BULGARIAN ACADEMY OF SCIENCES
INSTITUTE OF OCEANOLOGY

REPORT

BIOLOGICAL MONITORING OF COASTAL MARINE WATERS AND LAKES - BENTHIC INVERTEBRATE FAUNA

The present study was carried out within the Contract BUL 007/07 - “Capacity building aimed at the development of a Pilot Programme of measures for the Black Sea River Basin management plan of coastal waters at risk – Burgas and Varna bay”.

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1. STUDY AREA AND SAMPLING SITES

The study area covers the two largest bays along the Bulgarian Black Sea coast – Burgas bay (WB BG2BS000C008, BG2BS000C009, BG2BS000C010 and BG2BS000C011) and Varna bay (WB BG2BS000C005), as well as the two interconnected coastal lakes of Varna (WB BG2PR100L001) and Beloslav (WB BG2PR100L002) that used to be fresh water basins originally but nowadays are modified to brackish lagoons due to established connection with Varna bay through couple of artificial channels. Macrozoobenthos was sampled at eighteen locations, of which 7 stations in Beloslav-Varna lakes, 2 stations in the outlets of the channels between Varna lake and Varna bay, 2 stations in Varna Bay and 7 stations in the large Burgas bay area as shown on Figure 1, geographic coordinates and depth given in Table 1. Sampling was carried out in August 2008 onboard RV "Akademik" and FV "Elis".

Table 1. Geographic coordinates and depth of sampling stations.

Station	Coordinates		Sediment type	Depth (m)
	Latitude N	Latitude E		
1. Beloslav lake West	27°40'14	43°11'26"	Mud	7
2. Beloslav lake East	27°41'50	43°11'42"	Mud	2
3. Channel Beloslav-Varna lakes	27°44'22	43°11'38"	Mud	12
4. Varna lake West	27°46'28	43°11'35"	Mud	12.5
5. Varna lake North-West	27°47'29	43°11'55"	Mud	14
6. Varna lake Center	27°48'52	43°11'11"	Mud	14
7. Varna lake East	27°52'12	43°12'09"	Mud	8
8. Old Channel	27°54'33	43°11'23"	Sand	2
9. New channel	27°54'12	43°11'04"	Mud	12
10. Varna bay 1	43°11'07"	27°56'11"	Mud	17
11. Varna bay 2	43°12'07"	27°57'19"	Mud	16.4
12. Nesebar	42°40'48"	27°46'44"	Mud	22
13. Cocketrice	42°39'03"	27°53'20"	Sand	17
14. Rosenets	42°27'47"	27°31'01"	Mud	14.5
15. Burgas	42°30'23"	27°40'20"	Mixed	27
16. Burgas bay	42°30'00"	27°48'00"	Mud	35
17. Sozopol	42°26'03"	27°43'21"	Mud	38
18. Maslen nos	42°20'08"	27°49'09"	Mud	47

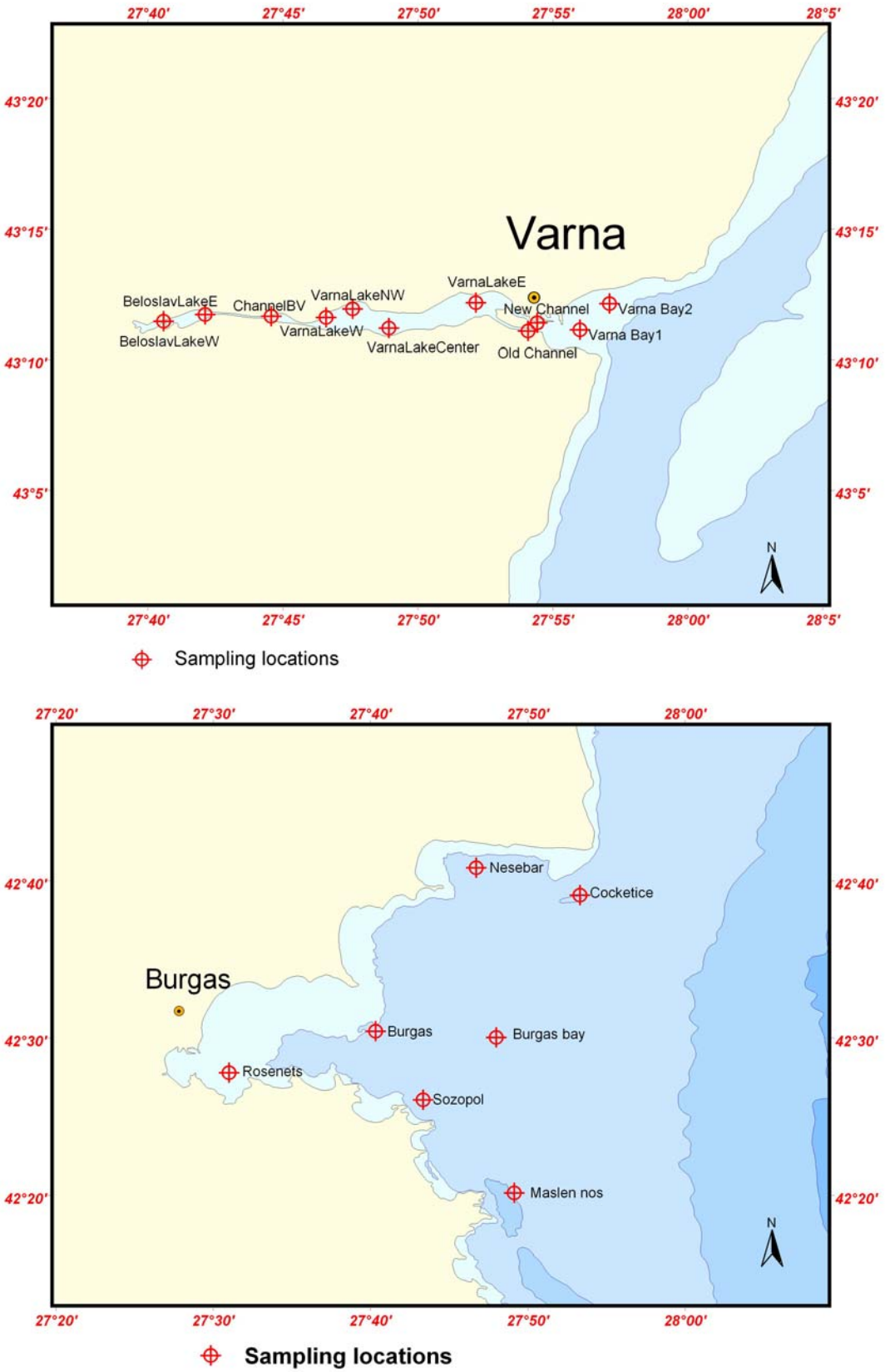

Figure 1. Sampling network for macrozoobenthos in Varna bay, Varna-Beloslav lakes (top) and Burgas bay (bottom).

2. MATERIALS AND METHODS

2.1. Sampling and sample processing

The procedures of collection, onboard and laboratory processing of samples were accomplished according to the "Manual for collection and treatment of soft bottom macrozoobenthos samples" (Todorova, Konsulova, 2005).

Van Veen grab with a sampling area of 0.1 m^2 was employed as a macrozoobenthos sampler. One replicate was collected at every station. The samples were initially sieved onboard through metal gauze sieves with mesh size 1.0 x 1.0 mm and 0.5 x 0.5 mm, fixed with 37-41 % buffered formaldehyde and appropriately labeled for further identification. Laboratory processing including sorting, taxonomic identification (Fauvel, 1923, 1927, Marinov, 1977, Morduhay-Boltovskoy, 1968, 1969, 1972), abundance and biomass (wet weight) determination was accomplished in the Marine Biology and Ecology Department by highly qualified personnel.

The raw data are provided in Annex 1.

2.2. Statistical analyses for ecological state assessment

Coastal waters

Shannon community diversity index (H') (Shannon and Weaver, 1963) was employed, reference and boundary values between ecological classes for water bodies with muddy sediments and water bodies with sandy and mixed sediments determined according to Trayanova, Todorova and Konsulova, 2007 (Table 2).

Table 2. Classification scheme for Shannon community diversity index (H').

Water bodies with muddy sediments					
Ecological status	**High**	**Good**	**Moderate**	**Poor**	**Bad**
H' average	3.6	2.9	2.2	1.5	0.7
Range	H' ≥ 3.3	3.3 > H' ≥ 2.5	2.5 > H' ≥ 1.8	1.8 > H' ≥ 1.1	H' < 1.1
EQR	1	0.8	0.6	0.4	0.2
Water bodies with sandy and mixed sediments					
Ecological status	**High**	**Good**	**Moderate**	**Poor**	**Bad**
H' average	4.5	3.6	2.7	1.8	0.9
Range	H' ≥ 4	4 > H' ≥ 3.1	3.1 > H' ≥ 2.2	2.2 > H' ≥ 1.3	H' < 1.3
EQR	1	0.8	0.6	0.4	0.2

Marine Biotic Index (AMBI) was used, the boundaries between the ecological classes are those identified by Borja *et al.,* (2000, 2003) and Muxica *et al.*, (2005) (Table 3). Different

from the original species ecological classification, the polychaete worm *Aricidea claudiae* was moved from group I (species very sensitive to organic enrichment) to group III (species tolerant to excess organic matter). The arguments in support of this shift are that in the Bulgarian Black Sea *Aricidea claudiae* occurs together with and shows similar ecological preferences as *Heteromastus filiformis* (ecological group IV), Oligochaeta (ecological group V), *Nephtys hombergii* (ecological group II), and *Melinna palmata* (ecological group III) as shown in the species similarity dendrogram on Figure 2. Therefore the middling ecological group from the above – group III is selected as characteristic of *A. claudiae*. Another argument is the fact that *Aricidea claudiae* attains high abundance in organically enriched muddy sediments.

Table 3. Classification scheme for A Marine Biotic Index (AMBI).

Ecological status	AMBI
High	0.0 < AMBI ≤ 1.2
Good	1.2 < AMBI ≤ 3.3
Moderate	3.3 < AMBI ≤ 4.3
Poor	4.3 < AMBI ≤ 5.5
Bad	5.5 < AMBI ≤ 6.0 Azoic sediment (7.0)

Multivariate AMBI (M-AMBI) was applied with the default EQR boundaries according to Borja *et al.*, 2006 (Table 4). In the calculation of M-AMBI the bad and high boundary values for diversity are those given above (Table 2) and the bad - high boundary values for richness are set as 9-40 for muddy and 14-50 for sandy/mixed sediments.

Table 4. Classification scheme for Multivariate AMBI (M-AMBI).

Ecological status	M - AMBI
High	M-AMBI ≥ 0.85
Good	0.85 > M-AMBI ≥ 0.55
Moderate	0.55 > M-AMBI ≥ 0.39
Poor	0.39 > M-AMBI ≥ 0.20
Bad	0.20 > M-AMBI

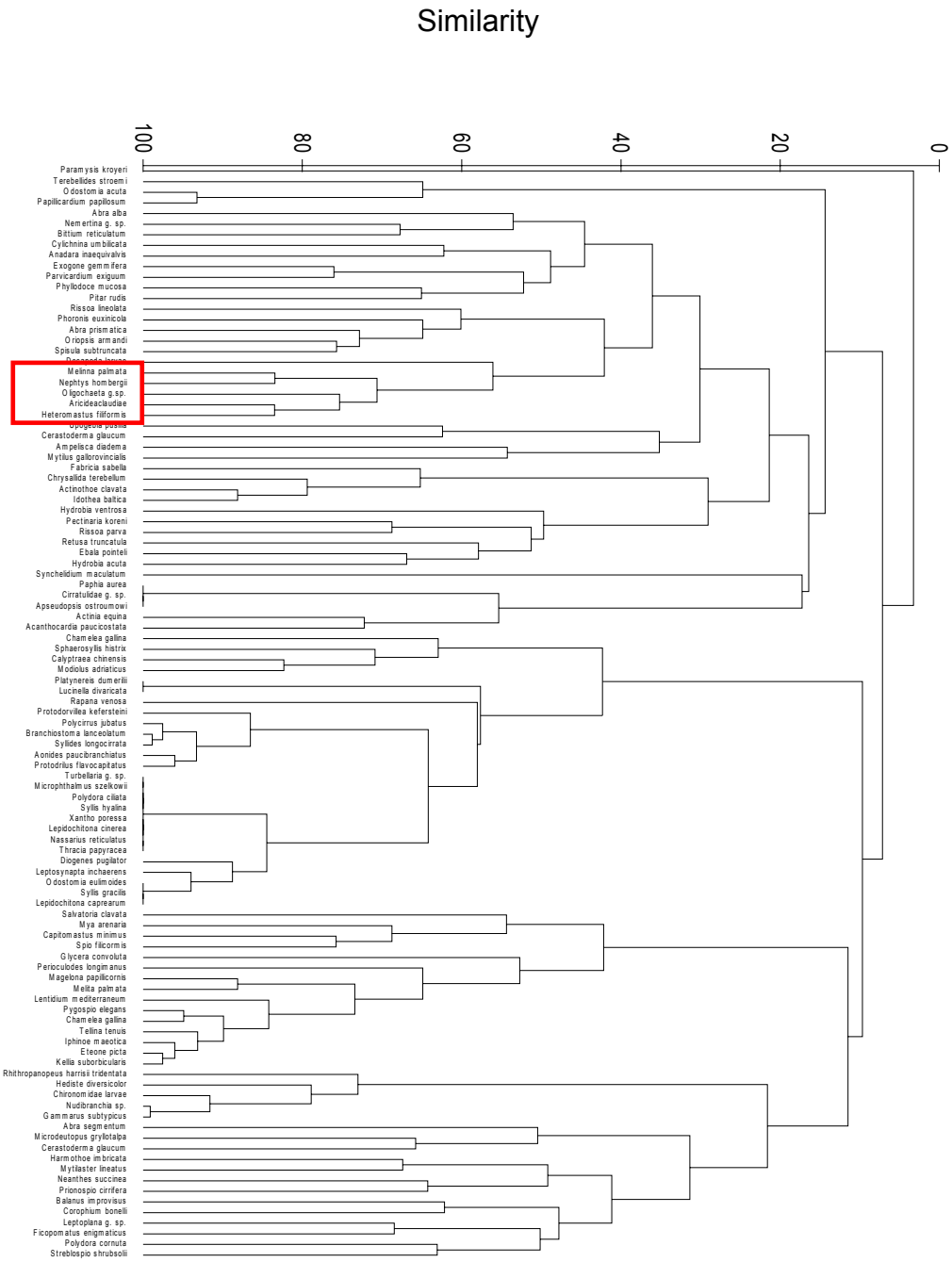

Figure 2. Dendrogram of Bray-Curtis similarity among species, based on log (x+1) transformed abundance with the group of *Aricidea claudiae* indicated in red frame.

Highly modified water bodies

An expert judgement and knowledge of the conditions under evaluation were applied for the assessment of the ecological status of Beloslav and Varna Lakes because no classification system has been adopted and verified until now. The assessment takes into account the species richness, diversity and sensitivity / tolerance of species to pollution. In case the sediments are defaunated or macrozoobenthos is presented by a single species bad status is attributed (stations Beloslav Lake West and Varna Lake Center – Tables 12 and 13). When the macrozoobenthic community is characterized by higher species richness, the percentage share of sensitive and tolerant to pollution species contribute to status evaluation (stations Beloslav lake East and Varna lake East - Tables 12 and 13).

For the overall classification of the ecological status of the water bodies the one-out-all-out principle has been applied, i. e. the worst value of all stations is accepted as final.

The historical trends in the ecological state were assessed on the basis of available data in IO-BAS database, the number of samples per water body / station by years, months and totally given in Annex 2.

PRIMER 5 (Primer-E Ltd) (Clarke and Warwick, 1994), AMBI 4.0 (AZTI-Tecnalia) and Microsoft Excel software packages were employed for the statistical analyses of data.

3. RESULTS

3. 1. Ecological state of coastal waters in Varna bay (BG2BS000C005) and Burgas bay (BG2BS000C008, BG2BS000C009, BG2BS000C010 and BG2BS000C011) in August 2008

The two stations situated in the outlets of the old and new channels connecting Varna lake to Varna bay are included in the assessment, considered as coastal waters due to similar invertebrate fauna as demonstrated on the dendrogram of Bray-Curtis similarity among sampling stations given on Figure 3.

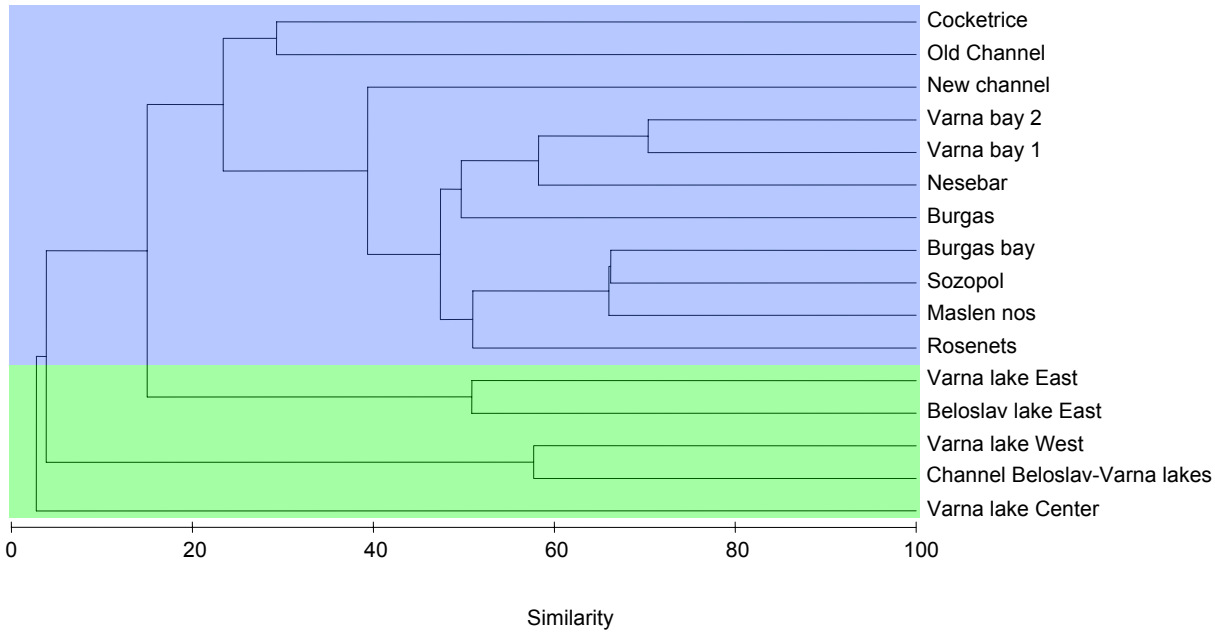

Figure 3. Dendrogram of Bray-Curtis similarity among stations, based on log (x+1) transformed abundance of macrofauna. Coastal marine stations indicated in blue background, lake stations indicated in green background.

The values of diversity (H'), AMBI and M-AMBI at the sampling stations in Varna and Burgas bay are given in Table 5.

The ecological state determined according to each of the indices used is given in Table 6. The overall assessment is made according to the principle "one-out-all-out", i.e. the final ecological state at a given location is the lowest estimation of all indices.

Table 5. Diversity (H'), AMBI and M-AMBI values at stations in Varna and Burgas bay.

Water Body	Station	Sediment type	H'	AMBI	M-AMBI
BG2PR100L001	Old Channel	Sand	2.91	4.04	0.46
	New channel	Mud	3.38	3.46	0.73
BG2BS000C005	Varna bay 1	Mud	1.97	4.56	0.32
	Varna bay 2	Mud	1.80	4.13	0.24
BG2BS000C008	Nesebar	Mud	1.98	4.11	0.32
	Rosenets	Mud	3.46	3.21	0.56
	Burgas	Mixed	1.39	3.00	0.38
BG2BS000C009	Cocketrice	Sand	3.45	3.09	0.67
BG2BS000C010	Burgas bay	Mud	1.31	3.18	0.35
	Maslen nos	Mud	1.78	2.93	0.46
BG2BS000C011	Sozopol	Mud	2.69	2.98	0.48

Table 6. Classification of the ecological status of Black Sea coastal waters in Varna and Burgas bays according to Diversity (H'), AMBI and M-AMBI values

Station	H'	AMBI	M-AMBI	Overall ES	Water Body	Overall ES
Old Channel	Moderate	Moderate	Moderate	Moderate	BG2PR100L001	Moderate
New channel	High	Moderate	Good	Moderate		
Varna bay 1	Moderate	Poor	Poor	Poor	BG2BS000C005	Poor
Varna bay 2	Moderate	Moderate	Poor	Poor		
Nesebar	Moderate	Moderate	Poor	Poor	BG2BS000C008	Poor
Rosenets	High	Good	Good	Good		
Burgas	Poor	Good	Poor	Poor		
Cocketrice	Good	Good	Good	Good	BG2BS000C009	Good
Burgas bay	Poor	Good	Poor	Poor	BG2BS000C010	Poor
Maslen nos	Moderate	Good	Moderate	Moderate		
Sozopol	Good	Good	Moderate	Moderate	BG2BS000C011	Moderate

The ecological state of Varna bay (BG2BS000C005) is poor according to both sampling stations and therefore is a water body at risk. Surprisingly, the stations in the new and old channels between Varna lake and Varna bay show moderate ecological state – better than the conditions in the proper Varna bay. Varna-Beloslav lakes are usually deemed as a major source of pollution to Varna bay, however the above results suggest that pressures, other than the industries situated around the lakes, contribute to the ecological decline in Varna

bay. Urbanisation, tourism, coastal defence constructions, and shipping possibly add significant pressure, thus worsening the ecological state in the coastal waters of Varna bay.

The internal Burgas bay (BG2BS000C008) is in poor ecological state according to stations Nesebar and Burgas, the assessment providing evidence that this coastal area is a water body at risk too. Quite unexpectedly, Rosenets, situated in the innermost part of Burgas bay, is in good ecological state, however following the rule “one-out-all-out” the overall ecological state of water body BG2BS000C008 is assessed as poor.

Cocketrice (BG2BS000C009), being on the external margin of large Burgas bay in direction to the sea and also being a protected site, is less disturbed and manifests good ecological state according to the benthic invertebrate fauna.

Station Maslen nos (BG2BS000C010) is also less disturbed, being in moderate ecological state. However, Burgas bay (BG2BS000C010), being in poor ecological state downgrades the final assessment for water body BG2BS000C010 to poor.

Sozopol (BG2BS000C011) is in moderate ecological state. Yet, it is rather questionable if station Sozopol is truly indicative of water body BG2BS000C011, since the station is situated on the margin of two adjacent water bodies. Moreover, it is demonstrated on the dendrogram of Figure 3 that there is a close similarity of station Sozopol (BG2BS000C011) with the stations Burgas bay and Maslen nos, both in water body BG2BS000C010. The question is raised whether the monitoring site for water body BG2BS000C011 should be moved to another more representative location. Clearly, a single station, besides marginal, is not sufficient to characterise the ecological state of the entire water body BG2BS000C011.

3. 2. Overview of the historical trends in the ecological state of Varna bay (BG2BS000C005), and Burgas bay (BG2BS000C009, BG2BS000C010)

Historical data available for Varna bay (BG2BS000C005) at locations close to the current sampling stations are limited to couple of stations - st.5 and st.8 from Varna bay monitoring network of IO-BAS, sampled in August 1991 and August 1998. The above stations correspond roughly to stations Varna bay 1 and Varna bay 2 respectively. The latter stations from the BSBD monitoring network were sampled in 2007, the data used in the assessment too.

The results for diversity H' and AMBI are controversial suggesting some improvement in the ecological state according to somewhat increasing diversity, however worsening according to increasing AMBI starting from the end of the 1990s (Figure 4, Table 7). Lack of sample replication does not allow assessment of the statistical significance of change.

Table 7. Historical trends in the ecological status of Varna bay (BG2BS000C005) according to Diversity (H'), AMBI and M-AMBI values and overall assessment.

Index / Stations/ Years	H'	Status	AMBI	Status	M-AMBI	Status	Overall ES by station	ES for WB BG2BS000C005
st.5/1991	1.75	Poor	3.13	Good	0.35	Poor	Poor	Bad
st.8/1991	1.05	Bad	3.02	Good	0.24	Poor	Bad	
st.5/1998	2.13	Moderate	4.34	Poor	0.33	Poor	Poor	Poor
st.8/1998	2.69	Good	3.91	Moderate	0.43	Moderate	Moderate	
VB1/2007	2.31	Moderate	4.54	Poor	0.38	Poor	Poor	Poor
VB2/2007	2.00	Moderate	4.03	Moderate	0.26	Poor	Poor	
VB1/2008	1.97	Moderate	4.56	Poor	0.33	Poor	Poor	Poor
VB2/2008	1.80	Moderate	4.13	Moderate	0.24	Poor	Poor	

The results for M-AMBI suggest persistent poor ecological state of Varna bay since the 1990s to the present day (Figure 5, Table 7). Another conclusion deriving from Figure 5 is that the northern part of Varna bay (st.8, VB2) is continuously in worse ecological state compared to the southern Varna bay area (st.5, VB1), except from 1998, when there is a slight improvement evident. However lack of replicate samples does not allow estimation of the statistical significance of M-AMBI differences. Varna lake inflow does not influence the northern bay as much as the southern bay, therefore other pressures play an important role in the ecological degradation of the northern area and should be adequately addressed for identification and mitigation.

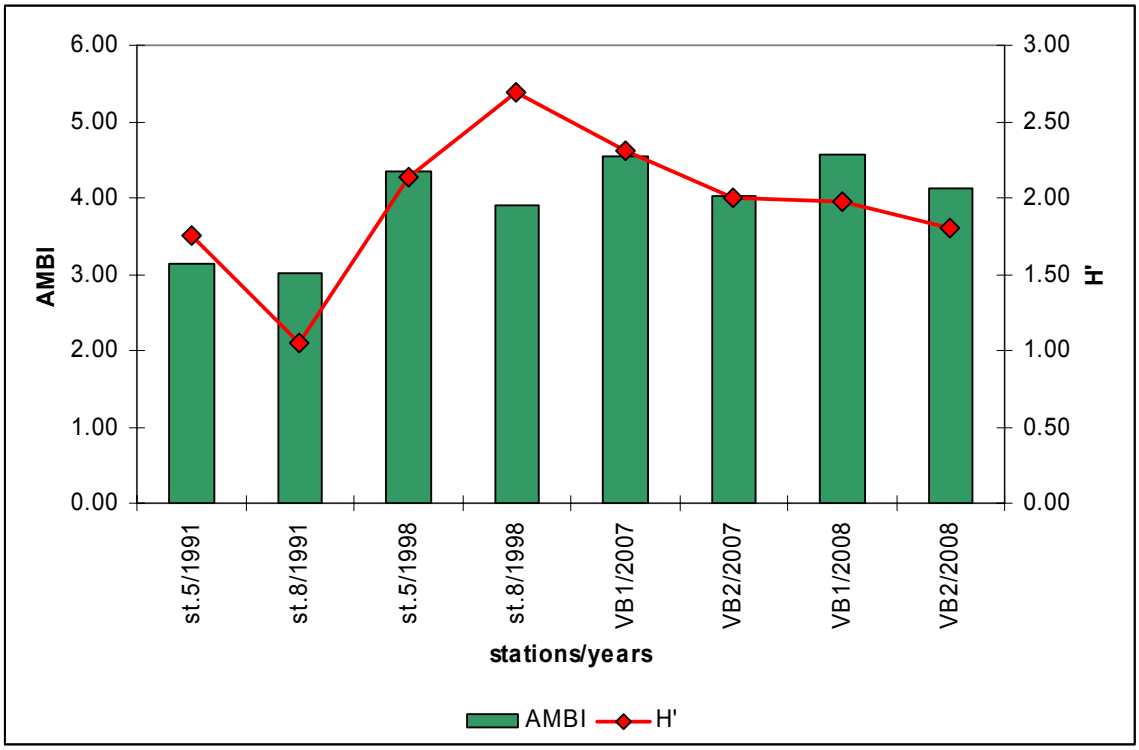

Figure 4. Diversity H' and AMBI for Varna bay stations by years.

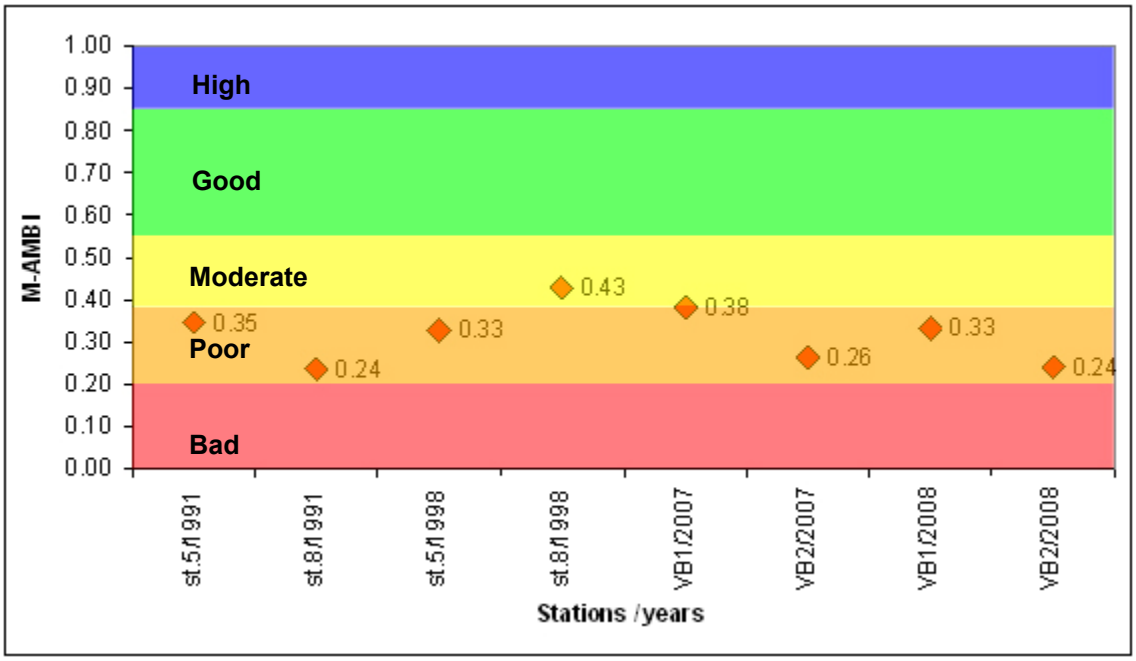

Figure 5. M-AMBI for Varna bay stations by years.

The historical trends in the ecological state of Burgas bay are drawn from three locations for which data series are available: Cocketrice (BG2BS000C009), Burgas bay and Maslen nos (both BG2BS000C010). Historical data series are not available for the rest of the stations, therefore tendencies in the ecological status of water bodies BG2BS000C008 and BG2BS000C011 cannot be delineated.

The historical data available for station Cocketrice (BG2BS000C009) encompasses a considerable period of 17 years since 1992 to 2008, though missing data for 6 years makes the dataset somewhat sporadic and irregular. AMBI fluctuates in the range 2.03 – 3.3, i.e. good ecological state is observed throughout the period 1992 – 2008 (Figure 6, Table 8), no trend of improvement or worsening is evident. Diversity shows strong variability in 1992, the three replicate samples with H' falling within the moderate, good and high range of values, the good state accepted as an average (Figure 6, Table 8). In 1993 H' values for both replicates are in the range of the moderate state. Since 1995 H' fluctuates weaker within the range of the good ecological state with the exception of 2007 when diversity shows moderate ecological state. The historical trends in M-AMBI largely follow the pattern of H' with stronger variability between moderate and high status in the beginning of the 1990s (1992, 1993) and more narrow fluctuation within the range of the good ecological state since 1995 to the present (Figure 7, Table 8). On the overall the indices show stabilization of the ecological state within the range of the good state values since mid1990s.

Table 8. Historical trends in the ecological status at station Cocketrice (BG2BS000C009) according to Diversity (H'), AMBI and M-AMBI values and overall assessment.

Index / Month/Year	H'	Status	AMBI	Status	M-AMBI	Status	ES for WB BG2BS000C009
08.1992-I	2.21	Moderate	2.51	Good	0.53	Moderate	Good
08.1992-II	3.88	Good	2.06	Good	0.79	Good	
08.1992-III	4.14	High	2.48	Good	0.86	High	
09.1993-I	2.71	Moderate	3.08	Good	0.55	Moderate	Moderate
09.1993-II	2.61	Moderate	2.68	Good	0.50	Moderate	
08.1995-I	3.46	Good	2.17	Good	0.63	Good	Good
08.1995-II	3.19	Good	2.03	Good	0.65	Good	
09.1998	3.70	Good	3.30	Good	0.67	Good	Good
09.2000-I	3.78	Good	2.77	Good	0.73	Good	Good
09.2000-II	3.82	Good	3.19	Good	0.75	Good	
08.2002	3.34	Good	2.84	Good	0.61	Good	Good
09.2004	3.34	Good	2.43	Good	0.63	Good	Good
08.2005	3.65	Good	2.20	Good	0.73	Good	Good
07.2006	3.47	Good	2.82	Good	0.56	Good	Good
08.2007	3.02	Moderate	2.84	Good	0.62	Good	Moderate
08.2008	3.45	Good	3.09	Good	0.67	Good	Good

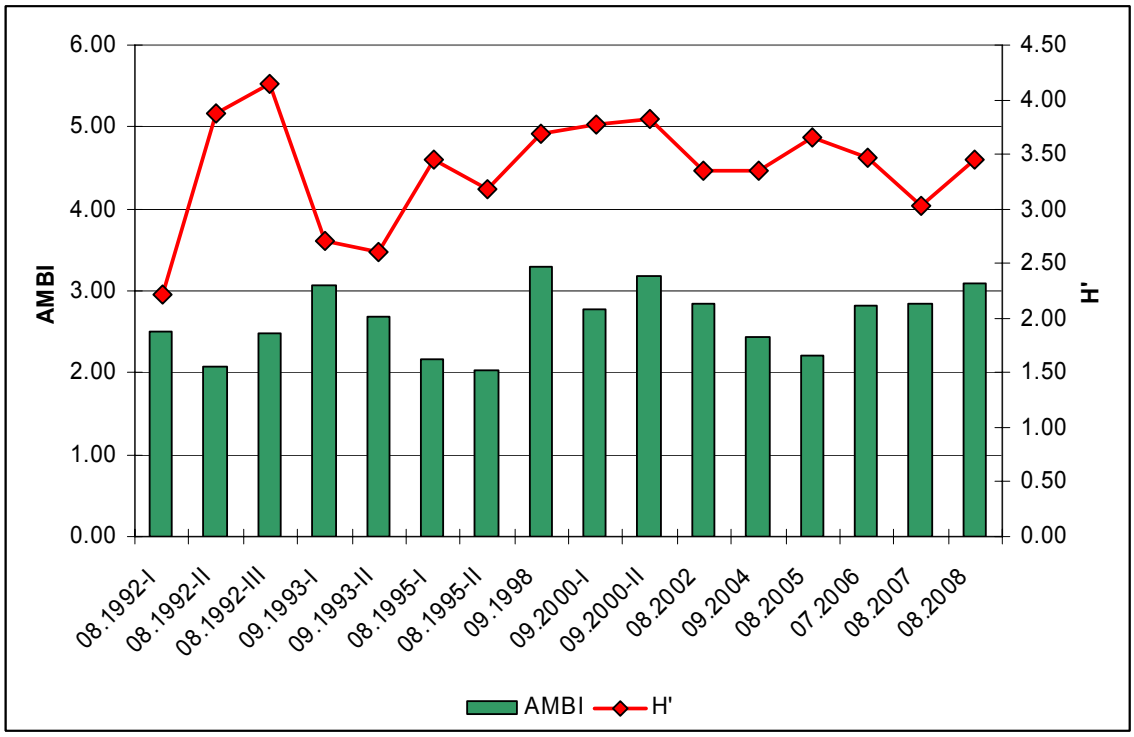

Figure 6. Diversity H' and AMBI for station Cocketrice by years.

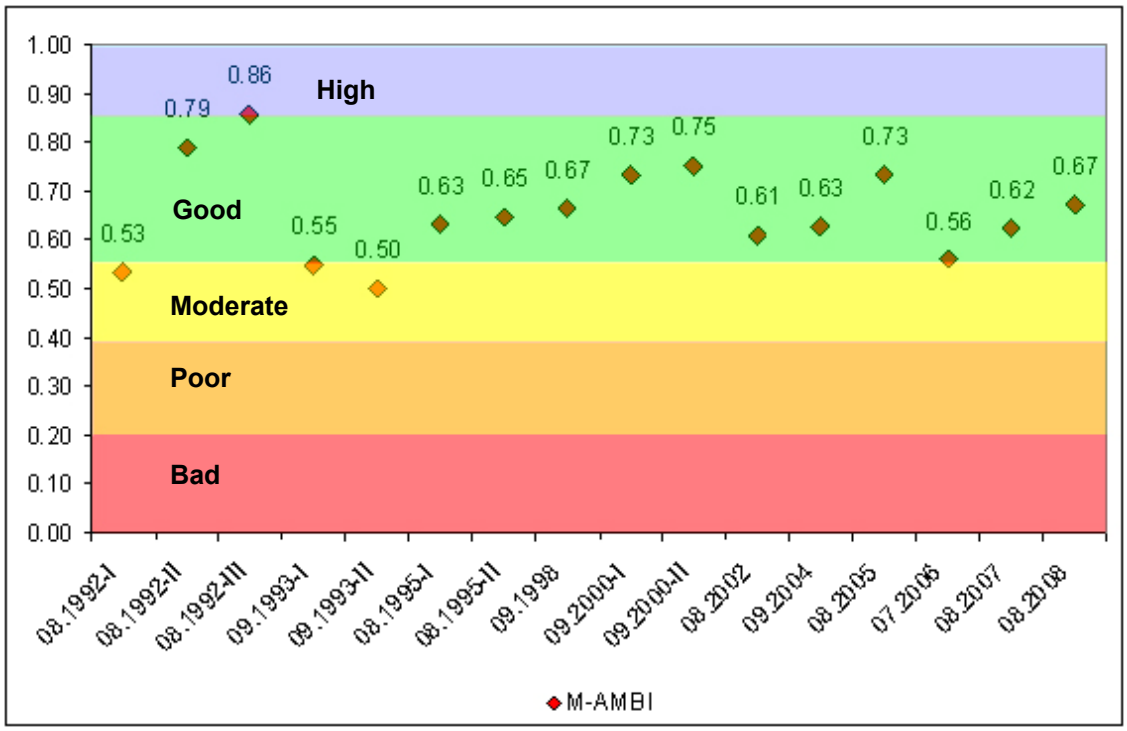

Figure 7. M-AMBI for station Cocketrice by years.

The historical data set available for station Burgas bay encompasses the period 1998-2008 with missing data in 2001 and 2003. Nevertheless the data are adequately indicative of the ecological state alterations during the last decade. Throughout the period AMBI fluctuates in the good ecological state range of values with the exception of 2006 when AMBI takes a moderate ecological state value (Figure 8, Table 9). Unlike AMBI, diversity H' varies in a broad range, taking values from high (2007) to poor (2005 and 2008), as well as good in 1998, 2006 and moderate in the period 1999-2004 (Table 9).

M-AMBI is also highly variable, taking values from high to poor in adjacent years (2007 and 2008 respectively) but for the most of the period in the range of the moderate/good ecological status (Figure 9, Table 9).

Uncertainly in the assessment derives from the lack of sample replication to account for the biological variability, however the decline in the ecological status in 2008, made evident by each of the indices used, as well as almost persistent moderate ES in the period 1999 – 2005 raise serious concern.

Table 9. Historical trends in the ecological status at station Burgas bay according to Diversity (H'), AMBI and M-AMBI values and overall assessment.

Index / Month/Year	H'	Status	AMBI	Status	M-AMBI	Status	Overall ES
08.1998	2.67	Good	2.72	Good	0.68	Good	Good
09.1999	2.32	Moderate	2.94	Good	0.52	Moderate	Moderate
09.2000	2.43	Moderate	2.99	Good	0.62	Good	Moderate
08.2002	2.09	Moderate	2.78	Good	0.44	Moderate	Moderate
09.2004	1.83	Moderate	2.84	Good	0.43	Moderate	Moderate
09.2005	1.23	Poor	2.87	Good	0.45	Moderate	Poor
07.2006	3.12	Good	3.39	Moderate	0.69	Good	Moderate
08.2007	3.37	High	2.55	Good	0.94	High	Good
08.2008	1.31	Poor	3.18	Good	0.36	Poor	Poor

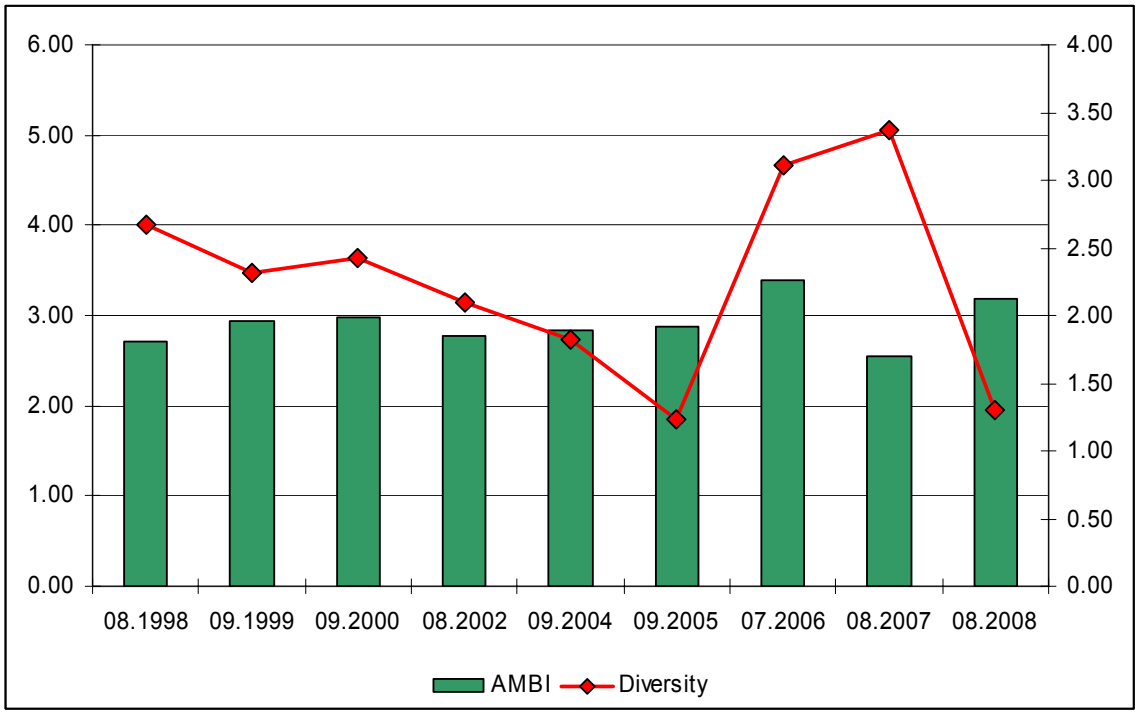

Figure 8. Diversity H' and AMBI for station Burgas bay by years.

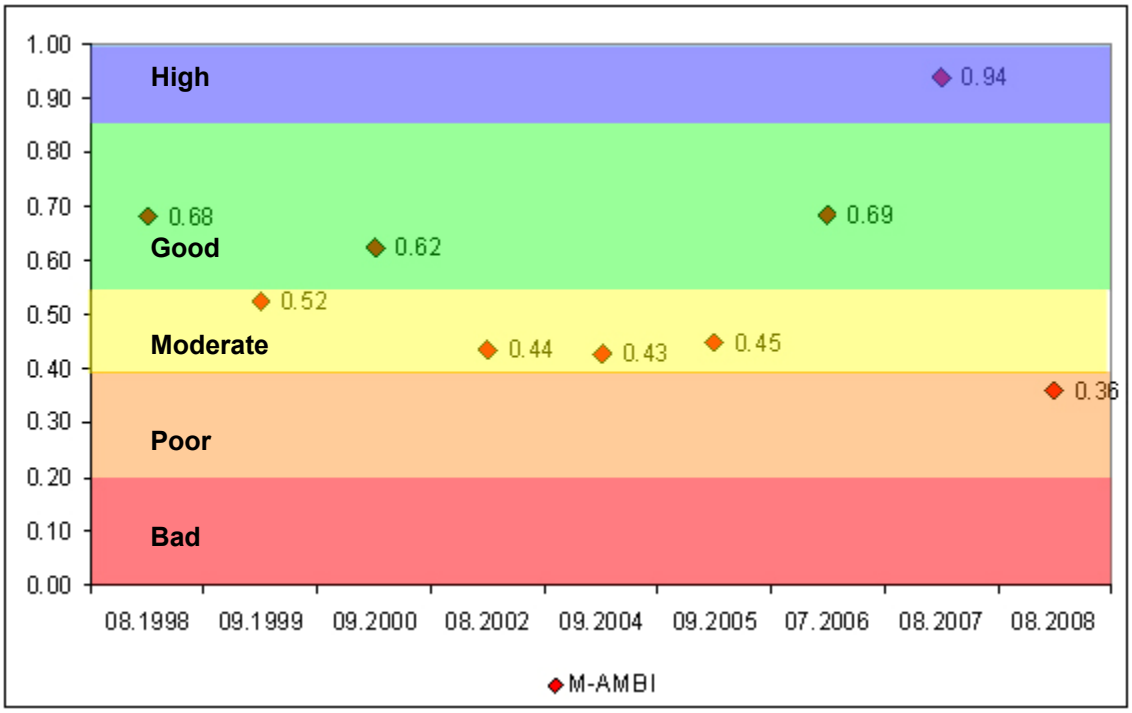

Figure 9. M-AMBI for station Burgas bay by years.

The historical dataset for station Maslen nos encompasses the decade 1999 – 2008 with missing data in 2001 and 2003. AMBI varies within the range of the good ES with an only exception in 1999 when AMBI takes a moderate ES value (Figure 10, Table 10). Diversity H' stays in the range of the good ES during the first half of the period, but since 2005 broad fluctuations take place, indicating poor ES in 2005 and 2008, good ES in 2006 and moderate ES in 2007 (Figure 10, Table 10). This is reflected in M-AMBI that declines from good ES in the beginning of the period (1999-2002) to moderate/poor since 2004, the worsening raising concern (Figure 11, Table 10). Broader fluctuation of M-AMBI and diversity suggest an ecological instability during last 5 years.

Table 10. Historical trends in the ecological status at station Maslen nos according to Diversity (H'), AMBI and M-AMBI values and overall assessment.

Index / Month/Year	H'	Status	AMBI	Status	M-AMBI	Status	Overall ES
09.1999	3.12	Good	3.68	Moderate	0.60	Good	Moderate
09.2000	2.56	Good	2.95	Good	0.63	Good	Good
08.2002	2.65	Good	2.68	Good	0.59	Good	Good
09.2004	2.34	Good	2.78	Good	0.48	Moderate	Moderate
09.2005	1.52	Poor	2.94	Good	0.31	Poor	Poor
07.2006	2.61	Good	2.72	Good	0.55	Good	Good
08.2007	2.29	Moderate	2.82	Good	0.51	Moderate	Moderate
08.2008	1.78	Poor	2.93	Good	0.45	Moderate	Poor

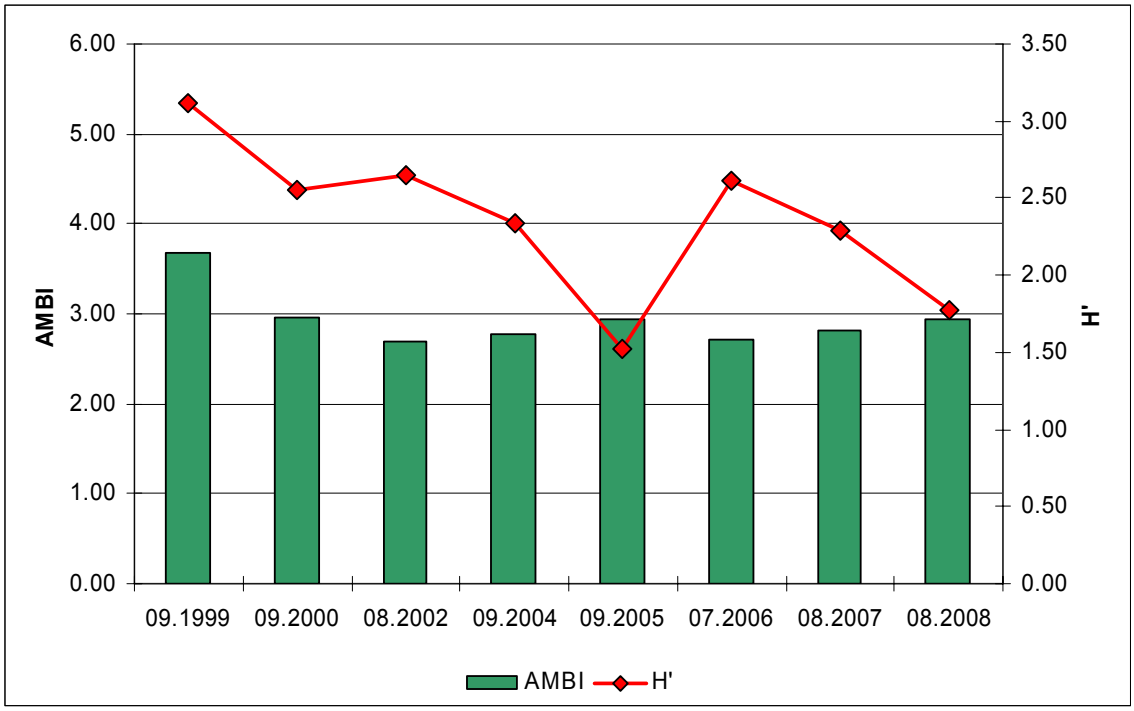

Figure 10. Diversity H' and AMBI for station Maslen nos by years.

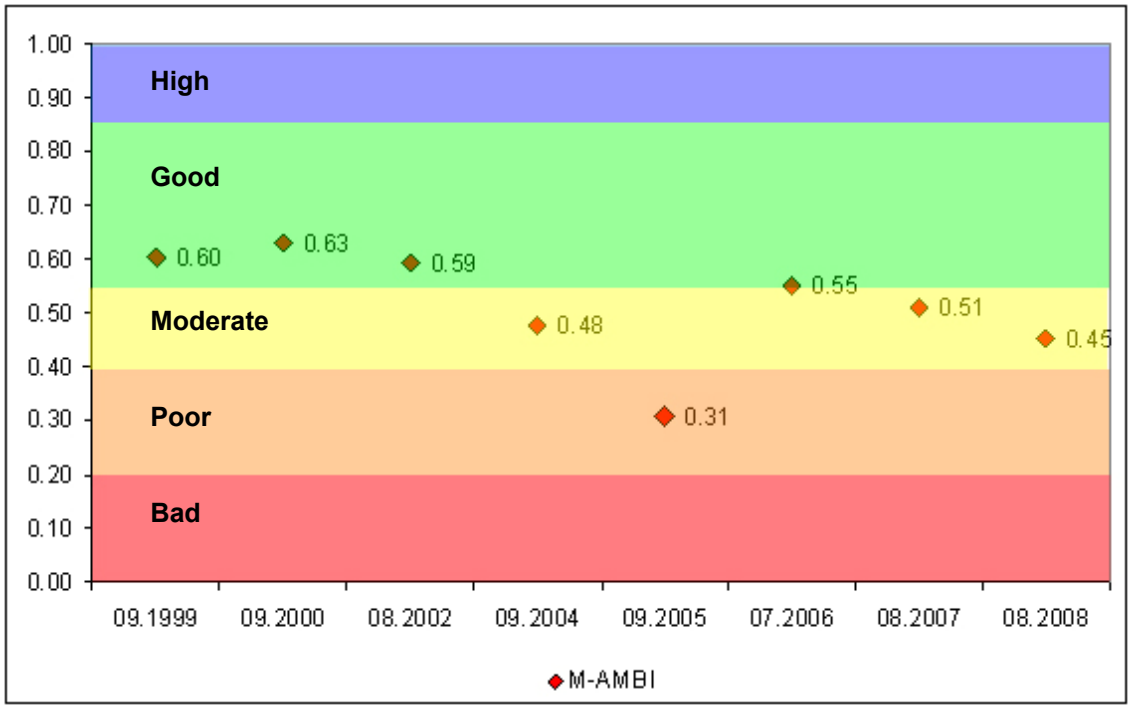

Figure 11. M-AMBI for station Maslen nos by years.

The overall assessment of the historical trends in the ecological state of water body BG2BS000C010 incorporates the data for both stations Maslen nos and Burgas bay (Table 11). Despite the spatial patchiness of the ES with better conditions manifested at station Maslen nos and worse state at station Burgas bay, throughout the last decade the water body was in generally moderate ecological state, worsening evident since 2005, with couple of poor ES years at both stations. The recent ecological decline in the water body raises significant concern and requires undertaking relevant management measures for mitigation.

Table 11. Historical trends in the ecological status of water body BG2BS000C010.

Ecological state / Month/Year	st. Burgas bay	st. Maslen nos	WB BG2BS000C010
08.1998	Good	No data	?
09.1999	Moderate	Moderate	Moderate
09.2000	Moderate	Good	Moderate
08.2002	Moderate	Good	Moderate
09.2004	Moderate	Moderate	Moderate
09.2005	Poor	Poor	Poor
07.2006	Moderate	Good	Moderate
08.2007	Good	Moderate	Moderate
08.2008	Poor	Poor	Poor

3. 3. Ecological state of the highly modified water bodies Varna lake (BG2PR100L001) and Beloslav lake (BG2PR100L002) in August 2008

The ecological status of Beloslav Lake based on two sampling stations is assessed as bad (Table 12). No living macrozoobenthos organisms in the western part of the Lake (station Beloslav lake West) have been found. Despite of greater species richness (S=13) the eastern part (station Beloslav lake East) is also in bad status due to low diversity (H'=0.89) and dominance of species tolerant to pollution (96.6 %).

Table 12. Ecological status of Beloslav Lake in 2008.

Station	S	H'	% of sensitive species	% of tolerant species	Ecological status	WB	Ecological Status
Beloslav lake West	0	n.c.*	0	0	Bad	BG2PR100L002	Bad
Beloslav lake East	13	0.89	0.1	96.6	Bad		

*n.c. – not calculated due to low species richness

The ecological status of Varna Lake is categorized as bad (Table 13). The soft bottom sediment of north-western part of the Lake (station Varna lake North-West) is defaunated; the central part is inhabited by a single species (station Varna lake Center); the macrozoobenthic community of western part (station Varna lake West) and the channel between the Lakes consists of two species. The eastern part of Varna Lake (station Varna lake East) is classified in moderate status due to higher species richness and diversity and presence of sensitive to pollution species.

Table 13. Ecological status of Varna Lake in 2008.

Station	S	H'	% of sensitive species	% of tolerant species	Ecological status	WB	Ecological Status
Channel Beloslav-Varna lakes	2	0.65	0	100	Bad	BG2PR100L001	Bad
Varna lake West	2	0.86	0	100	Bad		
Varna lake North-West	0	n.c.	0	0	Bad		
Varna lake Center	1	n.c.	0	0	Bad		
Varna lake East	16	2.61	2.8	42.6	Moderate		
Old Channel	31	2.91	4.5	42.1	Moderate		
New channel	34	3.38	2.9	32.9	Moderate		

3. 4. Overview of the historical trends in the ecological state of the highly modified water bodies Varna lake (BG2PR100L001) and Beloslav lake (BG2PR100L002) in August 2008

Data sets for two periods have been used for historical review of the status. The first set includes 24 stations sampled in the period 1999-2002 (Figure 12). The second set encompasses the period 1990-1991 (Figure 13).

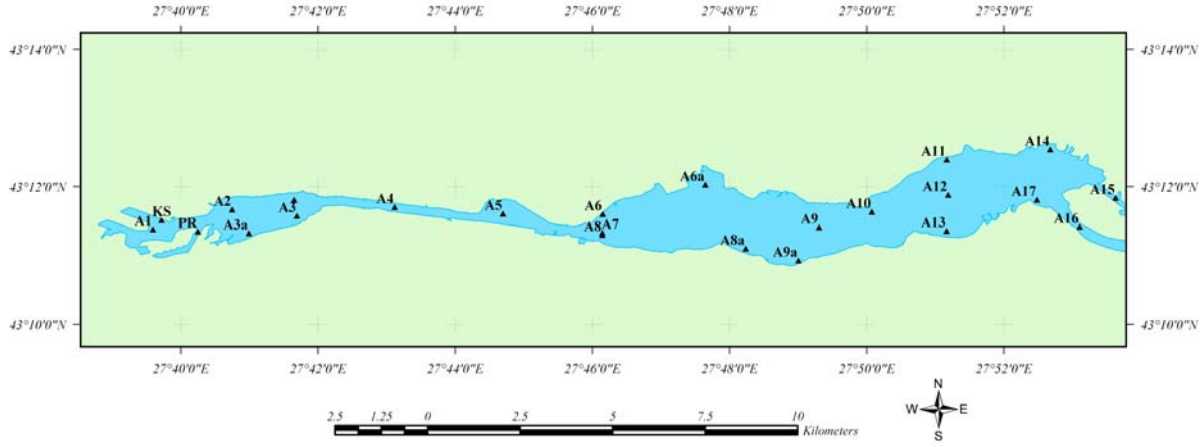

Figure 12. Sampling stations in Beloslav Lake, Varna Lake and the channels in 1999-2002.

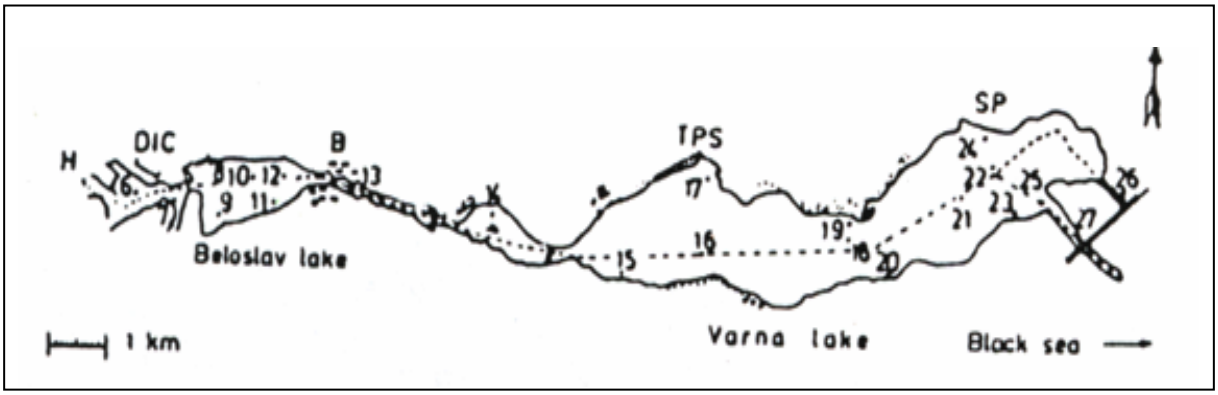

Figure 13. Sampling stations in Beloslav Lake, Varna Lake and the channels in 1990-1991.

The ecological status of Beloslav Lake in the period 1990-1991 has been assessed as bad (Tables 14, 15, 16 and 17). The worst conditions for macrofauna development offered the western part of the Lake (adjacent to the Port Varna-West) - the sediments are azoic throughout all seasons (station A6). The same was valid for the area in the vicinity of Provadijska River mouth (station A7), where only one species tolerant to pollution was registered in winter of 1991. The rest of the stations are characterized by absence of

macrofauna or by presence of few invertebrate species and dominance of Chironomid larvae, considered as tolerant to pollution (Borja et al., 2000).

In the period 1999-2002 the ecological status of Beloslav Lake ranged from bad to poor (Tables 18, 19, 20 and 21). Station A3, located in the south-eastern part of the Lake, reach moderate status in winter and spring (Tables 19 and 21). The winter offers better conditions for benthic invertebrates resulting in higher ecological status of water body (Table 19). The opposite is the case in summer (Table 20).

Table 14. Ecological status of Beloslav Lake in summer of 1990.

Station	S	H'	Ecological status	WB	Ecological Status
A6	0	n.c.	Bad	BG2PR100L001	Bad
A8	4	0.21	Bad		
A10	1	nc	Bad		
A11	2	0.08	Bad		
A12	4	0.08	Bad		

Table 15. Ecological status of Beloslav Lake in autumn of 1990.

Station	S	H'	Ecological status	WB	Ecological Status
A6	0	n.c.	Bad	BG2PR100L001	Bad
A7	0	n.c.	Bad		
A8	1	n.c.	Bad		
A9	1	n.c.	Bad		
A10	0	n.c.	Bad		
A11	1	n.c.	Bad		
A12	2	n.c.	Bad		

Table 16. Ecological status of Beloslav Lake in winter of 1991.

Station	S	H'	Ecological status	WB	Ecological Status
A6	0	n.c.	Bad	BG2PR100L001	Bad
A7	1	n.c.	Bad		
A8	1	n.c.	Bad		
A9	1	n.c.	Bad		
A10	1	n.c.	Bad		
A11	1	n.c.	Bad		
A12	1	n.c.	Bad		

Table 17. Ecological status of Beloslav Lake in spring of 1991.

Station	S	H'	Ecological status	WB	Ecological Status
A6	0	n.c.	Bad	BG2PR100L001	Bad
A7	0	n.c.	Bad		
A8	2	0.46	Bad		
A9	0	n.c.	Bad		
A10	1	n.c.	Bad		
A11	2	0.32	Bad		
A12	3	0.70	Bad		

Table 18. Ecological status of Beloslav Lake in autumn of 1999.

Station	S	H'	Ecological status	WB	Ecological Status
A1	2	0.97	Bad	BG2PR100L001	Bad
A2	1	n.c.	Bad		
A2a	1	n.c.	Bad		
PR	4	1.45	Poor		
A3	7	2.25	Poor		
A3a	9	1.28	Poor		

Table 19. Ecological status of Beloslav Lake in winter of 2000.

Station	S	H'	Ecological status	WB	Ecological Status
KS	5	1.99	Poor	BG2PR100L001	Poor
A1	4	1.68	Poor		
A2	6	1.90	Poor		
PR	7	1.86	Poor		
A3	9	1.97	Moderate		

Table 20. Ecological status of Beloslav Lake in summer of 2001.

Station	S	H'	Ecological status	WB	Ecological Status
A1	0	n.c.	Bad	BG2PR100L001	Bad
A2	12	2.09	Poor		
A2a	1	n.c.	Bad		
PR	1	n.c.	Bad		
A3	7	1.90	Poor		
A3a	1	n.c.	Bad		

Table 21. Ecological status of Beloslav Lake in spring of 2002.

Station	S	H'	Ecological status	WB	Ecological Status
KS	3	1.45	Bad	BG2PR100L001	Bad
A1	6	1.03	Poor		
A2	5	1.38	Poor		
A2a	10	2.05	Poor		
PR	3	0.67	Bad		
A3	9	1.95	Moderate		
A3a	5	1.60	Bad		

The ecological status of Varna Lake was classified as bad in the period 1990-1991 (Tables 22, 23, 24 and 25). Two dead zones throughout all seasons characterized the lake – in front of Thermo-electric Power Station (TEPS) Varna (station 17) and in front of WWTP Varna (station 24) (Konsulova, 1992).

In the period 1999-2002 the ecological status was ranked as bad (Tables 26, 27, 28 and 29). In summer the majority of the stations were in bad status (Table 28), which was attributed to oxygen deficiency in the bottom layers due to the enrichment with organic matter and limited vertical water exchange. More favourable were the environmental conditions in winter and spring when more station reached moderate status (Tables 27 and 29). The sediments of the stations located in front of TEPS Varna and TEPS Port were defaunated in summer and autumn.

Table 22. Ecological status of Varna Lake in summer of 1990.

Station	S	H'	Ecological status	WB	Ecological Status
A13	5	1.41	Poor	BG2PR100L001	Bad
A14	12	1.86	Moderate		
A15	7	1.56	Poor		
A16	11	1.71	Poor		
A17	0	n.c.	Bad		
A20	5	0.98	Bad		
A22	0	n.c.	Bad		
A24	0	n.c.	Bad		
A25	15	2.44	Poor		
A27	14	2.07	Poor		

Table 23. Ecological status of Varna Lake in autumn of 1990.

Station	S	H'	Ecological status	WB	Ecological Status
A13	1	n.c.	Bad	BG2PR100L001	Bad
A14	3	0.87	Bad		
A15	3	1.03	Bad		
A16	0	n.c.	Bad		
A17	0	n.c.	Bad		
A18	0	n.c.	Bad		
A19	8	2.05	Poor		
A20	4	1.19	Bad		
A21	2	1.00	Bad		
A22	0	n.c.	Bad		
A23	0	n.c.	Bad		
A24	0	n.c.	Bad		
A25	5	0.95	Poor		
A26	1	n.c.	Bad		
A27	5	0.95	Bad		

Table 24. Ecological status of Varna Lake in winter of 1991

Station	S	H'	Ecological status	WB	Ecological Status
A13	3	1.07	Bad	BG2PR100L001	Bad
A14	5	2.02	Poor		
A15	5	0.20	Bad		
A16	1	n.c.	Bad		
A17	0	n.c.	Bad		
A18	2	0.35	Bad		
A19	7	1.59	Bad		
A20	8	1.39	Bad		
A21	1	n.c.	Bad		
A22	4	1.02	Bad		
A25	12	2.01	Moderate		
A26	1	n.c.	Bad		
A27	13	2.11	Poor		

Table 25. Ecological status of Varna Lake in spring of 1991.

Station	S	H'	Ecological status	WB	Ecological Status
A13	1	n.c.	Bad	BG2PR100L001	Bad
A14	5	1.68	Poor		
A15	3	1.22	Bad		
A16	3	1.37	Bad		
A17	0	n.c.	Bad		
A18	4	1.21	Bad		
A19	7	1.15	Bad		
A20	10	1.43	Bad		
A21	0	n.c.	Bad		
A22	1	n.c.	Bad		
A23	8	1.06	Bad		
A24	0	n.c.	Bad		
A25	6	1.51	Bad		
A26	2	0.99	Bad		
A27	15	1.58	Poor		

Table 26. Ecological status of Varna Lake in autumn of 1999.

Station	S	H'	Ecological status	WB	Ecological Status
A4	3	1.10	Bad	BG2PR100L001	Bad
A5	14	1.23	Poor		
A6	0	n.c.	Bad		
A6a	3	1.50	Bad		
A7	3	1.27	Bad		
A8	10	0.55	Bad		
A8a	6	0.43	Bad		
A9	4	0.86	Bad		
A9a	9	1.70	Poor		
A10	10	1.79	Poor		
A11	11	1.43	Poor		
A12	10	2.59	Moderate		
A13	13	2.04	Poor		
A14	5	2.03	Poor		
A15	15	2.26	Moderate		
A16	23	3.14	Moderate		
A17	10	2.61	Poor		

Table 27. Ecological status of Varna Lake in winter of 2000.

Station	S	H'	Ecological status	WB	Ecological Status
A4	7	2.02	Moderate	BG2PR100L001	Bad
A5	5	0.67	Bad		
A6	2	0.65	Bad		
A7	4	1.47	Poor		
A8	4	1.14	Poor		
A9	5	1.05	Poor		
A10	13	2.47	Moderate		
A11	12	2.31	Moderate		
A12	8	1.67	Poor		
A13	12	2.65	Moderate		
A14	12	2.23	Moderate		
A15	17	2.71	Moderate		
A16	8	2.08	Bad		

Table 28. Ecological status of Varna Lake in summer of 2001.

Station	S	H'	Ecological status	WB	Ecological Status
A4	0	n.c.	Bad	BG2PR100L001	Bad
A5	9	2.48	Poor		
A6	0	n.c.	Bad		
A6a	0	n.c.	Bad		
A7	0	n.c.	Bad		
A8	8	1.68	Poor		
A8a	1	n.c.	Bad		
A9	0	n.c.	Bad		
A9a	4	0.99	Bad		
A10	6	1.16	Bad		
A11	0	n.c.	Bad		
A13	4	0.89	Bad		
A14	1	n.c.	Bad		
A15	8	0.98	Bad		
A16	7	2.12	Poor		
A17	9	1.61	Poor		

Table 29. Ecological status of Varna Lake in spring of 2002.

Station	S	H'	Ecological status	WB	Ecological Status
A4	2	1.00	Bad	BG2PR100L001	Bad
A5	12	1.81	Moderate		
A6	4	1.92	Poor		
A6a	4	1.31	Poor		
A7	11	2.37	Moderate		
A8	13	1.42	Poor		
A8a	2	0.92	Bad		
A9	4	1.66	Bad		
A9a	2	0.54	Bad		
A10	13	1.85	Moderate		
A11	9	1.56	Bad		
A12	7	1.69	Poor		
A13	17	2.53	Moderate		
A14	8	2.69	Poor		
A15	16	2.28	Moderate		
A16	20	1.78	Poor		
A17	16	1.51	Poor		

There is a tendency of status improvement in 1999-2002 in comparison to 90-ies in both lakes. It is expressed in lack of dead zones throughout all seasons and higher species richness and diversity, which results in better ecological status of certain stations.

The overall comparison reveals that the conditions under evaluation remain not appropriate for development of stable macrozoobenthic community in both water bodies (Table 30) and they meet the risk of failing to achieve good ecological status to 2015.

Table 30. Ecological status of Beloslav Lake (BG2PR100L002) and Varna Lake (BG2PR100L001) by years.

WB	2008	2002	2001	2000	1999	1991	1990
BG2PR100L002	Bad	Bad	Bad	Poor	Bad	Bad	Bad
BG2PR100L001	Bad	Bad	Bad	Bad	Bad	Bad	Bad

Conclusions and recommendations:

The ecological state of water body **BG2BS000C005** (Varna bay) in August 2008 is poor. Persistent poor ecological state is evident since the 1990s to the present day, although the historical dataset is sporadic. Pressures, other than the industries situated around the lakes, play an important role in the ecological degradation of the northern Varna bay area and should be adequately addressed for identification and mitigation. The water body of Varna bay is identified as a vulnerable area, which ecological state may not be improved without taking adequate management measures.

The ecological state of the water body **BG2BS000C008** (internal Burgas bay) in August 2008 is generally poor, despite the patchiness manifested at station Rosenets that is in good ecological state. The historical trends cannot be delineated due to lack of previous data at the monitoring stations.

The external areas of large Burgas bay in direction to the open sea (stations Cocketrice, Maslen nos and Sozopol) are generally less disturbed.

In water body **BG2BS000C009** (station Cocketrice) continuous good ecological state has been maintained over the last decade, excluding 2007 when a decline to moderate ES was observed.

In water body **BG2BS000C010** the ecological state in August 2008 is poor at both stations. High ecological instability is manifested during the last decade with broad fluctuations from poor to high ES, moderate ES being predominant at station Burgas bay and a trend of ecological deterioration from good in the beginning of the investigated period (1999-2002) to moderate/poor since 2004 to the present at station Maslen nos. Throughout the last decade the water body was in generally moderate ecological state, worsening evident since 2005, with couple of poor ES years at both stations.

Water body **BG2BS000C011** (station Sozopol) is in moderate ecological state in August 2008. Yet, the conclusion is rather dubious due to the marginal location of the monitoring station Sozopol on the boundary with water body BG2BS000C010, as well as lack of other representative sampling stations. Clearly, a single station, besides peripheral, is not sufficient to characterise the ecological state of the entire water body BG2BS000C011. Therefore, we recommend replacement of station Sozopol by at least two newly selected monitoring sites within the water body BG2BS000C011. Historical data are not available for the water body.

On the overall the geographic area of large Burgas bay as a whole is deemed a water body at risk not to meet the good ecological state requirements until 2015 without relevant management measures. The spatial patchiness in the ecological state should be taken into consideration when management measures for mitigation are being planned.

The western part of Beloslav Lake and the area adjacent to TEPS Varna are identified as the most affected by anthropogenic pressures areas, where status of waters may not be improved without appropriate measures. The cumulative effect of enrichment with organic matter and pollution with inert materials and toxic substances leads to poor quantitative development of benthic macrofauna, elimination of certain taxonomic groups and mass mortality of benthic invertebrates in summer and autumn.

Uncertainly in the above assessments derives from lack of sampling replication to account for the biological variability. This critical drawback should be overcome in future monitoring.

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Annex 1. Data on the species composition, abundance and biomass (wet weight) of macrozoobenthos at sampling stations.

Date: 31.07.2008
Station: Beloslav lake West; Depth: 7m;
Type of sediments: Mud
Coordinates: 43o11' 26" N; 27o40' 14" E
No living macrozoobenthos organisms

Date: 31.07.2008
Station: Beloslav lake East; Depth: 2m;
Type of sediments: Empty tubes of *Mercierella enigmatica* - huge quantity.
Coordinates: 43o11' 42" N; 27o41' 50" E

№	Species composition	Abundance	Biomass
1	Chironomidae larvae	560	1.132
2	Leptoplana g. sp.	20	0.012
3	Nudibranchia sp.	220	0.81
4	Hediste diversicolor	5940	40
5	Mercierella enigmatica	20	0.03
6	Neanthes succinea	20	0.08
7	Polydora cornuta	1760	1.216
8	Streblospio shrubsolii	880	0.182
9	Oligochaeta g. sp.	2360	0.188
10	Balanus improvisus	6880	241.8
11	Corophium bonelli	122480	26.32
12	Gammarus subtypicus	200	0.64
13	Rhithropanopeus harrisii tridentata	260	640.6
	Total:	**141040**	**953.01**

Date: 31.07.2008
Station: Channel Beloslav-Varna lakes; Depth: 12 m;
Type of sediments: Mud
Coordinates: 43o11' 38" N; 27o44' 22" E

№	Species composition	Abundance	Biomass
1	Corophium bonelli	100	0.01
2	Mytilus galloprovincialis	20	0.02
	Total:	**120**	**0.03**

Date: 31.07.2008
Station: Varna lake West; Depth: 12.5 m; Type of sediments: Mud
Coordinates: 43o11' 35" N; 27o46' 28" E

№	Species composition	Abundance	Biomass
1	Balanus improvisus	40	0.03
2	Corophium bonelli	100	0.014
	Total:	**140**	**0.044**

Date: 31.07.2008
Station: Varna lake North-West; Depth: 14 m; Type of sediments: Mud
Coordinates: 43o11' 55" N; 27o47' 29" E
No living macrozoobenthos organisms

Date: 31.07.2008
Station: Varna Lake Centre; Depth: 14 m; Type of sediments: Mud
Coordinates: 43o11' 11" N; 27o48' 52" E

№	Species composition	Abundance	Biomass
1	Polydora cornuta	20	0.012
	Total:	**20**	**0.012**

Date: 31.07.2008
Station: Varna lake East; Depth: 8 m; Type of sediments: Mytilus mud
Coordinates: 43o12' 09" N; 27o52' 12" E

№	Species composition	Abundance	Biomass
1	Leptoplana g. sp.	1180	6.96
2	Harmothoe imbricata	40	0.412
3	Mercierella enigmatica	3500	11.22
4	Neanthes succinea	3340	16.362
5	Polydora cornuta	14880	2.63
6	Prionospio cirrifera	40	0.008
7	Streblospio shrubsolii	1220	0.082
8	Oligochaeta g. sp.	1180	0.116
9	Balanus improvisus	2200	26.4
10	Corophium bonelli	100	0.03
11	Microdeutopus gryllotalpa	160	0.052
12	Rhithropanopeus harrisii tridentata	20	14.73
13	Abra segmentum	20	12.712
14	Cerastoderma glaucum	40	10.5
15	Mytilaster lineatus	900	16.44
16	Mytilus galloprovincialis	5100	3337
	Total:	**33920**	**3455.654**

Date: 31.07.2008
Station: Old Channel Varna Lake - Varna Bay ; Depth: 2 m; Type of sediment: Sand - vary hard
Coordinates: 43o11' 23" N; 27o54' 33" E

№	Species composition	Abundance ind/m^2	Biomass g/m^2
1	Nemertini g. sp.	20	0.003
2	Aricidea claudiae	40	0.009
3	Capitomastus minimus	4800	0.466
4	Eteone picta	80	0.47
5	Glycera convoluta	10	0.002
6	Heteromastus filiformis	70	0.048
7	Magelona papillicornis	10	0.052
8	Neanthes succinea	150	0.551
9	Platynereis dumerilii	10	0.004
10	Polydora cornuta	330	0.112
11	Prionospio cirrifera	160	0.041
12	Pygospio elegans	40	0.005
13	Salvatoria clavata	200	0.009
14	Spio filicornis	3910	1.48
15	Oligochaeta g.sp.	1210	0.111
16	Ampelisca diadema	30	0.017
17	Iphinoe maeotica	130	0.018
18	Melita palmata	20	0.024
19	Microdeutopus gryllotalpa	10	0.003
20	Perioculodes longimanus	30	0.004
21	Upogebia pusilla	50	58.7
22	Ebala pointeli	10	0.003
23	Bittium reticulatum	30	0.467
24	Cerastoderma glaucum	1620	8.497
25	Chamelea gallina	60	6.751
26	Kellia suborbicularis	100	0.197
27	Lentidium mediterraneum	470	2.8
28	Lucinella divaricata	10	1.052
29	Mya arenaria - juv.	480	0.575
30	Mytilus galloprovincialis - juv.	30	0.098
31	Tellina tenuis	200	52.3
	Total:	**14320**	**134.869**

Date: 31.07.2008
Station: New Channel Varna Lake - Varna Bay; Depth: 12 m;
Type of sediment: Mud+empty shells of Cardium; oil patches in the surfice of water. Smell of H2S
Coordinates: 43o11' 04" N; 27o54' 12" E

№	Species composition	Abundance ind/m^2	Biomass g/m^2
1	Actinothoe clavata	20	14.6
2	Nemertini g. sp.	30	0.02
3	Phoronis euxinicola	20	0.006
4	Capitomastus minimus	150	0.015
5	Fabricia sabella	650	0.035
6	Harmothoe imbricata	10	0.003
7	Heteromastus filiformis	2500	1.057
8	Melinna palmata	240	0.09
9	Nepthis hombergii	60	3.263
10	Neanthes succinea	30	0.009
11	Pectinaria koreni	20	0.005
12	Phyllodoce (Anaitides) mucosa	40	0.149
13	Polydora cornuta	240	0.069
14	Prionospio cirrifera	20	0.005
15	Streblospio shrubsolii	720	0.087
16	Spio filicornis	130	0.04
17	Oligochaeta g.sp.	310	0.03
18	Idothea baltica	10	0.002
19	Perioculodes longimanus	10	0.004
20	Upogebia pusilla	10	4.1
21	Bittium reticulatum	40	0.407
22	Cylichnina umbilicata	30	0.166
23	Chrysallida terebellum	60	0.056
24	Hydrobia acuta	30	0.11
25	Retusa truncatula	10	0.03
26	Rissoa lineolata	40	0.066
27	Abra alba	20	1.173
28	Abra prismatica	200	3.681
29	Cerastoderma glaucum	800	6.1
30	Ebala pointeli	40	0.009
31	Mya arenaria	300	0.03
32	Mytilaster lineatus	40	0.024
33	Parvicardium exiguum	20	0.008
34	Spisula subtruncata	20	0.134
	Total:	**6870**	**35.583**

Date: 31.07.2008
Station: Varna Bay 1; Depth 15 m; Type of sediment: Sand, Upogebia; Smell of H2S
Coordinates: 43o11' 07" N; 27o56' 11" E

№	Species composition	Abundance ind/m^2	Biomass g/m^2
1	Nemertini g. sp.	10	0.051
2	Aricidea claudiae	2080	0.512
3	Capitomastus minimus	10	0.016
4	Glycera convoluta	10	0.093
5	Heteromastus filiformis	260	1.943
6	Melinna palmata	10	0.024
7	Mercierella enigmatica	10	0.071
8	Nepthis hombergii	170	2.431
9	Phyllodoce (Anaitides) mucosa	10	0.013
10	Polydora cornuta	30	0.017
11	Prionospio cirrifera	50	0.009
12	Oligochaeta g.sp.	4150	3.081
13	Ampelisca diadema	90	0.061
14	Decapoda larvae	110	0.008
15	Upogebia pusilla	240	119.2
16	Bittium reticulatum	10	0.104
17	Calyptraea chinensis juv.	10	0.022
18	Cylichnina umbilicata	40	0.092
19	Anadara inaequivalvis juv.	20	0.243
20	Cerastoderma glaucum juv.	200	0.115
21	Mytilus galloprovincialis	40	0.16
22	Pitar rudis juv.	30	0.121
	Total:	**7590**	**128.387**

Date: 31.07.2008
Station: Varna Bay 2; Depth 16.5 m; Type of sediment: Mud
Coordinates: 43o12' 07" N; 27o57' 19" E

№	Species composition	Abundance ind/m^2	Biomass g/m^2
1	Nemertini g. sp.	10	0.009
2	Aricidea claudiae	5670	3.743
3	Heteromastus filiformis	2190	0.925
4	Melinna palmata	70	0.342
6	Neanthes succinea	10	0.012
5	Nepthis hombergii	230	1.677
7	Polydora cornuta	40	0.029
8	Prionospio cirrifera	30	0.006
9	Oligochaeta g.sp.	3710	0.514
10	Ampelisca diadema	30	0.008
11	Decapoda larvae (zoea)	50	0.004
12	Upogebia pusilla	140	62.7
13	Rapana venosa	10	32.2
14	Mytilus galloprovincialis	10	0.084
	Total:	**12200**	**102.253**

Date: 05.08.2008
Station: Cocketrice; Depth 16-17 m;
Type of sediment: Sand, Branchiostoma, Nassarius reticulatus, Decapoda, 1 Rapana venosa.
Coordinates: 42o39' 03" N; 27o53' 20" E

№	Species composition	Abundance ind/m^2	Biomass g/m^2
1	Branchiostoma lanceolatum	160	18
2	Leptosynapta inchaerens	30	4.184
3	Leptoplana sp.	10	0.004
4	Nemertini g. sp.	210	1.2
5	Turbellaria g. sp.	10	0.002
6	Aonides paucibranchiatus	310	0.983
7	Aricidea claudiae	10	0.002
8	Capitomastus minimus	10	0.006
9	Harmothoe reticulata	10	0.007
10	Heteromastus filiformis	10	0.008
11	Microphthalmus szelkowii	10	0.0003
12	Neanthes succinea	70	0.821
13	Plathynereis dumerilii	10	0.18
14	Polycirrus jubatus	220	0.369
15	Polydora ciliata	10	0.009
16	Prionospio cirrifera	580	0.254

17	Protodrilus flavocapitatus	500	0.015
18	Protodorvillea kefersteini	1380	0.31
19	Salvatoria clavata	830	0.08
20	Sphaerosyllis histrix	280	0.02
21	Spio filicornis	470	1.12
22	Syllis gracilis	20	0.075
23	Syllis hyalina	10	0.001
24	Syllides longocirrata	180	0.006
25	Oligochaeta g. sp.	4320	0.264
26	Balanus improvisus	100	2.995
27	Diogenes pugilator	50	6.557
28	Upogebia pusilla larvae	70	0.012
29	Xantho poressa	10	4.325
30	Lepidochitona cinerea	10	0.178
31	Middendorffia caprearum	20	0.004
32	Bittium reticulatum	10	0.041
33	Calyptraea chinensis	160	2.024
34	Nassarius reticulatus	10	12.2
35	Odostomia eulimoides	20	0.034
36	Anadara inaequivalvis	30	176.2
37	Chamelea gallina	720	130
38	Lucinella divaricata	10	0.007
39	Modiola adriatica	570	4.85
40	Mytilaster lineatus	500	2.9
41	Rapana venosa	10	686.9
42	Thracia papyracea	10	0.467
	Total:	**11970**	**1057.6143**

Date: 05.08.2008
Station: Nesebar; Depth 22 m; Type of sediment: Soft mud;
Upogebia (adults and postlarvae), Poilychaeta;
Coordinates: 42o40' 48" N; 27o46' 44" E

№	Species composition	Abundance ind/m^2	Biomass g/m^2
1	Leptoplana sp.	30	0.014
2	Aricidea claudiae	3680	1.396
3	Heteromastus filiformis	4050	1.605
5	Neanthes succinea	10	0.12
4	Nepthis hombergii	250	3.21
6	Oriopsis armandi	40	0.005
7	Phyllodoce (Anaitides) mucosa	50	0.028
8	Prionospio cirrifera	30	0.009
9	Oligochaeta g.sp.	2110	0.209
10	Paramysis kroyeri	10	0.005
11	Balanus improvisus	10	0.278
12	Decapoda larvae	100	0.006
13	Upogebia pusilla	60	30.4
14	Hydrobia acuta	50	0.046
15	Abra prismatica	70	0.768
16	Cerastoderma glaucum juv.	40	0.024
17	Chamelea gallina	10	22.1
18	Pitar rudis juv.	20	0.015
19	Spisula subtruncata	10	0.019
	Total:	**10630**	**60.257**

Date: 05.08.2008
Station: Rosenets; Depth 13.5 m; Type of sediment: Soft mud - poor.
Coordinates: 42o27' 47" N; 27o31' 01" E

№	Species composition	Abundance ind/m^2	Biomass g/m^2
1	Phoronis euxinicola	40	0.018
2	Aricidea claudiae	290	0.046
3	Heteromastus filiformis	200	0.057
5	Melinna palmata	300	0.125
4	Nepthis hombergii	110	3.216
6	Pectinaria coreni juv.	10	0.0001
7	Oligochaeta g.sp.	490	0.05
8	Decapoda larvae	340	0.081
9	Bittium reticulatum	260	1.603
10	Cylichnina umbilicata	60	0.18
11	Ebala pointeli	50	0.008

12	Hydrobia acuta	100	0.143
13	Hydrobia ventrosa	250	0.645
14	Retusa truncatula	20	0.083
15	Abra prismatica	180	16
16	Anadara inaequivalvis	30	0.021
17	Rissoa parva	40	0.12
	Total:	**2770**	**22.3961**

Date: 05.08.2008
Station: Sozopol; Depth 38 m; Type of sediment: Soft mud, Melinna, Actinariidae
Coordinates: 42o26' 03" N; 27o43' 21" E

№	Species composition	Abundance	Biomass
		ind/m^2	g/m^2
1	Actinia equina	10	0.01
2	Phoronis euxinicola	10	0.001
3	Aricidea claudiae	1560	0.73
4	Heteromastus filiformis	180	0.079
5	Melinna palmata	1020	4.301
6	Nepthis hombergii	340	3.074
7	Oriopsis (Fabricia) armandi	100	0.01
8	Oligochaeta g.sp.	510	0.081
9	Ampelisca diadema	40	0.067
10	Decapoda larvae	10	0.001
11	Synchelidium maculatum	10	0.003
12	Cylichnina umbilicata	520	1.208
13	Rissoa lineolata	60	0.08
14	Abra prismatica	70	2.9
15	Acanthocardia paucicostata	10	4.079
16	Spisula subtruncata	30	1.893
	Total:	**4480**	**18.517**

Date: 05.08.2008
Station: Maslen nos; Depth 47 m; Type of sediment: Hard mud, Melinna, Spisula, Poilychaeta;
Coordinates: 42o20' 08" N; 27o49' 09" E

№	Species composition	Abundance	Biomass
		ind/m^2	g/m^2
1	Nemertini g. sp.	30	0.04
2	Phoronis euxinicola	50	0.019
3	Aricidea claudiae	8380	2.507
4	Heteromastus filiformis	560	0.205
5	Melinna palmata	1280	10.1

6	Nepthis hombergii	360	4.962
7	Oriopsis (Fabricia) armandi	400	0.024
8	Sphaerosyllis hystrix	10	0.001
9	Terebellides stroemi	100	0.728
10	Oligochaeta g.sp.	200	0.018
11	Ampelisca diadema	20	0.008
12	Bittium reticulatum	10	0.008
13	Odostomia acuta	30	0.015
14	Retusa truncatula	10	0.005
15	Rissoa lineolata	50	0.1
16	Abra alba	20	0.159
17	Abra prismatica	130	1.576
18	Acanthocardia paucicostata	20	0.061
19	Mytilus gallorpovincialis	30	0.011
20	Papillicardium papillosum	50	0.112
21	Pitar rudis	20	10
22	Spisula subtruncata	120	44.1
	Total:	**11880**	**74.759**

Date: 05.08.2008
Station: Burgas Bay 1; Depth 35 m; Type of sediment: mud + empty shells; Melinna.
Coordinates: 42o30' 00" N; 27o48' 00" E

№	Species composition	Abundance	Biomass
		ind/m^2	g/m^2
1	Nemertini g. sp.	20	0.006
2	Phoronis euxinicola	110	0.033
3	Aricidea claudiae	11840	3.834
4	Exogone gemmifera	10	0.001
5	Heteromastus filiformis	640	0.256
6	Melinna palmata	500	4.366
7	Nepthis hombergii	220	2.096
8	Oriopsis (Fabricia) armandi	160	0.013
9	Phyllodoce (Anaitides) mucosa	10	0.002
10	Terebellides stroemi	20	1.581
11	Oligochaeta g.sp.	940	0.114
12	Synchelidium maculatum	10	0.003
13	Cylichnina umbilicata	10	0.005
14	Abra prismatica	270	2.761
15	Anadara inaequivalvis	10	40.5
16	Chamelea gallina	50	1.069
17	Parvicardium exiguum	10	0.002
18	Pitar rudis	10	0.018

19	Spisula subtruncata	20	0.015
	Total:	**14860**	**56.675**

Date: 05.08.2008
Station: Burgas ; Depth 27 m; Type of sediment: shell sand + mud;
Coordinates: 42o30' 23" N; 27o40' 20" E

№	Species composition	Abundance	Biomass
		ind/m^2	g/m^2
1	Actinia equina	10	0.329
2	Nemertini g. sp.	100	0.08
3	Phoronis euxinicola	10	0.021
4	Aricidea claudiae	13240	1.128
5	Capitomastus minimus	30	0.005
6	Cirratulidae g. sp.	10	0.1
7	Exogone gemmifera	30	0.002
8	Heteromastus filiformis	640	0.155
9	Melinna palmata	180	0.143
10	Nepthis hombergii	180	1.795
11	Pectinaria (Lagis) koreni	10	0.102
12	Polydora cornuta	10	0.003
13	Prionospio cirrifera	1300	0.235
14	Phyllodoce (Anaitides) mucosa	10	0.009
15	Sphaerosyllis histrix	10	0.001
16	Oligochaeta g.sp.	160	0.022
17	Apseudopsis ostroumowi	10	0.007
18	Balanus improvisus	10	0.277
19	Decapoda larvae	100	0.01
20	Bittium reticulatum	40	1.376
21	Calyptraea chinensis	120	0.789
22	Cylichnina umbilicata	20	0.011
23	Rissoa parva	10	0.022
24	Abra alba	200	1.408
25	Acanthocardia paucicostata	20	0.008
26	Anadara inaequivalvis	20	0.01
27	Chamelea gallina	20	10
28	Modiola adriatica	80	0.873
29	Mytilus galloprovincialis	40	137.6
30	Parvicardium exiguum	20	0.103
31	Pitar rudis	110	0.945
32	Tapes lineatus	10	20
	Total:	**16760**	**177.569**

Annex 2. Number of samples per water body or station by sampling years, months and totally

Year	Month	Water body			Stations					Number of samples
		Beloslav lake	Varna lake	Channels Lakes - Varna Bay	Varna Bay 1	Varna Bay 2	Cocketrice	Bourgas Bay	Maslen nos	
1990	**7**	5	9	1						**15**
	11	7	13	2						**22**
1991	**2**	7	11	2						**20**
	5	7	13	2						**22**
	8				1	1				**2**
1992	**8**						3			**3**
1993	**9**						2			**2**
1995	**8**						2			**2**
1998	**8**				1	1		1		**3**
	9						1			**1**
1999	**9**							1	1	**2**
	11	6	15	2						**23**
2000	**9**						2	1	1	**4**
	3	5	11	2						**18**
2001	**8**	6	14	2						**22**
2002	**8**	7	15	2			1	1	1	**27**
2004	**9**						1	1	1	**3**
2005	**8**						1			**1**
	9							1	1	**2**
2006	**7**						1	1	1	**3**
2007	**8**				1	1	1	1	1	**5**
2008	**8**	2	7	2	1	1	1	1	1	**16**
Number of samples		**52**	**108**	**17**	**4**	**4**	**16**	**9**	**8**	**218**