2018

REPUBLIC OF TURKEY
MINISTRY OF ENVIROMENT
AND URBANISATION

MARINE QUALITY BULLETIN

The Black Sea

DIRECTORATE GENERAL OF ENVIRONMENTAL IMPACT ASSESSMENT,
PERMIT AND INSPECTION

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

Ministry of Environment and Urbanization has been conducting pollution and quality monitoring studies in all seas of Turkey -the Black Sea, the Marmara Sea and Straits, the Mediterranean Sea and the Aegean Sea- since the 2000s under the Regional Sea Conventions signed by Turkey (Barcelona and Bucharest Conventions) and national and international legislation. Since 2011, the marine monitoring studies have been carried out on the basis of ecosystem-based management approach under the "Integrated Marine Pollution Monitoring Program". Through the monitoring program, it is aimed to establish a scientific background for the determination of national marine and coastal management policies and strategies for the Turkish seas; where comprehensive assessment reports are prepared about the findings based on the historical and up-to-date data.

The " Integrated Marine Pollution Monitoring Programme " conducted by the Ministry has been operated in 3-year periods since 2014 under the coordination of TÜBİTAK-Marmara Research Center with the cooperation and contributions of many acknowledged specialists and scientists from the universities and research institutions.

In the framework of the monitoring program; the physicochemical properties of the water column, ecological status indicators, state of pollution, radioactivity levels, marine litter accumulated at the coasts and the seas, the seafloor and water column biodiversity/habitats, contaminant levels in the target species of economic value are monitored. With these results, quality classifications have been made for assessing the status of coastal water bodies and marine areas. Also, multi-variable data sets have been created to determine and follow up the definitions and targets of "good environmental status" for our seas. The monitoring activities in all Turkish seas -Black Sea, Marmara Sea and the Straits, Mediterranean Sea and Aegean Sea- consist of the following components:

- Monitoring of biodiversity and ecological quality (including alien species),
- Monitoring of eutrophication,
- Monitoring of pollutant levels and their trends as well as in terms of human consumption,
- Monitoring of marine litter in sediments, water and at the coasts.

The Black Sea - Marine Quality Bulletin-2017 contains the eutrophication component assessments for the 2014-2017 period and ecological quality status assessments for the year 2016.

2 DEFINITIONS

CTD: Conductivity and **T**emperature measurements of sea water relative to **D**epth (In situ measurements).

Ecological Status: The structural and functional quality of aquatic ecosystems. According to the Water Framework Directive, coastal waters are assessed with 3 biological quality elements (phytoplankton, zoobenthos and macro algae) and in 5 quality classes (high/good/moderate/poor/bad).

Monitoring of Eutrophication: Relevant indicators like nutrient levels and their temporal changes, dissolved oxygen levels at the bottom and/or intermediate layer depths and their temporal changes, chlorophyll-a levels in euphotic water column, light penetration, prevalence and distribution of opportunistic macro algae are monitored at the seafloor and in the water column. The assessments are made with integrated data on pressures and impacts.

Secchi Disk Depth (SDD): It is an indicator of light transmittance in the marine environment which is commonly used in eutrophication assessments owing to both the ease of measurement and the possibility of comparison with historical data. The Secchi disk depth decreases when the particulate matter in water column increases, however, it increases when the light transmittance increases.

Water Management Unit (Coastal Water Body, CWB): Identifies a surface water part characterized by significant physical, hydro-morphological, ecological properties and by pressure analyses. It is the smallest coastal water management unit handled by the Water Framework Directive (2000/60/EC).

Marine Assessment Unit (MAU): Marine areas defined for monitoring as specified in the Marine Strategy Framework Directive (2008/56/EC); and initially was set with DeKoS Project which are still subject to official confirmation.

TRIX Index: Trophic Index (TRIX) is a scale for the trophic status (eutrophication) classification of coastal surface waters. It is a logarithmic calculation method including such parameters as the Total Phosphorus (TP) and Dissolved Inorganic Nitrogen (DIN) which are among nutrients; Chlorophyll-a (Chl-a) which is a quantitative indicator of planktonic biomass; and aDO% (oxygen saturation deviation from 100%DO) which is an indicator of photosynthesis intensity.

TRIX index (Vollenweider *et al*. 1998; Bendoricchio *et al*. 2005) is calculated with the following formula;

$$TRIX = (\mathrm{Log}_{10}[\text{Chl-a} \times \text{aDO\%} \times \text{TIN} \times \text{TP}] + k) / m$$

Chl-a: Chlorophyll-a concentration (μg/L),

aDO%: Absolute deviation from the oxygen saturation value: I 100-DO% I

DIN: Dissolved inorganic nitrogen: $(NO_3+NO_2+NH_4)$-N (μg/L)

TP: Total phosphorus (μg/L)

k: Equation constant; 1.5

m: Equation constant; 1.2

Classification ranges according to this index are given in the Table below.

Table 2.1 TRIX Values and Class Definitions

TRIX Value	Class Definition
< 4	No Risk of Eutrophication (High quality)
4 - 5	Less risk of eutrophication (Good quality)
5 – 6	High Risk of eutrophication (Moderate quality)
>6	Eutrophic (Bad quality)

Supplementary information about the sampling, measurement and analysis methods can be found in the Appendices.

3 GENERAL INFORMATION

This section includes general information about the monitoring stations and campaigns in the Black Sea. The monitoring activities from 2014 to 2017 were carried out by the TÜBİTAK Marmara Research Vessel which is a fully equipped oceanographic research ship with a hull length of 41.2 meters. The information about the monitoring stations in the 2014-2017 period is given in Table 3.1. Also, the detailed information about the stations monitored in 2017 is available in Appendix-1.

Table 3.1 Information about the Monitoring Stations in the Black Sea

Monitoring Components	2014	2015		2016		2017
	Summer	Winter	Summer	Winter	Summer	Summer
Water Column	79	81	82	84	94	97

3.1 The Black Sea Coastal Water Bodies (Water Management Units)

There are 16 Coastal Water Bodies (CWBs) in the Black Sea, listed in Table 3.2 and shown in Figure 3.1.

Table 3.2 Black Sea Coastal Water Bodies (Water Management Units)

Coastal Water Bodies (Water Management Units)
KAR01: West and East coast of İstanbul Strait
KAR02: Sakarya River
KAR03: Ereğli - Zonguldak
KAR04: Filyos-Bartın
KAR05: Cide- Sinop West
KAR06: Sinop East
KAR07: Kızılırmak
KAR08: Samsun Coast
KAR09: Samsun Open
KAR10: Yeşilırmak
KAR11: Ünye-Fatsa
KAR12: Ordu-Giresun
KAR13: Tirebolu-Akçaabat
KAR14: Trabzon
KAR15: Rize
KAR16: Hopa

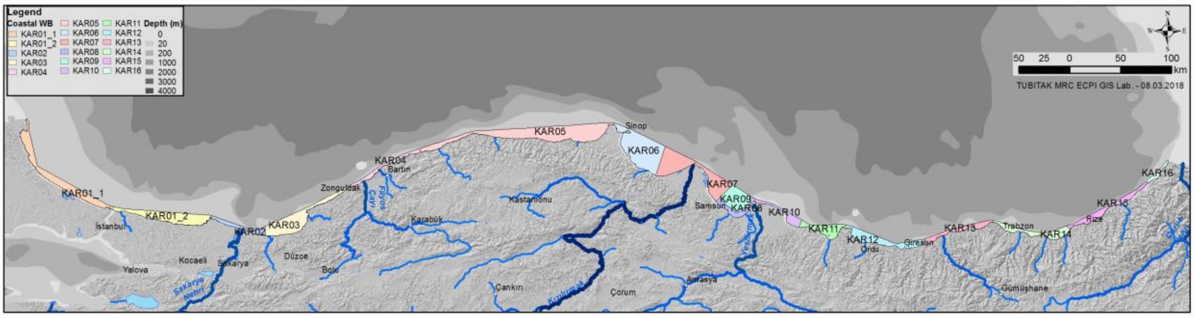

Figure 3.1 The Black Sea Coastal Water Bodies (Water Management Units) (DeKoS, 2014)

3.2 Information on the monitoring stations and campaigns in the Black Sea

Information about the monitoring stations (codes/location, coordinates, depths, etc.) studied in the Black Sea in the summer of 2017 are given in Appendix-1. Under the "Integrated Marine Pollution Monitoring Program", the summer period sampling activities in the Black Sea Region were performed in July 2017 via *in situ* measurements and samplings at 97 stations.

In the summer period, seawater physicochemical variables (CTD including in-situ fluorescence and radiation, dissolved oxygen, pH, nutrients, Secchi depths) and chlorophyll-a were measured. More than 30 stations were representing marine waters including 20-30 nm offshore ones to represent 5 marine assessment units at 7 transects.

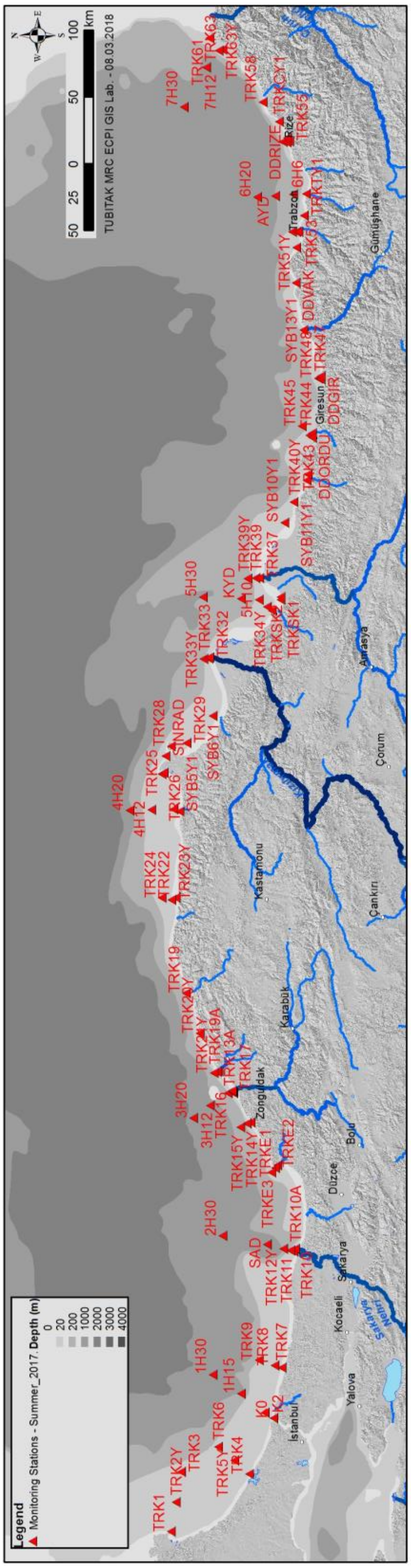

Figure 3.2 Map of the Black Sea monitoring stations in 2017

4 EUTROPHICATION STATUS of THE BLACK SEA

As part of the eutrophication assessment of the Black Sea, the following variables were also assessed together with Physical Variables (salinity, temperature, pH, density changes, etc.).

- Nutrient levels
- Chlorophyll-a levels
- Dissolved Oxygen levels
- Secchi Disc Depths

This section includes the assessment results of the above mentioned variables in the Black Sea coastal water bodies.

4.1 Variability of Nutrients

For surface distributions of nutrients; the surface dissolved inorganic nitrogen (DIN), silicate (Si), nitrite-nitrate nitrogen (Nox) and total phosphorus (TP) concentrations were assessed. 2014-2017 data (4 summers and 2 winters; Table 3.1) from the Black Sea CWBs on the surface layer (0-10m average) nutrients (NO_3+ NO_2 –N [Nox], NH_4, PO_4^{-3}, TP and Si), their ratios (N:P, Si:N) and comparisons of salinity-temperature properties are given in Figure 4.1 and Figure 4.2.

Although it is observed that winter periods reveal generally higher levels; the most prominent fact is that the CWBs (2, 7, 10) under the influence of rivers reveal high values of nitrogen and silicate. Besides, KAR08, which is under the influence of Samsun city, reveals a significantly high phosphorus level. Si:N ratio was observed to be quite low (<5) except for the 2017 summer period; which can be an indication of undesired conditions for the reproduction of diatoms. On the other hand, despite variations depending on CWBs and periods, the N:P ratio is mostly <2 which is quite below the ideal Redfield ratio (16) which was defined for oceanic and marine waters having no human induced pressures..

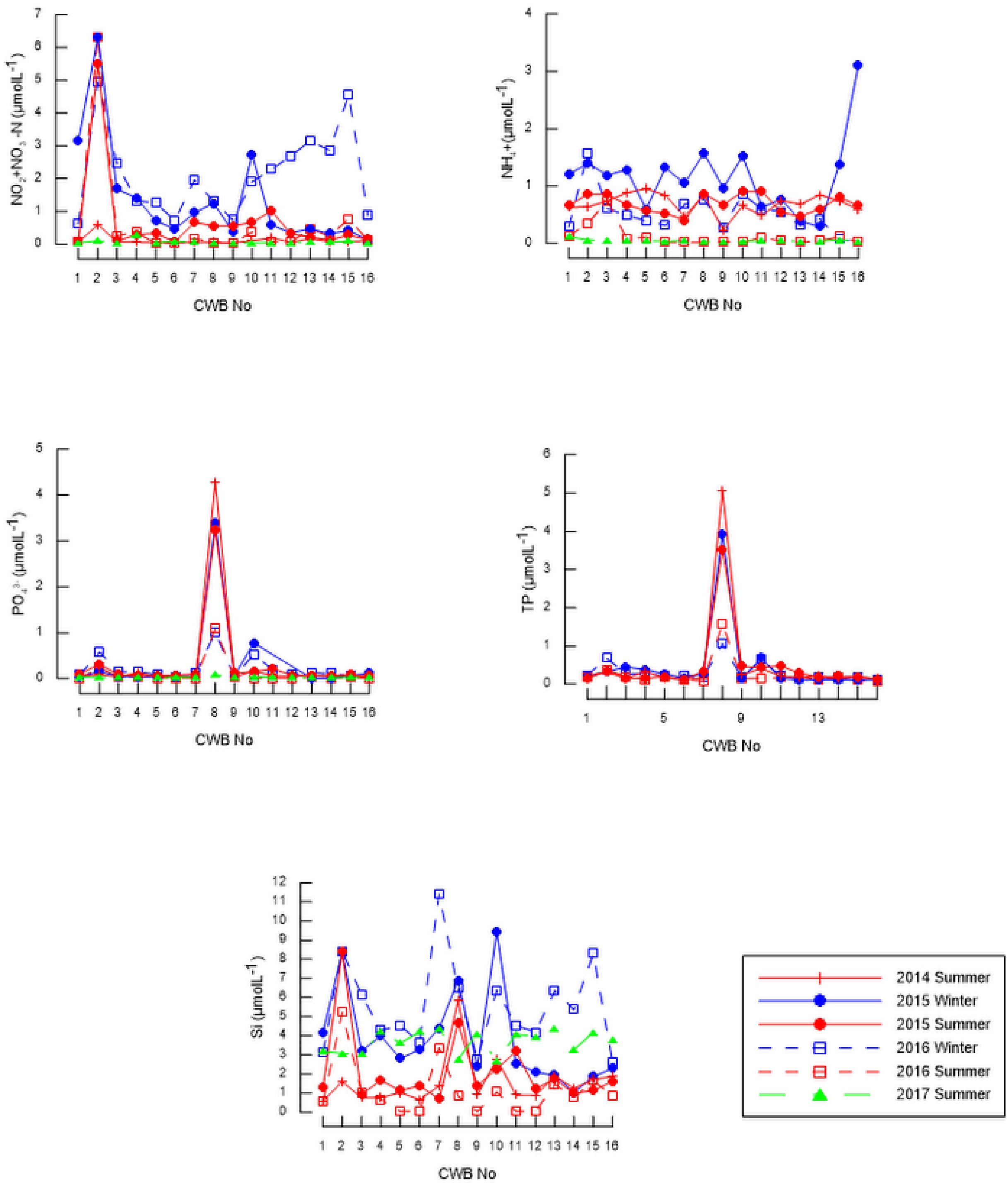

Figure 4.1 Comparison of the 2014-2017 data from the Black Sea CWBs on surface layer (0-10m average) nutrients

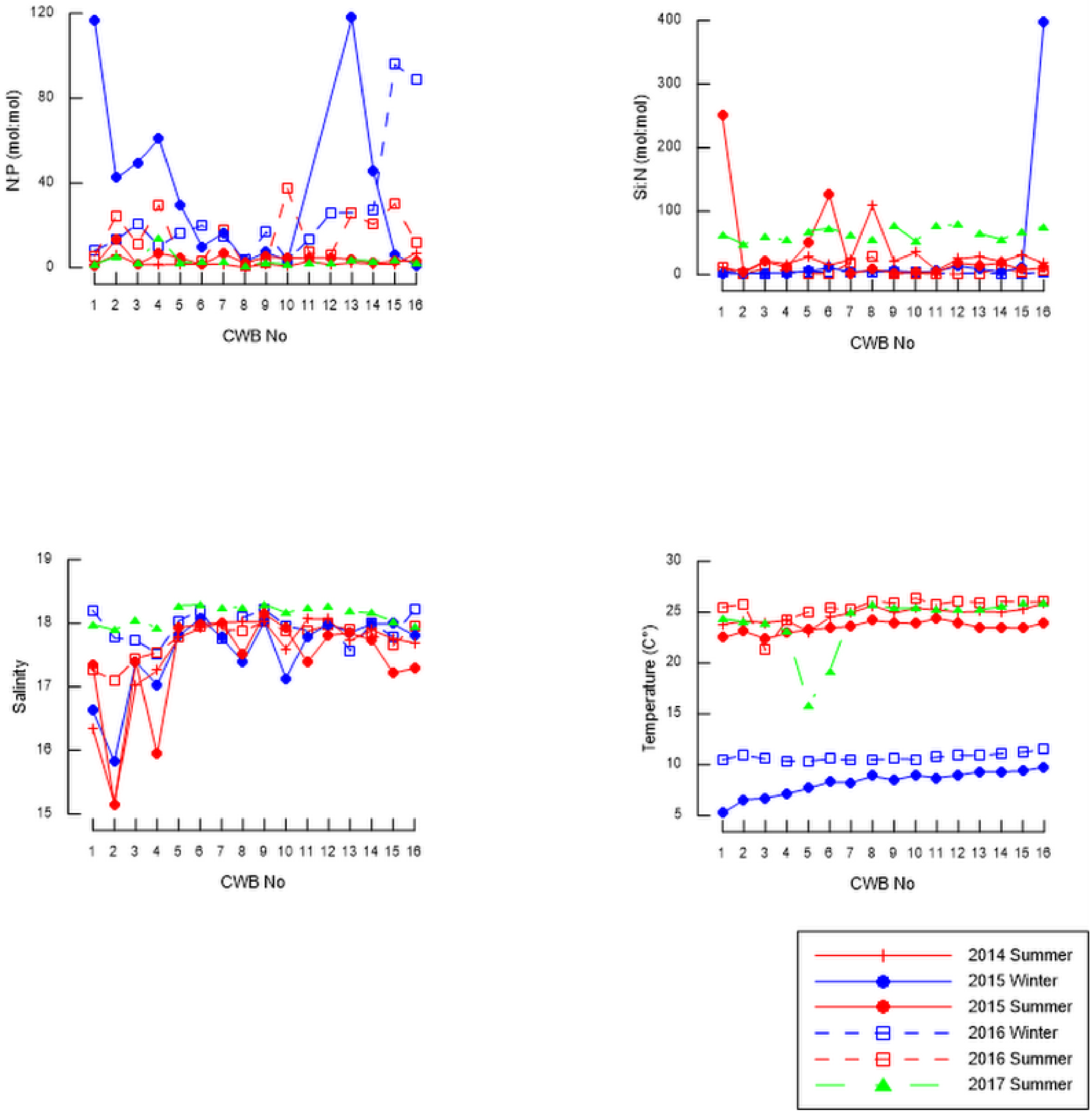

Figure 4.2 Comparison of the 2014-2017 data from the Black Sea CWBs on the rates of surface layer (0-10m average) nutrients and some physical properties

4.2 Chlorophyll-a levels

Figure 4.3 shows the comparison of the 2014-2017 surface layer (0-10m average) chlorophyll-a concentrations at the Black Sea CWBs. The 2017 summer period surface distributions of the chlorophyll-a, which is an indicator of phytoplankton biomass, reveal that the concentration across the Black Sea is <1 µg/L. Relatively higher values (>1-1.5 µg/L) were observed generally at the near-coastal stations in the Eastern Black Sea. All of the stations in the open sea revealed values <1 µg/L. The highest chlorophyll-a value (5 µg/L) was measured at TRK61 station. The comparison of the 2014-2017 data from the CWBs and the MAUs on surface layer chlorophyll-a concentrations indicates that the concentrations in the winter periods were generally higher than those in the summer periods, and the levels in the MAUs are generally lower than those in the CWBs. Summer concentrations in 2017 revealed comparable values with the previous summer periods.

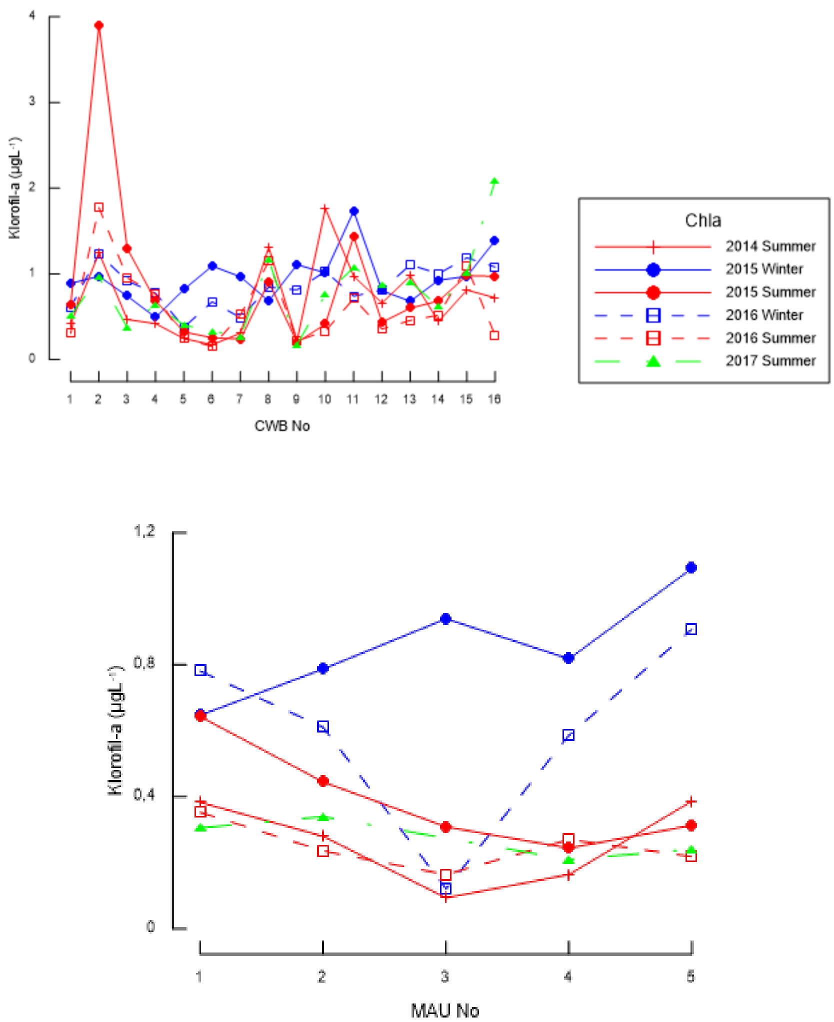

Figure 4.3 Comparison of the 2014-2017 data from the Black Sea CWBs on surface layer (0-10m average) chlorophyll-a concentrations

4.3 Dissolved Oxygen Levels

During the 2017 summer sampling in the Black Sea, the dissolved oxygen concentration (DO) was measured throughout the water column and the results of all the stations are presented in one graph (Figure 4.4). DO was quite variable (5-10 mg/L) from surface to 70m depth, however, after that layer (oxycline), it starts to decrease starting from 14.5 sigma-t density value. Falling to very low values at around 14.5 and 15.5 sigma-t (density) (oxycline-nitricline), DO was completely diminished at 16.2 sigma-t (> ≈130m depths depending on the location). These values reflect the general oxygen properties of the Black Sea (Oğuz and Gilbert., 2007).

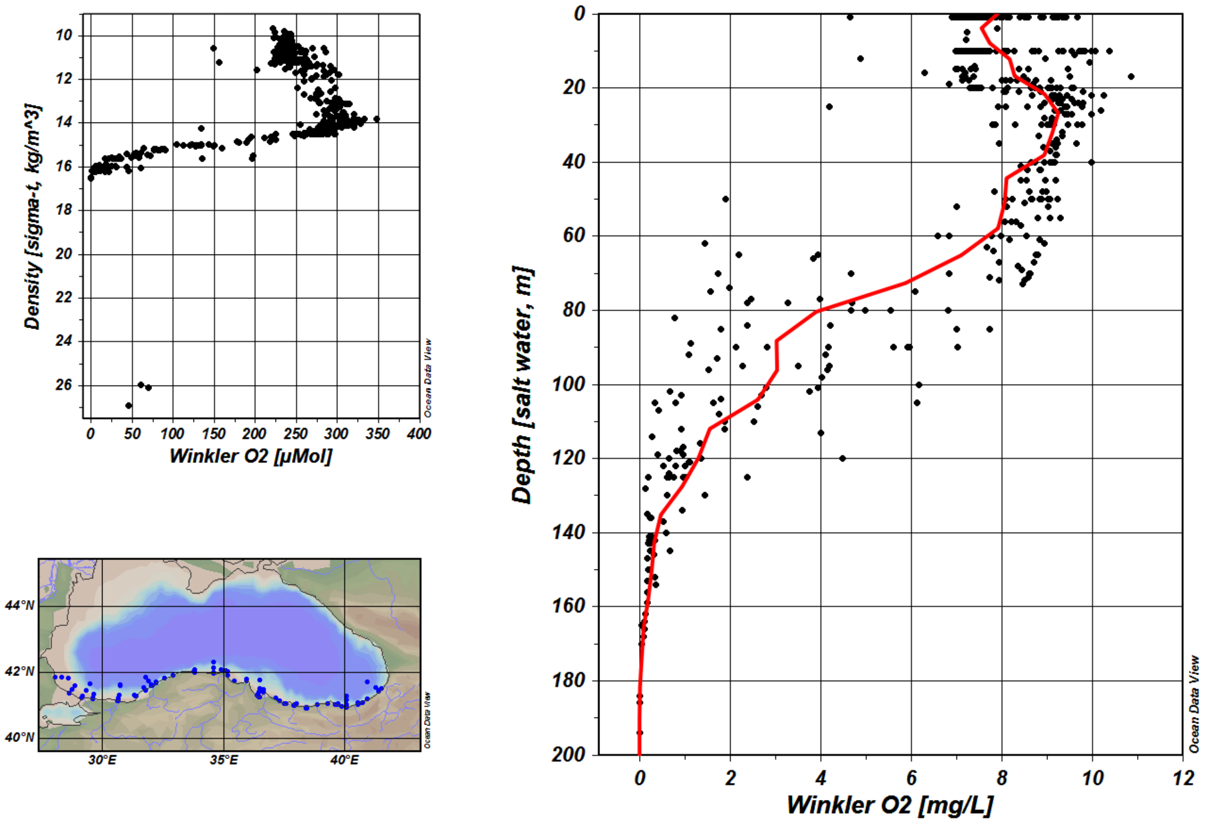

Figure 4.4 Dissolved oxygen profiles in the 2017 summer samplings of all the stations in the Black Sea

4.4 Secchi Disk Depth

Secchi Disc Depth was found to change between 3.5 and 13.5 m in the 2017 summer period in the Black Sea (Figure 4.5). SDD was measured to be higher in the summer period than in the winter period across the Black Sea. SDDs in the range from 3 to 5 m were generally measured at the stations located close to river mouths and at the coastal areas. Light transmission was observed to increase in the open sea, being measured to be >7m at all such stations. When the 2014-2017 SDDs are compared, the light transmission observed to increase in the summer periods. However, in 2017 summer measurements revealed significantly lower results than the other summer measurements.

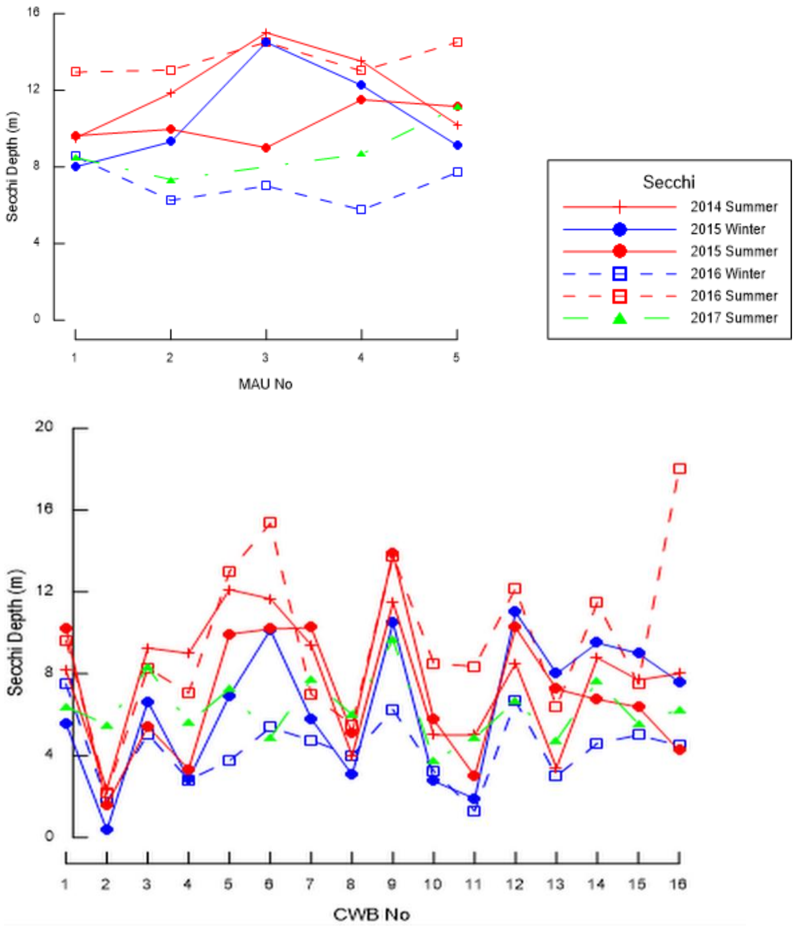

Figure 4.5 Comparison of the 2014-2017 Secchi disk depth averages at the Black Sea CWBs

5 TRIX INDEX ASSESSMENT

According to the TRIX Index values calculated with the trophic status indicator parameters (nutrients, chlorophyll and oxygen saturation percentage), in the coastal and open sea waters of the Black Sea, the TRIX values were generally calculated to be <4 (No risk of eutrophication) in the 2014-2016 sampling periods (Figure 5.1). TRIX values of the summer periods were mostly found to be lower than those of the winter periods; which could be attributed to the fully consumed nutrients in the photic zone until the summer due to primary production.

It is emphasized that the river inputs increase the risk of eutrophication on the coasts of the Black Sea. Therefore, the control and the reduction of river inputs are important for the Black Sea ecosystem.

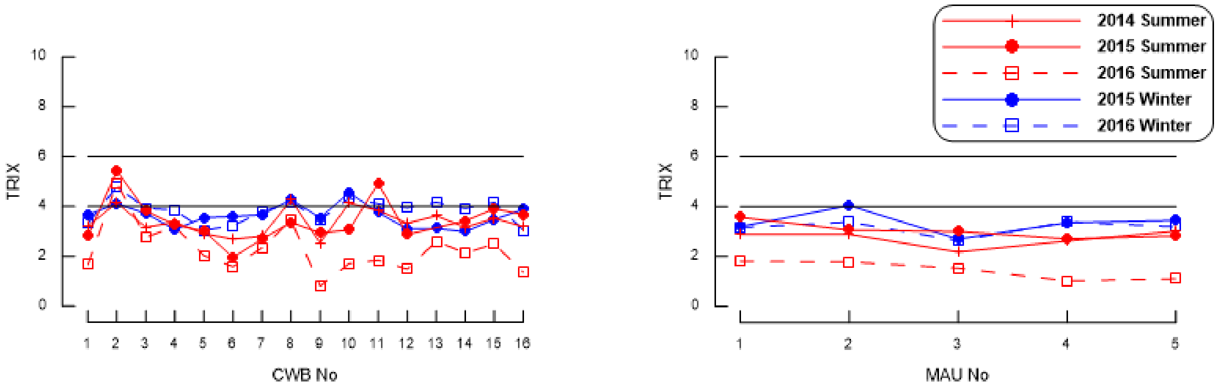

Figure 5.1 TRIX values of the CWBs and MAUs in the Black Sea in 2014-2016 sampling periods

TRIX could not have been calculated because the 2017 TP measurements are still in progress at TÜBİTAK-Marmara Research Center laboratories.

6 GENERAL ASSESSMENT

Ecological Quality Status of Coastal Water Bodies

This section includes ecological quality status assessments for the 2014-2016 period on the basis of the findings of CWBs according to Water Framework Directive by biological parameters (phytoplankton, macroalgae and benthic invertebrates) as well as supporting parameters (TP, Nox, SDD). The classification for the year 2016 is given in Figure 6.1.

Only CWBs 1, 5, 6 and 9 were classified as “Good”, others were included in the classes of "moderate/poor/bad". According to this assessment, coasts included in "Bad" class and remarked are respectively CWBs 2, 8 and 11, which are under the influence of Sakarya River, Samsun and Unye-Fatsa impact areas. Although only 2016 is presented here, there was not a significant difference among the sampling periods

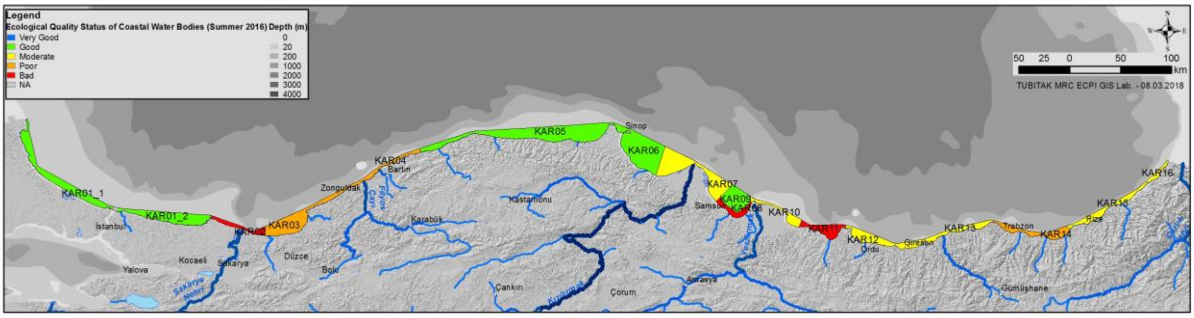

Figure 6.1 Coastal water bodies ecological quality assessment (2016)

7 APPENDICES

7.1 Appendix-1: Information on the stations and samplings in the summer of 2017

Station Number	Station Code	Station location	CWB / MAU No	Co-ordinates		Depth (m)	Distance from coast (km)
				Latitude	Longitude		
1	TRK1	İğneada and Danube Waters (Control)	KAR01	41° 52' 7"	28° 3' 38"	23	1,59
2	TRK2Y	İğneada and Danube Waters (Control)	MAU1	41° 50' 59"	28° 19' 32"	60	22,63
3	TRK3	İğneada and Danube Waters (Control)	MAU1	41° 49' 31"	28° 36' 11"	98	44,87
4	TRK6	Western Black Sea	MAU1	41° 35' 10"	28° 50' 56"	96	29,81
5	TRK5Y	Western Black Sea	MAU1	41° 28' 25"	28° 44' 11"	84	14,59
6	TRK4	Western Black Sea	KAR01	41° 22' 7"	28° 37' 25"	18	1,31
7	K0	Strait Exit - 1st Line	KAR01	41° 13' 32"	29° 8' 7"	67	1,53
8	K2	Additional - Strait Exit - Channel, 1st transect	MAU1	41° 17' 5"	29° 10' 53"	70	6,57
9	1H15	Additional - Strait Exit - Channel, 1st transect	MAU1	41° 27' 13"	29° 20' 13"	1045	25,16
10	1H30	Additional - Strait Exit - Channel, 1st transect	MAU1	41° 39' 5"	29° 29' 46"	1798	49,27
11	TRK9	Şile - Control	MAU1	41° 20' 38"	29° 38' 46"	126	18,26
12	TRK8	Şile - Control	KAR01	41° 14' 10"	29° 36' 11"	49	6,01
13	TRK7	Şile - Control	KAR01	41° 11' 28"	29° 35' 19"	22,5	1,67
14	TRK10	Sakarya River - Control (2nd transect)	KAR02	41° 8' 43"	30° 37' 44"	20	1,79
15	TRK10A	Sakarya River Delta	KAR02	41° 8' 5"	30° 39' 14"	6	0,83
16	TRK11	Sakarya River - Control	MAU1	41° 10' 1"	30° 38' 27"	48	4,30
17	TRK12Y	Sakarya River - Control	MAU1	41° 12' 48"	30° 39' 1"	730	9,47
18	SAD	Sakarya River - 12 miles	MAU1	41° 19' 31"	30° 40' 55"	1200	22,07
19	2H30	Additional - Sakarya River - 30 miles (2nd transect)	MAU1	41° 37' 36"	30° 44' 40"	1840	55,93
20	TRKE1	Karadeniz Ereğlisi	KAR03	41° 16' 28"	31° 23' 51"	14	0,49
21	TRKE2	Karadeniz Ereğlisi	KAR03	41° 17' 21"	31° 22' 22"	60	1,71
22	TRKE3	Karadeniz Ereğlisi	KAR03	41° 18' 52"	31° 19' 43"	95	5,44
23	TRK13	Zonguldak - Control	KAR03	41° 27' 37"	31° 46' 19"	21	0,63
24	TRK14Y	Zonguldak - Control	KAR03	41° 29' 13"	31° 45' 38"	84	3,35
25	TRK15Y	Zonguldak - Control	MAU2	41° 31' 46"	31° 43' 28"	725	8,71
26	3H20	Additional - Filyos - 20 miles (3rd Line)	MAU2	41° 51' 4"	31° 47' 54"	1580	36,26
27	3H12	Additional - Filyos - 12 miles (3rd Line)	MAU2	41° 44' 20"	31° 54' 58"	1420	20,56
28	TRK18Y	Filyos - Control (3rd Line)	MAU2	41° 37' 19"	32° 1' 48"	815	4,76
29	TRK13A	Filyos (Yenice) River Delta	KAR04	41° 35' 8"	32° 1' 53"	19	1,17
30	TRK16	Bartın - Control	KAR04	41° 35' 17"	32° 2' 37"	65	0,83
31	TRK17	Filyos - Control (3rd Line)	KAR04	41° 35' 30"	32° 3' 8"	19	1,01
32	TRK19A	Bartın Stream Delta	KAR04	41° 41' 10"	32° 13' 23"	6	0,12
33	TRK21	Bartın - Control	KAR04	41° 41' 51"	32° 13' 10"	80	1,14
34	TRK21Y	Bartın - Control	MAU2	41° 43' 7"	32° 12' 28"	750	3,66
35	TRK20Y	Cide - Control - 2	KAR04	41° 49' 11"	32° 33' 44"	23	0,98
36	TRK19	Cide - Control - 1	KAR05	41° 54' 47"	32° 55' 34"	43	3,52
37	TRK24	İnebolu - Control	MAU2	42° 4' 57"	33° 47' 11"	98	11,19
38	TRK22	İnebolu - Control	KAR05	41° 59' 17"	33° 47' 12"	27	1,04
39	TRK23Y	İnebolu - Control	KAR05	42° 1' 0"	33° 46' 2"	71	3,86
40	CWB5Y2	Off the coast of Ayancik Stream (4th Line)	KAR05	42° 0' 7"	34° 35' 19"	55	5,74
41	CWB5Y1	The front of Ayancik Stream	KAR05	41° 57' 49"	34° 34' 8"	13	1,66
42	4H12	Additional-Sinop cycle (4th Line)	MAU2	42° 9' 9"	34° 34' 52"	108	20,93
43	4H20	Additional-Sinop cycle (4th Line)	MAU2	42° 17' 59"	34° 34' 41"	1580	36,61
44	TRK26	Sinop 2 - Control	KAR05	42° 4' 52"	34° 54' 20"	48	3,27
45	TRK25	Sinop 2 - Control	KAR05	42° 3' 54"	34° 55' 2"	19	1,71
46	SINRAD	Radioactivity St.	KAR06	42° 3' 11"	35° 4' 13"	29	1,69
47	SYD	Sinop - 12 miles	MAU3				

Station Number	Station Code	Station location	CWB / MAU No	Co-ordinates		Depth (m)	Distance from coast (km)
				Latitude	Longitude		
48	TRK28	Sinop 1 - Control	KAR06	42° 1' 1"	35° 9' 23"	25	0,45
49	TRK29	Sinop 1 - Control	KAR06	41° 54' 38"	35° 10' 58"	47	5,92
50	CWB6Y1	Additional - Sinop, Kızılırmak - Control	KAR06	41° 43' 59"	35° 25' 35"	66	5,55
51	KYD	Kızılırmak cycle - 15 miles (5th Line)	MAU4	41° 31' 17"	36° 28' 31"	622	21,08
52	TRK33Y	Kızılırmak - Control	MAU4	41° 47' 16"	35° 56' 27"	235	5,74
53	TRK33	Kızılırmak - Control	KAR07	41° 45' 17"	35° 56' 47"	130	2,06
54	TRK32	Kızılırmak - Control	KAR07	41° 44' 42"	35° 57' 10"	72	0,88
55	5H30	Additional - Kızılırmak cycle - 30 miles (5th Line)	MAU4	41° 46' 44"	36° 30' 1"	1120	36,34
56	5H10	Additional - Kızılırmak cycle - 10 miles (5th Line)	MAU4	41° 24' 14"	36° 27' 40"	380	13,66
57	TRK35	Samsun - Control	KAR09	41° 20' 49"	36° 23' 41"	51	5,25
58	TRK34Y	Samsun - Control	KAR08	41° 18' 58"	36° 21' 38"	20	0,82
59	TRKSK1	Samsun Discharge Control 1 (5th Line)	KAR08	41° 15' 22"	36° 27' 8"	20	0,73
60	TRKSK2	Samsun Discharge Control 2 (5th	KAR08	41° 15' 25"	36° 28' 44"	20	0,44
61	TRK39Y	Yeşilırmak - Control	MAU5	41° 28' 27"	36° 39' 14"	250	10,20
62	TRK39	Yeşilırmak - Control	MAU5	41° 25' 13"	36° 39' 14"	105	4,23
63	TRK37	Yeşilırmak - Control	KAR10	41° 23' 37"	36° 39' 11"	8	1,29
64	CWB10Y1	ADDITIONAL-CWB10	KAR10	41° 12' 53"	37° 8' 28"	36	7,05
65	CWB11Y1	ADDITIONAL-SYB11	KAR11	41° 8' 39"	37° 19' 14"	27	2,16
66	TRK40Y	Fatsa - Control/Radioactivity	KAR11	41° 3' 5"	37° 30' 34"	170	1,46
67	DDFATSA	Deep Discharge	KAR11	41° 2' 32"	37° 33' 43"	70	1,68
68	TRK44	Ordu - Control	KAR12	41° 1' 11"	37° 54' 31"	48	3,37
69	DDORDU	Deep Discharge	KAR11	41° 0' 13"	37° 55' 36"	21	1,91
70	TRK43	Ordu - Control	KAR12	41° 0' 9"	37° 53' 29"	10	1,16
71	TRK45	Ordu - Control	KAR12	41° 4' 4"	37° 59' 40"	90	9,67
72	TRK48	Giresun - Control	KAR12	40° 56' 37"	38° 24' 54"	95	2,86
73	TRK47	Giresun - Control	KAR12	40° 55' 58"	38° 24' 40"	53	1,78
74	TRK46	Giresun - Control	KAR12	40° 55' 26"	38° 24' 18"	28	0,80
75	DDGIR	Deep Discharge	KAR13	40° 55' 28"	38° 25' 47"	21	1,19
76	CWB13Y1	Akçaabat - Control 1	KAR13	41° 1' 26"	38° 50' 58"	20	1,42
77	DDVAK	Deep Discharge	KAR14	41° 3' 31"	39° 16' 31"	25	0,75
78	TRK51Y	Akçaabat - Control	KAR14	41° 2' 25"	39° 35' 11"	70	2,15
79	TRK54Y	Trabzon - Control	MAU5	41° 3' 38"	39° 43' 53"	290	5,32
80	TRK54	Trabzon - Control	KAR14	41° 1' 52"	39° 43' 35"	93	2,00
81	TRK53	Trabzon - Control	KAR14	41° 1' 3"	39° 43' 41"	57	0,64
82	TRKTY1	Yomra Discharge Control	KAR14	40° 58' 21"	39° 52' 4"	75	1,50
83	TRKAR1	Araklı - Control (6th Line)	KAR14	40° 56' 51"	40° 3' 32"	10	0,32
84	6H6	Additional - Arsin - 6 miles (6th Line)	MAU5	41° 2' 8"	40° 3' 40"	912	8,78
85	AYD	Arsin - 10 miles (6th Line)	MAU5	41° 9' 23"	40° 3' 33"	925	21,99
86	6H20	Arsin - 20 miles (6th Line)	MAU5	41° 16' 38"	40° 3' 41"	1530	35,20
87	TRK57Y	Rize - Control	KAR15	41° 4' 44"	40° 32' 10"	718	4,66
88	TRK57	Rize - Control	KAR15	41° 3' 20"	40° 31' 53"	70	2,08
89	TRK55	Rize - Control	KAR15	40° 32' 23"	41° 2' 7"	17	0,00
90	DDRIZE	Deep Discharge	KAR15	41° 2' 50"	40° 34' 6"	61	0,48
91	TRKCY1	Çayeli - Control	KAR15	41° 5' 42"	40° 42' 59"	13	0,58
92	TRK58	Pazar - Control	KAR15	41° 11' 38"	40° 54' 13"	18	1,19
93	TRK63	Hopa - Control	KAR16	41° 26' 5"	41° 24' 5"	99	2,82
94	TRK63Y	Hopa - Control (7th Line)	MAU5	41° 27' 33"	41° 23' 39"	146	5,21
95	TRK61	Hopa - Control	KAR16	41° 30' 50"	41° 30' 48"	69	2,00
96	7H12	Batumi cycle - 12 miles (7th Line)	MAU5	41° 33' 14"	41° 15' 24"	1180	20,69
97	7H30	Batumi Cycle - 30 miles (7th Line)	MAU5	41° 43' 32"	40° 55' 4"	1412	51,55

7.2 Appendix-2: Sampling Methods

MATRIX	PARAMETER	SAMPLING METHOD	STORAGE METHOD	REFERENCE
SEA WATER	T,S,D	*In-situ* measurement	-	CTD Manual –Software Sea Monitoring Guidelines (2017)
	DO	*In-situ* measurement / Reagent must be added from rosette to bottle without contacting with air.		Winkler CTD Manual -Software / MTS 163 Sea Monitoring Guidelines (2017)
	SD Depth	*In-situ* measurement: with a 30cm diameter white disk	-	Sea Monitoring Guidelines (2017)
	Chl-a	Roset sampling, filtering with GF/F filters	-20 ^{0}C in deep freezer	Water Pollution Control Regulation Sampling and Analysis Methods Communiqué UNEP/MAP, 2005. Sampling and Analysis techniques for the Eutrophication Monitoring Strategy of MED POL. Technical Reports Series No: 163 Sea Monitoring Guidelines (2017)
	PO_4^+	From rosette to bottle	In HDPE bottles in deep freezer at -20 ^{0}C or immediate measurement	
	TP			
	SiO_2			
	NO_3+NO_2-N			
	NH_4-N			

7.3 Appendix-3: Measurement and Analysis Methods

MATRIX	PARAMETER	METHOD	INSTRUMENT	REFERENCE	LOD/LOQ	Unit	Measurement-Analysis Laboratory
SEA WATER	T,S,D	*In-situ* measurement	CTD prop	CTD Manual –Software Sea Monitoring Guidelines (2017)	-	-	R/V TÜBİTAK MARMARA Research Vessel
	DO	Iodometric Method (Winkler Method)	Titrator	S.M. 4500 B:2005 Sea Monitoring Guidelines (2017)	-	mg/L	R/V TÜBİTAK MARMARA Research Vessel
	SD Depth	*In-situ* measurement	Secchi Disk	Sea Monitoring Guidelines (2017)	-	m	R/V TÜBİTAK MARMARA Research Vessel
	Chl-a	Spectrophotometric Method-Extraction With Aceton	Spectrophoto meter	S.M 10200 H. Sea Monitoring Guidelines (2017)	0,05	µg/L	R/V TÜBİTAK MARMARA Research Vessel
	PO_4^+	Method of Determination of Orthophosphate	Autoanalyzer	S.M. 4500-P : 2005 G Sea Monitoring Guidelines (2017)	0,02/ 0,07	µmol/L	R/V TÜBİTAK MARMARA Research Vessel
	TP	Persulfate Method for Simultaneous Determination of Total Nitrogen and Total Phosphorus	Autoanalyzer, Autoclave	S.M. 4500- P J. Sea Monitoring Guidelines (2017)	0,055 / 0,183	µmol/L	TÜBİTAK MAM Environment and Cleaner Production Institute
	SiO_2	Colorimetric method	Autoanalyzer	SM 4500-SiO2- :2005 F Sea Monitoring Guidelines (2017)	0,06 /0,19	µmol/L	R/V TÜBİTAK MARMARA Research Vessel
	NO_3+NO_2-N	Cadmium Reduction Method	Autoanalyzer	S.M. 4500-NO3-I:2005 Sea Monitoring Guidelines (2017)	0,05 / 0,17	µmol/L	R/V TÜBİTAK MARMARA Research Vessel
	NH_4-N	Flow Injection Method	Autoanalyzer	S.M. 4500-NH3 H:2005 Sea Monitoring Guidelines (2017)	0,041 / 0,14	µmol/L	R/V TÜBİTAK MARMARA Research Vessel

8 REFERENCES

- ÇŞB-ÇEDİDGM and TÜBİTAK-MAM (2017). Integrated Pollution Monitoring Project (2017-2019). ÇTÜE 5178702, Report No. ÇTÜE.17.2116 (Black Sea Final Report, 2017), February 2018, Gebze-Kocaeli.

- ÇŞB-ÇEDİDGM and TÜBİTAK-MAM (2017). Integrated Pollution Monitoring Project (2014-2016). ÇTÜE 5148704, Report No. ÇTÜE.16.330 (Black Sea Final Report, 2016), May 2017, Gebze-Kocaeli.

- ÇŞB-ÇEDİDGM and TÜBİTAK-MAM (2016). Integrated Pollution Monitoring Project (2014-2016). ÇTÜE 5148704, Report No. ÇTÜE.15.264 (Black Sea Final Report, 2015), April 2016, Gebze-Kocaeli.

- ÇŞB-ÇEDİDGM and TÜBİTAK-MAM (2015). Integrated Pollution Monitoring Project (2014-2016). ÇTÜE 5148704, Report No. ÇTÜE.14.201 (Black Sea Final Report, 2014), April 2015, Gebze-Kocaeli.

- ÇŞB-ÇEDİDGM and TÜBİTAK-MAM (2017) Sea Monitoring Guidelines, Gebze-Kocaeli.

- DEKOS Project: TUBITAK-MRC and MoEU-GDEM (2014). Marine and Coastal Waters Quality Determination and Classification Project (DeKoS). ÇTÜE 5118703, Report No. ÇTÜE.13.155 (Final Report), February 2014, Gebze-Kocaeli, Turkey.

- TÜBİTAK-MAM and ÇŞB-ÇYGM (2014). Quality Assessment and Classification of Marine and Coastal Waters (DeKoS) ÇTÜE 5118703, Report No. ÇTÜE.13.155 (Final Report), February 2014, Gebze-Kocaeli.

- TÜBİTAK-MAM (2015) Project for the Determination of Basin Based Sensitive Areas and Water Quality Targets in Turkey. Project Final Report, TÜBİTAK Marmara Research Center Environment and Cleaner Production Institute (Project Owner Institution: OSİB-SYGM)

- Vollenweider, R.A., Giovanardi, F., Montanari, G. and Rinaldi, A. 1998. Characteriztion of the trophic conditions of marine coastal waters with specific reference to the NW Adriatic Sea: proposal for a trophic scale, turbidity and generalized water quality index. Environmetrics, 9: 329-357.

- Bendoricchio, G. and Boni, G. 2005, A water-quality model for the Lagoon of Venice, Italy. Ecological Modelling 184 (2005) 69–81

- UNEP/MAP, 2005. Sampling and Analysis techniques for the Eutrophication Monitoring Strategy of MED POL. Technical Reports Series No: 163

- Oğuz, Temel and Denis Gilbert, 2007. Abrupt transitions of the top-down controlled Black Sea pelagic ecosystem during 1960-2000 : Evidence for regime-shifts under strong fishery exploitation and nutrient enrichment modulated by climate-induced variations 54: 220–242. doi:10.1016/j.dsr.2006.09.010.