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REPORT ON THE STATE OF THE MARINE AND COASTAL ENVIRONMENT IN 2010

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ABSTRACT

The state and evolution trends of the Romanian Black Sea coastal environment continued to be monitored in 2010 from the physical, chemical and biological point of view, compared to the reference periods dating back in the early '60s or in more recent years, depending on parameters. Seawater salinity recorded values between 0.50-18.63 PSU. The maximum belongs to marine waters (Sulina 30 m, in March) and the minimum to transitional waters (Sulina 20 m, same month), following the Danube's input influence. Coastal and marine surface waters show differences due to winds, rainfall regime and river input influence. The maximum monthly average of 2010 was recorded in November, 16.91 PSU. Nutrient (inorganic forms of N, P and Si) concentrations recorded normal values, slightly higher in transitional waters under anthropogenic influence. Phosphate concentrations with comparable levels to those between 1960 and 1970 are highlighted. Heavy metals varied within value ranges encountered between 2002 and 2009, with slightly decreasing trends in some cases. Organic pollutants, mainly total petroleum hydrocarbons, showed only occasionally higher values than usual. Aromatic polynuclear hydrocarbons and organochlorurate pesticide values ranged within the variation limits for 2004-2009. The bioaccumulation of contaminants in edible bivalve mollusks did not affect their state of health.

In 2010, biodiversity and habitats continued to be characterized. Habitat mapping was made in two marine Natura 2000 sites, ROSCI0269 Vama Veche - 2 Mai and ROSCI0094 Underwater sulphur seeps from Mangalia. Romania proposed the designation of a new protected site, from the shoreline to the 45 m isobath, between the Costinești and 23 August villages. The aim of this proposal is to protect some sub-types of 1170-Reef habitat, including 1170-2-Biogenic reefs with *Mytilus galloprovincialis*, insufficiently covered in current sites.

The slight improvement of the state of the marine ecosystem signalled at the end of the '90s, beginning of 2000, continued to be proved by the decrease of phytoplankton densities/biomasses and related blooms; the reinstallment of *Cystoseira barbata* belts off Vama Veche; the increase of macrozoobenthic specific diversity (more than 50 species, compared to only 28 in the '90s). In 2010, there was a slight tendency towards qualitative balancing.

The revised Red List of macrophytes, invertebrates, fish and mammals summed over 300 species. The endangered species in the CR, EN and VU categories are 48 in the Red List, 26 of which were identified in 2010. Also, the state of living resources/fish stocks was surveyed taking into consideration the evolution of state, pressure and impact indicators.

The coastal processes during the geomorphological cycle 2009-2010 were dominated by erosion (61%) and accretion (22%), compared to dynamic equilibrium (17%), in spring, and erosion (53%), accretion (18%) and dynamic equilibrium (29%), in autumn. The sea level showed, in 2010, a constantly positive deviation from the annual average throughout the entire year, except for the interval from September to October. The annual average was +23.5 cm higher than the annual average from 1933 to 2009, the annual average of 2010 becoming the maximum of the annual averages for the 1933-2010 period.

In addition, the importance of ICZM was acknowledged, a valuable tool to ensure that the Romanian coastal zone is environmentally and economically sustainable. Thus, structures and legal framework were created to promote its implementation. The sustainable development of the coastal zone requires the cooperation of all countries bordering the Black Sea. In this respect, a Strategic Action Plan for the Rehabilitation and Protection of the Black Sea was developed.

During 2010, the maritime spatial planning studies were continued and developed, taking into account the fact that Maritime Spatial Planning (MSP) is an instrument that can be used as innovative approach of the EU's Integrated Maritime Policy. In this process, GIS applications and research in remote sensing satellite system were made. Last, but not least, the anthropogenic pressures in the Romanian coastal area were identified, pressures caused by the abrupt development of various socio-economic activities in the natural space of the coastal zone.

KEY WORDS: *Black Sea, Romanian coast, eutrophication, contamination, biodiversity, endangered species, habitats, protected areas, living resources, sustainable development, maritime spatial planning, anthropogenic pressures*

C O N T E N T S

Chapter 1 - WATER

1.1. State of the Black Sea water
1.1.2. Physical and chemical indicators

The analysis of the physico-chemical indicators utilized for the monitoring of Romanian Black Sea transitional, coastal and marine waters quality in 2010 is based on 210 samples collected from the seawater column of a 38 stations network, located between Sulina and Vama Veche, during six oceanographic expeditions between February and September. The network includes the monitoring of all water types mentioned in the Water Framework and the Marine Strategy Directives, as follows: 9 stations - transitional waters (Sulina, Mila 9, Sf. Gheorghe, and Portița - down to 20 m inclusive), 18 stations - coastal waters (Gura Buhaz, Constanța East, Casino Mamaia, Constanța North, Constanța South, Eforie, Costinești, Mangalia and Vama Veche, down to 20 m depths, between 30 m - 50 m). The long term statistical analysis was performed based on historical and daily collected data in 2010, from the Casino Mamaia 0 m station. The general indicators and those characterizing the eutrophication status: transparency, temperature, pH, salinity, dissolved oxygen, inorganic nutrients were analysed.

Nutrients were analysed through spectrophotometric methods, validated in the laboratory. The "Methods of Seawater Analysis" (Grasshoff, 1999) manual was the main reference. The equipment was an UV-VIS Shimadzu spectrophotometer with measuring interval: 0-1,000 nm. The limits of detection and relative extended uncertainties, k=2, coverage factor, 95.45% were measured and calculated during the validation process (Table 1).

Table 1. Limit of detection and relative uncertainties for dissolved nutrients analysis

No.	Parameter	UM	Limit of detection ($\mu mol/dm^3$)	Extended relative uncertainty, U (c) (%), k=2, coverage factor 95.45%
1.	$(NO_3)^-$	µM	0.12	8.4
2.	$(NO_2)^-$	µM	0.03	6.6
3.	$(NH_4)^+$	µM	0.12	7.1
4.	$(PO_4)^{3-}$	µM	0.01	14.0
5.	$(SiO_4)^{4-}$	µM	0.30	3.3

Salinity was determined using the Knudsen Mohr method and dissolved oxygen with the Winkler method, both volumetric. The pH was determined by the potentiometric method. Transparency was measured in-situ with the Secchi disc.

The data were processed with Ocean Data View, version 4.0 (Schlitzer, 2010) and Excel 2003 software.

1.1.2.1. General indicators

Temperature

Seawater temperature recorded, along the Romanian shore in the water column, values from 0.8^oC to 27.8^oC *(average 7.50^oC and Std.Dev.8.92^oC)*. The minimum values belong to February and the maximum ones to September, whatever the water body analysed, according to air temperature (Table 2).

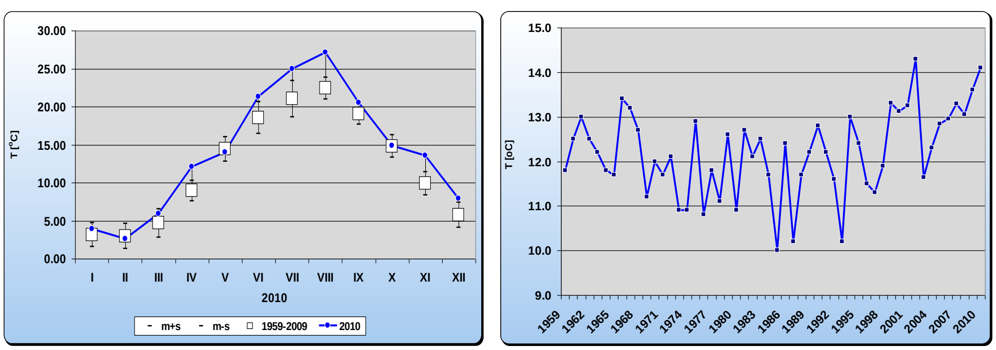
At Constanţa, the absolute minimum was - 0.4°C, in January, when the sea was frozen, and the absolute maximum was on the 17th of August 2010, 29.8°C. Thus, the 2010 temperature amplitude was 30.2°C, a difference that ecosystem had to compensate.

Table 2. Main values of seawater temperature from the Romanian shore
February - September 2010

Water body	**No. of sam-ples**	**Min (°C)**	**Station**	**Month**	**Max. (°C)**	**Station**	**Month**	**Average (°C)**	**St. Dev. (°C)**
Transitional waters	52	**1.3**	Sulina 20 m (0 m)*	Feb.	**23.5**	Portiţa 20 m (0 m)	Sept.	6.6	7.2
Coastal waters	54	**1.7**	C-ţa East 1 (0 m)	Feb.	**27.8**	Vama Veche 5 and 20 m (0 m)	Sept.	23.3	10.1
Marine waters	104	**0.8**	Sf. Ghe. 30 m (0 m)	Feb.	**27.5**	Costi-neşti 30 m (10 m)	Sept.	6.7	7.7

**Values from parenthesis represent sampling depth.*

The statistical analysis *(t test, confidence interval 95%, p=0.5473, t=0.6112, df=22, St. Dev. of difference=3.122)* of the historical data from the Cazino Mamaia 0 m station, based on daily observations, shows **insignificant** differences between the multiannual monthly averages from 1959-2009 and the monthly averages from 2010, even if in August 2010 the average was by 4.7°C higher than the multiannual monthly average of the same month (Fig. 1 a).



(a) (b)

Fig. 1. Comparative analysis of multiannual monthly (a) and annual (b) averages of seawater temperature (°C), Constanța, 1959-2009 and 2010

The annual averages of temperature oscillated between 10.0°C (1985) and 14.3°C (2002). The values are continuously increasing starting with 2003, until the 2010 annual average, the 2003-2010 annual averages being significantly different than those from 1959-2002 *(t test, p=0,0110)* (Fig. 1. b).

Transparency

The range of **Transparency** was 0.5 - 6.5 m *(average 1.8 m, st. dev. 5 m).* The maximum was in May, in coastal waters (East Constanța 2), and the minimum in February, in transitional waters (Sulina 20 m) (Table 3). In all cases, the minima are lower than 2 m, the allowed value for both the ecological state and human impact from Order 161/2006 - "Norms on surface water quality classification to determine the ecological status of water bodies".

Table 3. Main values of seawater transparency from Romanian shore
February - September 2010

Water body	No. of samples	Min. (m)	Station	Month	Max. (m)	Station	Month	Average (m)	St. Dev (m)
Transitional waters	13	**0.5**	Sulina 20m	Febr.	**3.0**	Portiţa 20m	Sept.	1.0	0.7
Coastal waters	13	**1.5**	C-ta South 5m	Sept.	**6.5**	East Cţa 2	May	3.0	1.6
Marine waters	13	**1.2**	Sf. Ghe. 30m	Sept.	**4.9**	Manga-lia 40m	May	3.2	1.3

The increased transparency gradient from transitional to marine waters and the highest variability of the coastal waters were observed (Fig. 2).

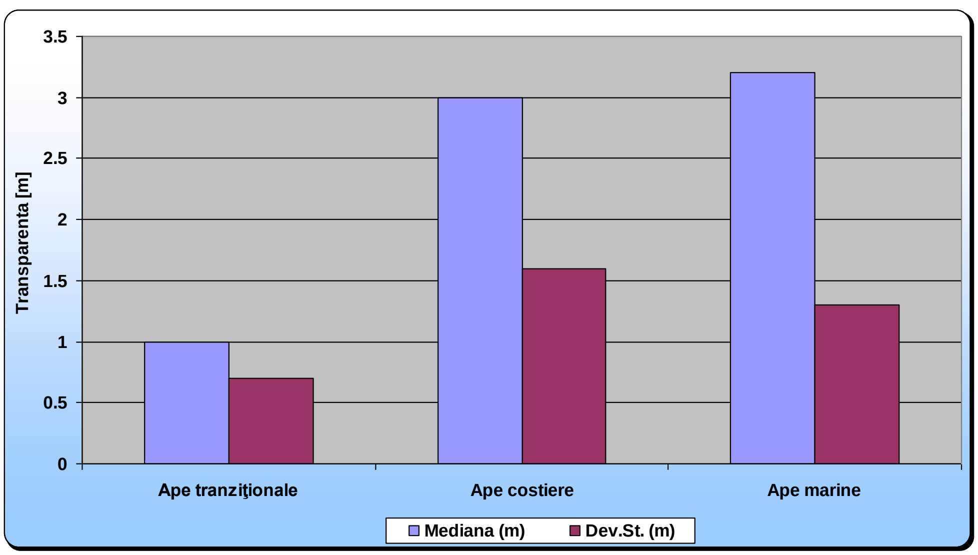


Fig. 2. Transparency average and standard deviations,
Romanian seawater, February - September 2010

Salinity

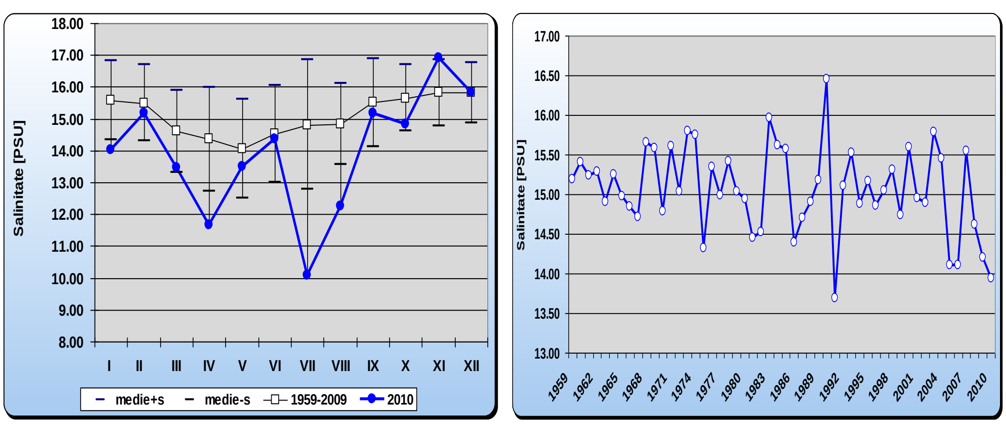
Transitional, coastal and marine waters salinity recorded values between 0.50-18.63 PSU *(average 16.93 PSU and Std. Dev. 3.359 PSU)*. The maximum belongs to marine waters (Sulina 30 m (20 m)) in March and the minimum to transitional waters (Sulina 20 m (0 m)), same month, following the Danube's input influence (Table 4). Coastal and marine surface waters show differences due to winds, rainfall regime and river input influence.

Table. 4 Main values of seawater salinity - Romanian shore,
February - September 2010

Water body	No. of samples	Min. (PSU)	Station	Month	Max. (PSU)	Station	Month	Average (PSU)	St. Dev. (PSU)
Transiti-onal waters	52	**0.50**	Sulina 20 m (0 m)	March	**18.13**	Sulina 20 m (10 m) Sf. Ghe. 20 m (20 m)	March	16.90	5.14
Coastal waters	54	**8.78**	East C-ţa 2 (0 m)	July	**18.46**	East C-ţa 2 (30 m)	July	15.78	1.95
Marine waters	104	**2.52**	Sf. Ghe. 30 m (0 m)	Febr.	**18.63**	Sulina 30 m (20 m)	March	17.52	2.55

**Values from parenthesis represent sampling depth.*

The statistical analysis of historical data *(t test, confidence interval 95%, p=0.0585, t=1.9959, df=22, St. Dev. of difference=0.577)* shows **insignificant** differences between the multiannual monthly averages from 1959-2009 and the monthly averages of the 2010 salinities, even if in April (11.65 PSU), July (10.09 PSU) and August (12.25 PSU) lower values were measured (Fig. 3. a). The maximum monthly average of 2010 was recorded in November, 16.91 PSU.



(a) (b)

Fig. 3. Comparative analysis of multiannual monthly (a) and annual (b) averages of seawater salinity (PSU), Constanța, 1959-2009 and 2010

Between 1959-2010, the annual averages range was 13.45 PSU (1991)-16.91 PSU (1990), with a slightly decreasing trend and important amplitudes compared to past years (Fig. 3. b.). The annual average in 2010 was 13.94 PSU.

pH

The monthly average pH value in coastal waters ranged at Constanţa between 8.10, in December, and 8.37, in January, *(average 8.24 and Std. Dev. = 0.08)* (Fig. 4).

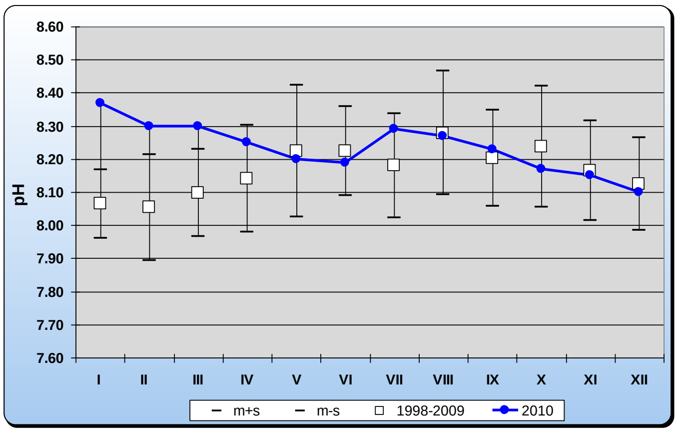


Fig. 4. Coastal waters pH at Constanţa (1998-2009 and 2010)

The pH monthly average statistical analysis *(t test, confidence interval 95%, p=0.0291, t=2.3338, df=22, St. Dev. of difference=0.030)* shows a significant difference between the monthly averages from 1998-2009 and 2010, due to the higher values in 2010, which do not confirm the acidification of coastal waters.

The dissolved oxygen in seawater represents an important and representative variable for the ecosystem assessment, particularly due to its easy measurement techniques - classic chemical or electrochemical. Its regime and influencing factors have a major contribution for impact assessment on marine ecosystems. The primary source in the marine environment is the seawater-air interface exchange and the biological production through aquatic plants, algae and bacterial photosynthesis. Strong gradients of dissolved oxygen concentrations from coastal waters could be produced by variations of temperature, salinity, nutrient input, bathymetry, water masses circulation, climatic factors and biological production. Sometimes, vertical stratification inhibits mixing and stimulates hypoxic and anoxic events, especially in the warm season. So, the dissolved oxygen variability of the seawater column results from physical transport and biological consumption interactions. The coastal zones host interface ecosystems between land and the marine environment, receiver of active biogeochemical input from all hydrographical basins of the studied areas. In the strong influenced areas, like the Black Sea's north-western shelf, organic matter decomposition could represent an important factor of the dissolved oxygen balance in the area.

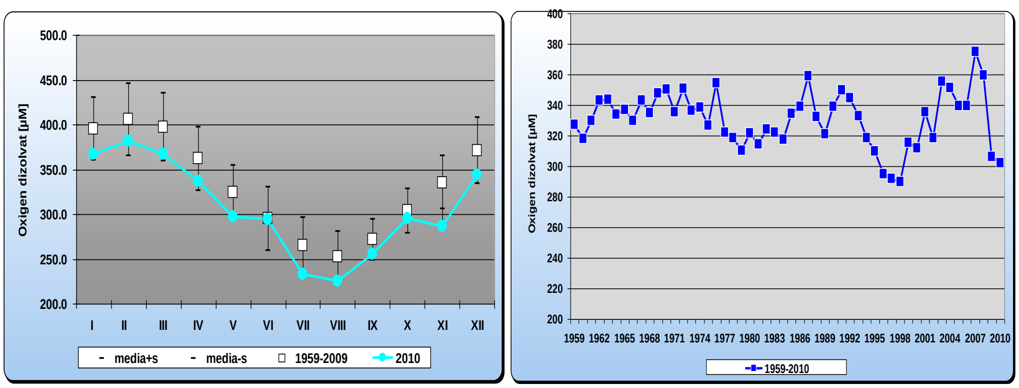
Dissolved oxygen concentrations ranged within 69.2 µM (Mangalia 30 m, (20 m)), in September, and 456.9 µM (Sulina 30 m (0 m)), in March, *(average 322.2 µM and std. dev. 67.9 µM)* (Table 5).

Water body	No. of samples	Min (µM)	Station	Month	Max (µM)	Station	Month	Ave-rage (µM)	St.Dev (µM)
Transi-tional waters	52	138.4 4.4 mg/l	Sulina 20 m (10 m)	Sept.	408.6	Mila 9 20 m (0 m)	Febr.	335.0	61.3
Coast-al waters	54	76.9 2.5 mg/l	East C-ţa 1 (10 m)	July	393.9	Manga-lia 20 m (10 m)	Febr.	264.8	72.1
Marine waters	104	69.2 2.2 mg/l	Mangalia 30 m (20 m)	Sept.	456.9	Sulina 30 m (0 m)	March	320.4	63.8

**Values from parenthesis represent sampling depth.*

Table 5. Main values of seawater dissolved oxygen - Romanian coast
February - September 2010

All minimum values are below 6.2 mg/l, the allowed concentration from Ord. no.161/2006 - "Norms on surface water quality classification to determine the ecological status of water bodies" and were recorded in the warm season, due to high air and water temperatures and water mass stratification. This was confirmed by the normal surface concentrations in the same stations.



(a) (b)

Fig. 5. Comparative analysis of multiannual monthly (a) and annual (b) averages of seawater dissolved oxygen (µM), Constanța, 1959-2009 and 2010

Although, generally, the monthly averages are decreasing in 2010, there are significant differences from the multiannual monthly averages 1959-2009 *(t test, confidence interval 95%, p=0.2741, t=1.1216, df=18, Std. Dev. of difference =21,930).* The lower values of the warm season are attributed to the natural variability of the Constanţa coastal area (Fig. 5. a.). The annual averages are within 289.9 µM (1998) and 374.9 µM (2007), the 2010 average being 306.8 µM.

The lower averages of July and August are due to extreme situations signalled in the summer of 2010. On the 29th of July, at Cazino Mamaia 0 m, the dissolved oxygen decreased close to anoxia (34.8 µM/**0.78 cm^3/l**), even if seawater temperature was low (21.4^{o}C). The situation led to fish mortalities.

Extreme, hypoxic phenomena were registered also in the oceanographic survey undertaken two days before. Hypoxia was observed at stations 1 and 3 and low oxygen values at stations 2 and 4 of the East Constanța profile, 10 meters depth (Fig. 6).

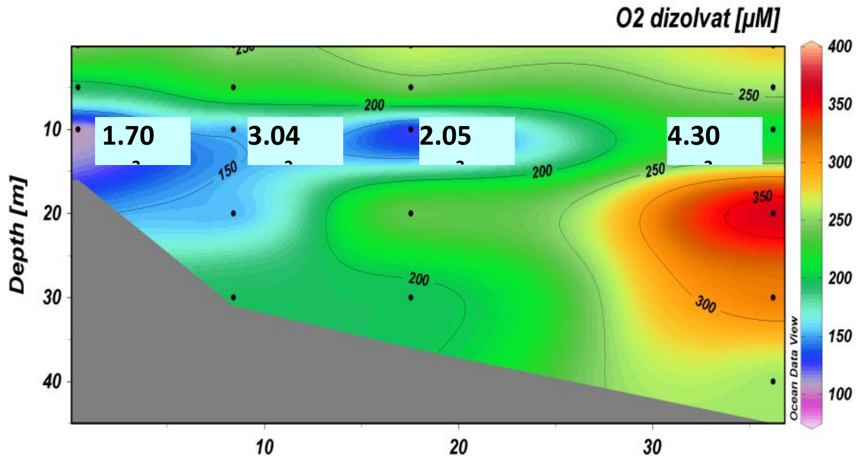


Fig. 6. Dissolved oxygen concentrations in the water column, East Constanţa, 27-28th of July 2010

The phenomena near the shore represented a consequence of water column dissolved oxygen consumption due to oxydative decomposition of organic matter resulted from summer algal blooms and winds regime, which favours upwelling. Water masses were pushed off shore, being replaced by others - colder, more salted, but hypoxic - of inferior layers of the deeper area (10-20 m). So, a strong, but episodic hypoxic event was registered in coastal waters. These events were recorded annually during the intense eutrophication period, but were absent after 2001 (Fig. 7).

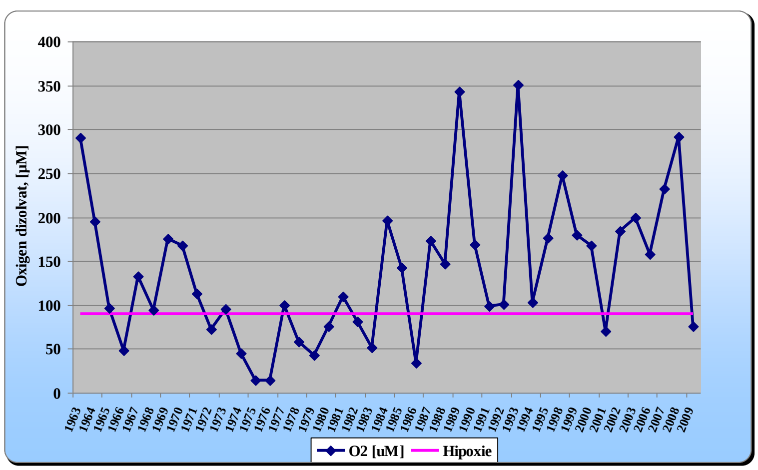


Fig. 7. Minimum dissolved oxygen concentrations, East Constanţa 1963-2010

The annual averages decreased starting with 2007, the maximum difference was between 2008 (359.7 µM) and 2009 (306.0 µM) (Fig. 4.3.5.1.1.5. b.).

The oxygen saturation was 29.3%-156.63% *(average 99.5%, Std. Dev. 16.9%)*, both extremes from coastal waters (Table 6). Similarly to dissolved oxygen, the minima were recorded in the warm season, in the water column, being lower than the allowed limit (80%), for ecological state and anthropic impact (Ord. no. 161/2006).

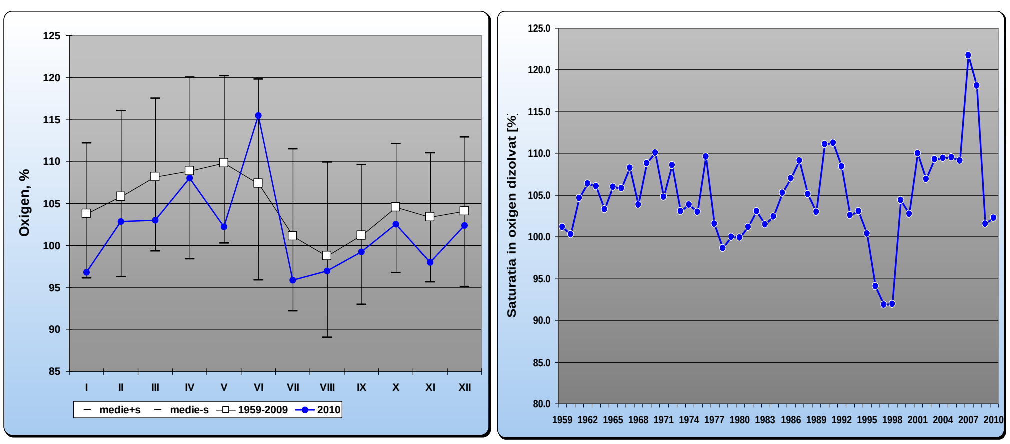
Table 6. Main values of seawater oxygen saturation - Romanian coast February - September 2010

Water body	No. of samples	Min (%)	Station	Month	Max (%)	Sta-tion	Month	Ave-rage (%)	St. Dev. (%)
Transitional waters	52	**56.4**	Sulina 20 m (10 m)	Sept.	**123.8**	Mila 9 5 m (0 m)	Sept	126.6	27.49
Coastal waters	54	**29.3**	East C-ța 1 (10 m)	July	**156.6**	C-ța South 20 m (0 m)	July	122.6	26.63
Marine waters	104	**29.9**	Mangalia 30 m (20 m)	Sept.	**135.0**	East C-ța 4 (20 m)	July	122.8	18.77

**Values from parenthesis represent sampling depth.*

Due to the minimum values recorded at East Constanța 1, 10 m depth, the saturation regime was also influenced by biological oxygen balance.

Statistically *(t test, confidence interval 95%, p=0.14775, t=1.5005, df=22, Std. Dev. of difference =1.867)*, the historical data (1959-2009) are insignificantly different from the 2010 monthly averages (Fig. 8. a).



(a) (b)

Fig. 8. Comparative analysis of multiannual monthly (a) and annual (b) averages of seawater oxygen saturation (%), Constanța,1959-2009 and 2010

1.1.2.2. Eutrophication indicators

Nutrients - Phosphates

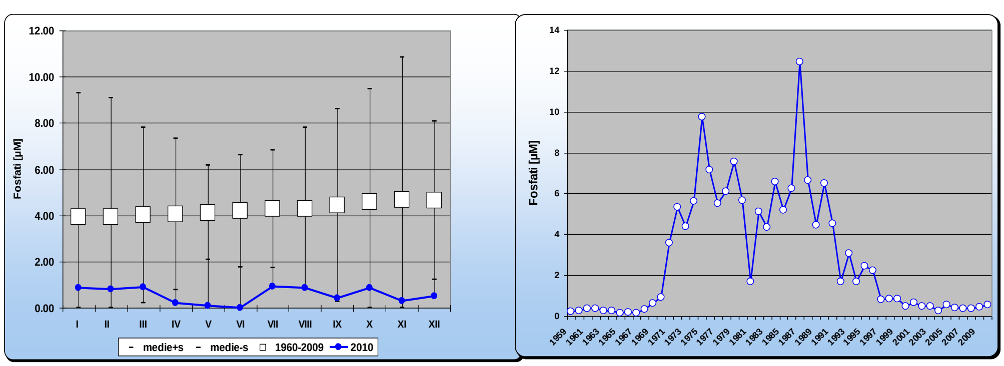
Phosphates, **$(PO_4)^{3-}$,** were within “undetectable” limits - 6.25 µM *(average 0.25 µM, Std. Dev. 0.58 µM)*, both extremes from coastal waters (Tab. 7). The maximum value is from the Constanţa South 5 m (0 m) station, as a consequence of waste water treatment plant influence.

Table 7. Main values of seawater phosphates - Romanian coast February - September 2010

Water body	No. of samples	Min. (µM)	Station	Month	Max (µM)	Station	Month	Avera-ge (µM)	St. Dev (µM)
Transi-tional waters	52	**0.3**	Portiţa 20 m (8 m)	May	**3.78**	Sulina 10 m (0 m)	March	0.33	0.69
Coastal waters	54	**<LOD**	East C-ţa 1 (5 m) East C-ţa 2 (0 m)	May	**6.25**	C-ţa South 5 m (0 m)	Sept.	0.23	0,87
Marine waters	104	**<LOD**	Manga-lia 50 m (20, 30, 40 m)	May	**1.11**	Sulina 30 m (0 m)	March	0.24	0.23

**Values from parenthesis represent sampling depth.*

Statistically *(t test, confidence interval 95%, p=0.0001, t=29.39, df=22, Std. Dev. of difference=0.126)*, the monthly multiannual averages from 1959-2009 are significantly different from those in 2010, due to the lower values of the last year (Fig. 9. a.). In June, all values were below the limit of detection, due to biological consumption resulting in the algal blooms the following month.



(a) (b)

Fig. 9. Comparative analysis of multiannual monthly (a) and annual (b) averages of seawater phosphate (µM), Constanţa, 1959-2009 and 2010

The long-term, annual averages oscillated within 0.3 µM (1967) and 12.44 µM (1987) *(average 1.29 µM, Std. Dev. 2.97 µM)*, with an important decrease starting with 2010. The average was 0.52 µM, following the slow increasing trend of the past 4 years.

Total phosphorus, representing the total amount of organic and inorganic phosphorus fractions in the seawater, shows concentrations in the range 0.15 - 8.22 µM *(average 0.84 µM, Std. Dev. 0.837 µM)*, following the same trend as phosphates, $(PO_4)^{3-}$ (Table 8).

Table 8. Main values of seawater total phosphorus - Romanian coast - February - September 2010

Water body	No. of samples	Min. (µM)	Station	Mon th	Max. (µM)	Statio n	Mont h	Ave-rage (µM)	St. Dev. (µM)
Transiti onal waters	38	**0.26**	Portiţa 20 m (0 m)	Feb.	**3.33**	Sulina 10 m (0 m)	Sept	0.91	0.64
Coastal waters	44	**0.15**	East C-ţa 2 (10 m)	July	**8.22**	C-ța South 5 m (0 m)	Sept	0.85	1.20
Marine waters	77	**0.33**	Mangali a 40 m (0 m)	Feb.	**5.86**	Mila 9 30 m (10 m)	Feb.	0.78	0.65

**Values from parenthesis represent sampling depth.*

The statistical analysis *(ANOVA, F=1.37, p=0.2582, F_{cr} = 3.054, df=158, α=0.05)* shows insignificant differences from the total phosphorus of the water bodies, the maximum value from Constanța South being accidental. Except the three maxima from transitional (river input), coastal and marine waters, all other values were within the allowed limit 0.1 mg/dm^3 (3.26 µM) (Table 8).

Nitrates, $(NO_3)^-$, from the Romanian Black Sea waters oscillated in 2010 within 0.81- 26.47 µM *(average 1.78 µM, Std. Dev. 4.05 µM)* (Table 9).

Table 9. Main values of seawater nitrate - Romanian coast – February - September 2010

Water body	No. of samples	Min. (µM)	Station	Month	Max (µM)	Station	Month	Average (µM)	St. Dev. (µM)
Transitional waters	52	**0.72**	Sf. Ghe. 20 m (18 m)	May	**26.47**	Portița 5 m (0 m)	Sept	2.71	6.17
Coastal waters	54	**0.81**	Vama Veche 20 m (10 m)	Sept.	**23.81**	Constanța South 5 m (0 m)	Sept	1.89	3.61
Marine waters	104	**0.32**	Manga-lia 40 m (35 m)	May	**23.81**	Mila 9 30 m (10 m)	May	3.47	3.27

**Values from parenthesis represent sampling depth.*

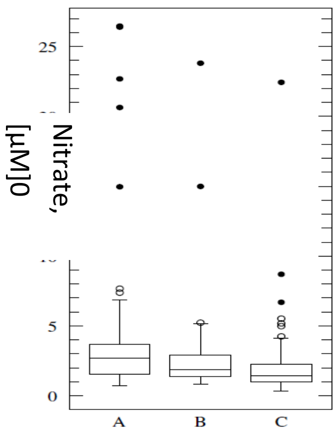
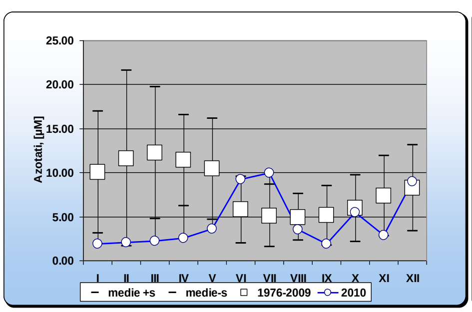


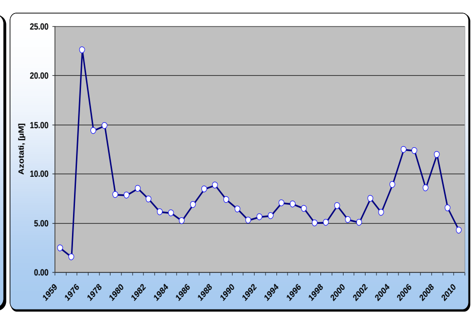
Fig. 10. Nitrate distribution in transitional (A), coastal (B) and marine (C) waters - 2010

Nitrate distribution in transitional (A), coastal (B) and marine (C) waters shows the decreasing gradient from transitional (A) to coastal (B) and marine (C) waters and the same orientation decreasing variation (Fig. 10).

The statistical analysis (t test, confidence interval 95%, p=0.0063, t=3.0181, df=22, Std. Dev. of difference = 1.214) of the long term data shows significant differences of the monthly nitrate average of 1976-2009 and 2010, due to the lower values of last year and the higher seasonal variability of 2010 (Fig. 11. a). The higher values form June and July contributed to the nutritional needs of algal blooms. On the long-term, 1976-2010, the annual averages ranged within 4.21 µM (2010) and 22.55 µM (1976) (average 6.89 µM, Std. Dev.3.66 µM). The nitrate concentrations still follow the decreasing trend of the last years (Fig. 11. b.).



(a)



(b)

Fig. 11. Comparative analysis of multiannual monthly (a) and annual (b) averages of seawater nitrate (µM), Constanța, 1959-2009 and 2010

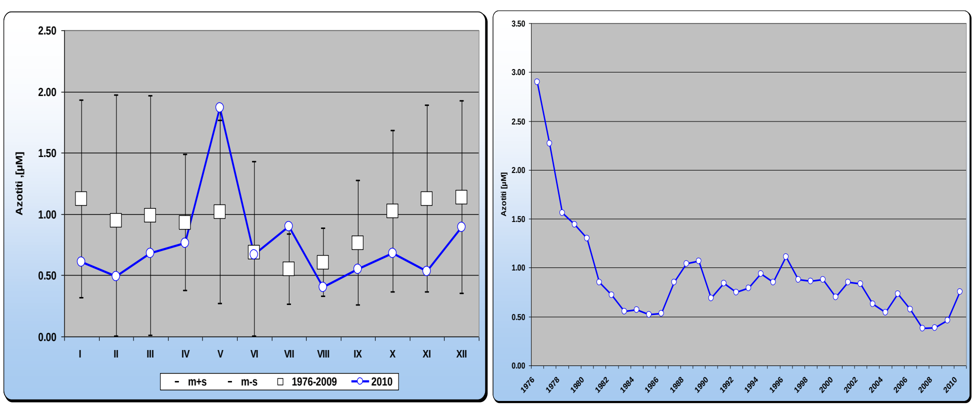
Nitrites, $(NO_2)^-$, intermediary forms of redox processes, which involve inorganic nitrogen species, presented concentrations from “undetectable” to 7.43 µM *(average 0.26 µM, Std. Dev. 1.38 µM)* (Table 10).

Table 10. Main values of seawater nitrite - Romanian coast - February - September 2010

Water body	No. of sam-ples	Min. (µM)	Station	Month	Max (µM)	Station	Month	Average (µM)	St. Dev (µM)
Transitional waters	52	**0.06**	Portiţa 20 m (0 m)	Sept.	**7.43**	Portiţa 10 m (9 m)	May	0.43	1.67
Coastal waters	54	**<LOD**	Gura Buhaz 20 m (0 m)	Sept.	**7.03**	East C-ţa 2 (8 m)	May	0.25	1.95
Marine waters	104	**<LOD**	Sf. Ghe. 30 m (10 m)	Sept.	**3.10**	Portiţa 30 m (30 m)	May	1.69	2.46

**Values from parenthesis represent sampling depth.*

Statistically (t test, confidence interval 95%, p=0.2399, t=1.2080, DF=22, Std. Dev. of difference=0.126), the 2010 values are insignificantly different from the monthly multiannual averages 1976-2009 (Fig. 12 a).



(a) (b)

Fig. 12. Comparative analysis of multiannual monthly (a) and annual (b) averages of seawater nitrite (µM), Constanța, 1976-2009 and 2010

On the long-term, starting with 1976, the annual average concentrations are decreasing significantly (t test, p<0.0001) from 2.90 µM, in 1976, to 0.38 µM, in 2007-2008 (Fig. 4.3.5.1.2.4.b.).

Ammonium, $(NH_4)^+$, is the easiest biologically assimilable inorganic nitrogen form, due to its maximum oxidation number (+3). Ammonium concentrations ranged within 0.22-30.66 µM (average 2.30µM, Std. dev. 3.88 µM), except at Constanța South 5 m, with the extreme value in September (50.58 µM) (Tab. 4.3.5.1.2.5).

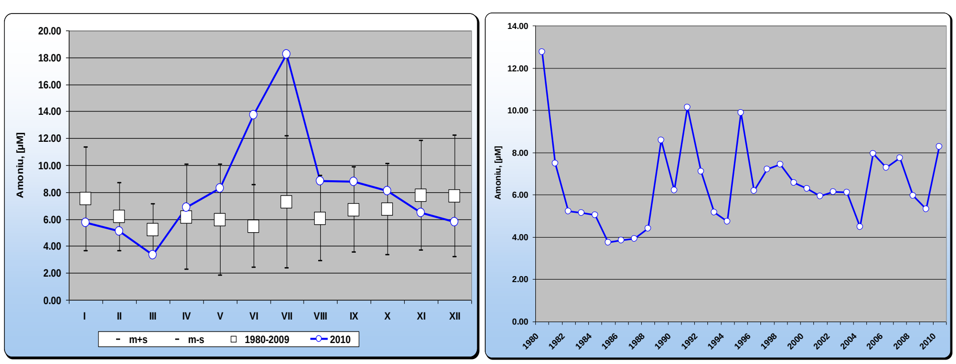
Although the monthly averages in 2010 exceeded the specific domain of those from 1980-2009, in June and July, statistically *(t test, confidence interval 95%, p=0.1660, t=1.4328, df=22, Std. Dev. of difference=1.202),* they are insignificantly different from the long term data (Fig. 12. a.).

The annual averages recorded concentrations within 3.73 µM (1985) and 12.75 µM (1980) *(average 6.19 µM, Std. Dev. 3.02 µM)*, with the 2010 average being 8.27 µM, the highest of the past 15 years (Fig. 12. B.).

Table 11. Main values of seawater ammonium - Romanian coast - February - September 2010

Water body	No. of sam-ples	Min. (µM)	Station	Month	Max. (µM)	Station	Month	Ave-rage (µM)	St. Dev. (µM)
Transitional waters	52	**0.95**	Portița 20 m (20 m)	May	**16.08**	Sf. Ghe. 5 m (0 m)	March	4.12	3.51
Coastal waters	54	**0.38**	Mangalia 20 m (13 m)	May	**50.58**	C-ța South 5 m (0 m)	Sept.	2.12	8.42
Marine waters	104	**0.22**	Mangalia 50 m (20 m)	May	**17.32**	Sf. Ghe. 30 m (0 m)	Febr.	1.77	2.69

**Values from parenthesis represent sampling depth.*



(a) (b)

Fig. 12 Comparative analysis of multiannual monthly (a) and annual (b) averages of seawater ammonium (µM), Constanța, 1980-2009 and 2010

In 2010, ammonium concentrations occasionally exceeded the allowed limit, 0.1 mg/dm^3 (7.14 µM NH_4^+), in all water bodies (Fig. 13).

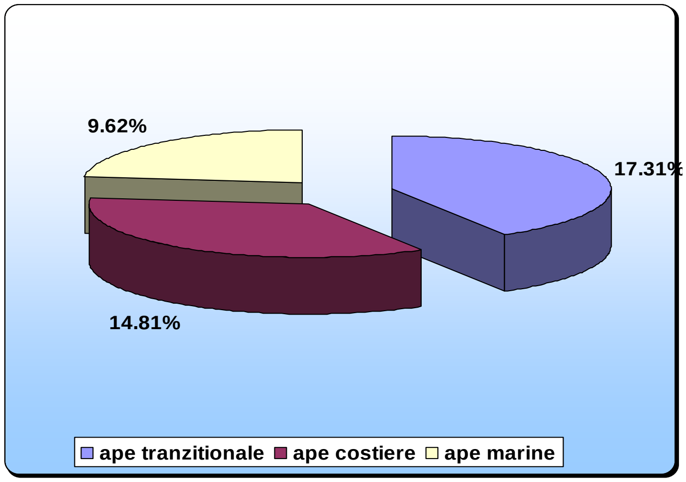
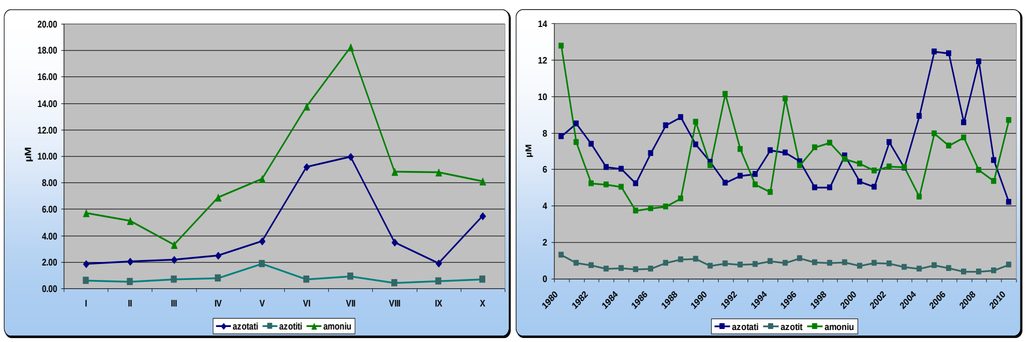


Fig. 13 Exceeding shares (%) of allowed limit of ammonium - Romanian coast, 2010

In 2010, the dominant form of inorganic nitrogen was ammonium, both from anthropic sources (river input and wastewater treatment plant) and regeneration from organic matter remineralisation (Fig. 14. a and b).



a) b)

Fig. 14. Comparative analysis of multiannual monthly (a) and annual (b) averages of seawater inorganic nitrogen (µM), Constanța, 1980-2009 and 2010

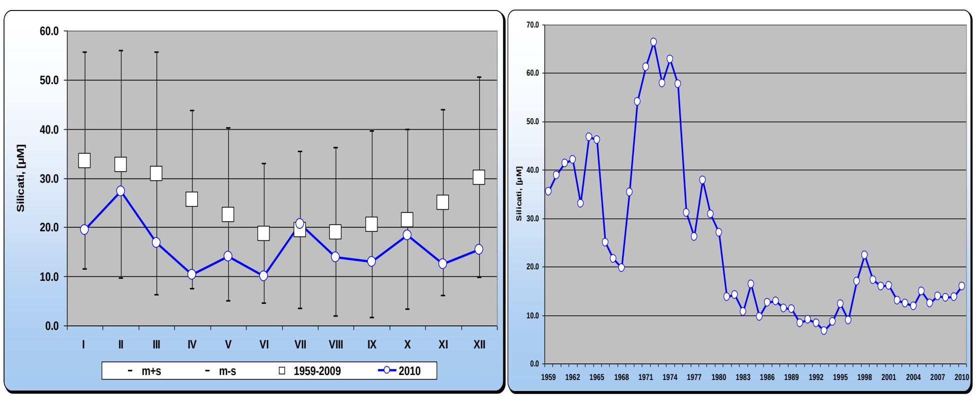
Silicates, $(SiO_4)^{4-}$, **had concentrations within** 0.3-99.0 µM *(average 8.4 µM, Std. Dev.15.5 µM)*, both extremes from marine waters (Table 12).

Table 12. Main values of seawater silicate - Romanian coast - February - September 2010

Water body	No. of samples	Min (µM)	Station	Month	Max (µM)	Station	Month	Average (µM)	St. Dev. (µM)
Transitional waters	52	**1.1**	Portiţa 20 m (5 m)	May	**85.3**	Sf.Ghe. 20 m (0 m)	Febr.	11.3	22.7
Coastal waters	54	**0.7**	Mangalia 20 m (0 m)	May	**31.5**	East C-ţa 1 (10 m)	July	8.6	6.1
Marine waters	104	**0.3**	Mangalia 40 m (0 m)	May	**99.0**	Sf. Ghe. 30 m (0 m)	Febr.	7.4	12.2

**Values from parenthesis represent sampling depth.*

The long term and the current data are statistically significantly different (*t test, confidence interval 95%, p=0.0004, t=4.1866, df=22, Std. Dev. of difference=2.134)* due to the lower 2010 values (Fig. 15. a).



(a) (b)

Fig. 15. Comparative analysis of multiannual monthly (a) and annual (b) averages of seawater silicate (µM), Constanța, 1959-2009 and 2010

The average annual concentrations of silicates had values within 6.7 µM (1993) and 66.3 µM (1972) *(average 16.4 µM, Std. Dev.16.8 µM)*, with the 2010 annual average 16.0 µM (Fig. 15. b.).

Regarding the general indicators, the following can be observed:

- The average annual temperature of seawater at Constanța has increased significantly in the plast 8 years compared to 1959-2002;
- Transparency averages are increasing from transitional to marine waters, being lower than 2009;
- Salinity is influenced by freshwater river input and climatic factors (particularly wind regime and rainfall) and recorded insignificant differences compared to 1959-2009, even if the 2010 average is the lowest from the past 19 years;
- The pH was higher in 2010 than in 1998-2009, particularly in the cold season.

- Although the dissolved oxygen was lower in July and August 2010 (when hypoxic events and fish mortality were recorded), the monthly averages were insignificantly different from the long term data;
- Unprecedented since 2001, hypoxic events reappeared in the water column due to oxygen consumption of organic matter produced in the algal blooms and climatic factors;
- Generally, on the long term, a slight decrease of the dissolved oxygen concentrations at Constanța can be noticed, starting with 2007.

The eutrophication indicators show that:

- In the Constanţa coastal zone, phosphates concentrations were very low, compared to the reference period of the ’60s, but with higher seasonal variability;
- Total phosphorus generally recorded normal values, except the river input influenced and anthropogenic sources stations, where the maxima exceeded the allowed limits;
- The nitrate concentration distribution showed a decreasing trend from transitional to marine waters. The values from 2010 are generally lower than in the previous years.
- Both anthropogenic and river ammonium input and regeneration were the dominant inorganic nitrogen form in 2010.
- Silicates recorded higher concentrations in the Danube’s influence area. On the long term, concentrations were still lower than in the reference period, even if slightly increasing starting with 2006.
- In 2010, two important nutrient sources were generally observed at the Romanian Black Sea littoral: the Danube river input and Constanța and Mangalia cities, due to neighbouring waste water treatment plants and ports.

Chlorophyll *a*

Chlorophyll *a* showed a large intra-annual variability in the Romanian near shore waters in 2010, its values ranging between 0.66 and 58.47 µg/l.

The seasonal distribution of chlorophyll *a* showed a late winter peak (early March), in accordance with the typical diatoms cycle; furthermore, during this period, the maximum chlorophyll of 2010 was recorded (Fig. 16). After lower concentrations recorded in late spring, the Danube’s increased flow, together with unusual higher sea surface temperatures, led to a significant increase of chlorophyll values in the warm season; the second chlorophyll peak was reached in August (Fig. 16). The chlorophyll *a* level remained relatively high until mid-fall, as a consequence of favorable thermal and haline conditions in coastal waters. Starting with late fall, chlorophyll *a* dropped sharply (Fig. 16), most of the values recorded in December were below 1µg/l.

The chlorophyll *a* values recorded in 2010 in the Romanian coastal waters were comparable to the highest concentrations recorded in 2006 (Fig. 17), when there were also high freshwater discharges of the Danube. These findings suggest that the thermal and haline regimes are mainly responsible for temporal chlorophyll variation, while the nutrient level, even in the periods with low water discharges of the Danube River, remains optimal for sustaining a high primary productivity in near shore waters.

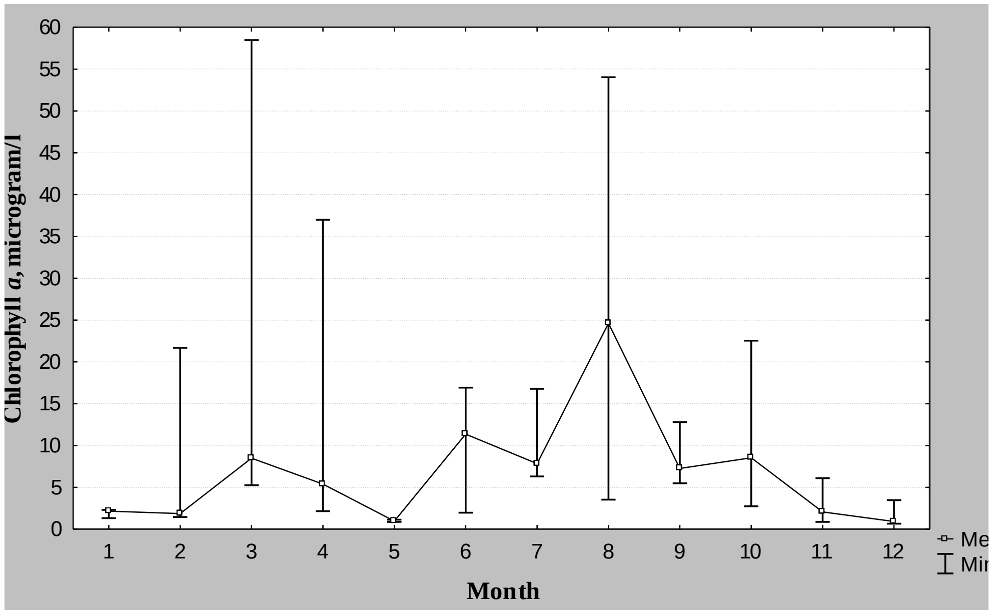


Fig. 16. Seasonal variation of chlorophyll *a* in the Romanian coastal waters, in 2010

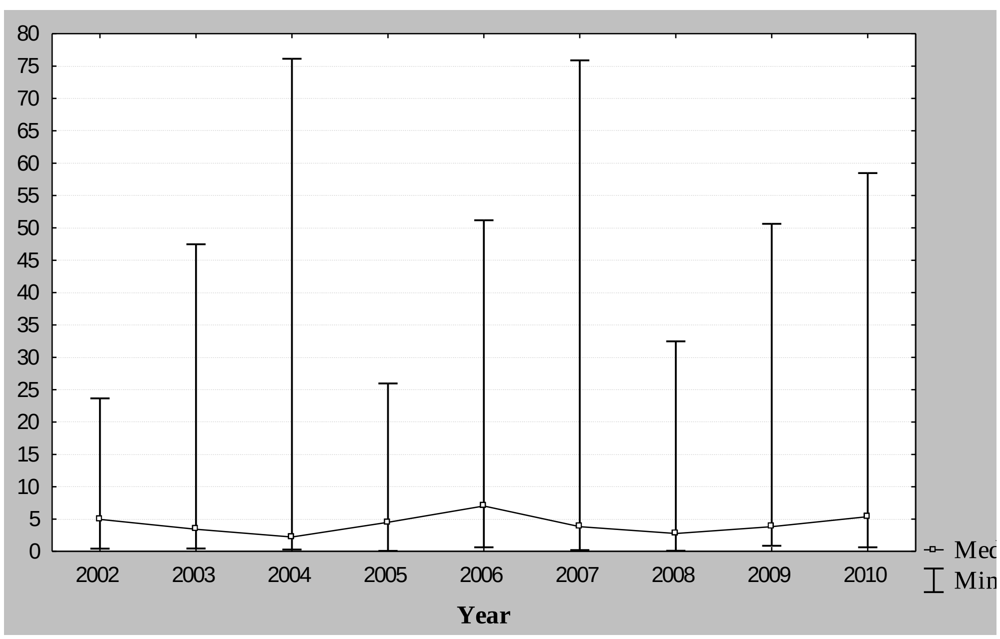


Fig. 17. Inter-annual variation of chlorophyll *a* in the Romanian coastal waters

1.1.2.3. Indicators of contamination

1.1.2.3.1. Heavy metals

Coastal zones represent complex and dynamic systems, being subjected to natural or anthropogenic influences. The heavy metal contamination of coastal areas can be directly related to urban or industrial sources such as factories, power plants, port facilities, wastewater treatment plants. The influence of rivers on coastal areas is significant, being a major source of metals, especially in particulate form, extreme hydrological events (floods) contributing at the increase of their input. Atmospheric metal flows, demonstrating both natural and anthropogenic influences, are also considered to be an important source for the European seas, both at coastal and river basin level, depending on local climatic variability and weather. (JRC 58087, EUR 24335-2010; http://europa.eu/).

The monitoring of heavy metals in 2010 was made by analyzing samples of seawater (surface horizon), surface sediments and biota collected during the February - September period from transitional (Sulina - Portița, 5-20 m), coastal (Gura Buhaz - Vama Veche, 0-20 m) and marine areas (depths over 20 m) (total of 44 monitoring stations).

Transitional, coastal and marine waters

Heavy metal concentrations determined throughout the year 2010 in monitoring stations were within the following areas of variation: 0.03 to 10.24 µg/L copper, 0.01 to 3.21 µg/L cadmium, 0.13 to 15.91 µg/L lead, 0.35 to 9.24 µg/L nickel, 0.01 to 5.21 µg/L chromium.

The unifactorial dispersion analysis (ANOVA) revealed significant differences for certain elements between water bodies: copper (df 2.90, $F = 17.67$, $p < 0.05$), lead (df 2.90, $F = 3.87$, $p < 0.05$), nickel (df 2.90, $F = 5.62$, $p < 0.05$). The annual average concentrations of these three elements were higher in transitional waters, although it should be noted that, for lead, the maximum values were measured in shallow coastal waters during the summer season. No significant differences were found for cadmium (df 2.90, $F = 1.55$, $p<0.05$) and chromium (df2.90, $F=0.52$, $p<0.05$), between the three water bodies, the ranges of values and annual average concentrations being relatively close (Fig. 18).

In relation to environmental quality standards in the field of water recommended by the national and European legislation (Order 161/2006, Directive 2008/105/2008), it was observed that, for all investigated elements, the annual average values calculated for each water body were included below the limit. However, some individual measurements during the year slightly exceeded the recommended standards (25% of the samples for lead, 12% of the samples for chromium and 30% of the samples for cadmium). In the case of copper and nickel, no concentrations were recorded in 2010 that exceed the quality standards.

In 2010, the average values and variation ranges for copper and chromium in transitional, coastal and marine waters were slightly reduced compared with the range of annual averages for the period 2006 to 2009. The concentrations of cadmium, lead and nickel measured in 2010 were within the ranges observed in the past 5 years (Fig. 19).

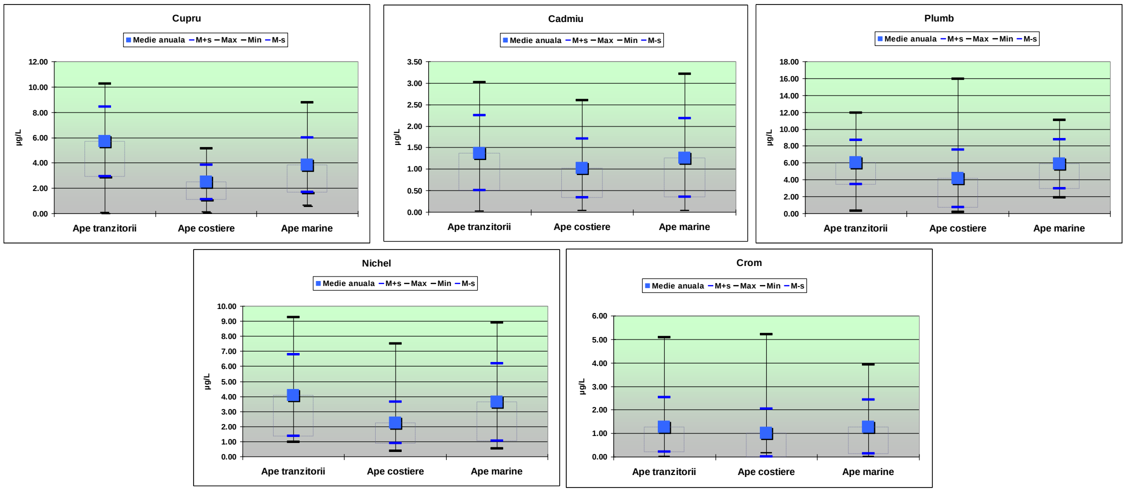


Fig. 18. Distribution of heavy metals concentrations in transitional, coastal and marine waters in 2010

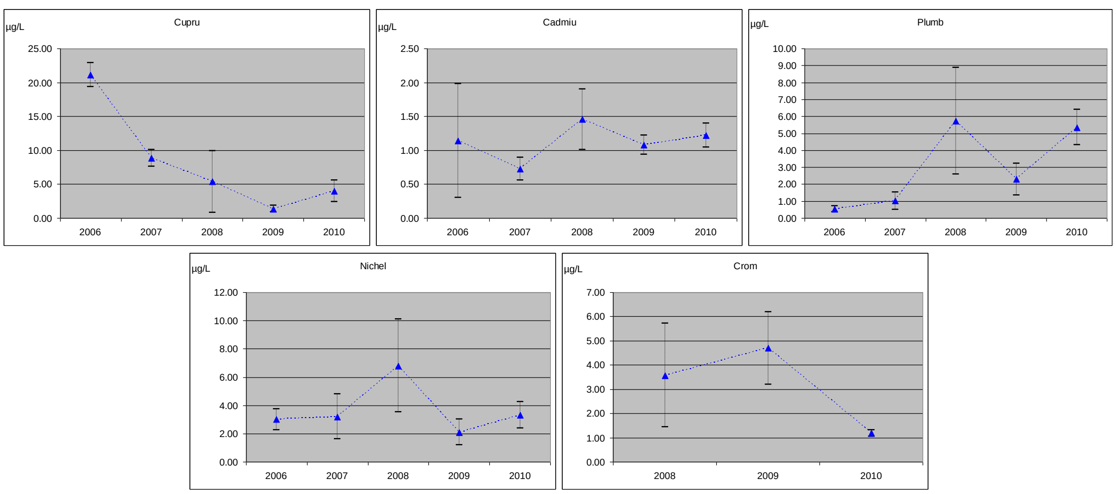


Fig. 19. Evolution of annual heavy metals concentrations in seawater during 2006 - 2010

Sediments

The distribution of heavy metal concentrations in sediments is influenced by the contribution of anthropogenic and natural sources and depends on the mineralogical and granulometric characteristics of the sediments. The heavy metal concentrations determined in 2010 in sediment samples were included within the following ranges of variation: 3.88 to 143.09 µg/g copper, 0.01 to 4.59 µg/g cadmium, 2,95 to 122.17 µg/g lead, 3.17 to 143.29 µg/g nickel, 4.66 to 158.01 µg/g chromium.

The unifactorial dispersion analysis (ANOVA) revealed significant differences for certain elements between sediments from different geographical zones: copper (df 2.84, F = 4.73, p <0.05) and chromium (df 2.84, F = 3 , 11, p <0.05). The average values were higher in sediments from transitional areas and at depths over 20 m. In the southern sector (0-20 m), however, increased concentrations were measured compared to the average annual value in certain locations under anthropogenic impact (ports, water treatment plants) such as Mangalia and Constanța South. No significant differences were found for cadmium (df 2.84, F = 1.43, p <0.05), lead (df 2.84, F = 1.38, p <0.05) and nickel (df 2.84, F = 1.41, p <0.05) between the three waterbodies, the ranges of concentrations and annual average values being relatively closed (Fig. 20).

In relation to marine sediment quality standards recommended by national legislation (Order 161/2006), the annual average concentrations calculated for the coastal zone (0-20 m) did not exceed the recommended target values. For transitional and marine sediments, with a greater capacity to accumulate heavy metals, due to their finer texture (mud, silt, clay) and a higher content of organic substance, average annual values for Cu, Cd and Ni that slightly exceeded the recommended quality standards were recorded.

In 2010, the average values and variation ranges of heavy metal concentrations in sediments were comparable, although slightly increased compared to the range of multiannual averages for the period 2006-2009 (Fig. 21) .

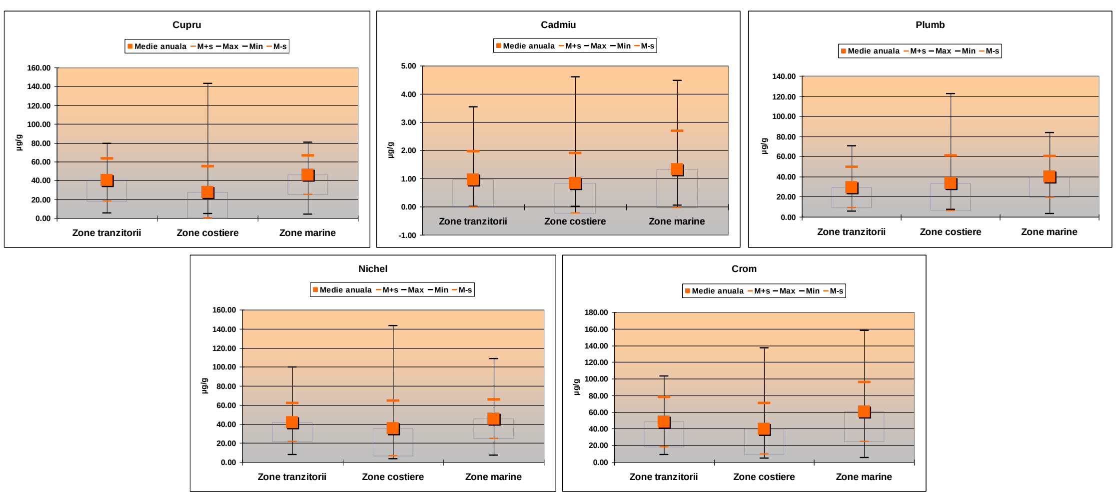


Fig. 20. Distribution of heavy metals concentrations in sediments in 2010

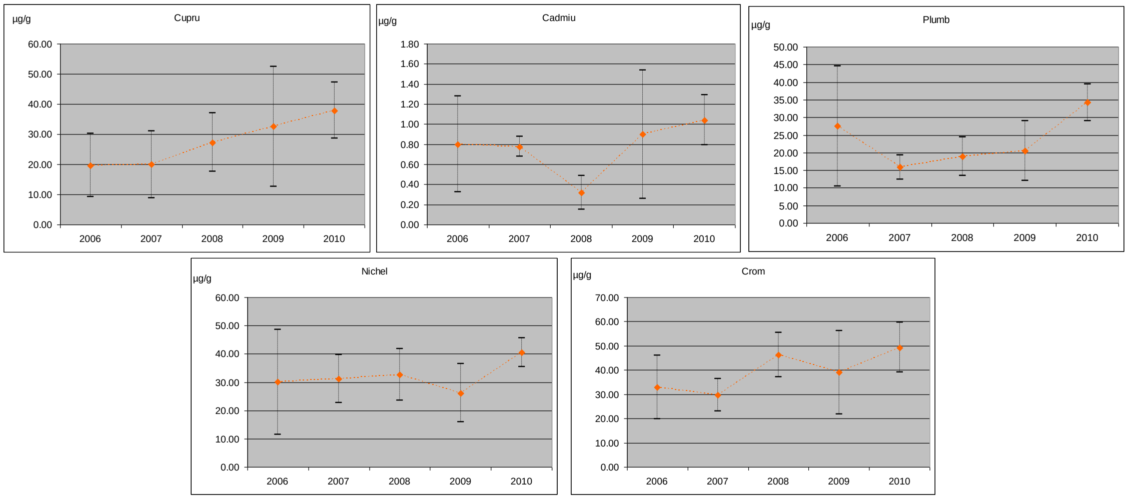


Fig. 21. Evolution of annual concentrations of heavy metals
in sediments during 2006 - 2010

Marine organisms

The bioaccumulation of heavy metals in mussels (*Mytilus galloprovincialis*) from the Romanian seaside investigated in 2010 was characterized by values generally included within the variation range observed in 2009 (especially for copper and nickel), with a decrease of the maximum values recorded for cadmium and lead and a slight increase observed for chromium. In relation to the maximum allowable concentrations for toxic heavy metals in shellfish meat (1 µg/g Cd, 1.5 µg/g Pb) recommended by European legislation (EC no. 1881/2006, amended by EC no. 629/2008), no sample investigation in 2010 exceeded the allowed limits.

The assessment of contamination indicators (heavy metals) in relevant matrices (water, sediments, biota) carried out in 2010 evinced the following conclusions:

- The distribution of metals in waters and sediments from transitional, coastal and marine areas highlighted the differences between various sectors of the coast, generally being observed slightly elevated concentrations in the marine zone under the influence of the Danube and in some coastal areas subjected to various anthropogenic pressures (ports, wastewater discharges).

- In relation to the maximum allowable concentrations of toxic heavy metals in shellfish recommended by European legislation, no *Mytilus galloprovincialis* samples investigated in 2010 exceeded the allowed limits.

1.1.2.3.2. Total petroleum hydrocarbons (TPHs)

Between February - September 2010, the analysis of organic pollutants was carried out on a total of 75 water and 60 sediment samples, taken from a network of 44 stations located between Sulina and Vama Veche.

The water monitoring covers all typologies included in the Water Framework and Marine Strategy Directives, as follows: 40 transitional water samples (Sulina Mila 9, St. Gheorghe, Portița stations - down to the 20 m isobath); 15 coastal water samples from East Constanța, Mangalia stations - down to the 20 m isobath and 20 marine water samples - all the stations on the 30 m and 50 m isobaths.

The level of water petroleum hydrocarbons pollution is given in Table 13. The average value was 108.1 µg/l, the concentrations varied in the range 17.5 - 651.65 µg/l. Low average values (< 200 µg/l) were recorded in all water bodies compared to 2006-2009, with a minimum in coastal waters and the maximum reached in marine waters (Sulina station - 30 m), probably due to accidental oil spills (Fig. 22).

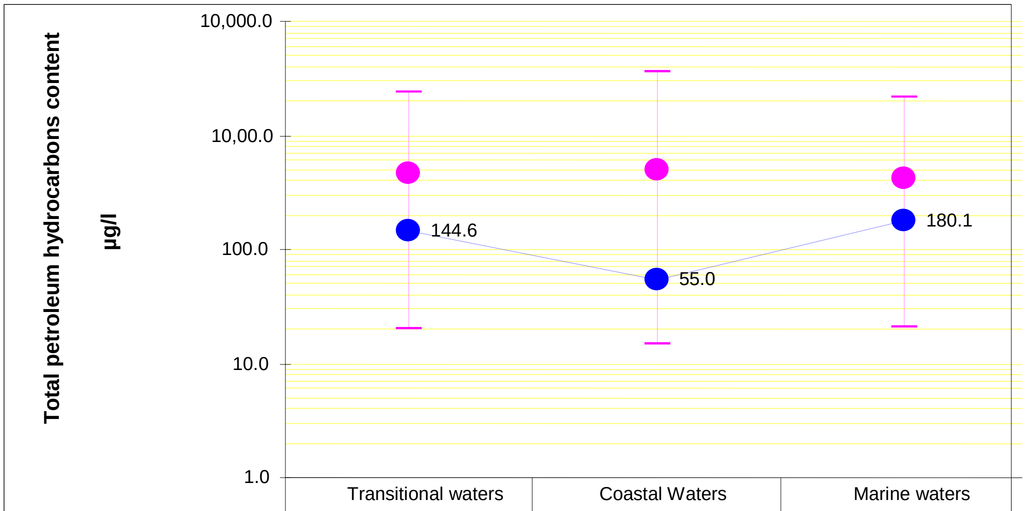
Table 13. The concentration of TPHs (µg/l) in transitional, coastal and marine waters in 2010, compared to 2006-2009

Typology of water bodies	2006-2009 Max. µg/l	2006-2009 Mean µg/l	2006-2009 Averages µg/l	2006-2009 Min. µg/l	2010 Mean µg/l	2010 Averages µg/l	Number of samples
Transitional	2400.0	468.0	378.0	20.0	144.6	129.8	67
Coastal	3592.0	494.6	422.0	15.0	55.0	30.8	316
Marine	2188.7	423.6	197.0	20.5	180.1	158.8	28

The TPHs content in the sediments falls within the range 9.60 - 550.0 µg/g, with an average of 112.6 µg/g. 60% of the sediment samples from Sulina-Vama Veche showed a load in total petroleum hydrocarbons <100 µg/g. The pollution was recorded in sediments of the northern (Sulina, Mila 9, Sf. Gheorghe stations - 30 m) and southern (Constanţa South - 20m, Mangalia stations - 0 and 53 m), sectors with TPH concentrations in the range 200 - 600 µg/g. In 2010, the maximum and average values were significantly lower compared to 2006-2009 (Fig. 23).

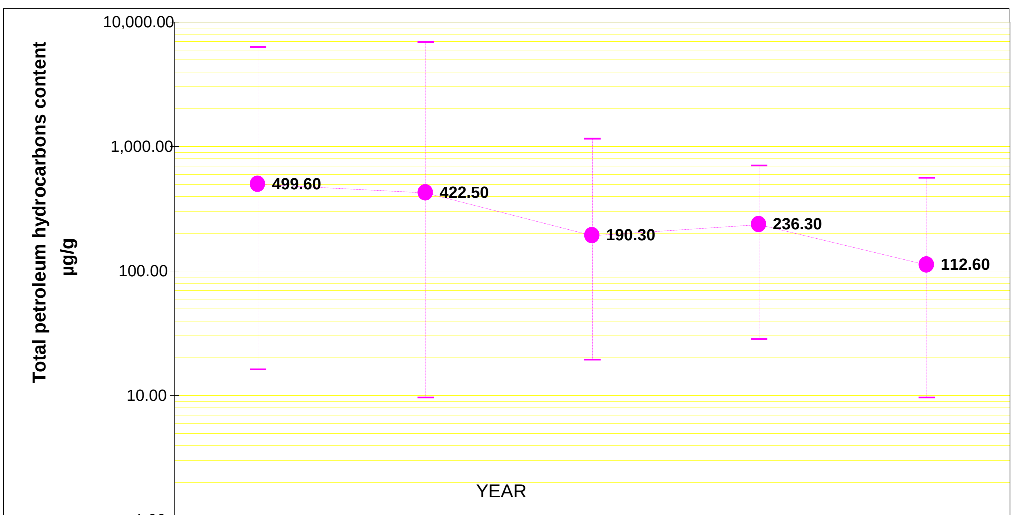
Thus, it results that:

- Water monitoring showed that total petroleum hydrocarbons content did not exceed 200 µg/l; 60% of the sediment samples from Sulina -Vama Veche showed a load in total petroleum hydrocarbons <100 µg/g;
- The downward trend in the concentrations of total petroleum hydrocarbons recorded in the past period, 2006-2009, in water and sediment, continued in 2010.



	Transitional waters	Coastal Waters	Marine waters
Max.µg/l	2,400.0	3,592.0	2,188,7
2006-2009 Average µg/l	468.0	494.6	423.6
Min.µg/l	20.0	15.0	20.5
2010 Average µg/l	144.6	55.0	180.1

Fig. 22. Variation of annual average of TPHs (µg/l) in transitional, coastal and marine waters in 2010, compared to 2006-2009



	2006	2007	2008	2009	2010
maximum µg/g	6,228.00	6,770.00	1,158.00	696.40	550.00
average µg/g	499.60	422.50	190.30	236.30	112.60
minimum µg/g	15.90	9.60	19.40	28.10	9.60

Fig. 23. The concentration of TPHs (µg/g) in sediments of Sulina-Vama Veche, in 2010, compared to 2006-2009

1.1.2.3.3. Polynuclear Aromatic Hydrocarbons (PAHs)

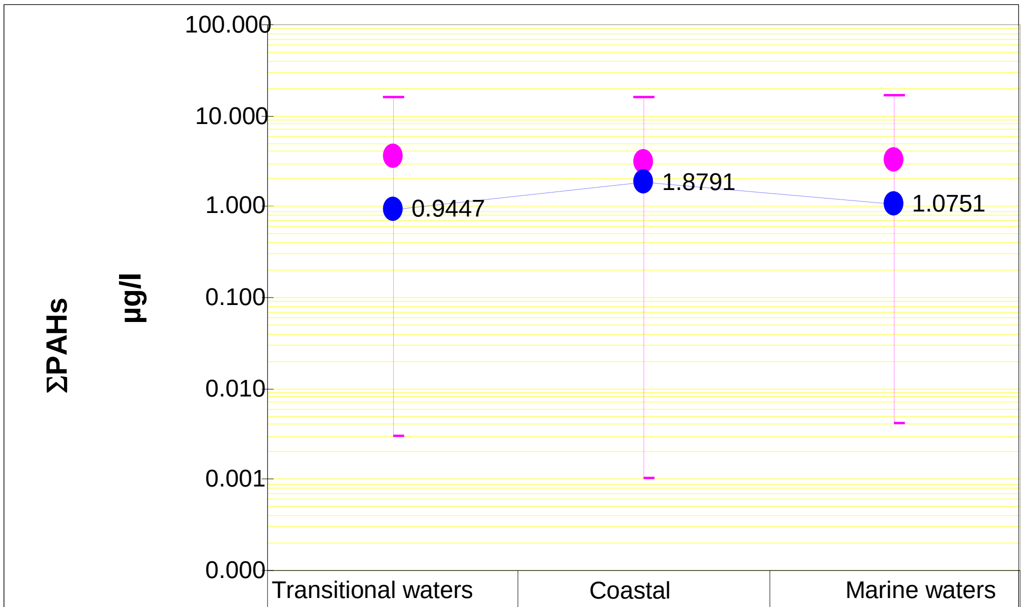
The results of PAHs monitoring in February - September 2010 showed the presence of 16 priority hazardous organic contaminants: naphthalene, acenaphthene, acenaphthylene, anthracene, phenanthrene, fluorene, fluoranthene, pyrene, benzo (a) anthracene, crysene, benzo (b) fluoranthene, benzo (k) fluoranthene, benzo (a) pyrene, benzo (g,h,i) perylene, dibenzo (a,h) anthracene, indeno (1,2,3-c,d) pyrene (Table 14)

Tabel 14. PAHs concentrations in water (µg/l) and sediments (µg/g), February - September 2010

COMPOUND	WATER (µg/l)			SEDIMENT (µg/g)		
	minimum	maximum	average	minimum	maximum	average
naphthalene	0.063	1.515	0.545	0.013	0.185	0.108
acenaphthylene	0.001	0.034	0.018	0.006	0.006	0.006
acenaphthene	0.001	0.032	0.010	0.005	0.009	0.007
fluorene	0.007	0.237	0.089	0.006	0.049	0.022
phenanthrene	0.035	1.525	0.473	0.024	0.214	0.104
anthracene	0.697	1.345	1.100	0.003	0.202	0.106
fluoranthene	0.003	0.266	0.031	0.015	0.279	0.051
pyrene	0.002	0.056	0.012	0.013	0.142	0.039
benzo (a) anthracene	0.005	0.603	0.087	0.005	0.152	0.033
crysene	0.014	0.590	0.162	0.005	0.069	0.021
benzo (b) fluoranthene	0.006	0.020	0.013	0.005	0.053	0.024
benzo (k) fluoranthene	0.019	0.028	0.023	0.019	0.096	0.046
benzo (a) pyrene	<0.008	-	-	0.061	0.419	0.236
benzo (g,h,i) perylene	<0.003	-	-	0.009	0.340	0.099
dibenzo (a,h) anthracene	<0.001	-	-	0.005	0.063	0.024
indeno (1,2,3-c,d) pyrene	<0.001	-	-	0.006	0.706	0.177

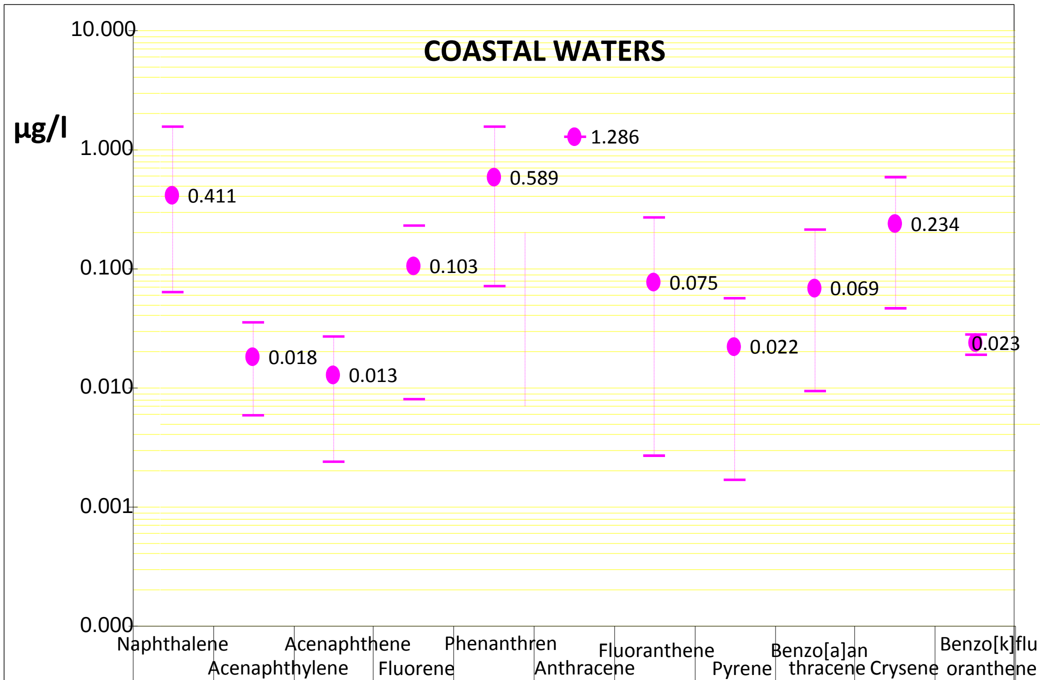
The total polynuclear aromatic hydrocarbons-ΣPAH concentrations in water(µg/l) fall within the range of 0.1056 - 4.4341 µg/l, with an average of 1.344 µg/l for 50 samples. In 2010, the average total content of polynuclear aromatic hydrocarbons in transitional, coastal and marine waters was situated within the specific range for the period 2006-2009 (Fig. 24). High PAHs concentrations of 2,8255 - 3,5370 µg/l were noted in marine waters (Sulina station - 20,30 m) and the maximum, 4,4341 µg/l, was reached in coastal waters (Constanța South station - 20 m).

Water monitoring showed the presence of low molecular weight PAHs (anthracene, phenanthrene, benzo (a) anthracene, crysene) in significant concentrations (Fig. 25, Fig. 26, Fig. 27).



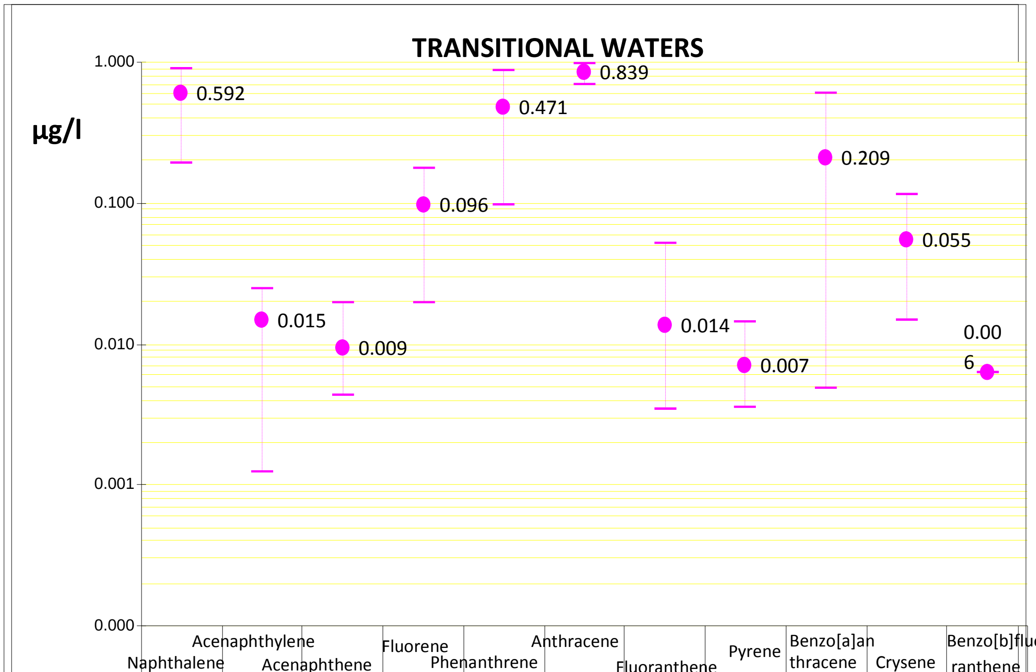
	Transitional waters	Coastal	Marine waters
Max. µg/l	15.8654	15.8690	16.5433
2006-2009 Average µg/l	3.4795	3.1126	3.2656
Min. µg/l	0.0030	0.0010	0.0040
2010 Average µg/l	0.9447	1.8791	1.0751

Fig. 24. The average, maximum and minimum of ΣPAHs (µg/l) in transitional, coastal and marine waters, in 2010, compared to 2006-2009



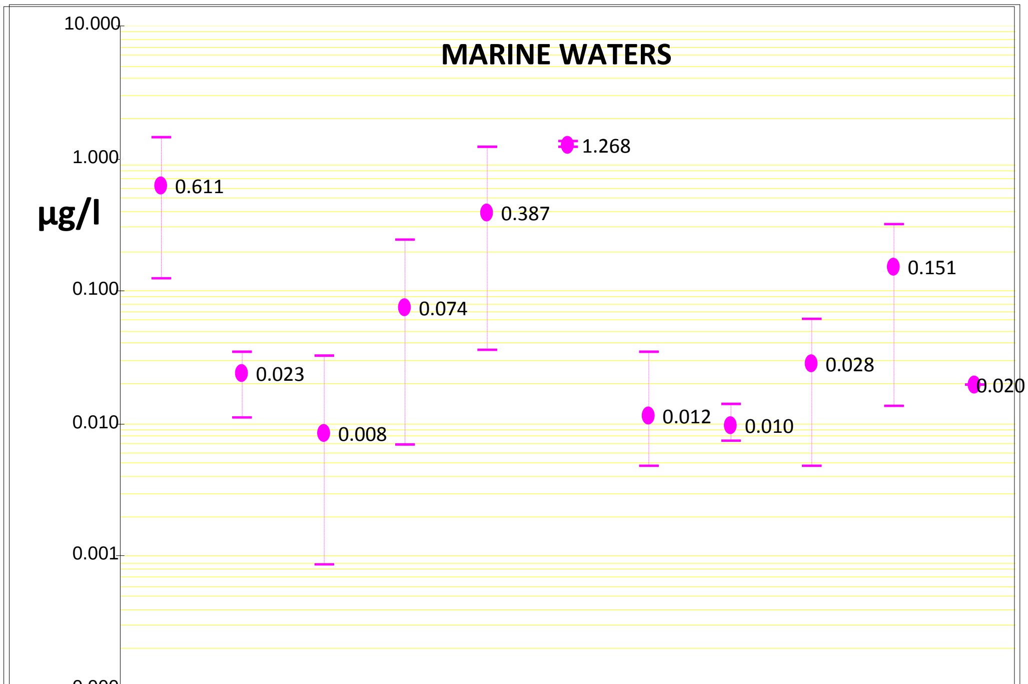
	Naphthalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthren	Anthracene	Fluoranthene	Pyrene	Benzo[a]anthracene	Crysene	Benzo[k]fluoranthene
maximum µg/l	1.515	0.034	0.027	0.223	1.525	1.286	0.266	0.056	0.214	0.590	0.028
2010,average µg/l	0.411	0.018	0.013	0.103	0.589	1.286	0.075	0.022	0.069	0.234	0.023
minimum µg/l	0.063	0.006	0.002	0.008	0.069	1.286	0.003	0.002	0.009	0.047	0.019

Fig. 25. The average, maximum and minimum concentration of PAHs (µg/l) in coastal waters, 2010



	Naphthalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benzo[a]anthracene	Crysene	Benzo[b]fluoranthene
maximum µg/l	0.890	0.024	0.019	0.178	0.868	0.980	0.052	0.014	0.603	0.115	0.006
2010, average µg/l	0.592	0.015	0.009	0.096	0.471	0.839	0.014	0.007	0.209	0.055	0.006
minimum µg/l	0.189	0.001	0.004	0.019	0.097	0.697	0.003	0.003	0.005	0.015	0.006

Fig. 26. The average, maximum and minimum concentration of PAHs (µg/l) in transitional waters, 2010



	Naphtkalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthren	Anthracene	Fluoranhtene	Pyrene	Benzo[a]anthracen	Crysene	Benzo[b]fluoranthene
maximum µg/l	1.417	0.034	0.032	0.237	1.224	1.345	0.034	0.014	0.062	0.314	0.020
2010, average µg/l	0.611	0.023	0.008	0.074	0.387	1.268	0.012	0.010	0.028	0.151	0.020
minimum µg/l	0.124	0.011	0.001	0.007	0.035	1.192	0.005	0.007	0.005	0.014	0.020

Fig. 27. The average, maximum and minimum concentration of PAHs (µg/l) in marine waters, 2010

The total polynuclear aromatic hydrocarbons - ΣPAH concentrations in sediment fell within the range 0.105 - 2,044 µg/g, with an average of 0.629 µg/g. 90% of samples from Sulina - Vama Veche showed a total polynuclear aromatic hydrocarbons-ΣPAH concentration > 0.1 µg/g. The maximum and average concentrations in 2010 recorded the lowest values compared to 2006-2009. The downward trend registered in recent years is noticeable (Fig. 28).

Sediment monitoring showed a high level of pollution for the following compounds: benzo (a) pyrene, naphthalene, phenanthrene, anthracene, fluoranthene, indeno (1,2,3-c,d) pyrene, benzo (g,h,i) perylene, pyrene, benzo (a) anthracene, with average values which fall within the range of 0.1-0.7µg/g (Fig. 29).

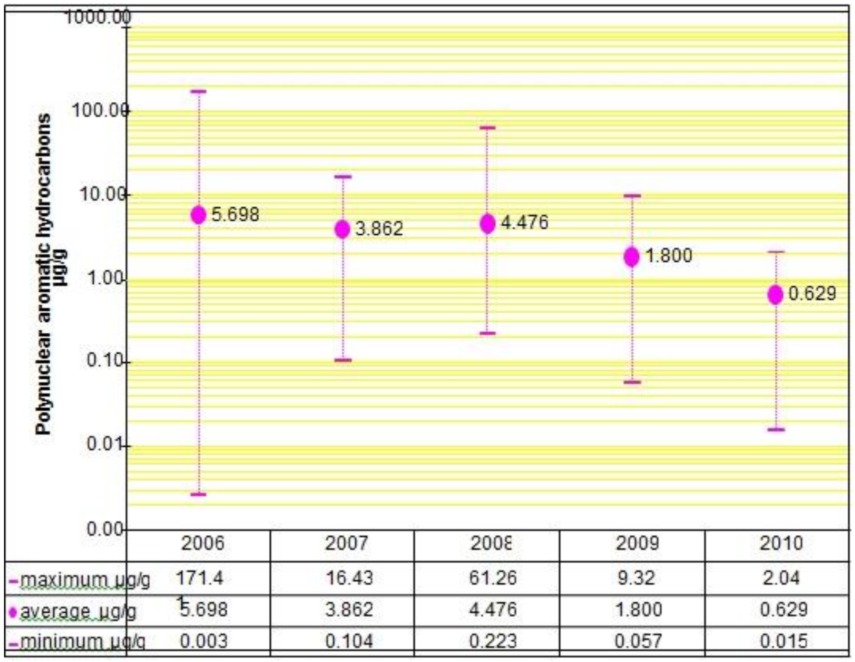


Fig. 28. Total polynuclear aromatic hydrocarbons-ΣHAP(µg/g) concentration in sediments in 2010, compared to 2006-2009

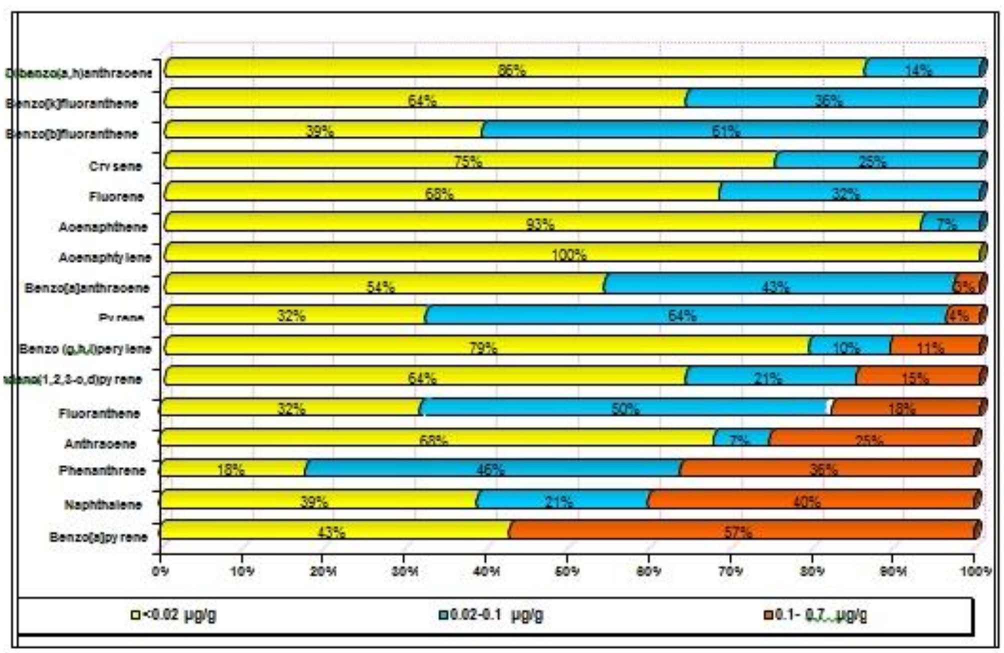


Fig. 29. The level of PAHs (µg/g) in sediments from Sulina - Vama Veche, 2010

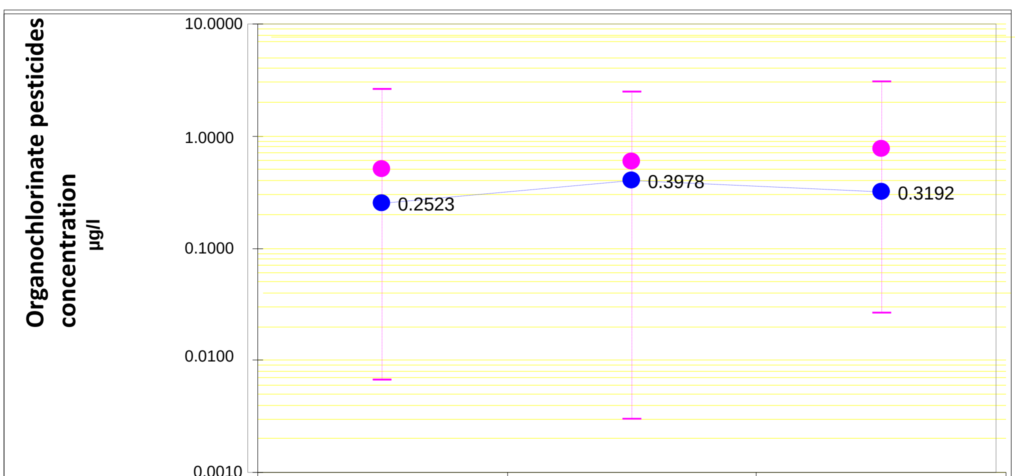
Therefore:

- In 2010, the water monitoring of Polynuclear Aromatic Hydrocarbons showed high concentrations for the following compounds: anthracene, phenanthrene, benzo (a) anthracene, crysene; the average total PAHs concentrations were situated within the specific range for the period 2006-2009 in all water bodies;
- Sediment monitoring recorded a high level of pollution for: benzo (a) pyrene, naphthalene, phenanthrene, anthracene, fluoranthene, indeno (1,2,3-c,d) pyrene, benzo (g,h,i) perylene, pyrene, benzo (a) anthracene.

1.1.2.3.4. Organochlorinate pesticides

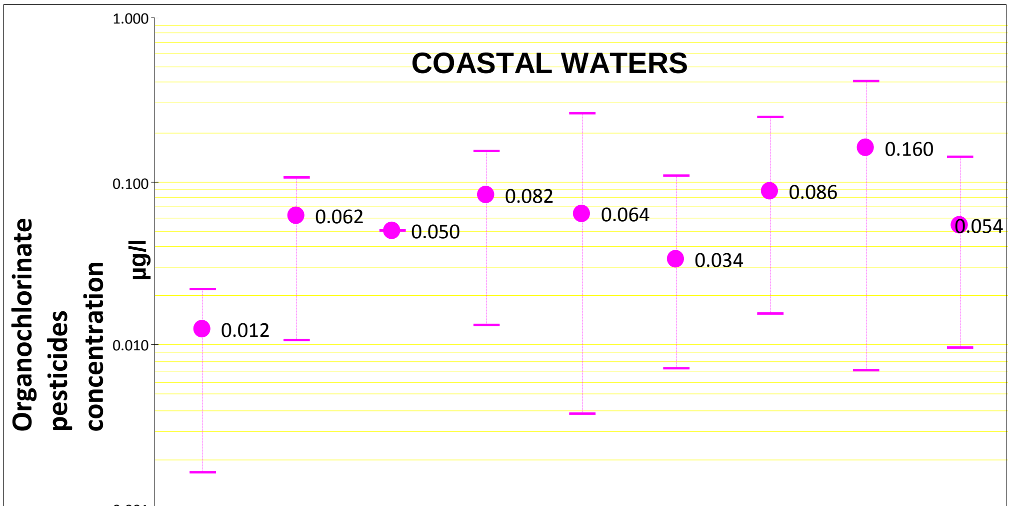
In 2010, the total organochlorinate pesticides content -Σμg/l (HCB, lindane, heptachlor, aldrin, dieldrin, endrin, pp'DDE, pp'DDD, pp'DDT) in seawater varied within the range of 0.0004-1.807μg/l, with an average of 0,2356 μg/l. Low average values were recorded in all water bodies compared to 2006-2009 (Fig. 30), the maximum was reached in marine waters (Sulina station - 30 m).

Significantly higher values were measured for pp'DDT (average - 0.160 μg/l) in coastal waters (Fig. 31). In marine waters, heptachlor is the dominant pollutant, with an average of 0.387 μg/l (Fig. 32). Marine waters showed high values for dieldrin and heptachlor, with averages of 0.121 and 0.169 μg/l (Fig. 33.).



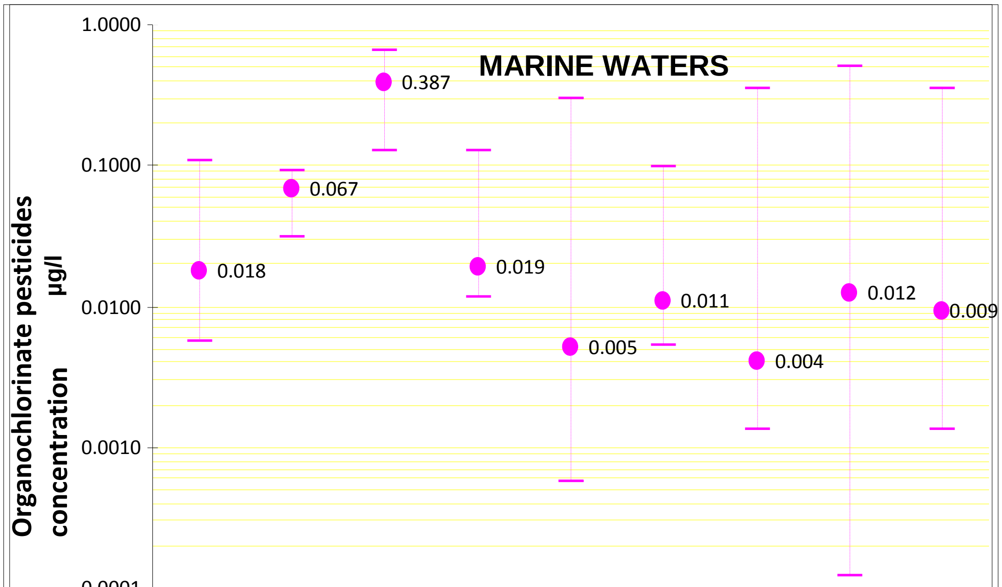
	Transitional waters	Coastal waters	Marine waters
Max. µg/l	2.5775	2.4457	3.0462
2006-2009 Average µg/l	0.5062	0.5938	0.7749
Min. µg/l	0.0067	0.0030	0.0260
2010 Average µg/l	0.2523	0.3978	0.3192

Fig. 30. Total organochlorinate pesticides content -Σ (μg/l) in transitional, coastal and marine waters in 2010, compared to 2006-2009



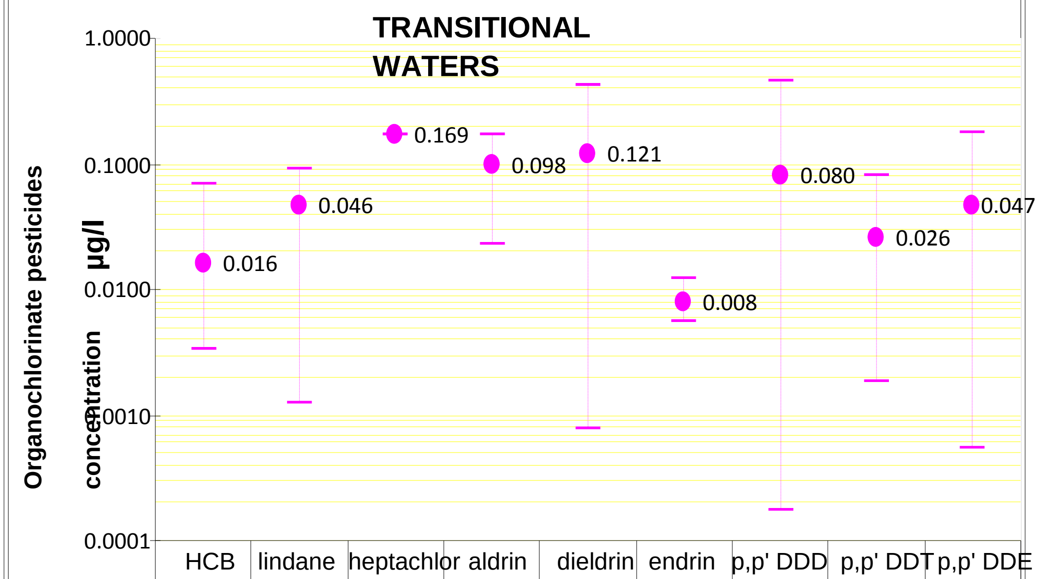
	HCB	lindane	heptachlor	aldrin	dieldrin	endrin	p,p' DDD	p,p' DDT	p,p' DDE
max. µg/l	0.022	0.105	0.050	0.151	0.260	0.107	0.245	0.406	0.141
average 2010 µg/l	0.012	0.062	0.050	0.082	0.064	0.034	0.086	0.160	0.054
min. µg/l	0.002	0.011	0.050	0.013	0.004	0.007	0.015	0.007	0.009

Fig. 31. Average, maximum and minimum concentrations of organochlorinate pesticides (µg/l) in coastal waters, 2010



	HCB	lindane	heptachlor	aldrin	dieldrin	endrin	p,p' DDD	p,p' DDT	p,p' DDE
max. µg/l	0.107	0.091	0.649	0.126	0.295	0.096	0.355	0.502	0.345
average 2010 µg/l	0.018	0.067	0.387	0.019	0.005	0.011	0.004	0.012	0.009
min. µg/l	0.006	0.031	0.125	0.012	0.001	0.005	0.001	0.0001	0.001

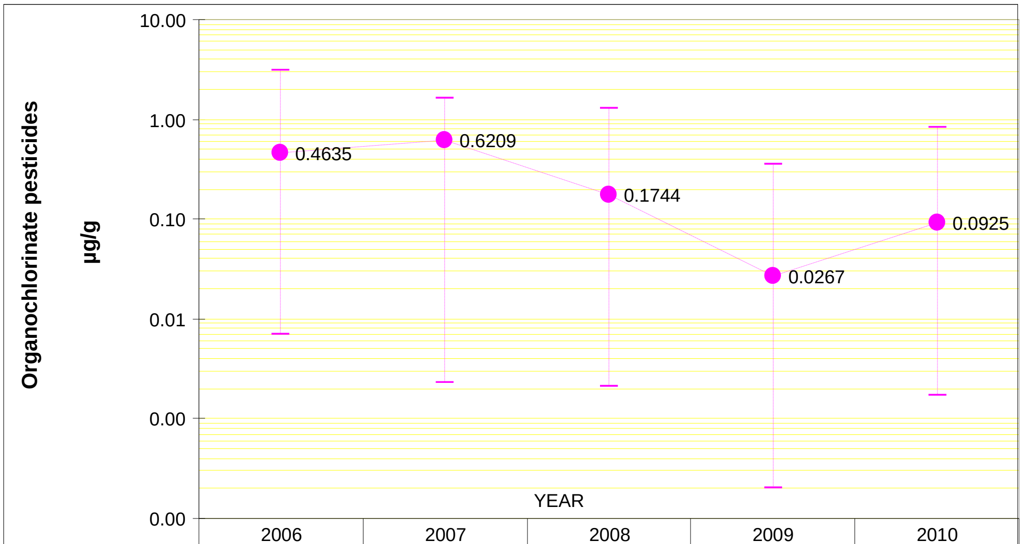
Fig. 32. Average, maximum and minimum concentrations of organochlorinate pesticides (µg/l) in marine waters, 2010



	HCB	lindane	heptachlor	aldrin	dieldrin	endrin	p,p' DDD	p,p' DDT	p,p' DDE
max. µg/l	0.069	0.089	0.169	0.172	0.413	0.012	0.455	0.081	0.179
average 2010 µg/l	0.016	0,046	0.169	0.098	0.121	0.008	0.080	0.026	0.047
min. µg/l	0.003	0,001	0.169	0.023	0.001	0.005	0.000	0.002	0.001

Fig. 33. Average, maximum and minimum concentrations of organochlorinate pesticides (µg/l) in transitional waters, 2010

The sediment monitoring of total organochlorinate pesticides content -Σ (µg/g) showed that the concentrations fall within the range of 0.0017 - 0.8355 µg/g, with an average of 0.0925 µg/g. The downward trend registered in the last period, 2006 to 2009, in sediments continued in 2010 (Fig. 34.). 70-80% of the samples recorded values < 0.0006 µg/g (Fig. 35.). The highest concentrations were measured in Sulina - 30 m (0.7583 µg/g) and Mangalia - 40 m (0.8355 µg/g) stations.



	2006	2007	2008	2009	2010
maximum µg/g	3.084	1.629	1.289	0.350	0.836
average µg/g	0.4635	0.6209	0.1744	0.0267	0.0925
minimum µg/g	0.0069	0.0023	0.0021	0.0002	0.0017

Fig. 34. Total organochlorinate pesticides content -Σ (µg/g)
in sediments, 2010, compared to 2006-2009

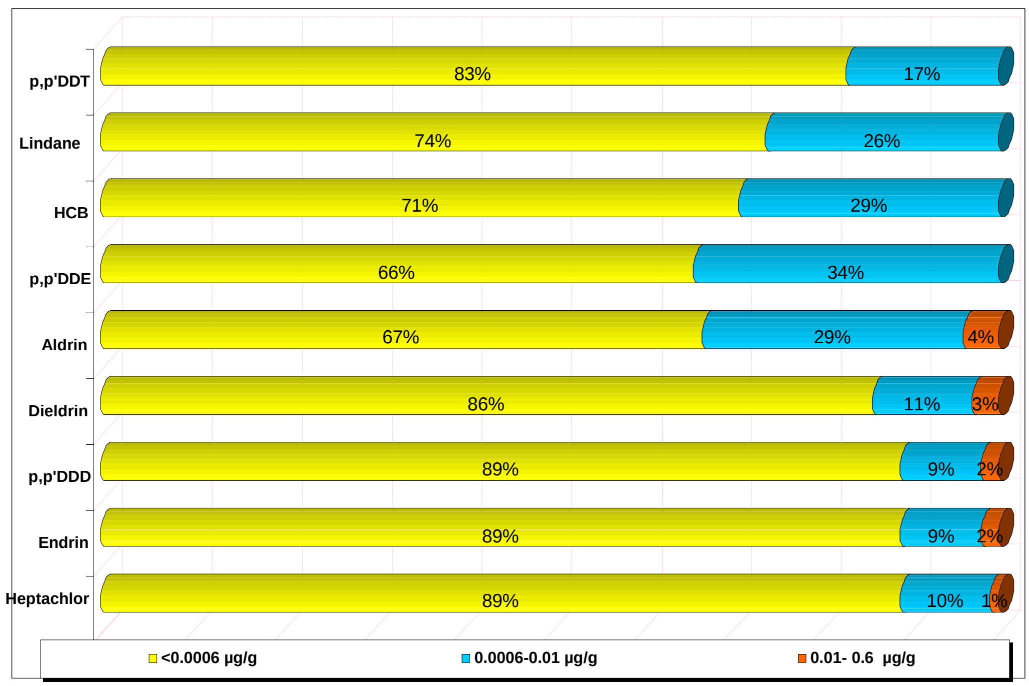


Fig. 35. Percentage of different concentration groups for chlorinate pesticides
from total samples, 2010

There is an obvious decreasing trend of chlorinate pesticides concentrations in water and sediment registered in the last period, 2006 to 2009, which continued in 2010, except for the Sulina - 30 m and Mangalia - 40 m stations.

1.1.2.3.5. Microbiological load

The microbiological load, a state indicator of contaminants in the marine environment, was acceptable in the Romanian Black Sea bathing water during 2010; the concentrations of enteric bacteria [total coliforms (TC), faecal coliforms (FC), faecal streptococci (FS)] were generally found varying below the limits of the National Norms and EC Bathing Water Directive and the values indicating the level of faecal pollution of bathing sea water (Fig. 36).

The frequency of exceeding mandatory and guide values registered in 2010 in some bathing areas (14% for TC and FC, and 21% for FS, respectively) was higher in comparison with the last year (2009), mainly due to not observing the general sanitary-hygienic norms by tourists during the hot summer season of 2010, with high shallow coastal seawater temperature (more than 29°C).

The situation identified during the summer season of 2010 reflects an evolution of bathing seawater quality greatly dependent on the particular hydro-meteorological conditions of the last three years (2008 - 2010), characterized by extremely hot weather, with increased values of shallow coastal seawaters temperature.

The highest values of enteric bacteria TC, FC and FS (> 16,000 germs / 100 ml) were identified, as usual, in the areas under the influence of sewage discharge, showing a possible negative impact on human and environmental health.

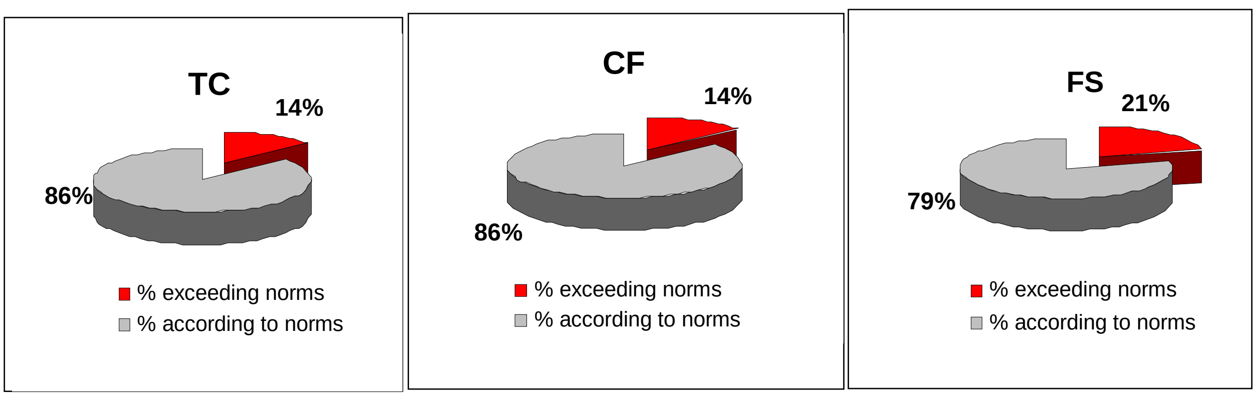


Fig. 36. The percentage (%) of Romanian coastal bathing waters (Mamaia and Neptun sites) compliance with mandatory and guide values (95 % < 10,000 per 100 ml mandatory value for TC; 95 % < 2,000 per 100 ml mandatory value for FC and 100 per 100 ml mandatory value for FS) of National Norms and EC Bathing Water Directive (76/160/CCE), during July-September 2010

Chapter 2 - NATURE AND BIODIVERSITY CONSERVATION, BIOSECURITY

2.1. Natural habitats. Wild flora and fauna

2.1.1. Marine habitats

The number of marine habitats of European importance (as defined in the Habitats Directive - 92/43/EEC) was evaluated to 8 general types (1110-Shallow water submerged sand bars, 1130-Estuaries, 1140-Sandy and muddy surfaces uncovered at low tides, 1150-Coastal lagoons, 1160-Sea arms and large shallow gulfs, 1170-Reefs, 1180-Underwater structures generated by gas emissions, 8330-Totally or partially submersed marine caves) with 28 sub-types.

In 2010, we did not develop researches dedicated to marine habitats; some information were obtained during underwater explorations made within other projects. So, in two Natura 2000marine sites, ROSCI0269 Vama Veche - 2 Mai and ROSCI0094 Underwater sulphur seeps from Mangalia, habitat mapping was made during 2010.

In ROSCI0269 Vama Veche - 2 Mai we identified 3 types of elementary habitats: 1140, 1170, 8330, with 14 sub-types, as following:

1. **1110-4: Well sorted sands**: Disposed immediately after shallow fine sands, from 3-4 m to the east limit of the site.
2. 1110-5: Wave-lashed coarse sands and fine gravels**:** This habitat is found in small gulfs and does not overcome a few tens of centimeters in depth.
3. **1140-1:** Supralittoral sands with or without fast-drying drift lines: Occupies the part of the beach that is covered by waves only during storms.
4. 1140-2: Supralittoral slow-drying drift lines**:** Occupies the area of boulders and rocks that is covered by waves only during storms. The boulders retain between them rests and humidity, so they hardly get dry.
5. **1140-3: Midlittoral sands**: Occupies the sand belt at shore on which the waves crash. It can be wider or narrower, depending on sea state. The sand is compact and mixed with shell rests and gravel.
   1140-4: Midlittoral detritus on shingle and boulders: Formed in the midlittoral of rocky shores, on boulders or gravel, in continuity with supralittoral slow-drying drift lines.
6. **1170-2: *Mytilus galloprovincialis* biogenic reefs**: Consisting of mussel banks whose shells accumulated in time, forming a rough substrate, higher than the surrounding sediments (mud, sand, mixture) and on which the living mussels are found.
7. **1170-4: Boulders and blocks**: Appear in the midlittoral of rocky shores. They can be rolled and eroded by water during storms, so the algal populations are ephemeral. The obscurity and structural complexity shelter a complex fauna.
8. **1170-5: Supralittoral rock**: Is situated above the sea level and becomes wet due to wave drops or during storms. The vertical expansion depends on hydro-dynamism, solar exposure and gradient. This type of habitat is populated by the *Verrucaria* lichen, isopod crustaceans and the *Pachygrapsus marmoratus* crab. It can be covered in a slippery film of epi- and endolithic cyanoficeae in the areas organically polluted.
9. **1170-6: Upper midlittoral rock**: Is situated in the superior part of the wave breaking area and is not permanently covered by water, being nevertheless wet intermittently by high waves.
10. **1170-7: Lower midlittoral rock**: Is situated in the lower part of the wave breaking area and it is covered by water most of the time. Humidity is high and constant and strong light is the dominant factor of this habitat. Encrusted *Lithophylum incrustans* coralline algae, as well as articulated

Corallina officinalis, C. elongate algae and ephemeral macrophyte *Ulva compressa, Enteromorpha sp.*, *Cladophora sp.* and *Ceramium sp*. algae occur. The fauna is characterized by *Balanus improvisus*, *Haliplanella*, *Mytilaster lineatus* and *Mytilus galloprovincialis*, briosoans, amphipod and isopod crustaceans, the *Pachygrapsus marmoratus* and *Eriphia verrucosa*.

11. **1170-8: Infralittoral rock with photolytic algae:** Is situated immediately under the inferior midlittoral level, where water emersions are only accidental, and stretches down to the inferior limit of the spreading of the photolytic and phanerogame algae. This inferior limit is conditioned by the penetration of light and is thus variable, according to the topography and water clarity. Generally, on the Romanian littoral, this limit is around 10 meters deep, but in the areas with high turbidity it can be less than 1 meter. The rocky substrate between these two boundaries is covered with rich and variant populations of photolytic algae. It includes various facets (including the ones containing the *Cystoseira barbata* and *Corallina officinalis* perennial macrophyte algae) and a great algal and faunistic diversity (Photo 1).
12. **1170-9: Infralittoral rock with *Mytilus galloprovincialis***: The infra-littoral rock with *Mytilus galloprovincialis* stretches down to maximum 28 meters deep, at the inferior limit of the rocky platforms. In the photolytic algae area, it overlaps the previous habitat, but continues deeper, overcoming its limits. The fauna is extremely diverse, including numerous sponge, hydrozoas, polichaet, mollusk, crustacean and fish species, characteristic only for this type of habitat, some of them being rare or protected.
13. **1170-10: Infralittoral hard clay banks with *Pholidae***: It is shaped as plateaus that can be partially covered by the surrounding sediments. The galleries dug by the *Pholas dactylus* and *Barnea candida* perforating bivalves provide this habitat a high tridimensional complexity and allow the fixation of a special faunistic association.
14. 8330: Submerged or partially submerged sea caves**:** The ceiling and walls shelter marine invertebrate communities (sponges, hydrozoas, actiniae, briozoars, colonnial tunicates) and sciaphyle algae.

Photo 1. Infralittoral rock with photolytic algae in ROSCI0269
(photo NIMRD)

ROSCI0094 Underwater sulphur seeps from Mangalia is much more diverse compared to the previous one, having represented 19 sub-types of important habitats, as follows:

1. **1110-1 *Zostera* meadows on clean or slightly muddy fine sands:** *Zostera marina*, *Z. noltii* and *Zanichellia pedicellata* form monospecific or mixed underwater meadows, inside sheltered bays with depths down to 4 meters, where the sedimentary stability leads to a slight mudding process of the sand. The characteristic animal species are the mollusks *Tellina tenuis*, *Loripes lacteus*, *Lucinella divaricata*, *Solen marginatus*, the crustaceans *Upogebia pusilla*, *Carcinus aestuari* and the fish species *Zoosterion ophiocephalus*, *Nerophis ophidian*, *Hippocampus* sp.
2. **1110-3: Shallow fine sands:** Fine biogenic sands, mixed with rests of shells and gravel, disposed from shore to 3-4 m isobaths.
3. **1110-4**: **Well sorted sands**: Disposed immediately after the shallow fine sands, from 3-4 m to the east limit of the site.
4. **1110-5: Wave-lashed coarse sands and fine gravels:** This habitat is found in small gulfs and does not overcome a few tens of centimeters in depth.
5. **1110-6: Infralittoral cobbles:** The habitat is composed of submerged beaches made of round and flattened rocks, usually calcareous, white, and modeled by the waves. The inferior limit corresponds to the zone where the wave strength becomes insufficient to roll the rocks.
6. **1110-9: Sandy mud and muddy sands bioturbated by *Upogebia*:** muddy sands bioturbated by the crustacean *Upogebia:* forms a continuous belt at 10 - 30 m, on muddy sands.
7. **1140-1: Supralittoral sands with or without fast-drying drift lines**: It occupies the beach part that is covered by water only during storms. The deposits are made of the materials brought by the sea of vegetal origin (tree trunks, wood pieces, algae, leafs), of animal origin (underwater animal corpses, drowned terrestrial animals) and of anthropogenic origin (solid wastes), as well as the dense foam of marine plankton.
8. **1140-2: Supralittoral slow-drying drift lines:** The habitat occupies the portion of the rocky shores or beaches that is covered by waves only during storms. They accumulate in the space between the described remnants, but also humidity, so that the remnants are drying in time.
9. **1140-3: Midlittoral sands**: The habitat occupies the shore sand, on which the waves break. Depending on the sea bustle, the portion may be wider or narrower, but in the Black Sea it is limited by the low tide. The sand is compact and mixed with shell remains and gravel.
10. **1140-4: Midlittoral detritus on shingle and boulders**: Occupies the midlittoral portion of the shores formed of boulders and rocks. They retain in the spaces between them the remains brought by the sea.
11. **1170-2: *Mytilus galloprovincialis* biogenic reefs**: The Mytilus *galloprovincialis* organogenic reefs are made of mussel banks the shells of which have accumulated in time, forming a rough support higher than the surrounding sediments (mud, sand, gravel or mixture), on which living mussel colonies fix themselves.
12. **1170-3 Shallow sulphur seeps**: The sulphur seeps are present in the Mangalia - Cap Aurora area, between 0 and 15 meters deep, on a rocky substrate. The sulphurous waters come to the surface through the creeps and channels of the Sarmatian limestone. The seeps are easily located due to the yellow rounded halos, formed by the tiophyle bacteria that develop around them. The algal flora does not survive in the vicinity of the seep, but the high content of nutrients helps its luxuriant development nearby.
13. **1170-4: Boulders and blocks**: Rock and boulder piles appear on the midlittoral of rocky shores, at the base of rocky cliffs. These blocks can be rolled or eroded by the water charged with sand during storms, which is why algal populations are ephemeral. The structural complexity and the obscurity attract an extraordinarily diverse fauna for such shallow waters. This habitat is actually a mosaic of microhabitats, representing midlittoral enclaves of species that normally belong to deeper areas.
14. **1170-5: Supralittoral rock**: The upper-littoral rock is situated above the sea level and becomes wet to due wave drops or during storms. The vertical expansion depends on hydro-dynamism, solar exposure and gradient. This type of habitat is populated by the *Verrucaria* lichen, isopod crustaceans and the *Pachygrapsus marmoratus* crab.

15. **1170-6: Upper midlittoral rock**: The midlittoral superior rock is situated in the superior part of the wave breaking area and is not permanently covered by water, being nevertheless wet intermittently by high waves. The most characteristic faunistic element is the cirriped crustacean *Chthamalus stellatus*, rarely encountered on the Romanian littoral.
16. **1170-7: Lower midlittoral rock**: The inferior midlittoral rock is situated in the lower part of the wave breaking area and it is covered by water most of the time. High humidity is high and constant and strong light are the dominant factors of this habitat. Encrusted *Lithophylum incrustans* coralline algae, as well as articulated *Corallina officinalis, C. elongate* algae and ephemeral macrophyte *Ulva compressa, Enteromorpha sp., Cladophora sp. şi Ceramium sp*. algae occur. The fauna is characterized by *Balanus improvisus*, *Haliplanella*, *Mytilaster lineatus* and *Mytilus galloprovincialis*, briozoas, amphipod and isopod crustaceans, the *Pachygrapsus marmoratus* and *Eriphia verrucosa*. *Corallina* and *Mytilaster* (in clean waters) and *Cladophora*, *Ulva compressa* and *Balanus* in organically polluted waters can form dense belts.
17. **1170-8: Infralittoral rock with photolytic algae:** The infra-littoral rock with photolytic algae is situated immediately under the inferior midlittoral level, where water immersions are only accidental, and stretches down to the inferior limit of the spreading of the photolytic and phanerogame algae. This inferior limit is conditioned by the penetration of light and is thus variable, according to the topography and water clarity. Generally, on the Romanian littoral, this limit is around 10 meters deep, but in the areas with high turbidity it can be less than 1 meter. The rocky substrate between these two boundaries is covered with rich and varies populations of photolytic algae. It includes various facets (including the ones containing the *Cystoseira barbata* and *Corallina officinalis* perennial macrophyte algae) and a great algal and faunistic diversity (Photo 2).
18. **1170-9: Infralittoral rock with *Mytilus galloprovincialis*:** The infralittoral rock with *Mytilus galloprovincialis* stretches down to maximum 28 meters deep, at the inferior limit of the rocky platforms. In the photolytic algae area, it overlaps the previous habitat, but continues deeper, overcoming its limits. The fauna is extremely diverse, including numerous sponge, hydrozoas, polichaet, mollusk, crustacean and fish species, characteristic only for this type of habitat, some of them being rare or protected.
19. **1170-10: Infralittoral hard clay banks with *Pholidae***: Red hard clay banks, shaped as plateaus, that can be partially covered by the surrounding sediments. The galleries dug by *Pholas dactylus* and *Barnea candida* perforating bivalves provide this habitat a high tridimensional complexity and allow the fixation of a special faunistic association - for example, the *Brachynotus sexdentatus* crab, which lives only here.

Photo 2. *Cystoseira* near a sulphur seep in ROSCI0094
(photo NIMRD)

Other important aspects:

In ROSCI0197 Submerged beach from Eforie North - Eforie South, we discovered the habitat 1170-Reefs on about 27% of the site area, aspect which was not known at designation time.

In ROSCI0094, at Mangalia, we discovered an area of 3,886 sq m covered by sub-type 1110-1 *Zostera* meadows, in addition to the surface known at designation, which was, according to previous measurements, of 988 sq m.

During the process of evaluation for the marine area of the Black Sea biogeographic region by the European Commission experts, the biogeographic seminary took place in 2010.

In this context, Romania proposed the designation of a new site, from the shoreline to the 45 m isobath, between the Costinești and 23 August villages. The aim of this proposal is to protect some sub-types of the 1170-Reef habitat, including 1170-2-Biogenic reefs with *Mytilus galloprovincialis*, insufficiently covered in the current sites.

2.2. State of Marine Protected Areas

2.2.1. Marine Protected Areas

In accordance with the stipulations of Government Ordinance no. 57 from June 20, 2007, regarding the regime of protected areas, the preservation of natural habitats, of the wild flora and fauna (Official Monitor no. 442 from June 29, 2007), as well as with the 79/409/CEE and 92/43/CEE European Directives, the following natural protected areas are established in the Romanian marine zone:

- ROSPA0076 Black Sea: site of community importance, according to the 79/409/CEE Birds Directive, directly nominated Special Protected Area - SPA - through GD no. 1284/2007 regarding the declaration of avifaunistic protected areas as an integrating part of the Natura 2000 European ecological network in Romania - 147,242.9 ha;
- ROSCI0094 - The Sulphur Seeps in Mangalia (362 ha), ROSCI0197 - The Submerged Beach in Eforie North - Eforie South (141 ha), ROSCI0273 - The Cape Tuzla Marine Area (1,738 ha), ROSCI0237 - The Submerged Methanogen Structures in Sfântu Gheorghe (6,122 ha): Sites of Community Importance, according to the 92/43/CEE Habitats Directive, adopted through 2009/92/CE Decision;
- ROSCI0269 - Vama Veche - 2 Mai: Site of Community Importance, according to the 92/43/CEE Habitats Directive, adopted through 2009/92/CE Decision, which overlaps the 2 Mai - Vama Veche Marine Reserve, natural protected area of national importance - 5,272 ha;
- ROSCI0066 - the Danube Delta Biosphere Reserve - the marine area: Site of Community Importance, according to the 92/43/CEE Habitats Directive, adopted through 2009/92/CE Decision, which overlaps the marine area of the Danube Delta Biosphere Reserve - natural protected area of national and international interest - 121.697 ha.

In 2010, within a project financed by The National Scientific Research Authority through the Nucleu Program, NIMRD started mapping the European interest habitats in the ROSCI0269 Vama Veche - 2 Mai (Fig. 37) and ROSCI0094 - The Sulphur Seeps in Mangalia (Fig. 38.) sites, transposing the data in GIS format.

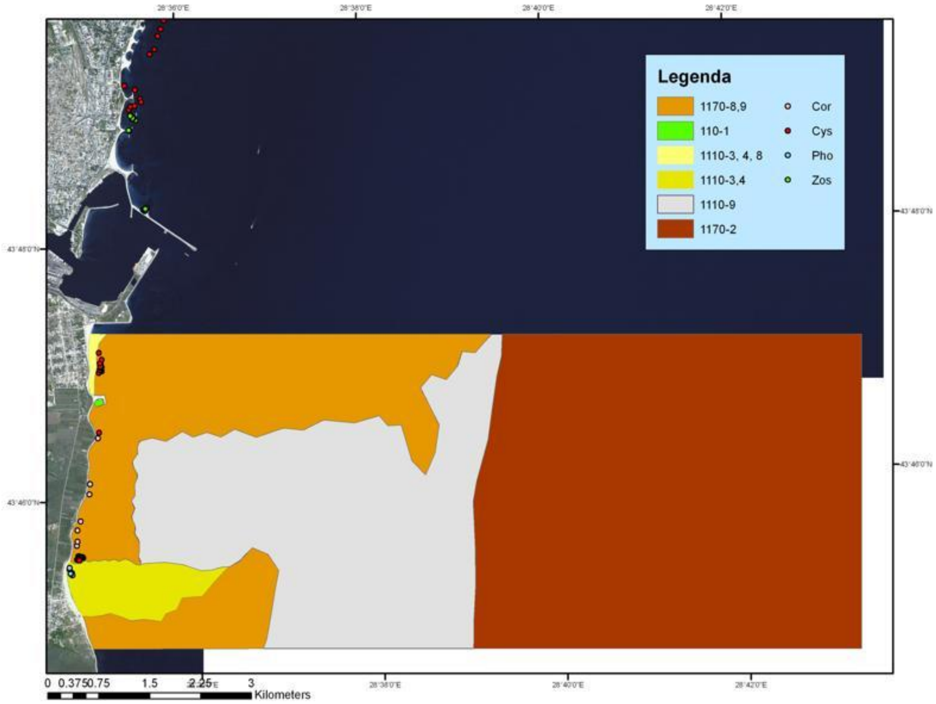


Fig. 37. Map of the Natura 2000 habitats from ROSCI0269

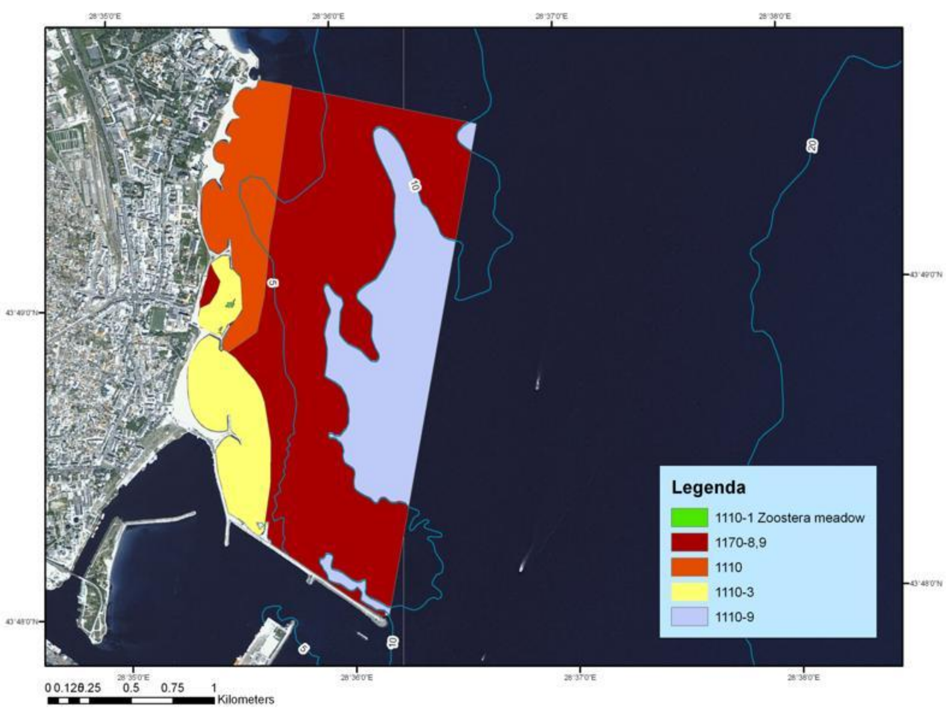


Fig. 38. Map of the Natura 2000 habitats from ROSCI0094

As a follow up of the marine biogeographic seminar in Brindisi (Italy, 15-17 June 2010), where the need to expand the area occupied by marine Natura 2000 sites was emphasized, within a study funded by the MEF, NIMRD has proposed the creation of two new sites, which are to be validated by MEF:

- one site expanding from the shoreline out into sea to the 45 m isobath between Costineşti and 23 August. The proposal aims to protect several subtypes of the 1170-Reefs habitat, including 1170-2 *Mytilus galloprovincialis* biogenic reefs, insufficiently covered both geographically and in size by the sites designated up to the present date;

- one site adjacent to the ROSCI 0094 in Mangalia near the shoreline in the north close to Venus resort and then only offshore to the north, up to Comorova/Tatlageac. This extension aims at protecting the shallow area facing the Hergheliei Marsh, which contains many unique elements, as well as protecting the 1170-2 *Mytilus galloprovincialis* biogenic reefs, insufficiently covered both geographically and in size by the sites designated up to the present and also protecting the *Tursiops truncatus* şi *Phocoena phocoena* cetacean species.

The Danube Delta Biosphere Reserve has its own management plan, containing provisions for expenses regarding the conservation of biodiversity, the marine area included. In 2010, the University of Agriculture and Veterinary Medicine Bucharest won a project dedicated to the marine area of DDBR "*Management Measures for the ROSCI0066 Danube Delta - Marine Area Natura 2000 sites (SCI's)*", and DDBRA won another project, dedicated to „*Improving the Conservation State of the Biodiversity in the Pontic Sector of DDBR through awareness, information, visitations*". Within the same program, "Mare Nostrum" NGO started carrying out the project "*Improving the Conservation State of Marine Biodiversity in the Romanian Coastal Zone, Particularly Dolphins*", implemented in the marine area of DDBR.

Also in 2010, work began on the project "*Integrated Management of the Natura 2000 Marine Sites Network - SCI's on the Romanian littoral*", financed through ENVIRONMENT SOP - Axis 4, which has the overall objective of ensuring the background for an efficient management of the marine sites (SCI's) in the Natura 2000 ecological network, in order to preserve biological diversity, marine habitats and marine flora and fauna species of community and national interest, as well as specific objectives.

2.3. Marine and coastal environment
2.3.1. State of marine ecosystems and living resources. State of endangered species
2.3.1.1. State of littoral and coastal zone
2.3.1.1.1. Coastal processes

In order to assess the changes in the Năvodari-Vama Veche beach area in 2010, were used measurements made during spring 2009-2010 and autumn 2009-2010.

The rate of change in sea-shore line was used to determine the magnitude of coastal processes (erosion/dynamic balance/accretion) by grouping them into seven classes, as follows: **EP** - Strong Erosion : <-12.5 m, **EM**-Erosion Average:-12.5÷ -7.6 m, **ES**-Weak erosion:-7.5÷-2.6 m, **SR**-Dynamic balance: 2.5 ÷-2,5 m, **AS**-Weak accretion: 2.6÷7.5 m; **AM**-Average accretion: 7.6÷12.5 m, **PA**-Strong accretion:>12.5 m.

The coastal processes had the following percentage for the spring season 2009 - 2010 (Fig. 39)

- erosion 61%;
- relative stability 17%;
- accretion 22%.

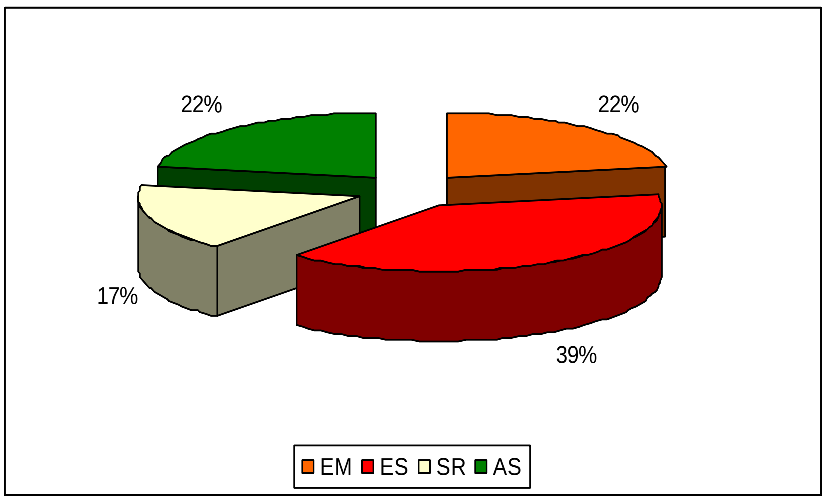


Fig. 39. The share of coastal processes (erosion/relative stability/accretion) on the Năvodari-Vama Veche coastal beaches, spring 2009-2010

In autumn 2009 -2010, the share of coastal processes for the Năvodari - Vama Veche area was (Fig. 40):

- erosion 53%;
- relative stability 29%;
- accretion 18%.

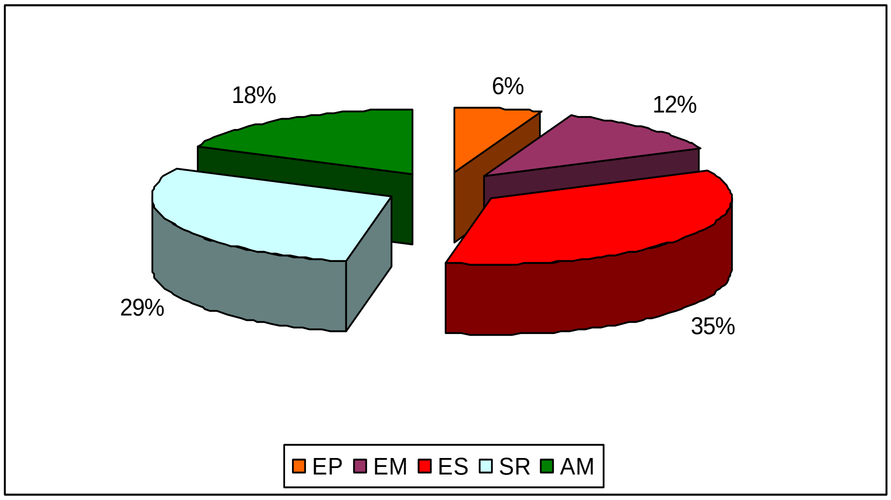


Fig. 40. The share of coastal processes (erosion/relative stability/accretion)
on the Năvodari-Vama Veche coastal beaches, autumn 2009-2010

The geomorphological changes of the backshore from the southern Romanian coast were determined on a length of 11,800 m, for which the ration erosion/ accretion was calculated, as an indicator of environmental status, of 2.77, in the spring season, and 2.94, for autumn, with the remark that the relative stability increased from 17% in spring (after the cold season, when the beach erodes) to 29%, in autumn (after the hot season, when the beach was rebuilt).

2.3.1.1.2. Sea level

The sea level as a *state indicator* of the coastal zone showed, in 2010, a constantly positive deviation from the annual average throughout the entire year, except for the interval from September to October (Fig. 41). It can be seen that the year 2010, except for the above mentioned period, overlaps on the maximum monthly multi-annual values. The annual average was +23.5 cm higher than the annual average from 1933 to 2009, the annual average becoming the maximum of the annual averages for the 1933-2009 period.

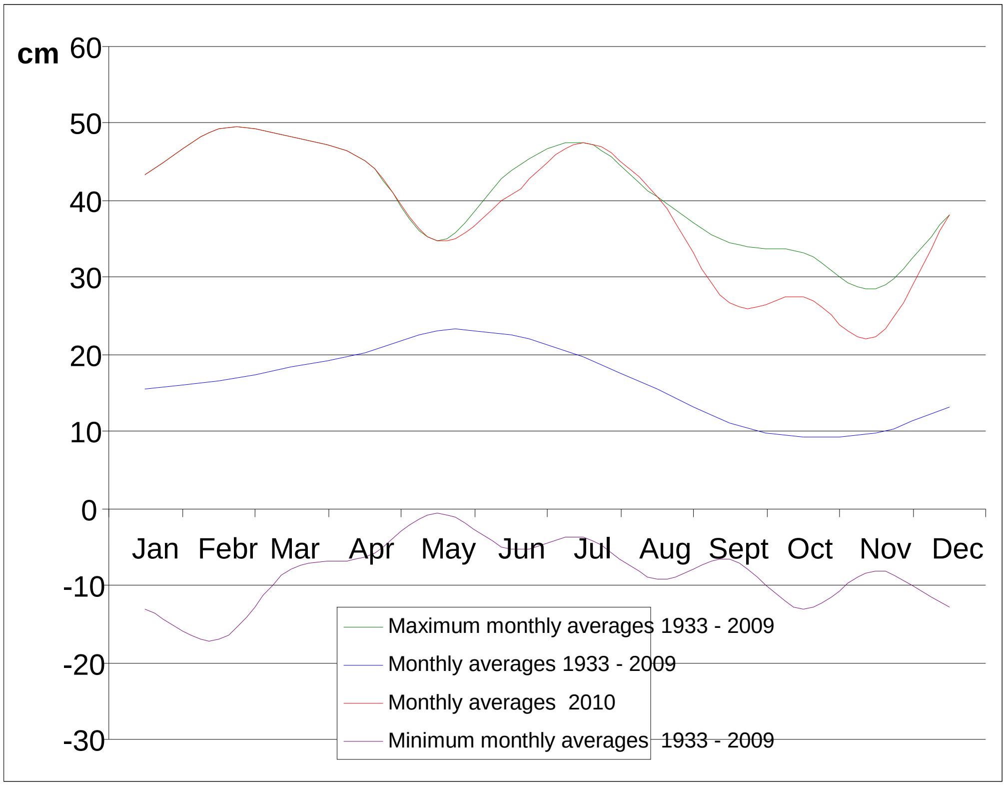


Fig. 41. Black Sea level oscillations on the Romanian littoral in 2010

2.3.1.2. State of the marine ecosystem
2.3.1.2.1. Phytoplankton

The identification of the qualitative and quantitative structure of the phytoplankton composition as a state indicator of eutrophication was made as a follow up of the analysis of samples collected during the year (March, July and September), on profiles established along the entire coastline on the 5 m, 20 m and 30 m isobaths. The continuity of the results is based on the analysis of samples collected twice a week from the Cazino Mamaia station (reference station for the evolution in time of the phytoplankton).

In the structure of phytoplankton, 191 species were identified, with varieties and forms belonging to seven taxonomic groups (Bacillariophyta, Dinoflagellata, Chlorophyta, Cyanophyta, Chrysophyta, Euglenophyta and Cryptophyta). The highest number of species (150 species) was identified in transitional waters (Fig. 42), where the influence of the Danube is observed, the percentage of Cyanophytes and Chlorophytes being the highest (32.7%), closely followed by diatoms, which reached the maximum of 64 species in this sector. Coastal waters showed the lowest diversity, with dinoflagellates dominant as number of species at 38.5%, followed by diatoms (37.5%) and chlorophytes (11.5%). In marine waters, the number of phytoplankton species was 124, this time the diatoms being dominant (38.7%), followed by dinoflagellates (27.4%) and chlorophytes (18.5%). The last three groups (Chrysophyta, Euglenophyta and Cryptophyta) were underrepresented in the phytoplankton population, their share varying between 1 - 5.2%.

The abundances and biomasses of the phytoplankton in all areas and throughout the period from March to September were characterized by seasonal, spatial and temporal variability. Phytoplankton densities ranged between March to September 2010 from 15.6 to $49.5 \cdot 10^{6}$ cel$\cdot$l^{-1}. The distribution of quantities by water types (Fig. 43.) highlights variations of up to three orders of magnitude between the values of phytoplankton density, the peaks being recorded in coastal and marine waters.

Thus, the highest values in coastal waters were recorded in March in the Constanţa 1 station ($27.2 \cdot 10^6$ $cel \cdot l^{-1}$) and in September in the Constanţa South 5 m station ($37.06 \cdot 10^6$ $cel \cdot l^{-1}$). For the coastal waters, the Constanţa area is under the strong influence of the Constanţa South waste water treatment plant, causing unusual amounts of nutrients both in March and in September (max. 6.25 µM $P\text{-}PO_4$ - Constanţa South, max. 80.29 µM total inorganic nitrogen - Constanţa South 5 m).

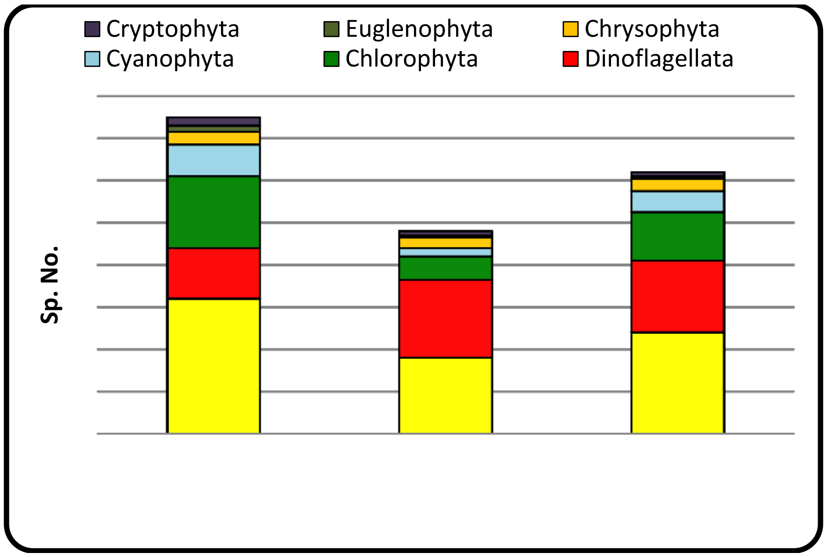


Fig. 42. Taxonomic structure of the phytoplankton in the Romanian sector of the Black Sea

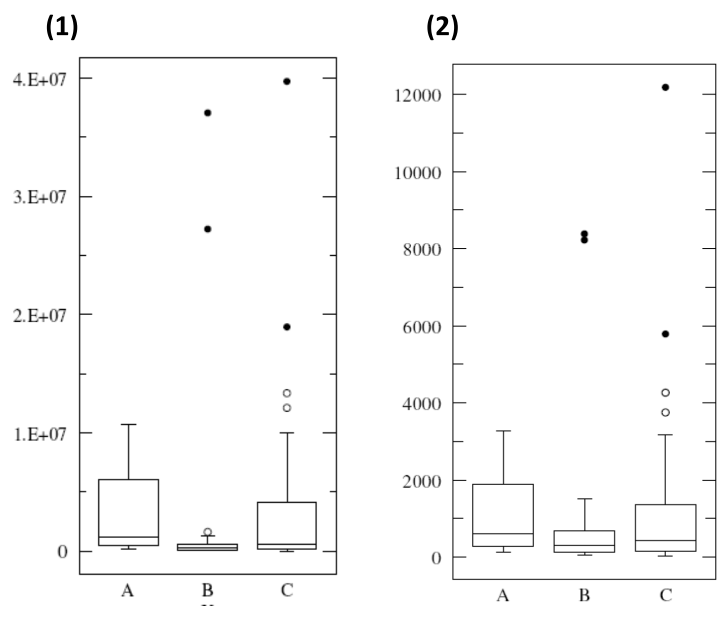


Fig. 43. Density ($cel \cdot l^{-1}$) (1) and biomass ($mg \cdot m^{-3}$) distribution (2) in Romanian transitional waters (A), coastal (B) and marine (C), between March - September 2010

In marine waters, the maximum growth was recorded in March ($39.7 \cdot 10^6$ cel·l^{-1}), as a result of increased river input, supporting the phytoplankton bloom phenomenon, that also develops in transitional waters, but at a lower span. The phytoplankton biomass recorded developments in the range of 0.029 and 12.2 g·m^{-3}, with peaks also in coastal and marine waters.

Diatoms dominated both in the qualitative and quantitative structure of the phytoplankton, the main species with significant developments being *Skeletonema costatum* ($49.4 \cdot 10^6$ cel·l^{-1}), *Cerataulina pelagica* ($5.4 \cdot 10^6$ cel·l^{-1}), *Nitzschia delicatissima* ($1{,}030 \cdot 10^3$ cel·l^{-1}), *Chaetoceros socialis* ($550 \cdot 10^3$ cel·l^{-1}), *Chaetoceros curvisetus* ($560 \cdot 10^3$ cel·l^{-1}), *Cyclotella caspia* ($1{,}480 \cdot 10^3$ cel·l^{-1}), along with the cryptophyte *Cryptomonas* sp. ($1{,}760 \cdot 10^3$ cel·l^{-1}) and chlorophyte *Carteria* sp. ($1{,}630 \cdot 10^3$ cel·l^{-1}).

Analyzing the multiannual evolution of numeric phytoplankton density in the Romanian sector of the Black Sea, it was noted that the annual average of 2010 ($2.6 \cdot 10^6$ cel·l^{-1}) was approx. two times higher than the multiannual average of the 2000-2009 period ($1.4 \cdot 10^6$ cel·l^{-1}) (Fig. 44), but still being far below the densities recorded during the period of eutrophication.

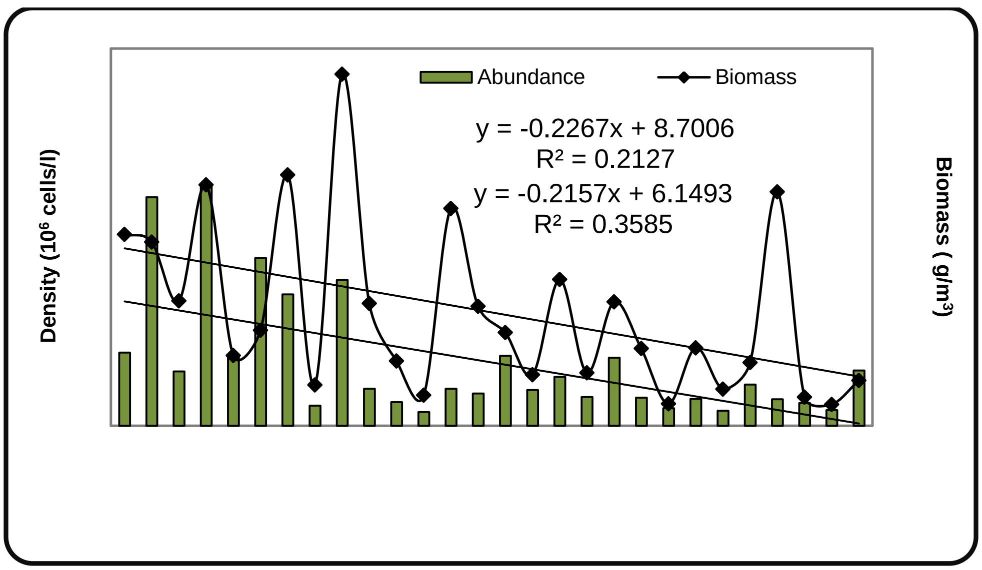


Fig. 44. Multiannual averages of phytoplankton density and biomass in marine waters in the Constanța area between 1983 - 2010

2.3.1.2.2. Algal blooms, as an indicator of the impact of eutrophication on the marine environment, showed a downward trend as number of phenomena, but the number of species growing over one million cells/l remained relatively high.

During 2010, eight species manifested developments over one million cells per liter, compared to 10 species in 2008 and only six species in 2009. Of these, the species *Skeletonema costatum* recorded the largest algal bloom phenomenon, both in the shallow waters of Mamaia and the entire continental shelf, in particular in the northern coast in March and September (see Table 15), phenomenon that has not been met at this scale since 2005.

The dominant group of the diatoms *Cyclotella caspia* and *Cerataulina pelagica* characterized, by the developments of $1.48 \cdot 10^6$ cel·l^{-1} and $5.4 \cdot 10^6$ cel·l^{-1}, respectively, the shallow waters of Mamaia in May. *Cyclotella Caspia* returned in September as accompanying species ($6{,}5 \cdot 10^6$ cel·l^{-1}) of the diatom *Skeletonema costatum*, which developed a new blooming phenomenon that month, reaching a maximum density of $30.3 \cdot 10^6$ cel·l^{-1}.

The diatoms *Nitzschia tenuirostris* ($2{,}070 \cdot 10^3$ $cel \cdot l^{-1}$), *N. delicatissima* ($1{,}030 \cdot 10^3$ $cel \cdot l^{-1}$) and *Thalassionema nitzschioides* ($5{,}890 \cdot 10^3$ $cel \cdot l^{-1}$) characterized the phytoplankton community of shallow waters in Mamaia in the first two decades of July.

Table 15. Maximum densities (10^3 $cel \cdot l^{-1}$) of the main phytoplankton species of the waters in the Romanian sector of the Black Sea in 2010

Species	Transitional waters		Coastal waters			Marine waters			Mamaia
	III	IX	III	VII	IX	III	VII	IX	Bay
Skeletonema costatum	10640		27160		30360	39540	272		49440
Cyclotella caspia	124				6500	18.6	282	131	1480
Nitzschia tenuirostris		175		131.2	1440			1122	2070
Nitzschia delicatissima		808			423.6	298.2		680	1030
Cerataulina pelagica									5400
Thalassionema nitzschioides					223.4		385		5890
Chaetoceros curvisetus									560
Chaetoceros socialis						128.8			550
Glenodinium paululum									430
Scrippsiella trochoidea									340
Carteria sp.									1630
Dactylococcopsis irregularis					266.8				
Cryptomonas sp.									1760
Eutreptia lanowii									210

100-1000 x 10^3 $cel \cdot l^{-1}$ 1000-10000 x 10^3 $cel \cdot l^{-1}$ >10000 x 10^3 $cel \cdot l^{-1}$

With the reduction in number and intensity of algal bloom events, the number of species growing over 10 million $cells \cdot l^{-1}$ decreased from 11, in the ’90s, to only 9, between 2001-2005 and a single species in 2009 and (the diatom *Nitzschia delicatissima* - *Nitzschia delicatissima* - $15.5 \cdot 10^6$ $cel \cdot l^{-1}$), and in 2010 (the diatom *Skeletonema costatum* - $49 \cdot 10^6$ $cel \cdot l^{-1}$), respectively.

2.3.1.2.3. Zooplankton

In 2010, the zooplankton was characterized on the basis of four sets of samples collected in March, May, July and August. The zooplankton was dominated by the trophic component in March and August, while the non-trophic component dominated in May and July (Fig. 45).

The non-trophic zooplankton, an eutrophication status indicator of marine waters, showed maximum values of abundance and biomass in July, on the Constanța East profile, near the shore (242,849 ind.m^{-3} and 21,370 mg.m^{-3}, respectively).

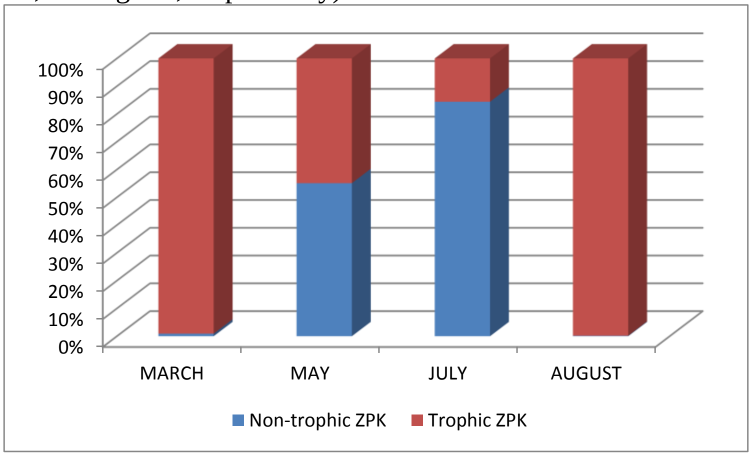


Fig. 45 - Evolution of the total zooplankton abundance (ind.m^{-3}) during 2010

The trophic component also showed the maximum development in August, on the Eforie South profile, where the abundance reached 225,013 ind.m^{-3} and the biomass 5,815 mg.m^{-3}. Throughout the entire year, copepods dominated the trophic component in terms of both biomass and densities (Fig. 46).

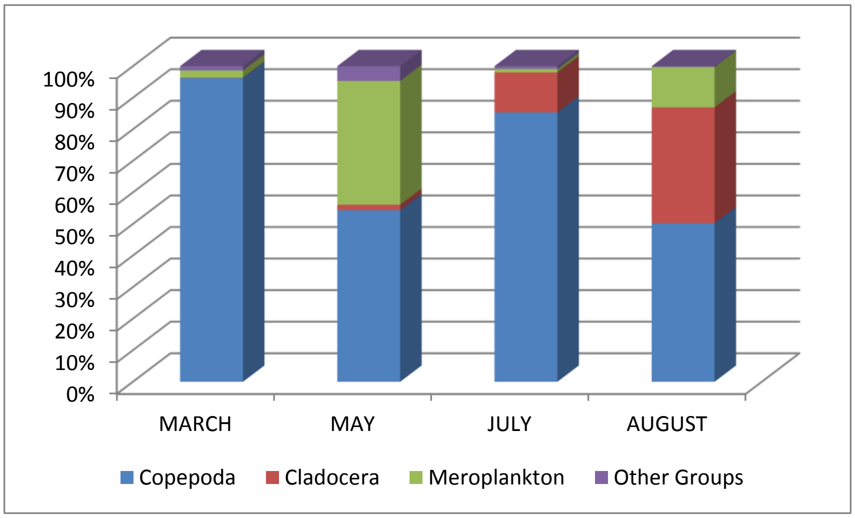


Fig. 46 - Evolution of the trophic zooplankton abundance (ind.m^{-3}) during 2010

The qualitative structure of the zooplankton was represented by 33 taxa, belonging to 16 taxonomic groups.

The dinoflagellate *Noctiluca scintilans*, the copepods *Acartia claus*, *Pseudocalanus elongatus*, *Paracalanus parvus*, the cladoceran *Pleopis polyphemoides*, the apendicular *Oikopleura dioica* and the chetognate *Parasagitta apendicularul* were constantly present in the samples analysed. In the water in front of the Danube mouths, several freshwater species were identified (*Daphnia cuculata*, D. *longispina*, *Chidorus sphaericus*).

In the summer of 2010, *Oithona brevicornis* was identified for the first time in front of the Romanian littoral, species already reported in the Black Sea by Ukrainian and Russian researchers. *Oithona brevicornis* was identified in all development stages, so we can consider that this new species has adapted to the conditions in front of the Romanian littoral (Fig. 47).

Fig. 47. Adult specimen of *Oithona brevicornis*

The exotic ctenophors *Mnemiopsis leidyi* and *Beroe ovata* were registered with high abundance and low biomass.

Centropages ponticus, Pontella mediterranea, Anomalocera patersoni and *Oithona nana* were the only zooplanktonic species identified during 2010 and present in the Black Sea Red Data Book.

2.3.1.2.4. Phytobenthos

In 2010, the sampling necessary to study the phytobenthos in the area between Năvodari and Vama Veche was conducted during the cold season (March and November, 2010) and in summer (June-August). After the qualitative analysis, 27 taxa were identified (25 species and 2 varieties), highlighting the dominance of the specific diversity of the phylum Chlorophyta - 12 species, representing 44.4% of all identified species, followed by the phylum Rhodophyta - 8 species and 2 varieties of *Ceramium rubrum*, the phylum Phaeophyta, with 4 species (*Cystoseira barbata, Punctaria latifolia, Ectocarpus siliculosus, Scytosiphon lomentaria*) and one marine eelgrass (*Zostera noltii*). In 2010, the clear dominance of green algae, due to the proliferation of the *Cladophora* and *Enteromorpha* genera, manifested (as in previous years) also at the quantitative level (Fig. 48). Thus, during the summer of 2010, the macroalgal flora had a dominant feature characterized by opportunistic species: *Ulva lactuca* (1,315 g/m^2 wet weight; 650 g/m^2 w.w.), *Enteromorpha* sp.- 577.5 g/m^2 w.w.), *Cladophora albida* - 315 g/m^2 w.w., *C. sericea* and *C. vagabunda* - 335 g/m^2 w.w.; among red algae, *Ceramium* (*C. rubrum, C. diaphanum*) dominated the hard substrate - 1,737 g/m^2 w.w. The *Cladophora* sp. thrived during summer and in November 2010; *Ceramium rubrum* (1,400 g/m^2 w.w.), with a high capacity to reproduce, developed abundantly in shallow waters. *Enteromorpha* sp. (750 g/m^2 w.w.) also thrived during the cold season of 2010 in the southern part of the Romanian seashore (Mangalia - Vama Veche).

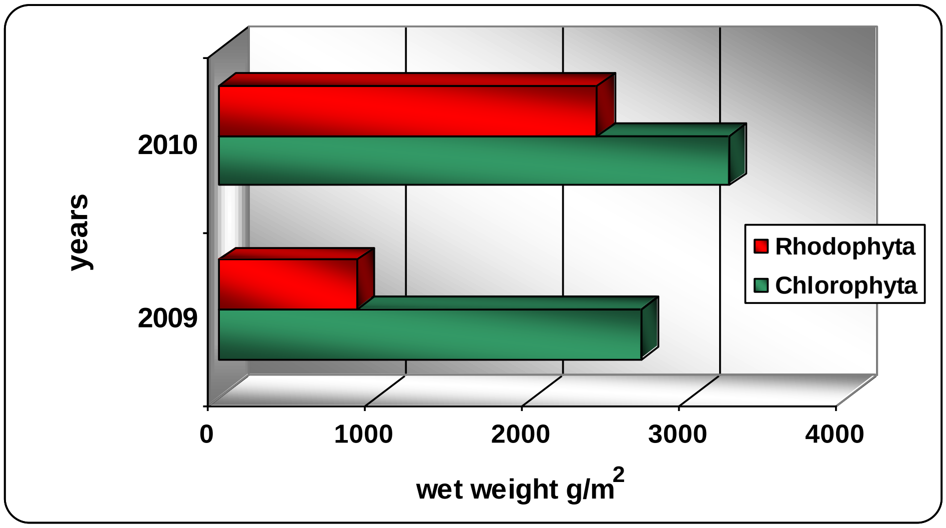


Fig. 48. Average wet weight for the dominant groups
along the Romanian seashore during summer in 2009 and 2010

Among the brown algae, a special attention envinced the perennial species *Cystoseira barbata*, particularly important for the marine ecosystem, found in 2010 from Mangalia to Vama Veche. Thus, the *Cystoseira* field at Vama Veche is well developed, compact, composed of strong specimen, with a lower degree of epiphytes compared to 2009 and with a considerable wet biomass. A positive fact was noticed at Mangalia, where juveniles of *Cystoseira* were identified, as thick bunches.

Zostera noltii (dwarf eelgrass) was also reported in 2010, as a well-developed grassland at Mangalia. Compared to the previous year, in 2010, the species was encountered at smaller depths, with a high fresh biomass (1,605 g/m^2 w.w., in summer, 1,800 g/m^2 w.w., during the cold season 2010). A meritorious presence was that of the microscopic exclusively epiphyte red alga *Acrochaetium thuretii*, a clean water indicator, that strongly epiphyted the flexible *Zostera* thallus during the summer of 2010. This red alga was not reported in November, when *Zostera* thalli presented a fresh appearance without epiphytes. The identification of *Lomentaria clavellosa* (Rhodophyta), a species considered extinct from the Romanian Black Sea coast, is another positive aspect manifested during 2010. In the past, *L. clavellosa* (together with *Antithamnion cruciatum*) formed complex associations in the Romanian coastal waters and marked the limit of algal vegetation development.

Although, at present, the number of macroalgal species identified on the Romanian shore is much lower compared to the '60s and '80s, due to both unfavorable natural factors (sea frost, lack of light, high turbidity) and anthropogenic influence (spatial cliffs, construction of dams, port excavations), a slight increase in the value of this number can be noticed in recent years (Fig. 49).

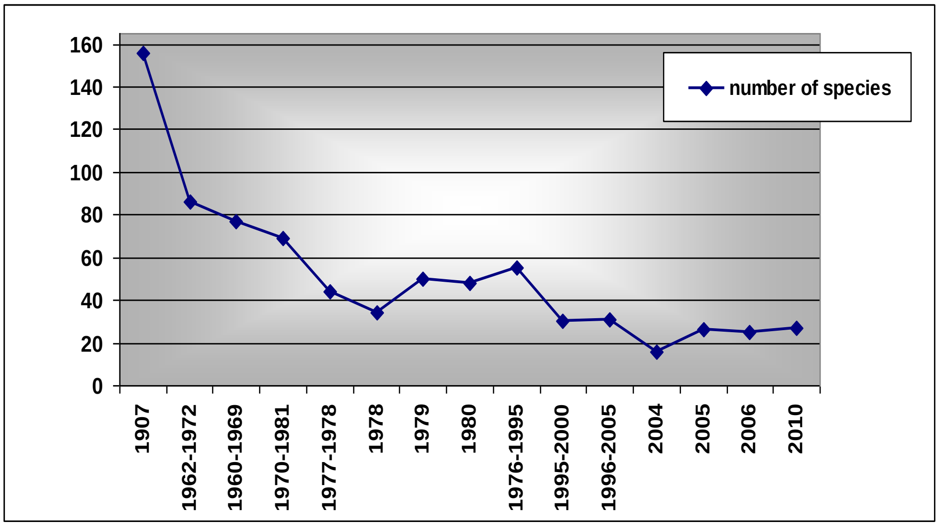


Fig. 49. Phytobenthos qualitative evolution on the Romanian Black Sea coast

The storms and strong waves during the summer of 2010 threw on the shore species like *Enteromorpha intestinalis, Cladophora vagabunda, C. sericea, Ulva lactuca, Ceramium rubrum, C. elegans*, *Cystoseira barbata*, *Zostera noltii*, which formed macroalgal deposits along the seashore, a fact also noticed in the past few years.

During the summer of 2010, the macroalgal flora was dominated by the genus *Cladophora* and, during the cold season, by the genus *Ceramium*. A positive trend is the restoring of the *Cystoseira barbata* fields, maintained in the last years. *Zostera noltii*, until recently considered an extinct species on the Romanian seashore, now forms a well-developed field off-shore Mangalia and is also in a regeneration process compared to the previous years.

2.3.1.2.5 Zoobenthos

Zoobenthos, as eutrophication status indicator, still showed a constant evolution, in terms of species diversity. The qualitative assessment in all monitored areas led to the record of 50 macrozoobenthic species, the faunistic panel keeping the characteristics of the previous years (Fig. 50). In 2010, there was a slight tendency towards qualitative balancing. The faunal assessment showed an improvement in the diversity of species present in coastal waters if we compare this state with the ‘90s period, when the benthic fauna was represented by a maximum of 28 species.

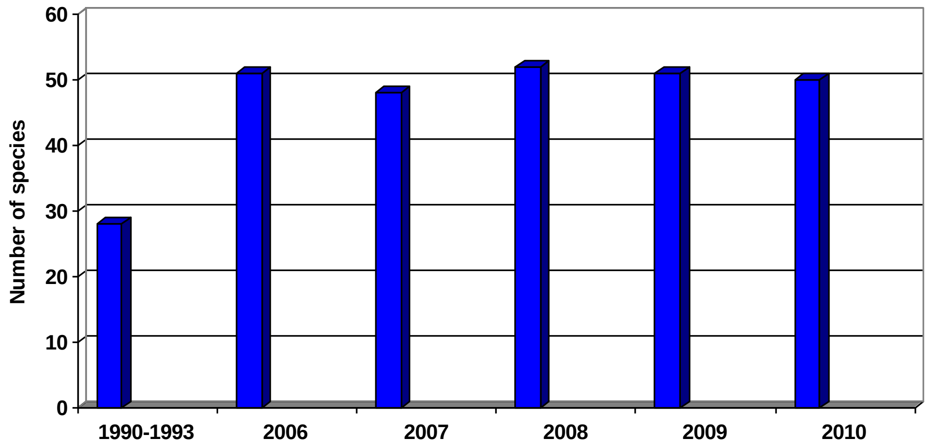


Fig. 50. The evolution of the number of species in coastal waters (Sulina-Vama Veche), in 2006-2010 compared to 1990-1993

A massive growth of detritofagous endobenthic species was noted, especially polichaet species, *Dipolydora quadrilobata, Capitella capitata, Polydora cornuta, Heteromastus filiformis,* known as dominant species, especially in areas with high organic load in sediments and in polluted areas.

In the northern part of the littoral (Sulina - Portița), the quantitative indicator of density recorded values up to 1.4 times lower (5,628 ex/m^2) compared to 8,114 ex/m^2 in 2008-2009. The same situation was observed in the biomass, with an estimated average of 189 g/m^2, with a reduction of 2.2 times compared to 2008, when the recorded biomass was 425 g/m^2.

In the southern sector (Eforie Sud and Mangalia), the quantitative indicator of density registered an increase over two times higher compared to 2009. In contrast, a reduction of up to four times lower of biomass values (88 g/m^2) was noted compared to the 2009 assessments (327 g/m^2), when the weight contribution of mollusks was more significant compared to 2010.

The assessment of the response of benthic communities to anthropic pressures on the marine environment quality was performed by using specific biotic indexes (AMBI and M-AMBI). The results of the average values obtained for water bodies investigated in 2008-2010 characterized a moderate quality state, with a slight tendency towards a good condition in areas less affected by eutrophication, mainly in the southern sector (AMBI: 1.71 to 2.42, M-AMBI: 0.73 to 0.87, according to the limits set for sandy areas: 1.2 <AMBI ≤ 3.3 and 0.85> 0.55 ≥ M-AMBI (Borja and Muxika, 2005).

In order to conserve and improve some parts of the coastal ecosystems, one required solution is to limit the eutrophication, by controlling the effects of fertilizer discharges, particular restrictions on wastewater discharges, especially during summer, given the fact that species with a low degree of tolerance/sensitive recover with more difficulty when natural and/or anthropogenic pressures are higher.

2.3.1.2.6. Biodiversity indicators

The marine biodiversity of the Romanian coast was characterized by the values of the specific indicators.

The biodiversity status was defined by the total number of species identified on the Romanian coast and the number of threatened species (CR, EN and VU). In the past 15 years, in the Romanian marine waters, over 700 species of the main marine groups (phytoplankton, zooplankton, macrophytobenthos, zoobenthos, fish and marine mammals) have been identified. In order to get a more accurate picture of this indicator, we used the number of species identified each year of the main marine biotic components. The values obtained are quite subjective, varying from year to year, conditional on the number of samples and especially the involvement of specialists in species identification. Between 1996 - 2009, on average, 200 - 300 species were identified annually. In 2010, over 300 species of the groups mentioned above were identified. The endangered species in the CR, EN and VU categories are 48 in the Red List, 26 of which were identified in 2010.

The pressure on biodiversity was expressed by the existence of 29 exotic species (18 of which are listed in the most invasive species in Europe catalogue, established in 2006), 8 species which are exploited commercially (6 fish and 2 mollusks) and 12 types of human activities affecting the conservation status of biodiversity.

The impact on biodiversity was assessed by the ratio between the number of endangered species / the total number of species identified in 2010, i.e. 26/345, and the number of extinct species / the total number of species, i.e. 7/750; the only self-adapting species was *Mugil soiuyi*. The number of endangered species (48) includes species belonging to the IUCN Red List categories CR, EN and VU, considered categories of endangerment proper.

The response recorded in the environment and environmental policies was evaluated by the ratio of protected marine species / the total number of species, that is 16/750 (birds excluded), considering the species protected by GEO 57/2007. Regarding human resources, in 2010, less than 50 specialists worked in the marine biodiversity field.

2.3.1.3. Endangered species status

The Red List of macrophyte, invertebrate, fish and mammal species, status indicator for marine biodiversity in the Romanian marine sector, was completely updated in 2008 and only for fish in 2009. It includes 223 species, classified in eight IUCN categories (IUCN categories according to v. 3.0 2003 and their implementing guidelines, 2004 and 2006 versions), namely: 19 macrophytes and higher plants (8.5%), 58 invertebrates (26 %), 142 fish (63.7%) and 4 mammals (1.8%) (Fig. 51).

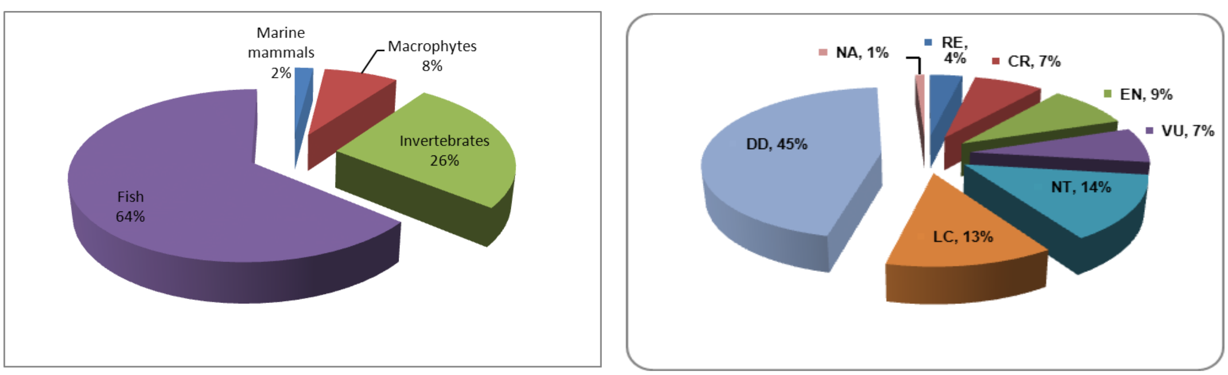


Fig. 51. The main marine organisms categories in the Red List (left) and the IUCN categories they are included in (IUCN, v. 3.0, 2003, 2004, 2006)

Among the macrophyte algae and phanerogames included in the Red List, in the summer of 2010, the brown alga *Cystoseira barbata* was identified, endangered species (EN), on the southern coast, in the Mangalia - Vama Veche area. In Mangalia, the *Cystoseira* population is better represented than in the marine reserve, as dense clusters, the thalli being strongly epiphyted by opportunistic species of the genera *Enteromorpha*, *Cladophora* and *Ceramium*. In the same area, *Zostera noltii* was also identified, phanerogame whose populations are also discontinuous. The IUCN categorization includes six categories (RE, CR, EN, VU, LC, DD) one species (5%) considered extinct in the region (RE), 3 (16%) - Critically Endangered (CR), 7 (37%) - Endangered (EN), 3 (16%) Vulnerable (VU) 2 (11%), of Low Concern (LC) and 3 (16%) with not enough data (DD) (Tab. 16).

Table 16. Sozologic status of the species in the Red List updated in 2007

Species group	**Status of the IUCN categories v.3.1, 2001 and v.3.0, 2003**								
	RE	**CR**	**EN**	**VU**	**NT**	**LC**	**DD**	**N**	**Total**
Macrophytes	1	3	7	3	0	2	3	0	1
Invertebrates	6	12	6	8	1	11	12	2	5
Fish	0	0	2	4	27	32	77	0	142
Mammals	0	0	3	0	0	1	0	0	4
Total	**7**	**15**	**18**	**15**	**28**	**46**	**92**	**2**	**223**

For the invertebrates, the 58 species on the List were divided into 8 categories: RE (6 - 10%), CR (12 - 21%), EN (6 - 10%), VU (8 - 14%), NT (1 - 2%), LC (11 - 19%), DD (12 - 21%) and NA (2 species - 3%) (Tab. 6.4.2.3.1). Among the five calanoid copepod species *Anomalocera patersoni*, *Labidocera brunescens*, *Pontella mediterranea*, *Oithona nana* and *Centropages ponticus*, in 2010, four were noticed (*Centropages ponticus*, *Pontella mediterranea*, *Anomalocera patersoni* and *Oithona nana*). Of the benthic invertebrates in the Red List, 16 were identified in 2010, among which we mention: *Donax trunculus* (VU), *Paphia aurea* (VU), *Tricolia pullus* (CR), *Calyptrea chinensis* (VU), *Clibanarius erythropus* (CR), *Carcinus aestuarii* (EN), *Callianassa truncata* (VU), *Eriphia verrucosa* (NT) and the *Arenicola marina* (VU) polichaet.

The classification of fish species in the IUCN categories was changed completely in 2009, in order to assess their state of conservation taking into account the categories in which they were included by IUCN worldwide. Applying the methodology for assessing the conservation status of species at the regional level, the fish are currently included only in five categories: EN, VU, NT, LC and DD, most species (77-54%) being widely spread DD, followed by - LC (32-23%). The species listed under the categories of endangerment (EN, VU and NT) are together less than a quarter (23%) of those comprised in the List (Tab.6.4.2.3.1). Among the 41 species identified in 2010, three belong to the VU category (*Acipenser stellatus*, *Trachurus mediterraneus ponticus* and *Alosa pontica pontica*), 13 to the NT category and 6 to the category of species with insufficient data (DD). The latter will be categorized in the coming years either in a category of endangerment or in low-risk category (LC).

With regard to marine mammals, in 2010, dolphins were not the object of a special monitoring program; however, shoals consisting of 2 to 50 individuals were observed both near the coast and in offshore areas, especially in summer. Also, 42 dolphins were found stranded on the shore, of which 36 individuals of *Phocoena phocoena*, 4 of *Tursiops truncatus* and 2 *Delphinus delphis*. It must me noticed that 90% of the stranded dolphins come from illegally installed turbot nets. The categorization of the three dolphin species *Delphinus delphis*, *Phocoena phocoena* and *Tursiops truncatus* remained the same as in the previous assessment, namely Endangered (EN) both at the Black Sea and at national level, although in the IUCN Red List only *Tursiops truncatus* is listed as a vulnerable species (VU), the other two being low risk (LC).

2.3.2 State of the marine fishery stocks

2.3.2.1 Indicators of living marine resources

In 2010, as in previous years, in the Romanian marine sector, the fishing industry practiced by fishermen was done in two ways: active fishing gear with coastal trawler vessels, made at depths of 20 m, and fixed fishing gear, practiced along the coastline in 20 fishing points, located between Sulina and Vama Veche, in shallow waters (3-11 m). Additionally, we mention the small-scale coastal fishing.

In the Romanian marine sector, the following trends were reported:

► Evolution of the state indicators:

● **stock biomass** for the main fish species (Table 17) indicates:

- for ***sprat***, which usually had a natural fluctuation, almost normal biomass and actually a relatively good stock, estimated, as in the past two years, at 60,000 tons, compared to 45,000 tons/2005 and 14,750 tons/2006, when, due to the existence of special hydro climatic conditions, the species crowded in other areas of the sea;
- for ***whiting***, the biomass was estimated at 10,000 tons, 15% more than it was estimated in the last years, when it varied between 6,000 and 8,500 tons (2004-2008);
- for ***turbot***, the biomass was estimated at 1,300 tons, less than in 2008 and closer to the value of 2007;
- for ***dogfish,*** there was a 2,500 tons biomass, higher compared to the one in 2008, but lower than in 2007 (4,300 tons).

Table 17 - Stock value (tons) for major fish species in the Romanian Black Sea

Species	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
sprat	45,000	14,750	60,000	60,000	60,000	60,000
whiting	8,000	7,000	6,000	8,500	10,000	11,000
anchovy	19,000	20,000	20,000	20,000	-	-
goby	600	600	600	500	-	500
turbot	1,080	1,150	1,300	2,356	1,500	1,350
dogfish	1,650	2,000	4,300	1,450	2,500	2,500

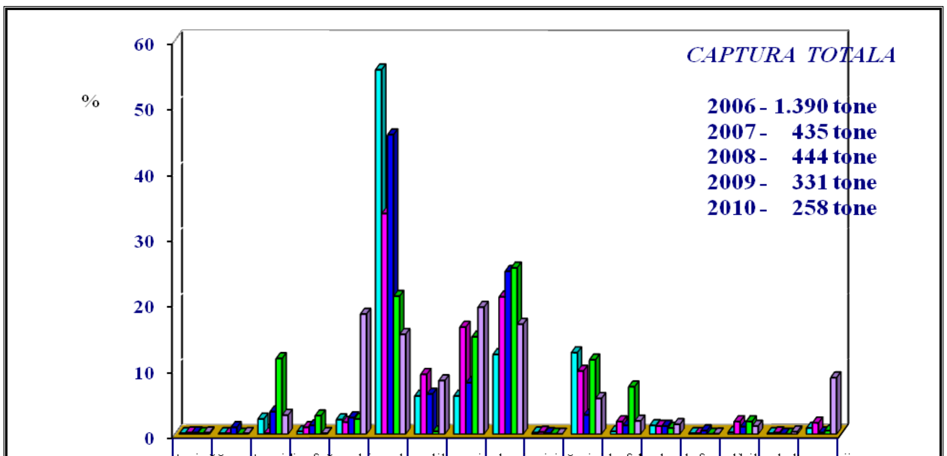
● **the population structure** indicates, as in previous years, the presence in the catches of a greater number of species (over 20), in which the mainstream belonged to small species (sprat, anchovy, whiting, goby), as well as to the larger ones (turbot and shad). As in previous years, the low share of some species, such as: dogfish, horse mackerel, needlefish, mullet, bluefish, but also the recurrence as isolated specimens of blue mackerels (mackerel) and bonito were reported (Fig. 52);

► **Evolution of the pressure indicators:**

● The fishing effort continues the trend of reduction reported since 2000. Thus, in 2010, in the case of active fishing specialized for sprat (using the pelagic trawler), only one vessel was active and 114 boats for the turbot (6-12 m). In fishing with fixed gear, practised along the Romanian coast, were used: 205 crafts (36 boats, smaller than 6 m, and 169 boats sized between 6-12 m), 20 trap nets, 3,691 turbot gillnets, 1,442 shad gillnets, 41 goby gillnets, 8 beach nets, 187 mullet gillnets, 171 dogfish gillnets, 27 horse mackerel gillnets, 400 long liners and 950 handlines;

● **the total catch** continued the downturn after 2000, from over 2,000 tons between 2001-2002, at 1,390-1,940 tons between 2003-2006 and 500 tons in the last three years (2007-2009), 435 t/2007, 444 t/2008, 331 t/2009 and 258 t/2010, respectively (Fig. 53.). The low level of catches made in 2010, 258 tons, respectively, was due to the effort reduction (decrease of the number of coastal trawlers, the number of trap nets and staff engaged in fishing activities), the increase of production costs and the influence of hydro climatic conditions on fish populations;

● the Total Admissible Catch (TAC) of the main fish species caught between 2006-2010 remained at the same level (Table 18).



	aterina	zărgan	stavrid	rizeafcă	scrumbie	sprot	bacaliar	hamsie	calcan	gingirică	guvizi	chefal	barbun	lufar	rechin	limba de mare	alte specii
2006	0,1	0,1	2,3	0,4	2,2	55,5	5,8	5,8	12,12	0,2	12,4	0,4	1,3	0,1	0,28	0,1	0,9
2007	0,2	0,1	0,1	1	1,8	33,6	9,1	16,3	20,9	0,3	9,6	1,9	1,2	0,1	1,9	0,2	1,7
2008	0,2	1	3,4	1,3	2,5	45,6	6,1	7,8	24,8	0,1	2,9	1,3	1,2	0,5	1,1	0	0,2
2009	0,1	0	11,5	2,8	2,3	21	0,4	14,8	25,3	0	11,3	7,2	0,9	0	1,9	0	0,5
2010	0,20	0,11	2,87	0,1	18,27	15,19	8,14	19,33	16,74	0	5,43	1,98	1,47	0,03	1,22	0,35	8,57

Fig. 52 - The catch structure (tons) of the main fish species in the Romanian marine sector during 2006-2010

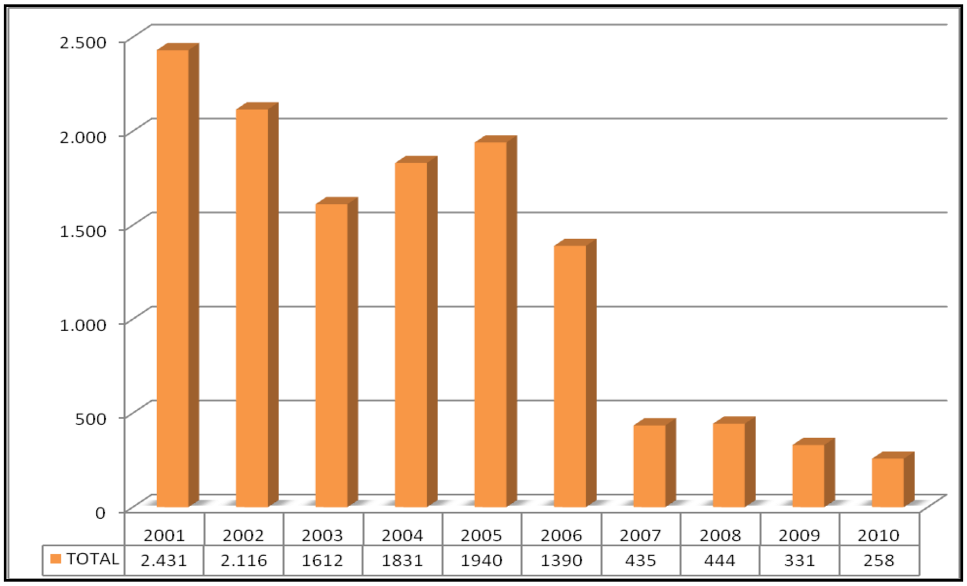


Fig. 53 - Total catches (tons) made in the Romanian sector of the Black Sea, between 2001-2010

Table 18. The value of the TAC (Total Admissible Catch) for the main fish species in the Romanian Black Sea

Specia	**TAC (tons)**				
	2006	**2007**	**2008**	**2009**	**2010**
sprat	10,000	10,000	10,000	10,000	3,443
whiting	1,000	500	500	500	600
goby	100	200	100	100	100
turbot	50	50	50	50	43.2
dogfish	50	50	50	50	50

► **Evolution of the impact indicators:**

● **the percentage** of species whose stocks are outside safe limits was close to that of previous years, which is nearly 90%. Overcoming the limits of safety is not due only to the exploitation in the Romanian marine sector, because most fish species have a cross-border distribution, which requires management at regional level;

● **the percentage** of additional species in the Romanian catches continue to be maintained at a level similar to that in recent years, being 25%;

● **changes in the size class structure** (age, length): compared to the period 1990-2009, except sprat, which stands a rejuvenation of the shoals, due to a very good addition, for the other catches the biological parameters remained almost at the same values;

● **C.P.U.E** (catch per unit effort), for fishing on the Romanian littoral:
- with fixed gear/trap nets, it was 1,943.83 kg/month, 100.51 kg/day, respectively, with an effort made by 20 trap nets and 1,141 days and a total catch of 114,686 kg;

- with fixed gear/turbot gillnets, it was 13.08 kg/gillnet, 19.24 kg/day and 423.23 kg/boat, with an effort made by 3,691 turbot gillnets, 2,580 days, 114 boats and a total catch of 48,248 kg;
- with active fishing gear/pelagic trawl, 240 kg/vessel, 120 kg/day, 120 kg/trawl and 120 kg/hour, with an effort made by only one vessel, 2 fishing days, 2 trawls and 8 trawling hours.

2.3.2.2. Measures for solving critical issues:

► **Nationally**:

● **harmonization** of sustainable development strategies in the fisheries sector in the Romanian marine sector by implementing the concept of fisheries management based on the ecosystem approach and the Code of Conduct for Responsible Fisheries through:

- avoidance of creating an excess fishing capacity;
- practice of responsible fishing;
- conservation of biological diversity of marine ecosystems and protection of the threatened species;
- development and use of selective fishing gear and techniques: non-destructive, cost effective, environmental friendly and protecting living marine resources;
- development and diversification of marine aquaculture products.

► **Regionally**:

- regional harmonization of legal and institutional framework for sustainable use of living resources;
- improvement of the management of fish stocks through exploitation assessment methodology agreed at regional level;
- development programs / projects to assess the status of fish stocks and to monitor the environmental conditions and biological factors that have influences;
- creation of partnerships between research institutions, governments and producer organizations to develop joint research programs;
- construction of a regional fishery database;
- urgent action against illegal fishing.

2.3.3. The Black Sea and sustainable development

Introduction

The Romanian Coastal Zone is 244 km long, representing 7.65% of the Romanian border, and is divided into two main zones, from the viewpoint of economy and social structure. The northern zone (aprox. 164 km) lies between the Musura Gulf and Cape Midia. The southern zone (80 km) lies between Cape Midia and Vama Veche. (Fig. 54)

The northern zone consists of a large protected deltaic zone, including the Danube Delta. On the Danube Delta territory, the Danube Delta Biosphere Reserve is established. Romanian and international legislation require that economic activities developed in this area be compatible with the status of the natural reserve. Thus, the ecological balance is maintained.

The southern zone is considered a development area. The more permissive conditions here regarding economic activities lead to the concentration of economic activities. The most important urban center of the coastal zone is located in the south: the Constanța Municipality is the second city in the country by size. The Black Sea largest harbor is included in the administrative limits of the city.

Fig. 54. The Romanian coastal zone

The Romanian coast is facing serious problems of habitat destruction, coastal erosion, water pollution and natural resource depletion. The rapid increase in population and tourism, large-scale exploitation of natural resources and rapid development of infrastructure - has resulted in the severe degradation and decline of the quality of the Romanian coastal zone (e.g. around the city of Constanța in the south), whereas other parts (e.g. the Danube river Delta Biosphere Reserve, in the north) are already managed and protected by national and international regulations. The depletion of the limited resources of the Romanian coastal zone is leading to increasingly frequent conflict between users.

Therefore an integrated approach is required to ensure that the Romanian coastal zone is environmentally and economically sustainable, which allows the co-ordination of multiple, often contradictory, interests in order to use all the resources with the highest social, economic and ecological benefit for the present and future generations.

Consequently, Romania has recognized that ICZM is a valuable tool and created structures and legal framework to promote its implementation. Since 2002, the Romanian Government decided to initiate and strengthen efforts on integrated coastal zone management by issuing the Emergency Ordinance for ICZM.

Regional cooperation

The sustainable development of the coastal zone requires the cooperation of all countries bordering the Black Sea. In this respect, a Strategic Action Plan for the Rehabilitation and Protection of the Black Sea was developed. Its general objectives include providing a healthy environment for the population in the Black Sea region, both in urban and rural areas, obtaining a biologically diverse marine ecosystem, containing variable and viable natural populations and sustainable higher organisms, including marine mammals and sturgeons, and to support sustainable activities such as fishing, aquaculture and tourism in all Black Sea countries.

NIMRD “Grigore Antipa” has 5 national focal points operating within the Black Sea Commission Advisory Groups, in the following domains:

- Environmental Aspects of the Management of Fisheries and other Marine Living Resources
- Conservation of Biological Diversity
- Pollution Monitoring and Assessment
- Development of Common Methodologies for Integrated Coastal Zone Management
- Control of Pollution from Land Based Sources.

2. Relevant projects to implement sustainable development in the coastal zone, conducted in 2010

National coastal zone projects

1. **NUCLEU Programme 2009 - 2011**

a) dynamic interactions in the abiotic component of the marine ecosystem under the influence of climate and present anthropogenic changes;
b) biotic activity of the marine ecosystem under the influence of increased anthropogenic pressure and climate change;
c) development of methodology for analysis and evaluation in the ICZM process.

2. **Urban Area Plan regarding the Romanian coastal zone, southern sector (2010 - 2011)**

3. **SOP Environment, Priority Axis 5 - Implementation of the adequate structure for natural risks prevention / Intervention domain 2 - Decrease of coastal erosion (2010 - 2011)**

International Projects

- EC-FP6: European Coastal-shelf sea operational observing and forecasting system (ECOOP), 2007 to 2010;
- EC / Development and pre-operational validation of marine GMES Services and upgraded capabilities (MyOcean), from 2009 to 2011;
- NATO: Bio-optical characteristics of the Black Sea, 2009 - 2011;
- EC/FP6: Upgrade Black Sea Scene (UBSS), from 2009 to 2011;
- EC/FP6: Pan-European infrastructure for Ocean & Marine Data Management (SEADATANET), from 2006 to 2011;

- EC/FP6: Southern European Seas: Assessing and modeling ecosystem changes (SESAME), from 2006 to 2010;
- EC/FP7 Scientific and Technological Collaboration for the study of sea-level changes and vertical crustal movements at the Western Black Sea (EMODNet), from 2009 to 2011;
- EC/FP7: Options for delivering ecosystem-based marine management (ODEMM) 2010 - 2013
- PN I/PDP: Influence of geo-climatic changes on global and regional sustainable development in Dobrogea (GLOBE) / CNMP, from 2007 to 2010;
- PN II, Partnerships - Evaluation of macrophytes communities from the Romanian coast and possibilities for recovery of deposits of macroalgae on beaches, 2008 - 2010;
- PN II, Partnerships'- Complex system of application of remote sensing and GIS techniques to support quality environmental monitoring and integrated management development activity in the Romanian Black Sea shore, 2008 - 2010;
- PN II, Partnerships '- Research on factors limiting populations of turbot (*Psetta Maeotica Maxima*) from the Romanian coast in the assessment, exploitation, conservation and species protection, from 2008 to 2010;
- National Plan for fishery data collection / ANPA-DG Mare, 2009 - 2010.

Scientific and public participation

On October 29th, 2010, NIMRD „Grigore Antipa" organized the Jubilee National Symposium with International Participation, dedicated to the 40th anniversary of the Romanian Marine Research Institute Constanța and to the International Black Sea Day, under the auspices of the Romanian National Committee of Oceanography (RNCO - UNESCO).

2.3.4. Maritime Spatial Planning

During 2010, the maritime spatial planning studies and research as a process of analysis and allocation of spatial and temporal distribution of activities in the Romanian marine area were continued and developed, taking into account the fact that Maritime Spatial Planning (MSP) is an instrument that can be used as innovative approach of the European Union's Integrated Maritime Policy.

In this process, GIS applications and research in remote sensing satellite system were made.

Based on the synoptic scale, the proposed aims were the understanding of the coastal processes of the Romanian shore and also the possibility for essential selection of different variants of planning solutions, in order to avoid predictable and unpredictable conflicts, at overall and sectorial levels. Some of the steps taken for these researches are mentioned as follows:

- Realizing GIS base support and IT (GIS and ESRI-GIS station 9.3);
- Establishing GIS products, contours (shape), primary thematic maps;
- Obtaining integrated thematic maps, regarding the integrated marine monitoring network, anthropogenic impact sources, coastal risks and vulnerabilities, including coastal erosion, operating activities, transportation and navigation lines, harbor platforms, coastal and marine protected areas, exploitable natural resources, suitable areas for marine aquaculture and for shellfish water quality;
- quality testing for programs and satellite images processing (BEST BEAT/VISAN, ERDAS IMAGINE etc.)

Three case studies were developed in 2010 in the northern part of the Romanian coast, considered a complex area in terms of MSP, under direct and double influence of continental and marine factors.

Establishing the reference area, identifying activities and pressures, assessing the anthropogenic impact were taken into consideration:

Case 1. Sulina - Musura Bay area, an urban type spatial complex, port, international waterway with sedimentation impact, included systematic planning spaces, wetlands, protected areas, areas of multicultural and archaeological interest, deltaic and marine tourist areas, with conflicting activities, stressing in particular the formation of a new land area, having territorial, political, ecological implications. These aspects are shown in Figures 6.4.4. (1-6).

Case 2. Sinoe Lagoon - Chituc Levee area and their related maritime space, including the coastal area of the Portița - Vadu sector, have traditional aspects of climate instability (hydrology, winds, waves, floods, droughts, storms etc.). Coastal and marine activities are limited by the imposed status of protected area of the area, the dominant component remaining the fishing activity. The maritime waterways and different exploitations are more distant from the shore; in consequence, they have impact on natural resources in the offshore area.

Case 3. Maritime activities in the Periboina, Edighiol, Corbu - Midia-Năvodari industrial sector - Mamaia Sat, Taşaul-Corbu Lakes area (Natura 2000 site/ROSPA 0060) have predictable effects on the environment and living organisms, by emissions and transport of possible hazardous substances.

The obtained research results carried out by NIMRD Constanţa prove the significant natural self-potential of the marine ecosystem. Zonal imbalances signals are still present and it is necessary to remove all the causes that produced them, which require the maintenance of monitoring, protection and careful planning measures.

The obtained results contribute to the current situation knowledge validation for coastal and marine areas, concerning the natural processes, new territorial structure issues, socio-demographic and economic activities (including industrial, ports, agriculture, tourism, energy, services). It is also important to maintain the operational type monitoring.

Fig. 55 (1-6). (1), Sulina, urban area plan, (2,3,4), urban waters network systematization programs, coastal area/tourist beach and island territory under formation/Musura island, (5-6) Ships stranded on the sand belt at 1 m depth - in front of the Musura island and in the coastal area of Sulina - 14.04.2010; 4 km south of the Danube mouth in Sulina, impacting on the typical habitats and organisms

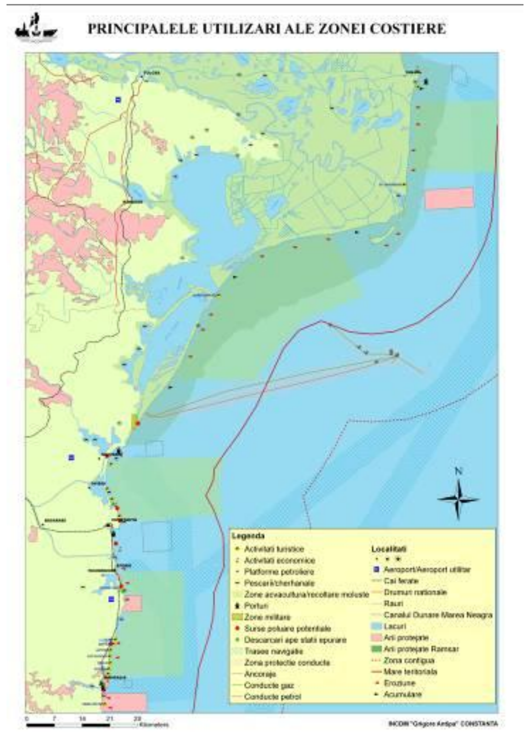


Fig. 56 - Integrated Map of Maritime Activities on the Romanian coast

2.3.5. Anthropogenic pressures

The main anthropogenic pressures identified in the Romanian coastal area are generally caused by the abrupt development of various socio-economic activities in the natural space of the coastal zone:

- Tourism and leisure
- Constructions / holiday residential buildings in tourist areas
- Enlargement and modernization of existing tourist ports: dredging activities
- Ports and shipping
- Shipbuilding
- Marine fisheries
- Agriculture and food industry
- Petrochemical industry, refineries
- Mining industry: ore, sand in shallow coastal areas
- Nuclear energy industry
- Steel industry
- Manufacturing industry
- Airport and air transport
- Military and defense activities: land-sea shootings, installation of high frequency antennas etc.

The key environment issues identified in 2010, in the Romanian coastal zone, induced by anthropogenic factors, are:

- Coastal erosion/Sediments dynamics at the mouths of the Danube (closing/clogging of the Musura Bay);
- Periodical, uncontrolled breaking of the littoral belt during unpredictable storms (the Chituc Levee - eastern shore);
- Implementation of solutions for protection against beach erosion (deposits of plastic/geotextile encasings on the beaches);
- Sea water penetration into coastal aquifers (the former Costinești Lake area);
- Natural resources/sand extraction from the beach (the Mamaia, Eforie Nord, Mangalia areas);
- Water/air pollution with solid wastes from diffuse sources;
- Excessive exploitation of valuable fish stocks, such as shads, horse mackerel, gray mullet, blue fish, turbot etc.
- Habitat loss and species endangerment - seaboard protection coastal constructions (the Eforie North and South, Tuzla, Costinești, Tatlageac, Olimp areas); coastal habitats clogging by the the turbidity field occurring near worksites, containing fine cliff material/ *terra rosa);*
- Demographic congestion of population in the coastal area, during summer season;
- Urban development/covering the beach area with buildings (the Mamaia area);
- Uncontrolled development of tourist constructions and tourism and leisure activities beyond the endurance capacity of the environment in certain limited areas;

The research carried out emphasized the main environmental impact conditions:

- The greater frequency and intensity of extreme meteorological phenomena (storms, tempests, tornados) - action of sand scattering winds on the beaches, action of the extremely violent waves during storms;
- The high content of biogenic substances, accumulated in time in the water and the degraded substrate, speeding up the eutrophication of coastal waters, lakes and ponds, explosive algal blooms, with negative consequences on the oxygen levels, water transparency, typical biodiversity;
- High anthropogenic ecologic pressure, caused by the geographic situation and the influence of various activities, such as uncontrolled farming, zootechnical, food, chemical and petrochemical wastes, construction, shipping, tourism, leisure and balneary treatment wastes.

Knowing these details is extremely important for the continuous assessment of risks and the impact of natural conditions, traditionally unstable, along with the anthropogenic impact, that influences negatively, ecologically and economically, the coastal area, which calls for the making of the appropriate political decisions for a sustainable use and development.

CONCLUSIONS

The state and trends in the Romanian marine and coastal environment were monitored in 2010 in terms of physical, chemical and biological parameters, compared to the reference period of the '60s or more recent data. The state of the marine and coastal environment in 2010 confirms the general trend of slight improvement in the parameters mentioned and the state of convalescence of the ecosystem.

To protect and conserve marine biodiversity, the coherent network of marine protected areas, national and of European interest, was developed in 2010, by new proposals and allocating the custody of most existing ones.

The synthesis of the data for 2010, compared to the historical data on the state and evolution of the Romanian coastal environment, is contributing to the "Report on the Environmental Factors State of Romania" of the Ministry of Environment and Forests.