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Eutrophication assessment at national level

Overview of the existing eutrophication monitoring
Programme ID: BLKBG-D5-Eutrophication

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Assessment areas/ MRU /monitoring stations network

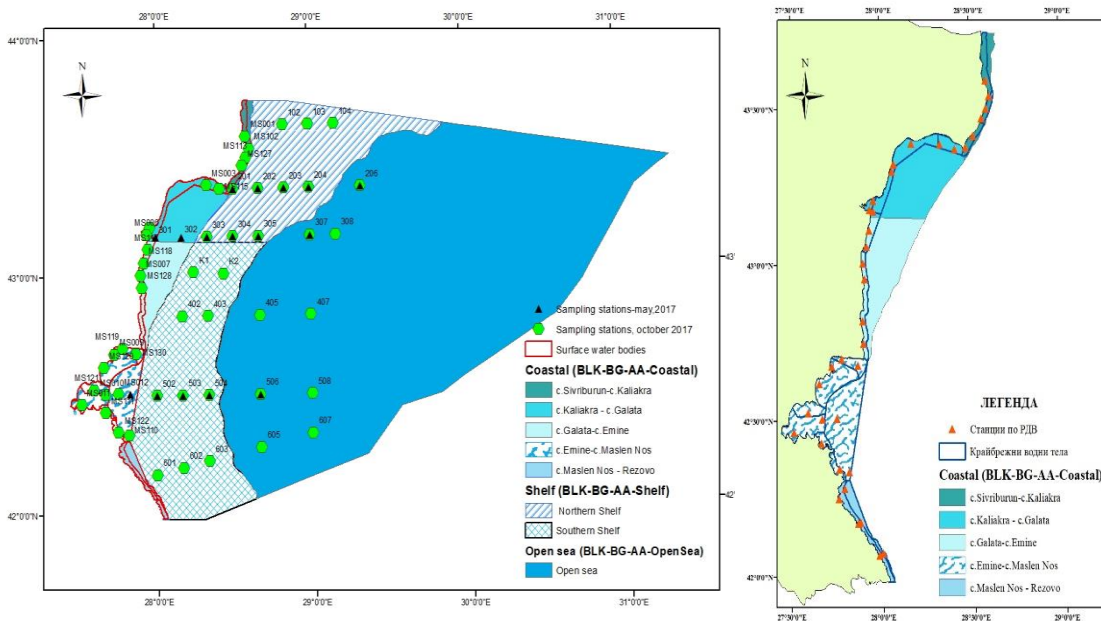


Figure.1. Maps of monitoring stations and Marine Reporting Units (MRU) in the coastal, shelf and open sea pelagic habitat

WFD: 17 WBs – 37stations
 MSFD: Coastal 5 MRUs – 37+7=44stations
 Shelf 2 MRUs – 19 stations
 Open sea 1 MRU - 9 stations

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	Code and name of the MRU	Depth range, [m]	Surface MRU, [km ²]
(BLK-BG-AA Coastal)	BLK-BG-AA-SivriburunKaliakra	0-30	162
	BLK-BG-AA-KaliakraGalata	0-30	828
	BLK-BG-AA-GalataEmine	0-30	699
	BLK-BG-AA-EmineMaslennos	0-30	856
	BLK-BG-AA-MaslennosRezovo	0-30	155
(BLK-BG-AA Shelf)	BLK-BG-AA-NorthernShelf	30-200	3879
	BLK-BG-AA-SouthernShelf	30-200	5521
(BLK-BG-AA Open Sea)	BLK-BG-AA-OpenSea	>200	22423

Total No stations - 72

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Assessment criteria, indicators and methods; thresholds values for GES

List of Criteria elements and criteria according to COMMISSION DECISION (EU) 2017/848 of 17 May 2017 laying down criteria and methodological standards on good environmental status of marine waters and specifications and standardised methods for monitoring and assessment, and repealing Decision 2010/477/EU; Criteria and methodological standards for good environmental status of marine waters, relevant to the qualitative descriptors in Annex I to Directive 2008/56/EC, and to the indicative lists set out in Annex III to that Directive, and specifications and standardised methods for monitoring and assessment

Criteria D5C1 — Primary: Nutrient concentrations are not at levels that indicate adverse eutrophication effects

State indicator: Nutrients in the water column ($\mu\text{mol/l}$):

Dissolved Inorganic Nitrogen (DIN = $\text{NH}_4 + \text{NO}_3 + \text{NO}_2$), Total Nitrogen (TN),

Dissolved Inorganic Phosphorus (DIP), Total Phosphorus (TP)

Additional parameters- Si and Total Organic Carbon (TOC)

Frequency: spring-summer (April-September) - monthly sampling

Thresholds (statistical methods on data for the last 10 years)

Concentration $\mu\text{M/l}$	Spring			Summer			Autumn		
	coastal	shelf	open sea	coastal	shelf	open sea	coastal	shelf	open sea
N-NH4	0.9	0.50	0.50	0.70	0.60	0.50	0.6	0.4	0.4
N-NO2	0.3	0.08	0.06	0.12	0.08	0.06	0.10	0.08	0.05
N-NO3	1.0	0.50	0.30	0.30	0.25	0.20	0.5	0.45	0.30
P-PO4	0.15	0.10	0.10	0.15	0.08	0.08	0.14	0.10	0.07

**No thresholds
TP, TN, TOC, Si**

Criteria D5C2 — Primary: Chlorophyll a concentrations ($\mu\text{g/l}$) in the water column are not at levels that indicate adverse effects of nutrient enrichment.

Frequency: spring-summer (April-September) - monthly sampling

Thresholds

Concentration $\mu\text{g/l}$	Spring				Summer			
	1 n.m.	coastal	shelf	open sea	1 n.m.	coastal	shelf	open sea
chl.a	3.3	3.3	1.4	4.0	1.5	1.4	1.2	0.36

Criteria D5C3 — Secondary: The number, spatial extent and duration of harmful algal bloom events are not at levels that indicate adverse effects of nutrient enrichment.

State indicator: Harmful algal blooms (e.g. cyanobacteria) in the water column:

- **Bloom intensity** abundance of a single phytoplankton species (monoalgal bloom) or 2-3 species exceeding values 1×10^6 cells/l during spring- summer (April-September) that indicate adverse effects of nutrient enrichment (data from **D1,additional parameter** in compliance to point 2 “For D5C2 and D5C3, Member States may in addition use phytoplankton species composition and abundance” as well as to reflect the presence of potentially toxic species initiating blooms- Dzhenbekova, Moncheva, 2015)

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- **Bloom intensity:** Chl.a concentrations above the defined bloom threshold due to the proliferation of a single phytoplankton species (monoalgal bloom) or 2-3 species during spring- summer (April-September) that indicate adverse effects of nutrient enrichment (data from D1)
- abundance of potentially toxic species exceeding the species specific threshold for toxicity that indicate adverse effects of nutrient enrichment (additional parameter)
- **Bloom areal extent** - area of pelagic habitats in the shelf and open sea with chl.a concentration in the surface waters (remote-sensing) exceeding the defined bloom threshold (April-September)
- **Bloom duration** number of days with chl.a concentration in the surface waters (remote-sensing) exceeding the defined bloom threshold (April-September) in the shelf and open sea
- proportion of *Noctiluca scintillans* (B %) from the total mesozooplankton biomass in spring (additional parameter) – a typical for the Black Sea blooming species in spring with direct and indirect adverse effects

Thresholds

Thresholds for **primary and secondary bloom intensity** based on biooptical algorithm (Kopelevich et, 2012) and remote-sensing data from MODIS Aqua/Terra, for the period 1999- 2013.

Pelagic habitat	Season	Bloom type	Threshold
Shelf	spring	primary	3.8
Shelf	spring	secondary	2.9
Shelf	summer	primary	2.7
Shelf	summer	secondary	2.0
Open sea	spring	primary	1.5
Open sea	spring	secondary	1.1
Open sea	summer	primary	1.3
Open sea	summer	secondary	1.0

The **proportion of *Noctiluca scintillans*** biomass (B %) of the total mesozooplankton biomass do not exceed 30% in spring

No thresholds defined for bloom duration and abundance of potentially toxic species

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Criteria D5C4 - Secondary: The photic limit (transparency) of the water column during spring-summer (April-September) is not reduced, due to increases in suspended algae, to a level that indicates adverse effects of nutrient enrichment

State indicator: Photic limit (transparency) of the water column, m

Frequency: spring-summer (April-September) - monthly sampling

Thresholds

Photic limit, m	Spring				Summer			
	1 n.m.	coastal	shelf	open sea	1 n.m.	coastal	shelf	open sea
Secchi depth	5.2	4.5-7.0	5.8-6.5	9-10	4.7	5.5-7.0	6.5-7.7	11-13

Criteria D5C5 - Primary (may be substituted by D5C8): The concentration of dissolved oxygen is not reduced, due to nutrient enrichment, to levels that indicate adverse effects on benthic habitats (including on associated biota and mobile species) or other eutrophication effects.

State indicator: Dissolved oxygen (DO, mg/l)/Oxygen saturation (OS,%) in the bottom of the water column. Additional parameter Dissolved oxygen (DO, mg/l)/Oxygen saturation (OS,%) at the surface waters of the water column

OS%	Season	Coastal	Shelf	Open Sea
Surface homogenous layer	Spring	100-120	100-120	100-120
	Summer	95-120	100-115	100-115
Bottom layer (depth <40m)	Summer	> 75		

No threshold for bottom O2 concentration

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Criteria D5C6 - Secondary: The abundance of opportunistic macroalgae is not at levels that indicate adverse effects of nutrient enrichment. The abundance /biomass of opportunistic macrophyte species in the coastal waters do not exceed the WFD thresholds.

State indicator: Opportunistic macroalgae of benthic habitats

- % of the wet biomass of tolerant species (ESGII) from the total wet biomass ;
- Ecological index EI, (Dencheva K., Doncheva V., 2014, Berov D., 2015), applicable for infralitoral rocky habitat down to 3 m depth;
- Epiphytes on the seagrass leaves (additional parameter)

Thresholds

the % of the wet biomass of tolerant macroalgae species (ESGII) is < 40 % from the total wet biomass normalized for the infralitoral rocky habitat down to 3 m depth ;

- Ecological index EI > 6 normalized for infralitoral rocky habitat down to 3 m depth;
- *The threshold for Criteria D5C4 to assess the adverse effect of nutrient enrichment related to Criteria D5C6 is specified as follows: The annual average transparency (Secchi disk, m) in the seagrass meadows should be ≥ 6 m , not exceeding this threshold in more than 10% of the monthly values in spring and 5 % in summer (April-September)

No threshold for Epiphytes on the seagrass leaves

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Criteria D5C7 — Secondary: The species composition and relative abundance or depth distribution of macrophyte communities achieve values that indicate there is no adverse effect due to nutrient enrichment including via a decrease in water transparency

State indicator: Macrophyte communities (perennial seaweeds and seagrasses such as fucoids, eelgrass) of benthic habitats

- % of the wet biomass of macroalgal species from the first ecological group (ESGI) normalized for the infralitoral rocky habitat down to 3 m depth
- Ecological index EI, (Dencheva K., Doncheva V., 2014, Berov D., 2015), normalized for the infralitoral rocky habitat down to 3 m depth
- Proactive coverage of *Cystoseira spp* and other macrophytes from the first ecological category (ESGI), normalized for the infralitoral rocky habitat down to 3 m depth
- Depth distribution of *Cystoseira barbata* and *C. bosphorica* (in case a suitable substrate is available) ;
- Depth distribution of seagrass meadows;
- Depth distribution of *Phyllophora crispa* and other perennial sciophilic macrophytes (in case a suitable substrate is available)
- Other indicators for lower infralitoral: benthic proactive coverage by species *Phyllophora crispa*, *Apoglossium ruscifolium*, *Zanardinia typus*, *Gelidium spinosum* as well as other species from the second ecological group (ESGII)
- Underground biomass of *Zostera noltii* , ratio below ground/aboveground biomass of *Zostera noltii*, density of *Zostera noltii* shoots, length of *Zostera noltii* shoots

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Thresholds

% of the wet biomass of macroalgal species from the first ecological group (ESGI) > 60 % normalized for the infralitoral rocky habitat down to 3 m depth

Ecological index EI > 6 normalized for the infralitoral rocky habitat down to 3 m depth

Proactive coverage of *Cystoseira spp* and other macrophytes from the first ecological category (ESGI), ≥ 40% (measured by the method of Orfanidis et al. 2011, as modified by Berov, 2013 in the upper infralitoral, depth between 2, 3 m)

Depth distribution of *Cystoseira barbata* ≥ 10 m and *C. bosphorica* ≥ 4m in case a suitable substrate is available)

Depth distribution of seagrass meadows ≥ 6 ;

Depth distribution of *Phyllophora crispa* and other perannual sciophilic macrophytes ≥ 17 m (in case a suitable substrate is available) (Berov et al., in prep.)

Total benthal proactive coverage by species *Phyllophora crispa*, *Apoglossium ruscifolium*, *Zanardinia typus*, *Gelidium spinosum* ≥ 35%

Benthal proactive coverage by species from the second ecological group (ESGII) *Cladophora albida*, *Cladophora coelothrix*, *Chaetomorpha linum*, *Ulva rigida*) ≤ 15% (measurements by the method of Berov, 2013; Berov et al., in prep.)

Bellow ground biomass of *Zostera noltii* , ratio above ground/bellow ground biomass of *Zostera noltii*, density of *Zostera noltii* shoots, length of *Zostera noltii* shoots

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Thresholds for *Zoster noltii* indicators

Z. noltii parameters	Bellow ground biomass, bg [g.m-2]	Ratio above/bellow the ground biomass (ag-bg ratio)	Leaf length [mm]	Shoots density [shoots.m-2]
GES threshold	>105.2	<2.4	≥ 151.5 - ≤ 270.5	≥ 500.6 - ≤ 1696.6

D5C8 — Secondary (except when used as a substitute for D5C5): The species composition and relative abundance of macrofaunal communities, achieve values that indicate that there is no adverse effect due to nutrient and organic enrichment

State indicator: Macrofaunal communities of benthic habitats

- Number of species S
- Index of biodiversity Shannon H'
- Biotic index AMBI,
- M-AMBI*n (composite index integrating S, H' and AMBI)

The criteria is developed in D1,6



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Existing data and information; data sets and time-series

The monitoring program is based on the following sources of data:

- Field surveys by ship
- Real time data from Argo profilers in the shelf and open sea O2 (0-150 m) vertical profile and chl. a
- Remote sensing data (shelf and open sea) - Criteria D5C3: - bloom intensity , duration and spatial scale

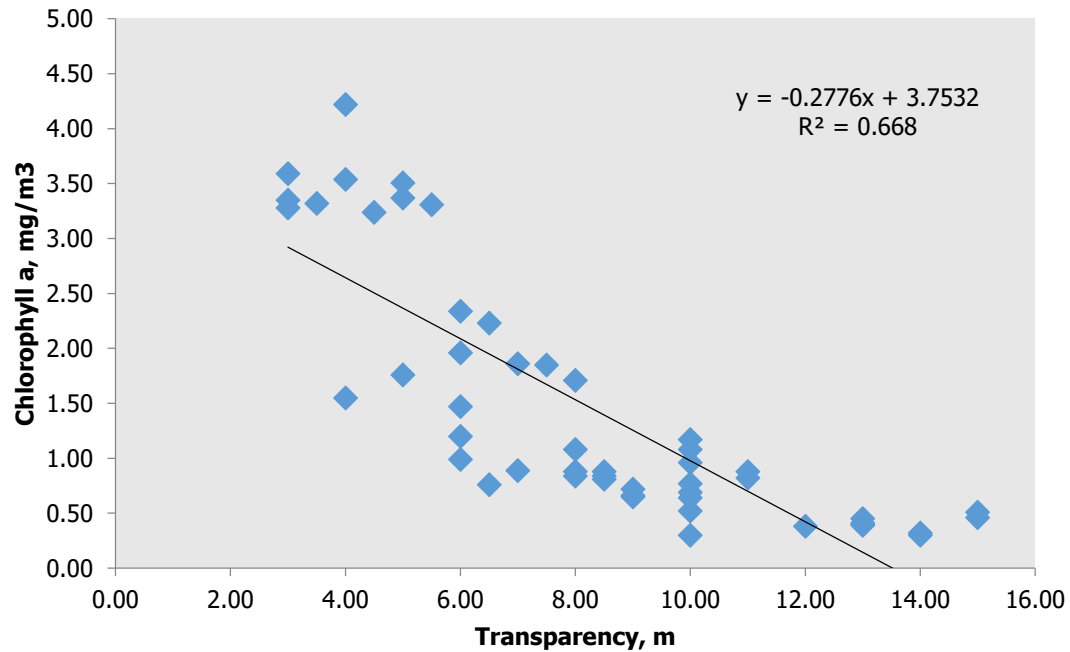
The Real time Argo data provide information for Chlorophyll a (0-150 m) – vertical profile - Criteria D5C2 and Criteria D5C3-

Monitoring campaigns

Year/month	WFD - No stations						MSFD- No stations					
	IV	V	VI	VII	VIII	IX	IV	V	VI	VII	VIII	IX
2012		21	21	21	21	21		9	9	9	9	9
2013			20		20	20					6	
2014			13	13		13						
2015					13			8			8	
2016	25	25		25	25	25						
2017								16				28

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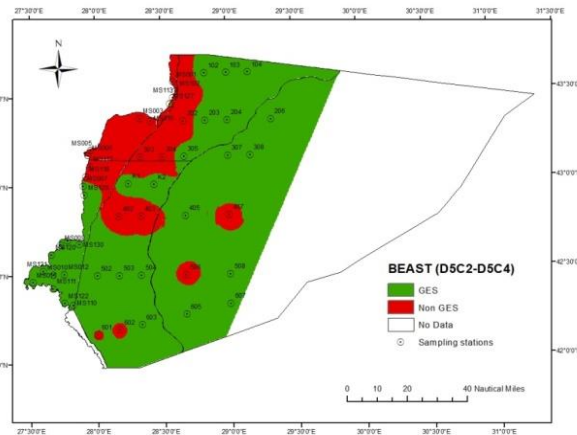
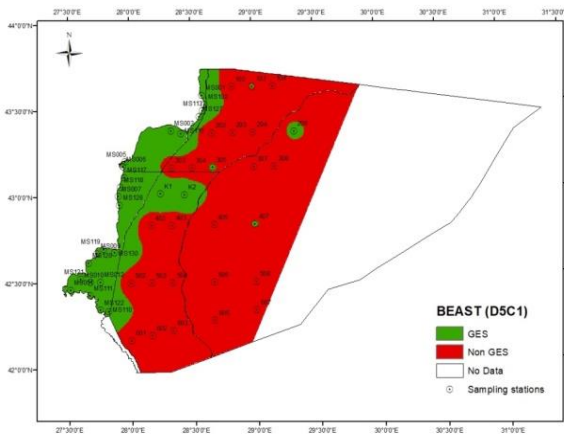
Example of eutrophication assessment



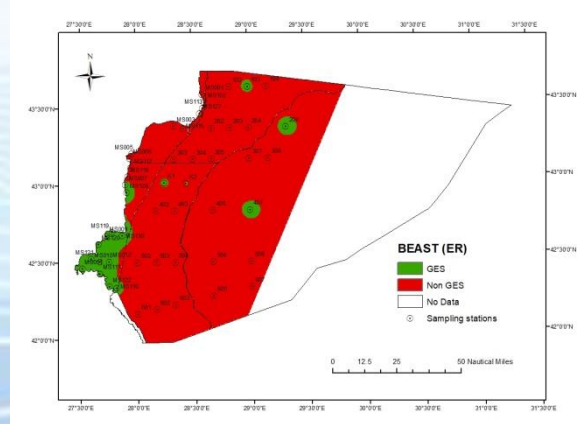
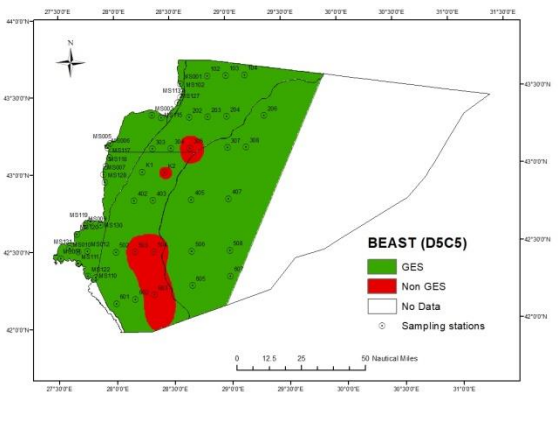
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Example of eutrophication assessment (BEAST)



C1 = D5C1
C2 = D5C2 + D5C3 + D5C4
C3 = D5C5
ER





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Overview of the existing eutrophication monitoring

Funding

- Ministry of Environment and Water
- Projects:
 - MISIS - EC
 - ISMEIMP – Norway mechanism
 - Bio-Opt – ESA
 - ANEMONE - CBC

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Assessment of Black Sea eutrophication status

- Initial assessment of Black Sea waters, MSFD art. 8,9,10; 2006 – 2011 period
- Annual monitoring reports (2012-2018)
- SoE Report – MISIS
- National Reports to the BS Commission
- Report Project ISMEIMP (in Bulgarian only)
- SoE –Phytoplankton – BS Commission ???
- Re-evaluation of IA, art. 17, 2012 – 2017 period – not done yet

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Knowledge gaps and research needs

A. Validation and revision (determination where lacking) GES thresholds for D5 criteria/indicators

B. Need of additional indicators/parameters

- Development of classification system for: wet biomass of macroalgae from the first and second ecological group (ESGI и ESGII), ecological index EI, proactive coverage of *Cystoseira* spp. And other macroalgae from ESGI и ESGII for macroalgae communities at depths >3m
- For a lot of the monitored parameters and indicators there is a need of enough data of relevant spatio-temporal resolution to reflect the natural variability of the parameter (e.g. phytoplankton, macrophytes etc) and differentiate the natural from anthropogenic impacts
- Supporting (min monthly) measurements (data) for pressure (nutrients) of all possible sources (point, diffuse, land-based, sea-based, atmospheric deposition)
- Supporting information (data) for nutrients loads from the Danube and the BG rivers
- Supporting information (data) for physical, hydrodynamic and chemical parameters of the marine environment



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Knowledge gaps and research needs

C. Application of up-to-date technological and methodological approaches for monitoring

- Making use of the biogeochemical ARGO profilers real time data
- Operational application of the unmanned airborne system model Spy Owl 200 (Project MARLEN) for monitoring and assessment of bloom events and the spatial extent of sea grass meadows in the close coastal zone
- Introduction in the monitoring programs of molecular methods for taxonomy of phytoplankton especially related to potentially toxic species.

E. Organizational improvements

- Better coordination between the various organizations providing data and information related to the status/pressures/impacts on the marine environment;
- Providing relevant funding for monitoring in full compliance to the requirements of MSFD;
- Improvement of data management related to the marine environment;
- Improvement of accessibility to regional and national data bases and outputs of Project funded by public funds

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