October)

11.5. Assessment of status

Assessment of status on the basis of the CARLIT and PREI index for macroalgae and *Posidonia* beds respectively, in relation to nutrient enrichment requires further knowledge of the links between ecological status of the relevant biological elements and nutrient levels in the marine environment. For this purpose, data on nutrient levels and status for macroalgae and *Posidonia* beds as per 'seabed habitats' monitoring factsheet will be assessed through expert judgement in the initial monitoring years.

12. Monitoring sub-programme 5: *Nutrient inputs – land-based and sea-based sources*

- Data on input of nutrients/organic matter in the marine environment will be collected by operators in line with the following requirements as indicated in Table 15:
  - Urban Waste Water Treatment Directive;
  - E-PRTR
  - Industrial Emissions Directive
  - National Baseline Budgets of Pollutant Emissions and Releases (NBBs) within the framework of the LBS Protocol of the Barcelona Convention (MEDPOL).

Table 15: Monitoring of nutrient input through discharges into the marine environment

Parameter	Unit	UWWT	E-PRTR	IED[40]	MEDPOL
Biochemical Oxygen Demand	mg/l	×		×	×
Chemical Oxygen Demand	mg/l	×	×		×
Total Suspended Solids	mg/l	×		×	×
Total Nitrogen	mg/l, kg/year	×[41]	×	×	×
Total Phosphorous	mg/l, kg/year	×[42]	×	×	×
Additional parameters (reporting of which to be determined on a case-by-case basis through environmental permitting procedure)					
Phosphates (PO_4-P)	mg/l			×	Optional
Ammonium ions (NH_3-N)	mg/l				Optional
Ammonium ions (NH_4-N)	mg/l				Optional
Nitrates (NO_3-N)	mg/l			×	Optional
Nitrites (NO_2-N)	mg/l				Optional
Silicate (SiO_4)	mg/l				Additional

- Location of discharge points and or relevant land and sea-based operations shall be mapped as part of the WFD requirements for an inventory of coastal/marine discharges.

- Data on discharge of nutrients/organic matter into the marine environment requested as part of the environmental permitting system (e.g. aquaculture) shall be used for the purposes of this monitoring factsheet's implementation.

- Occurrence of malfunction of sewage pumping stations as well as of waste water treatment plants in Malta and Gozo shall be recorded.

[40] Requirement depends on type of industry and would need to be assessed on a case-by-case basis
[41] Monitored only in sensitive areas i.e. Ic-Cumnija
[42] Monitored only in sensitive areas i.e. Ic-Cumnija

- Compilation of data as part of the requirements of the Nitrates Action Programme (2011) will contribute to the monitoring of activities relevant to nutrient and organic matter enrichment. Relevant NAP measures include:
  - Records on the Use of Fertilisers: The Competent Authority responsible for Nitrates shall keep a register of all persons and farm holdings making use of organic and/or inorganic fertilisers;
  - Farm Holding Records: Records shall be kept so as to allow the following information to be ascertained on an annual basis:
    - the farmer for the calendar year in question;
    - the total agricultural area including the size and location of each field;
    - the cropping regimes and their individual areas;
    - the number of livestock kept on the holding, their species and type, and the length of time for which they were kept on the holding;
    - the capacity of the livestock manure storage space, and where applicable the details of rented storage, farmyard manure production, manure separation, the details of any rental or contractual agreement;
    - the quantity of each type of nitrogen fertiliser moved onto or off the holding, the amount of each type of fertiliser applied, the nutrient content of the chemical fertiliser, the location where used;
  - The National Nitrates Database (NND) containing the following data;
    - Registered farmers making use of fertilisers;
    - Information about the holdings pertaining to the farmers (link with the LPIS); Information about livestock farms buildings, manure storage facilities and a link with the National Livestock Database (NLD);
    - Information about land management practices;
    - Information about the landscape, soil types, water sources and water courses;
    - Information about the sales and movements of livestock manure;
    - Data about the sales and purchases of chemical fertilisers;
    - Findings of monitoring and controls;

13. Links to monitoring processes

Monitoring in terms of this factsheet is linked with monitoring for other marine elements as follows:

- Monitoring stations are shared with those proposed for 'contaminants', 'water column habitats' and hydrographical changes;
- Monitoring parameters for phytoplankton are used for monitoring in terms of 'Water Column Habitats';
- Monitoring parameters for nutrients are used for monitoring of 'hydrographical changes';

- Monitoring of 'benthic habitats' will generate data to assess indirect effects of nutrient enrichment.

14. Quality Assurance & Quality Control

Sampling methodologies and analysis of samples shall be carried out in line with standards and guidance documents listed in this section. Contents of this section reflect Annex V of the EU Water Framework Directive and proposed amendments which were under discussion at the time of compiling the factsheet.

In general, monitoring should be in line with the 'Eutrophication Monitoring Strategy of MEDPOL'[43] and regulation 10 of Legal Notice 24 of 2011, including WFD technical specifications for chemical analysis and monitoring of water status as per Directive 2009/90/EC. This schedule provides definitions related to water monitoring aspects, choice of methods of analysis, minimum performance criteria for the methods of analysis, calculation of and presentation of mean values, as well as quality assurance and control recommendations.

Standards for sampling:

- EN ISO 5667-3: 2012 including guideline procedures for sampling programmes and techniques, preservation and handling of different types of water and sediments, bio-testing of samples and other general techniques.

Standards for phytoplankton:

- EN 15204:2006: Water Quality – Guidance standard on the enumeration of phytoplankton using inverted microscopy (Utermöhl Technique)
- EN 15972:2011: Water Quality – Guidance on quantitative and qualitative investigations of marine phytoplankton
- ISO 10260:1992: Water Quality – Measurement of biochemical parameters – Spectrometric determination of the chlorophyll-a concentration

15. Data collection, storage and dissemination

All data should be collected and stored in accordance with the INSPIRE Technical Specifications listed in this section and/or any other relevant INSPIRE standard as identified through the Marine Pilot Project[44]. Processed data to be uploaded in a geoportal.

- 'D2.8.II/III.7 INSPIRE Data Specification on Environmental Monitoring Facilities – Technical Guidelines'[45].

[43] UNEP(DEC)/MED WG. 231/14
[44] https://circabc.europa.eu/w/browse/bc33dff1-0f8c-467a-8382-7724c5f79d45
[45] http://inspire.ec.europa.eu/index.cfm/pageid/2

- 'D2.8.III.15 Data Specification on Oceanographic geographical features – Technical Guidelines'[46]
- D2.8.III.19 Data Specification on Species Distribution – Technical Guidelines[47]
- 'D2.8.III.8 Data Specification on Production and Industrial Facilities – Technical Guidelines'[48].

16. Responsible organisations

Theme	Sub-themes	Responsible authorities
Nutrient levels, phytoplankton; physical and chemical characteristics of the water column; organic matter in sediment; direct and indirect effects of eutrophication;		MEPA
Nutrient inputs – land-based and sea-based sources	Aquaculture	MEPA
	Urban Waste Water Treatment Plants & pumping stations	MEPA & WSC
	Industry	MEPA
	Nitrates Action Programme	Agriculture Department

17. Gaps and Research Needs

Gaps	Plans to address gaps
Eutrophication	
No thresholds for nutrient and chlorophyll-a concentrations in water have been set for Malta.	National thresholds for nutrients and for other eutrophication indicators will be set on the basis of the data generated through the implementation of the monitoring factsheet and the WFD intercalibration exercise.
There are knowledge gaps related to links between physico-chemical parameters and biological parameters	Research studies will be channelled towards establishing links between the physico-chemical parameters and the biological parameters. The potential contribution of the CARLIT and PREI indices to assess the direct and indirect effects of eutrophication on macroalgae and seagrasses should be assessed.
Sources of nutrients in the marine environment	
Nutrient input from diffuse sources is not quantified	Research shall be channeled towards attaining better knowledge on the extent of nutrient input in the marine environment from diffuse sources.
While land-based sources of nutrient enrichment are relatively known, sea-based sources of nutrients have been poorly studied.	Collaboration with the shipping industry will be sought to assess the extent of sewage disposal offshore or in remote coastal areas (when not in port) from marine vessels (including fishing vessels and pleasure crafts).

[46] http://inspire.ec.europa.eu/index.cfm/pageid/2;
[47] http://inspire.ec.europa.eu/index.cfm/pageid/2
[48] http://inspire.ec.europa.eu/index.cfm/pageid/2;

18. Main Sources

- AAE Consortium (ADI Associates Ltd, Ecoserv Ltd and E Cubed Consultants). 2014. Long Term Monitoring Strategy for the Marine Environment of the Maltese Islands under the Marine Strategy Framework Directive. Service Contract for the development of a long-term monitoring strategy for the marine environment, a social and economic analysis of the use of marine waters and costs of degradation, and baseline sediment survey in inland waters (MEPA tender ref: CT3048/2012). ERDF156 - Developing national environmental monitoring infrastructure and capacity. Malta, unpublished report, 252 pp.

- AAE Consortium (ADI Associates Ltd, Ecoserv Ltd and E Cubed Consultants). 2014. Long Term Monitoring Programme for the Marine Environment of the Maltese Islands under the Marine Strategy Framework Directive. Service Contract for the development of a long-term monitoring strategy for the marine environment, a social and economic analysis of the use of marine waters and costs of degradation, and baseline sediment survey in inland waters (MEPA tender ref: CT3048/2012). ERDF156 - Developing national environmental monitoring infrastructure and capacity. Malta, unpublished report, 346 pp.

- CIBM & Ambiente SC. 2013. Development of Environmental Monitoring Strategy and Environmental Monitoring Baseline Surveys – Water Lot 1 – Long-term monitoring – September 2013. ERDF156 - Developing national environmental monitoring infrastructure and capacity