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# REPORT ON THE STATE OF THE MARINE AND COASTAL ENVIRONMENT IN 2011

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**CONSTANŢA / ROMANIA**

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## CONTENTS

## ABSTRACT

The state and evolution trends of the Romanian Black Sea coastal environment continued to be monitored in 2011 from the physical, chemical and biological point of view, compared to the reference periods dating back in the early 1960s or in more recent years, depending on the parameters considered.

The annual averages (1959-2010) of **seawater temperature** vary in Constanța between 10.0$^o$C (1985) and 14.3$^o$C (2002). The mean value for 2011 - 12.5$^o$C (std. dev. 8.1$^o$C) interrupts the temperature increasing trend of the past years.

**Transparency:** In all water types, the minimum values are below 2 m, the allowed value both for the ecological state, as well as for human activity impact area pursuant to Order 161/2006 - "Regulatory document on the classification of surface water quality with the view to determining the ecological state of water bodies".

The **salinity** of transitory, marine and coastal waters in the Romanian littoral area recorded values ranging between 1.72 - 18.91 PSU (mean value 15.68 PSU, median 16.83 PSU and standard deviation 2.99 PSU). The minimum values were determined in surface waters as a follow-up of river or human freshwater input. The maximum values were reported in coastal and marine waters in the southern area, where the influence of river input is much diminished.

The **pH** of coastal waters in the Constanța area recorded mean monthly values ranging between 8.02 in December and 8.30 in June. The pH monthly average values during 1998-2010 vary **insignificantly** compared to 2011.

**Dissolved oxygen:** on the long term, despite the decreasing trend of the monthly averages in relation to the range characteristic for the area, the multiannual monthly mean values during 1959-2011 vary insignificantly from those of 2011, thus allowing to ascribe the lower values to the natural variability of the Constanța coastal area and to the optimal negative correlation with temperature.

**Phosphates** $(PO4)^{3-}$: on the long term, the monthly averages of 2011 vary significantly from the multiannual mean value for 1960-2010, due to the low values reported in 2011. During 1960-2010, the monthly mean value of phosphate concentrations ranged between 0.13µM (1967) - 12.44µM (1987), noticing the decrease of phosphate concentration starting with 1987. The mean value for 2011, 12.54 µM, remains within the characteristic range of the reference period.

The **nitrate** $(NO\ 3)^-$ concentrations recordered, during the studied period, values ranging betwen 1.08-70.97 µM (average 8.69 µM, median 5.68 µM and standard deviation 9.88 µM). The multiannual monthly mean concentrations (May and July) of nitrates show high values, comparable with those reported during the eutrophication period. However, the effects of this nutrient input have a smaller extent, as a follow-up of reducing the phosphate concentrations - limitative factors of phytoplankton development.

**The silicates** $(SiO_4)^{4-}$ recorded concentrations ranging between 0.3-24.2 µM (average 4.8 µM, median 3.1 µM and standard deviation 5.0 µM), with higher values in summer, in the water column. As the main silicate sources in the Romanian Black Sea waters are represented by river input, the low Danube flow in 2011 determined the drop of silicate concentrations in the Romanian Black Sea waters, down to values 2-3 times lower than during the reference period, namely the 1960s.

In 2011, the mean **chlorophyll *a*** content in coastal waters recored a value almost twice lower compared to 2010 (4.91 µg/l compared to 9.51µg/l), yet under the annual average determined for the period 2001-2010 (6.27 µg/l), thus confirming the recovery of the ecological state of the coastal ecosystem in the Romanian Black Sea waters, reported in the past years.

The evolution trends of **heavy metals** in marine waters in the past 5 years record various behaviors, depending on the investigated elements. Thus, copper and lead displayed a slightly increasing trend in 2011, while the figures for cadmium are low compared to previous years (2007-2010). The concentrations of nickel and chrome measured in 2011 framed within the variation ranges reported during 2007-2010. The evolution trends of heavy metals in marine sediments in the past 5 years point out the fact that the values measured in 2011 frame within the variation ranges for 2007-2010.

The evolution of the **heavy metal bioaccumulation** levels in *Mytilus galloprovincialis* in the past years reveals a slight diminishment trend for cadmium in 2011, while the other elements are within the variability limits observed during 2007-2010.

In 2011, low values (< 200 µg/l) of the **Total Petroleum Hydrocarbon contents (TPH)** (µg/l) were recorded in water. The petroleum hydrocarbon pollution level in sediments recorded in 2011 is significantly lower.

The monitoring of the **polynuclear aromatic hydrocarbons (PAHs)** in water and sediments reveals mean values within the characteristic limits for 2006-2010. Anthracene is an exception, revealing high values in all environmental components investigated.

The monitoring of **organochlorine pesticides** showed high values for the following pollutants: p,p' DDT, lindane, p,p' DDE and aldrine. The mean values ranged within the same variation limits as for the period 2006-2010.

The **microbiological load**, state indicator for contaminants in the marine environment, was fair in 2011 in the bathing area, the encountered enteric bacteria concentrations (total coliforms/TC, faecal coliforms/FC, faecal steptococci/FS) ranging generally within the limits provided the the National Regulations and the European Community Directives, values reflecting the degree of faecal pollution of marine bathing waters.

The number of **Community interest habitats** (as defined in the Habitats Directive - 92/43/EEC) was assessed 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 submerged marine caves), with 28 sub-types.

In 2011, through the Order of the Ministry of the Environment and Forests no. 2387/2011 amending the Environment and Sustainable Development Minister's Order no. 1964/2007 on establishing the protected area status of Community importance sites, as part of the Natura 2000 European ecological network, Romania approved the designation of **two new sites**, under the Habitats Directive: **ROSCI0281 Cape Aurora, ROSCI0293 Costinești-23 August** (currently, no custodian for either site).

Based on determinations of the sea-shoreline contact modification rhythms, the assessment of the **coastal processes** extent was performed (erosion/dynamic balance/accretion) for the beach sectors, by grouping them into 7 classes (the class interspace being 5 m), as follows: SE - strong erosion, below 12.5 m, AE - average erosion, 12.5 m to 7.6 m; WE - weak erosion, -7.5 m to -2.6 m; DB - dynamic balance, 2.5 m to -2.5 m; WA - weak accretion, 2.6 m - 7.5 m; AA - average accretion, 7.6 m - 12.5 m; SA - strong accretion > 12.5 m.

The **sea level**, as one of the indicators of the coastal zone state, presented, during 2011, a constantly positive deviation from the long term monthly averages, except for December, when the monthly average was 6.9 cm below the long term average for this month. The annual trend was a decreasing one, from 40.8 cm in January to 6.5 cm in December 2011. The annual average was only + 5.7 cm higher than the long term annual average (1933 - 2010).

The **phytoplankton** composition included 173 species, with varieties and forms belonging to 7 taxonomic groups (Bacillariophyta, Dinoflagellata, Chlorophyta, Cyanobacteria, Chrysophyta, Euglenophyta and Cryptophyta). The largest number of species (112 species) were identified in transitional waters, where marine species were joined by freshwater and fresh-brackish water species.

**Algal blooms**, as an indicator of the eutrophication impact on the marine environment, showed a decreasing trend both in the number of events and also the number of blooming species. During 2011, only three species produced developments over one million cells per liter.

The **non-trophic zooplankton** recorded lower values compared to the previous year, the peak development stage occurring in July, in station Portița 4. The **trophic** component recorded the maximum development values in the shore area of the southern littoral, on the Costinești profile, in May. Throughout the year, copepods dominated the trophic component, both as biomass and as density.

**Phytobenthos:** during 2011, 25 macroalgal taxa were identified, classified as follows: 10 belonging to the Chlorophyta phylum, 4 species belonging to the phylum Phaeophyta (*Cystoseira barbata* and *Punctaria latifolia*, an epiphyte, in early smmer, at 3 m depth), 9 species belonging to the Rhodophyta phylum and 2 Phanerogama (*Zostera noltii* and *Potamogeton pectinatus*).

The **zoobenthos**, as eutrophication status indicator, still showed a constant evolution, in terms of species diversity. The qualitative assessment on all monitored areas led to the record of 53 macrozoobenthic species, the faunistic panel keeping the characteristics of previous years. Among the multiannual number of species evolution present in the Romanian water sectors, a slight but continuous tendency to qualitative balancing was observed, if compared with the 1990s period, when the benthic fauna was represented by a maximum of 28 species. It includes 220 species categorized under 8 IUCN categories (in accordance with IUCN categories v. 3.0/ 2003 and their application guidelines, version 2004 and 2006), namely: 19 macrophytes and higher plants (9%), 56 invertebrates (25%), 141 fish (24%) and 4 mammals (2%).

The **Red List** of macrophyte, invertebrate, fish and mammal species, state indicator for biodiversity in the Romanian Black Sea sector, was entirely updated in 2008 and just for fish in 2009.

The **state of marine fishery stocks**: the stock biomass for the main fish species indicates:

- for ***sprat***, which generally had a natural fluctuation, the biomass is almost normal and a fair stock, the biomass being estimated similarly to the past 5 years to approx. 60,000 tons, compared to 45,000 tons/2005 and 14.750 tons/2006, when, due to special hydro-climatic conditions, the species aggregated in other areas of the Black Sea;
- for ***whiting***, the biomass was estimated to 21,000 tons, almost three times higher than estimations during 2005-2008, when it ranged between 6,000 and 8,500 tons;
- for ***turbot***, the biomass was estimated at approx. 1,150 tons, equal to the previous year, yet smaller compared to 2008-2009 and close to the period 2005-2007;

- for ***dogfish***, the biomass was approximately 10,000 tons, about equal to the one estimated in 2010, but four-five times higher compared to 2009 (2,500 tons).

**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 Danube shad). As in previous years, we point out the low share of some species, such as dogfish, needlefish, mullet and bluefish, but also the occurrence as isolated specimens of blue mackerels (mackerel) and bonito.

**The fishing effort** continues the trend of reduction reported since 2000. Thus, in 2011, in the case of specialized active fishing (using the pelagic trawler), two vessels were operational, while for stationary fishing a total number of 198 crafts were used, namely 41 boats smaller than 6 m and 156 boats sized between 6-12 m and one larger craft (18-24 m).

**The total catch** continued the downturn after 2000, from over 2,000 tons between 2001-2002 to 1,390-1,940 tons between 2003-2006 and below 500 tons in the past five years (2007-2011), namely 435 t/2007, 444 t/2008, 331 t/2009, 258 t/2010 and 568 t/2011.

The **Total Admissible Catch (TAC)** of the main fish species caught between 2007-2011 remained at the same level.

During 2011, the **Maritime Spatial Planning** studies and research were continued and developed. The objectives realized in 2011 implied the scientific and technical support for the elaboration of the Action Plan necessary for the integrated marine strategy and policies case studies of the central and southern coast, main cities, resorts and marine protected areas: Mamaia Bay, Eforie North, Eforie South, Vama Veche.

The permanent assessment of risks and impacts of natural conditions, traditionally unstable, is continuously updated with the information on human impact, which negatively influences, ecologically and economically, the coastal area. 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.

* * *

***To sum up, the current state of the marine and coastal environment in 2011, outlined in an indicative manner, confirms the general trend of slight improvement in the parameters mentioned and can be compared to a convalescent person, whose health equilibrium is extremely fragile and an inappropriate human intervention might have disastrous effects.***

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

## Chapter 1 - WATER

### 1.1. . State of the Black Sea Waters
#### 1.1.1. 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 2011 is based on 149 samples collected from surface water and seawater column (0-50 m) during two oceanographic surveys (May 11-14, N=51 and July 4-8, N=98) from the 44 stations network, located between Sulina and Vama Veche, during six oceanographic surveys, 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:

- transitory waters - 10 stations (Sulina, Mila 9, Sf. Gheorghe, Portiţa, - down to the 20 m isobath inclusively);
- coastal water - 23 stations (Gura Buhaz, East Constanţa, Cazino Mamaia, Constanţa North, Constanţa South, Eforie, Costineşti, Mangalia, Vama Veche, - down to the 20 m isobath inclusively); and
- marine waters - 11 stations (all stations in the network located between the 30 m and 50 m isobaths).

The long term statistical analysis was performed based on daily collected data in 2011, from the Cazino Mamaia 0 m station, and historical data (1959-2010) held for the same sample collection point.

The general physical-chemical indicators and those characterizing the eutrophication status: transparency, temperature, pH, salinity, dissolved oxygen, inorganic nutrients were analysed.

Temperature was measured in-situ, with the reversible thermometers of the Nansen sample collecting equipment. 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. Nutrients were analysed through spectro-photometric methods, internally validated in the SR EN ISO/CEI 17025:2005 certified laboratory. The “Methods of Seawater Analysis” (Grasshoff, 1999) manual was the main reference. The limits of detection and relative extended uncertainties, k=2, coverage factor, 95.45%, are given in Table 1.1.1.1. The equipment used for measurement was an UV-VIS Shimadzu spectro-photometer with measuring interval: 0-1,000 nm.

**Table 1.1.1.1.**
**Limit of detection and relative uncertainties for dissolved nutrients analysis**

| No. | Parameter | MU | 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 |

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

### 1.1.1.1. General Indicators

***Temperature***

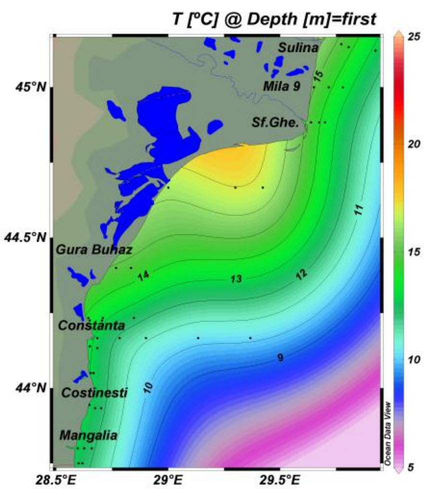
During May-July 2011, seawater temperature along the Romanian coastline recorded values ranging between 5.4°C and 25.0°C (average temperature 15.2°C, median 14.90°C and standard deviation 5.2°C). The minimum values were registered at depths below 10 m in the water column (Table 1.1.1.1.1.)

**Table 1.1.1.1.1.**
**Main values of seawater temperature on the Romanian coast in 2011**

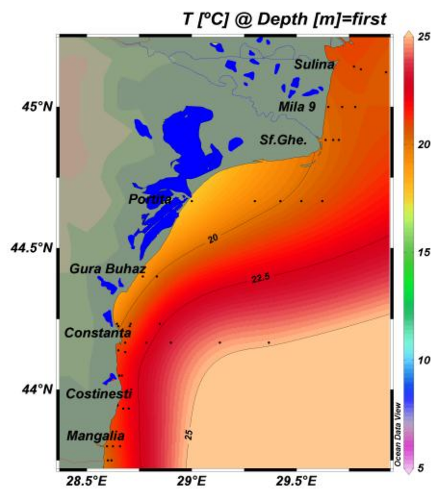
| Water body | Sample no. | Min. (°C) | Station | Month | Max. (°C) | Station | Month | Median (°C) | St. Dev. (°C) |
|---|---|---|---|---|---|---|---|---|---|
| **Transitional waters** | 22 | **12.3** | Sf. Ghe. 20 m (10 m)* | July | **22.3** | Sulina 10 m (0 m) | July | 17.30 | 2.9 |
| **Coastal waters** | 54 | **5.4** | EC 2 (30 m) | May | **24.5** | C-ţa South 20 m (0 m) | July | 14.40 | 4.8 |
| **Marine waters** | 73 | **6.0** | EC 5 (50 m) | May | **25.0** | EC 4 (0 m) | July | 13.90 | 5.8 |

**Values from parenthesis represent water column depth*

The horizontal distributions of temperature along the Romanian coastline point out the seasonal variability of temperature, under the influence of air temperature and wind and current regime (Fig. 1.1.1.1.1).



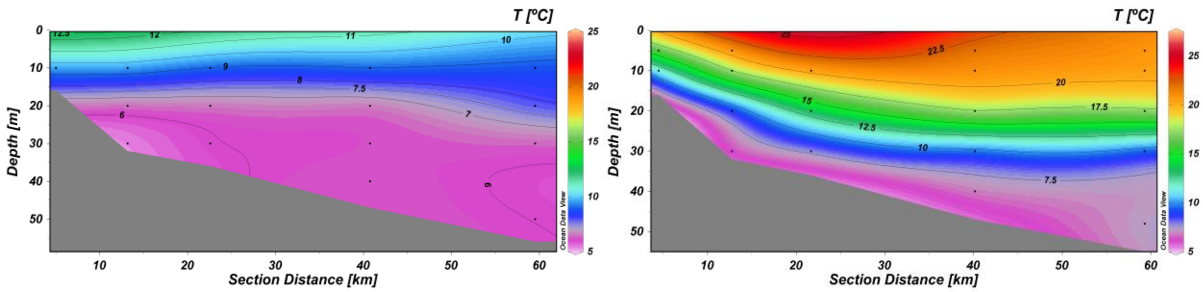

(a)




(b)

**Fig. 1.1.1.1.1. Horizontal distribution of seawater temperature along the Romanian coastline in May (a) and July (b) - 2011**

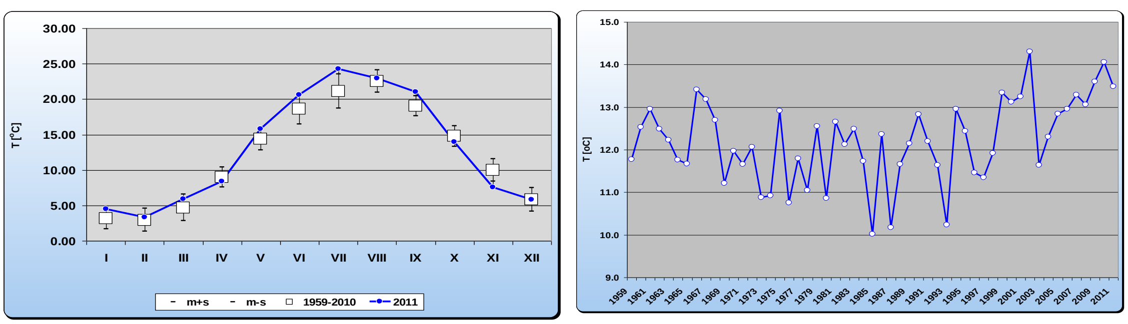
The thermocline is well outlined in marine waters in July, phenomenon which contributes to the stratification of water masses and represents a natural barrier against the sedimentary resuspension of nutrients (Fig. 1.1.1.1.2).




**(a)** **(b)**

**Fig. 1.1.1.1.2. Vertical distribution of seawater temperature - East Constanța profile, in May (a) and July (b) - 2011**

In Constanța, the absolute minimum temperature was -1.0$^o$C, on February 4. It was the only negative value recorded, however the sea did not freeze. The absolute maximum temperature, 27.2$^o$C, was measured on July 19. The mean monthly values of 2011 vary **insignificantly** in relation to the multiannual monthly averages between 1959-2010 (t test, confidence range 95%, p = 0.8298, t = 0.2175, df = 22, St. Dev. Of the difference = 3.065) (Fig. 1.1.1.1.3 a).




**(a)** **(b)**

**Fig. 1.1.1.1.3 - Comparative analysis of multiannual monthly (a) and annual (b) averages of seawater temperature in Constanța, 1959-2009 and 2011**

The multiannual mean values of seawater temperature (1959-2010) in Constanța range between 10.0$^o$C (1985) and 14.3$^o$C (2002). The average for 2011, 12.5$^o$C (std. dev. 8.1$^o$C) interrupts the temperature increase series of the past years (Fig. 1.1.1.1.3 b).

***Transparency***

**Transparency** (N=19 in May and N=34 in July) ranged between 0.5 - 10.8 m *(median 3.5 m, std. dev. 27 m).* Both extreme values were reported in July, as follows: the minimum value was recorded in Sulina 10 m, in transitional waters under the direct influence of river input, and the maximum value was recorded in East Constanța 3, in marine waters (Table 1.1.1.1.2). In all water types, the minimum values are below 2 m, the value allowed both for the ecological state, as well as for the impact area of human activity in Order 161/2006 - “Regulating Document on the Classification of Surface Water Quality with the view to Establishing the Ecological State of Water Bodies“.

**Table 1.1.1.1.2. Main values of seawater transparency on the Romanian coastline - 2011**

| Water body | Sample no. | Min. (m) | Station | Month | Max. (m) | Station | Month | Median (m) | St. Dev. (m) |
|---|---|---|---|---|---|---|---|---|---|
| **Transitional waters** | 16 | **0.5** | Sulina 10 m | July | **4.0** | Portiţa 20 m | July | 1.8 | 0.93 |
| **Coastal waters** | 20 | **1.5** | C-ța South 5 m | July | **10.0** | East Cţa 2 | July | 5.0 | 2.37 |
| **Marine waters** | 17 | **1.7** | Portiţa 30 m | May | **10.8** | East Cţa 3 | July | 4.2 | 2.78 |

The distribution of transparency medians and standard deviations points out the high variability range of marine waters, which are, in the northern area, still under the influence of river input (Fig. 1.1.1.1.4).

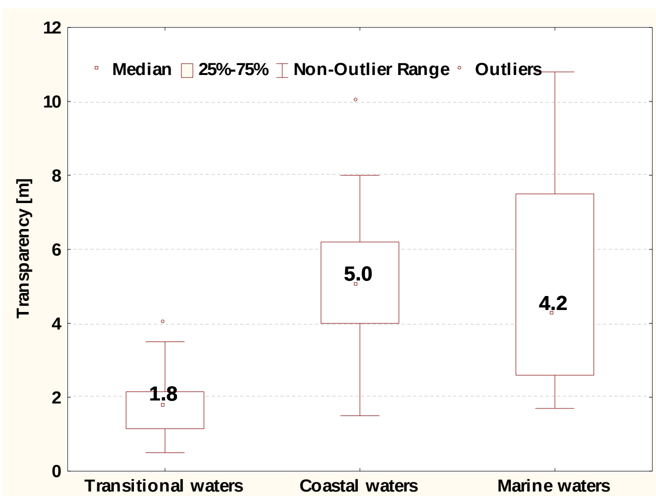



**Fig. 1.1.1.1.4. Sea water transparency (m) along the Romanian littoral - 2011**

***Salinity***

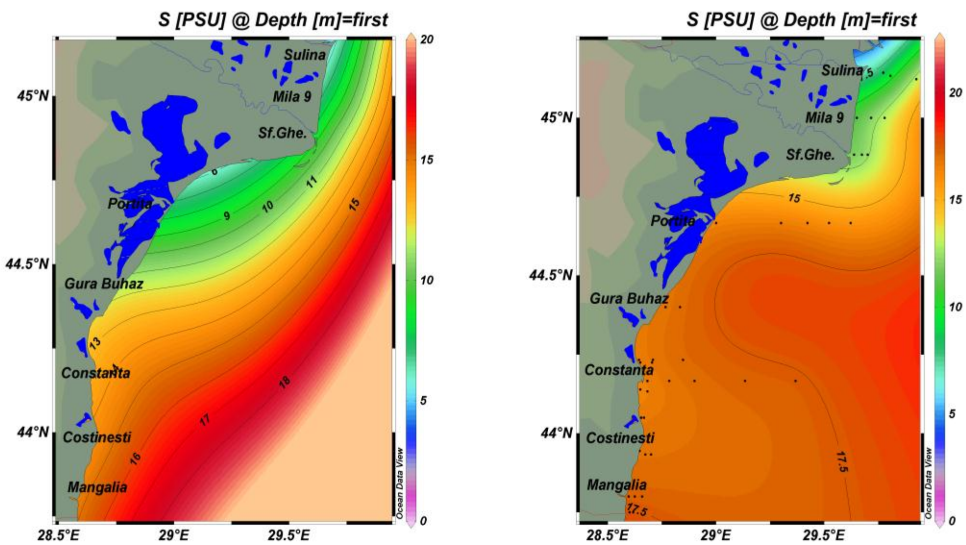
Transitional, coastal and marine waters salinity recorded values within the 1.72 - 18.91 PSU range (mean value 15.68 PSU, median 16.83 PSU and standard deviation 2.99 PSU). The minimum values were determined from surface waters due to river or anthropogenic freshwater input. The maximum value was recorded both in southern coastal and marine waters, due to the diminished influence of river input. (Tab. 1.1.1.1.3).

**Table 1.1.1.1.3**
**Main values of seawater salinity along the Romanian littoral - 2011**

| Water body | N | Min. (PSU) | Station | Month | Max. (PSU) | Station | Month | Median (PSU) | Std. Dev. (PSU) |
|---|---|---|---|---|---|---|---|---|---|
| **Transitional waters** | 22 | **1.72** | Sulina 10 m (0 m)* | July | **17.32** | Portiţa 20 m (0 m) | July | 11.67 | 4.90 |
| **Coastal waters** | 54 | **11.42** | C-ţa South 5 m (0 m) | May | **18.91** | Vama Veche 5m (0 m) | July | 16.79 | 1.73 |
| **Marine waters** | 73 | **8.19** | Mila 9 30 m (0 m) | May | **18.91** | Mangalia 30 m (30 m) | July | 16.95 | 1.61 |

**Water column sampling depth*

The salinity spatial distribution showed an increasing gradient from the Danube's mouths to the southern and offshore areas regardless of the sampling period, but with an expanded influence in May 2011 (Fig. 1.1.1.1.5).




**(a)** **(b)**

**Fig. 1.1.1.1.5.**
**Seawater salinity horizontal distribution along the Romanian coast - May (a) and July (b) 2011**

The analysis of the salinity distribution highlights the extreme values of 8.19 PSU and 10.67 PSU in marine waters, recorded at the surface in May, in stations Mila 9 30 m and Portiţa 30 m, respectively, due to river input and winds and currents regime (Fig. 1.1.1.1.6.).

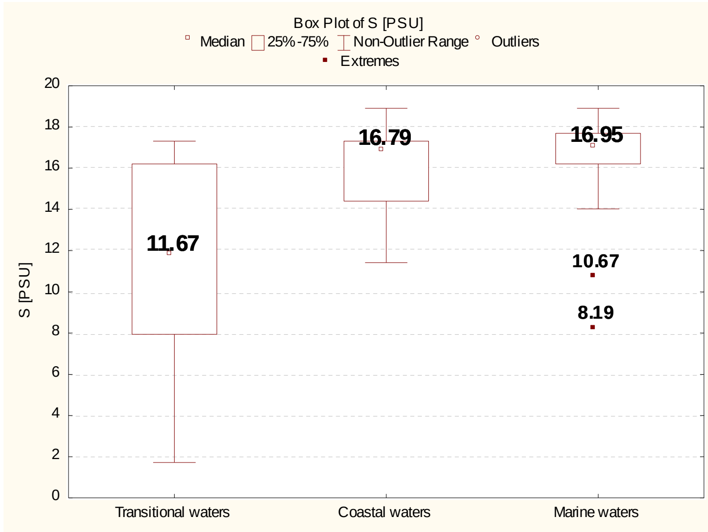
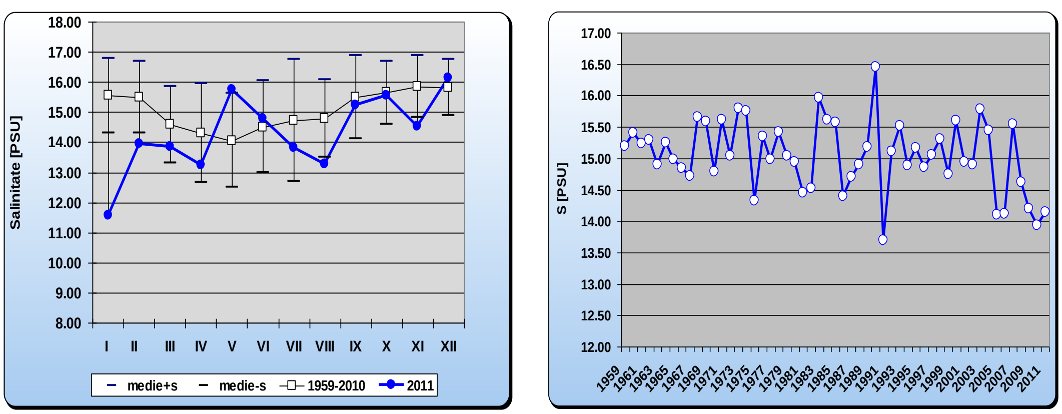



**Fig. 1.1.1.1.6. Seawater salinity (PSU) along the Romanian coast - 2011**

The long-term monthly means from 1959-2010 are not significantly different from 2011 (*t test, confidence range 95%, p=0.0830, t=1.816, df=22, Std. Dev.=0.415*). In 2011, the absolute minimum salinity at Constanța was 7.57 PSU (January 20) and the absolute maximum value was 17.87 PSU (October 28) (Fig. 1.1.1.1.7 a).




**(a)** **(b)**

**Fig. 1.1.1.1.7. Seawater salinity multiannual (a) and annual (b) means in Constanța during 1959-2010 and in 2011**

The annual mean value of salinity in 2011 (14.3 PSU) is found among the lowest of the 1959-2011 time interval (Fig. 1.1.1.1.7b).

### *pH*

Coastal waters from the Constanța area recorded pH monthly mean values ranging between 8.02 in December and 8.30 in June (*median 8.19 and std. dev.= 0.10*) (Fig. 1.1.1.1.8).

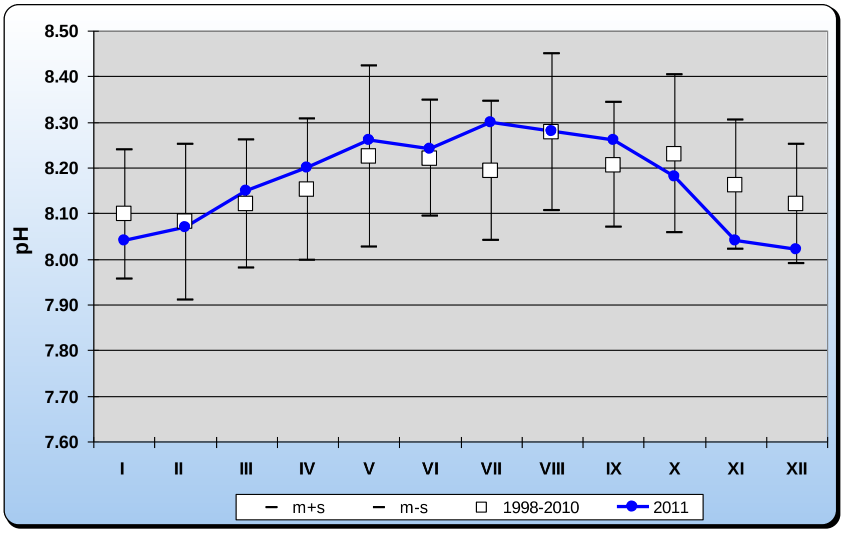



**Fig. 1.1.1.1.8. Seawater pH - multiannual and 2011 monthly means (1998-2010 and 2011)**

The pH monthly values from 1998-2010 and 2011 are **not significantly different** (*t test, confidence 95%, p=0.9243, t=0.0961, df=22, Std. Dev.=0.035*).

In May and July 2011, seawater pH ranged along the Romanian littoral within normal values: 7.37 - 8.58 (mean 8.28, median 8.33 and std. dev. 0.21) correlated with temperature (r = 0.38), oxygen saturation (r = 0.57) and silicate concentrations (r = -0.68).

***Dissolved Oxygen***

Along the Romanian littoral, the seawater dissolved oxygen concentrations oscillated between 152.3 µM (3.41 $cm^3$/l) and 495.1 µM (11.09 $cm^3$/l), mean value 306.2 µM (6.86 $cm^3$/l), median 304.6 µM (6.82 $cm^3$/l) and standard deviation 22.3 µM (0.50 $cm^3$/l) (Tab. 1.1.1.1.4).

**Table 1.1.1.1.4. Main values of seawater dissolved oxygen along Romanian littoral - 2011**

| Water body | N | Min. (µM/ $cm^3$/l) | Station | Month | Max. (µM/ $cm^3$/l) | Station | Month | Median µM/ $cm^3$/l | Std. Dev. µM/ $cm^3$/l |
|---|---|---|---|---|---|---|---|---|---|
| **Transitional waters** | 22 | **194.3** | Sulina 10 m (0 m)* | July | **495.1** | Portiţa 5 m (0 m) | May | 333.7 | 87.4 |
| | | **4.35** | | | **11.09** | | | 7.47 | 1.96 |
| **Coastal waters** | 54 | **152.3** | C-ţa South 5m (0 m) | May | **436.9** | Mangalia 20 m (0 m) | May | 303.9 | 51.1 |
| | | **3.41** | | | **9.78** | | | 6.86 | 1.06 |
| **Marine waters** | 73 | **203.6** | Portiţa 30 m (28 m) | July | **401.7** | Portiţa 30 m (28 m) | May | 302.8 | 38.1 |
| | | **4.56** | | | **9.00** | | | 6.78 | 0.87 |

**Water column sampling depth*

Spatially, the surface waters were well oxygenated both under the influence of exchanges with the atmosphere and the magnitude of photosynthetic production during spring. An exception is the minimum value 152.3 µM in coastal waters, determined in the Waste Water Treatment Plant Constanța South influence area in May due to oxygen consumption in the organic matter oxidative decomposition process (Fig. 1.1.1.1.9).

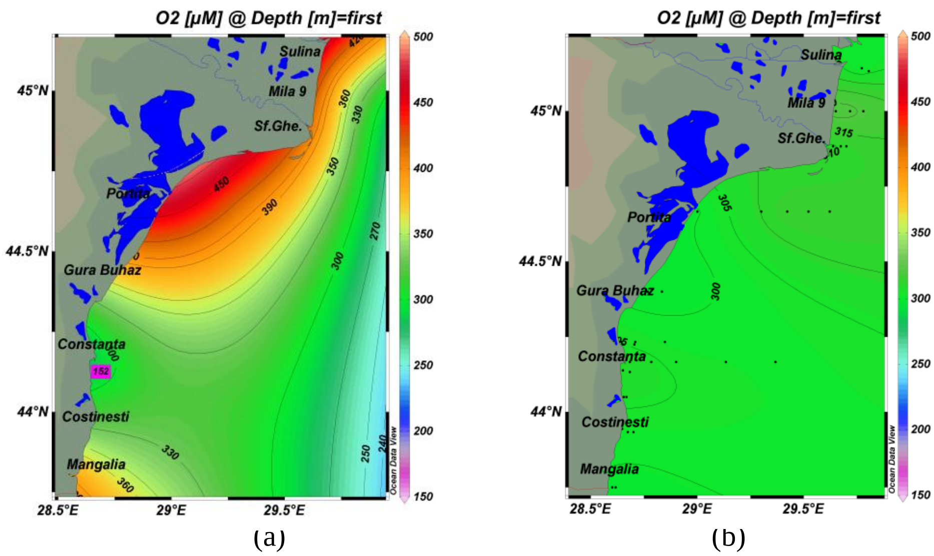



**Fig. 1.1.1.1.9. Seawater dissolved oxygen horizontal distribution along the Romanian coast - May (a) and July (b) 2011**

However, both in May and July, values below the allowed limit were also determined (80%), both for the ecological state and the impact area of human activity in Order 161/2006 - "Regulatory Document on the Classification of Surface Water Quality with the View to Determining the Ecological State of Water Bodies". These were measured in the water column, as a follow-up of organic matter decomposition and water mass stratification (Fig. 1.1.1.1.10).

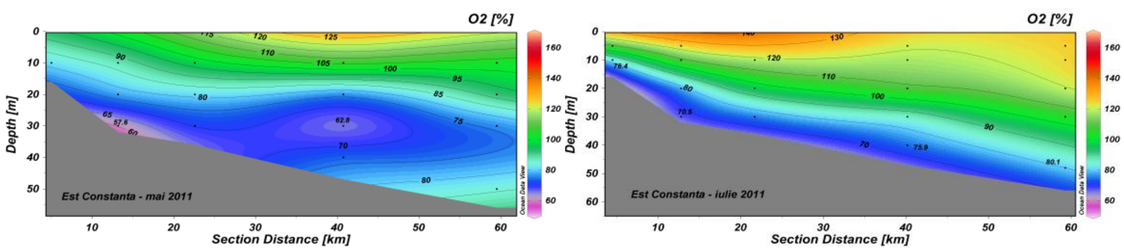
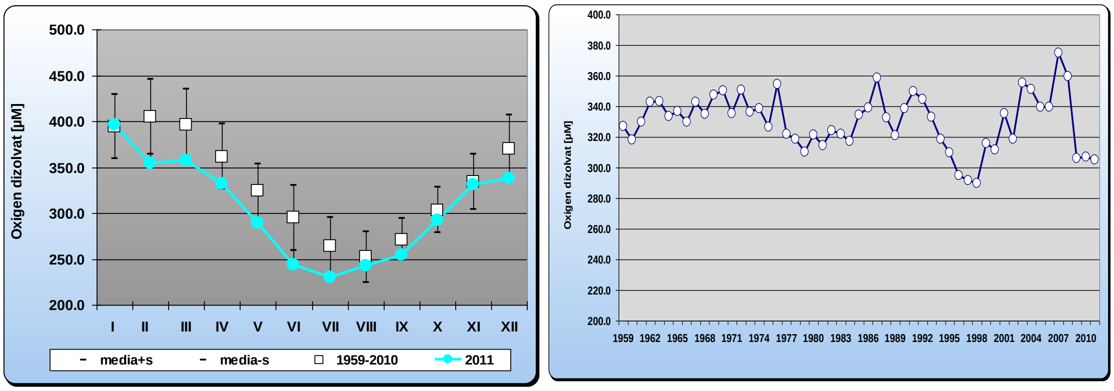



**Fig. 1.1.1.1.10. Vertical distribution of seawater oxygen saturation (%), East Constanța profile, 2011**

On the long-term, although in the warm season there is a decreasing trend compared to the characteristic range of the area, the multiannual means from 1959-2010 and 2011 are **insignificantly different** (*t test, confidence 95%, p=0.2539, t=1.1716, df=22, Std. Dev.=22.14*). Thus, the decreased values could be attributed to the natural variability of the Constanța coastal area and to the very good negative correlation with temperature (r = -0.86) (Fig. 1.1.1.1.11a). The absolute minimum, 105.0 µM, was recorded on July 15, when seawater temperatures were the highest.




**(a)** **(b)**

**Fig. 1.1.1.1.11. Seawater dissolved oxygen - multiannual and 2011 monthly means (a) and annual means 1959-2010 (b)**

Between 1959-2010, the annual mean values ranged between 289.9 µM (1998) and 374.9 µM (2007), the 2011 mean value being 305.0 µM. The annual mean value evolution highlights the maintaining of the dissolved oxygen concentrations within the downward trend of the past years (Fig. 1.1.1.1.11 b).

### 1.1.1.2. Eutrophication Indicators

***Nutrients***

**Phosphate** concentrations, **$(PO4)^{3-}$** recorded values ranging from "undetectable" to 7.30 µM (mean value 0.22 µM, median 0.10 µM and standard deviation 0.7 µM). The minimum values of all water bodies were recorded in May, due to phytoplankton consumption, specific for the season. 50% of the values measured in May (N = 53) were below the detection limit of the method (0.01 µM), including in transitional waters under the direct influence of river input (Table 1.1.1.2.1).

**Table 1.1.1.1.2.1.**
**Main values of seawater phosphates along the Romanian coast - 2011**

| Water body | N | Min. (µM) | Station | Month | Max. (µM) | Station | Month | Median (µM) | Std. Dev. (µM) |
|---|---|---|---|---|---|---|---|---|---|
| **Transitional waters** | 22 | **<LOD** | 50% of values | May | **1.48** | Sulina 10 m (0 m)* | July | 0.13 | 0.37 |
| **Coastal waters** | 54 | **<LOD** | | | **7.30** | C-ţa South 5 m (0 m) | May | 0.11 | 1.11 |
| **Marine waters** | 73 | **<LOD** | | | **1.22** | Costineşti 30 m (10 m) | July | 0.09 | 0.15 |

**Water column sampling depth*

The maximum phosphate value in Romanian waters, 7.30 µM, was determined in the coastal waters near the Waste Water Treatment Plant Constanța South in May and represents an extreme. In marine waters, the maximum was found in July, in the southern part of the littoral, at Costineşti 30 m, in the water column, due to phosphate stock regeneration by decomposing organic matter (Fig. 1.1.1.2.1).

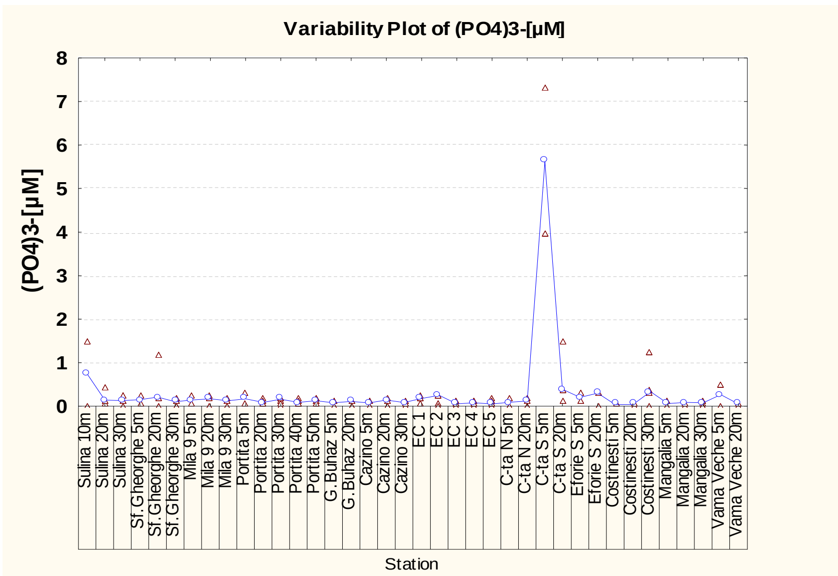



**Fig. 1.1.1.2.1. Phosphate spatial variability along the Black Sea Romanian littoral - 2011**

With 95% of values below 0.5 µM, phosphate concentrations in the Romanian marine waters represent values close to those of the reference period of the 1960s (Fig. 1.1.1.2.2).

On the long-term, the monthly means of 2011 are **significantly different** (*t test, confidence 95%, p<0.0001, t=7.7741, df=22, Std. Dev.= 0.114*) from the multiannual averages for 1960-2010, due to the low concentrations of 2011 (Fig. 1.1.1.2.3 a).

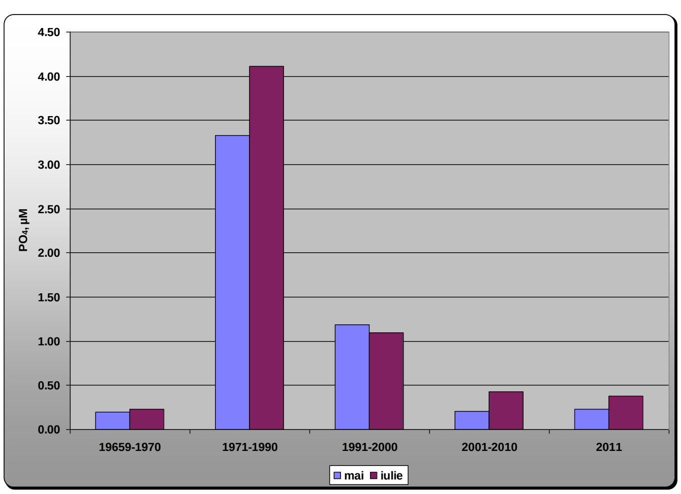
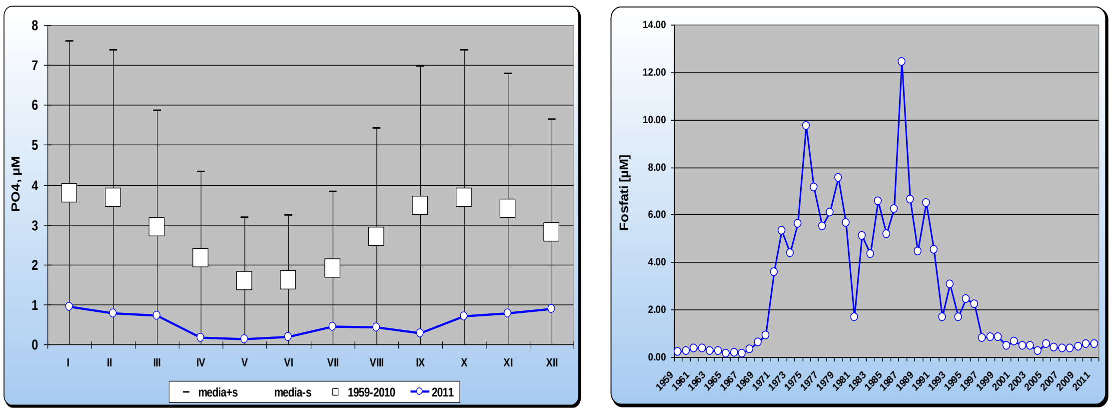



**Fig. 1.1.1.2.2 - Comparison between multiannual monthly means (May and July) of surface waters phosphate concentrations from the Romanian Black Sea - 1959-2011**

During 1960-2010, the annual means of phosphate concentrations ranged between 0.13 µM (1967) and 12.44 µM (1987) (*median 1.29 µM, std. dev. 2.97 µM*). The increased concentrations of the intense eutrophication period (1970-1990) started to decrease since 1987. The annual mean of 2011, 0.54 µM, is still within the characteristic range of the pristine reference period of the 1960s (Fig. 1.1.1.2.3 b).




**(a)** **(b)**

**Fig. 1.1.1.2.3 - Seawater phosphates - multiannual 1960 - 2010 (a) and 2011 monthly means (b)**

**Nitrates $(NO_3)^-$** recorded concentrations ranging from 1.08 µM to 70.97 µM (mean value 8.69 µM, median 5.68 µM and standard deviation 9.88 µM) (Tab. 1.1.1.2.2).

**Table 1.1.1.2.2.**
**Main values of seawater nitrates along the Romanian coast - 2011**

| Water body | N | Min. (µM) | Station | Month | Max. (µM) | Station | Month | Median (µM) | Std. Dev. (µM) |
|---|---|---|---|---|---|---|---|---|---|
| **Transitional waters** | 22 | **2.92** | Sulina 20 m (10 m)* | July | **50.33** | Sulina 10 m (0 m) | July | 10.69 | 14.97 |
| **Coastal waters** | 54 | **1.08** | EC 1 (5 m) | July | **70.97** | C-ţa South 5 m (0 m) | May | 6.89 | 10.97 |
| **Marine waters** | 73 | **1.81** | Costineşti 30 m (10 m) | July | **30.66** | Mila 9 30 m (0 m) | May | 5.22 | 4.14 |

**Water column sampling depth*

The minimum nitrate concentration values were determined in July, in the water column. The maximum concentrations were recorded in July both in the transitional waters and northern marine waters due to river input and in May in the coastal waters near the waste water treatment plants of Constanța and Mangalia. Thus, unlike the phosphates, the main nitrate source seems to be the river input, where 50.33 µM is normal for the transitional waters (Fig. 1.1.1.2.4).

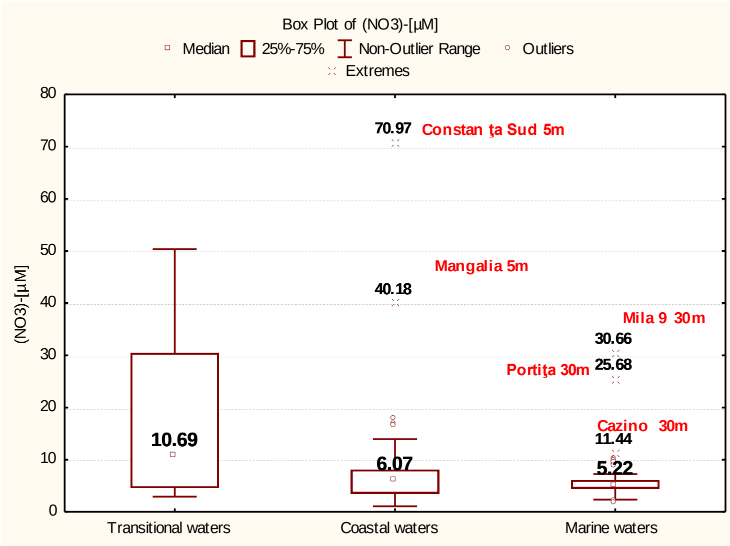



**Fig. 1.1.1.2.4. Seawater nitrate concentrations along the Romanian coast in May and July - 2011**

Nitrate monthly mean concentrations, for May and July 2011, are still comparable with those of the intense eutrophication period, but the effects of the nutrient input are of lesser intensity due to phosphate concentration reduction, limitative factor of phytoplankton proliferation (Fig. 1.1.1.2.5).

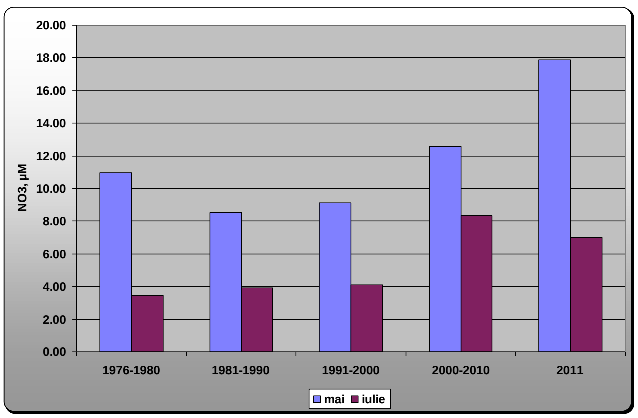
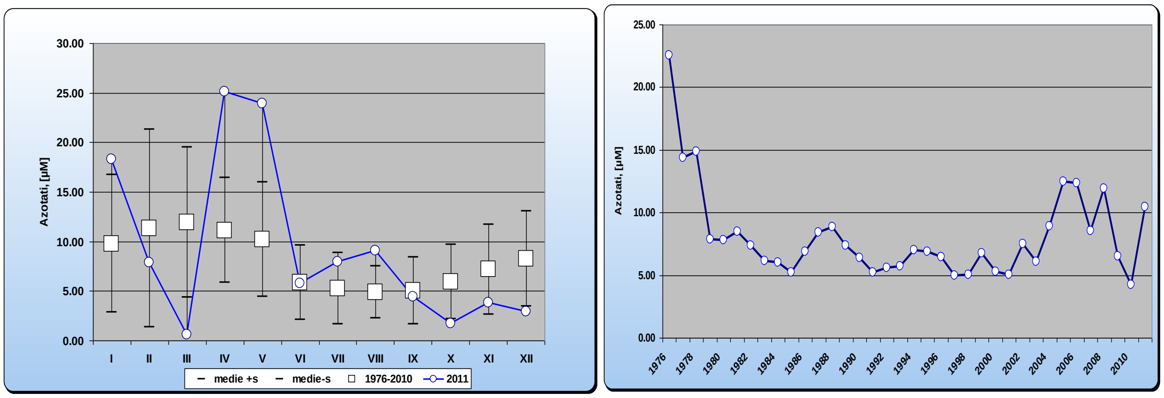



**Fig. 1.1.1.2.5. Comparison between the multiannual monthly means (May and July) of surface waters nitrate concentrations from the Romanian Black Sea coast - 1976-2011**

At Constanţa, the monthly multiannual means of 1976-2010 and 2011 are **insignificantly different** (*t test, confidence 95%, p=0.6349, t=0.4815, df=22, Std. Dev.=2.565*) (Fig. 1.1.1.2.6 a). However, in April and May, high values were recorded, which contributed to the nutritional requirements of the blooming phenomena.

On the long-term, concentrations ranged between 4.21 µM (2010) and 22.55 µM (1976) (*median 6.89 µM, std. dev. 3.66 µM*). The annual mean of 2011 increased up to 10.47 µM (Fig. 1.1.1.2.6 b).




**(a)** **(b)**

**Fig. 1.1.1.2.6. Comparison between the multiannual (a) and annual (b) mean values of nitrate concentrations in seawater in Constanța between 1976-2010 and 2011**

**Nitrites, $(NO2)^-$**, intermediary forms of redox processes which are involving inorganic nitrogen species, recorded concentrations from 0.02 µM to 6.17 µM (mean value 0.63 µM, median 0.29 µM and standard deviation 0.98 µM) (Tab. 1.1.1.2.3).

**Ammonium, $(NH4)^+$**, the polyatomic ion in which nitrogen holds the maximum oxidation number (+3), is the easiest biologically assimilable inorganic nitrogen form. Ammonium concentrations ranged within “undetectable” - 63.94 µM (mean value 4.62 µM, median 2.83 µM and standard deviation 7.31 µM) (Tab. 1.1.1.2.4).

**Table 1.1.1.2.3. Main values of seawater nitrites along the Romanian coast - 2011**

| Water body | N | Min. (µM) | Station | Month | Max. (µM) | Station | Month | Median (µM) | Std. Dev. (µM) |
|---|---|---|---|---|---|---|---|---|---|
| **Transitional waters** | 22 | **0.06** | Mila 9 20 m (10 m)* | July | **6.17** | Sulina 10 m (0 m) | July | 0.92 | 1.34 |
| **Coastal waters** | 54 | **0.07** | C-ța North 20 m (10 m) | July | **4.04** | EC 2 (30 m) | July | 0.34 | 1.00 |
| **Marine waters** | 73 | **0.02 LOD** | Sulina 30 m (20 m) | July | **4.01** | Cazino 30 m (20 m) | July | 0.15 | 0.79 |

**Water column sampling depth*

**Table 1.1.1.2.4. Main values of seawater ammonium concentrations along the Romanian coast - 2011**

| Water body | N | Min. (µM) | Station | Month | Max. (µM) | Station | Month | Median (µM) | Std. Dev. (µM) |
|---|---|---|---|---|---|---|---|---|---|
| **Transitional waters** | 22 | **1.10** | EC 2 (10 m)* | July | **17.85** | Portița 5 m (0 m) | May | 5.62 | 4.08 |
| **Coastal waters** | 54 | **0.18** | Portiţa 20 m (10 m) | July | **63.94** | C-ţa South 5m (0 m) | May | 3.65 | 11.02 |
| **Marine waters** | 73 | **0.07 <LOD** | EC 5 (20 m) | May | **19.20** | Cazino 30 m (0 m) | May | 1.78 | 2.61 |

**Water column sampling depth*

All maximum values exceeded the limit (0.1 mg/dm$^3$ and 7.14 µM, respectively), both for the ecological state and the anthropogenic impact area of Order 161/2006 - "Regulatory Document on the Classification of Surface Water Quality with the View to Determining the Ecological State of Water Bodies" (Tab. 1.1.1.2.4). The influence of the Constanța South Waste Water Treatment Plant was also felt for the ammonium, which had an extreme concentration in May.

The dominant form for the inorganic nitrogen compounds was represented by nitrates (Fig. 1.1.1.2.7).

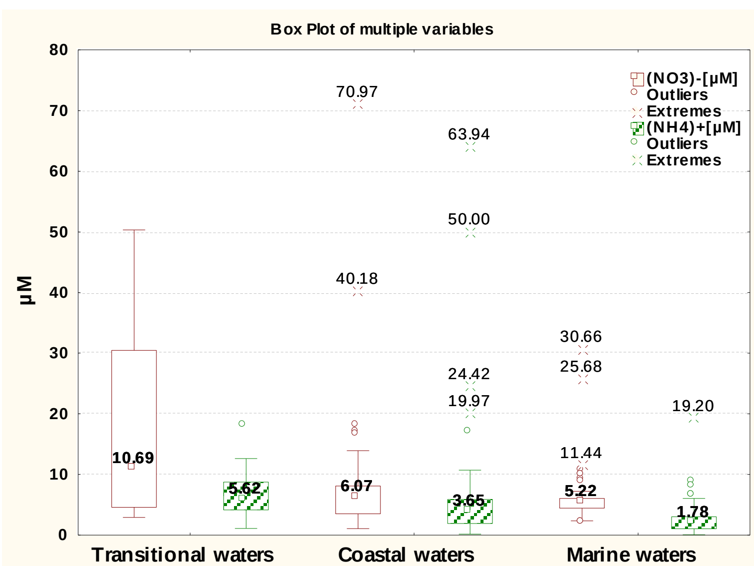



**Fig. 1.1.1.2.7. Seawater nitrate and ammonium concentrations along the Romanian littoral - 2011**

**Silicates (SiO4)$^{4-}$** had concentrations within the 0.3-24.2 µM range (mean value 4.8 µM, median 3.1 µM and standard deviation 5.0 µM), with higher values in summer, in the water column (Tab. 1.1.1.2.5).

**Table 1.1.1.2.5.**
**Main values of seawater silicate concentrations along the Romanian coast - 2011**

| Water body | N | Min. (µM) | Station | Month | Max. (µM) | Station | Month | Median (µM) | Std. Dev. (µM) |
|---|---|---|---|---|---|---|---|---|---|
| **Transitional waters** | 22 | **0.3** | Mila 9 20 m (10 m)* | July | **24.2** | Sulina 10 m (0 m) | July | 1.7 | 7.4 |
| **Coastal waters** | 54 | **0.2 LOD** | Costineşti 5 m (0 m) | May | **15.7** | EC 2 (20 m) | July | 3.3 | 4.0 |
| **Marine waters** | 73 | **0.2 LOD** | Mangalia 30 m (0 m) | May | **20.2** | Costineşti 30 m (20 m) | July | 3.4 | 4.8 |

**Water column sampling depth*

Given the fact that silicon contained in diatoms is not soluble as long as they are alive, the increased concentrations from July, in the water column, may represent a consequence of the dissolution of biogenic silicon derived from decomposed diatoms (Fig. 1.1.1.2.8).

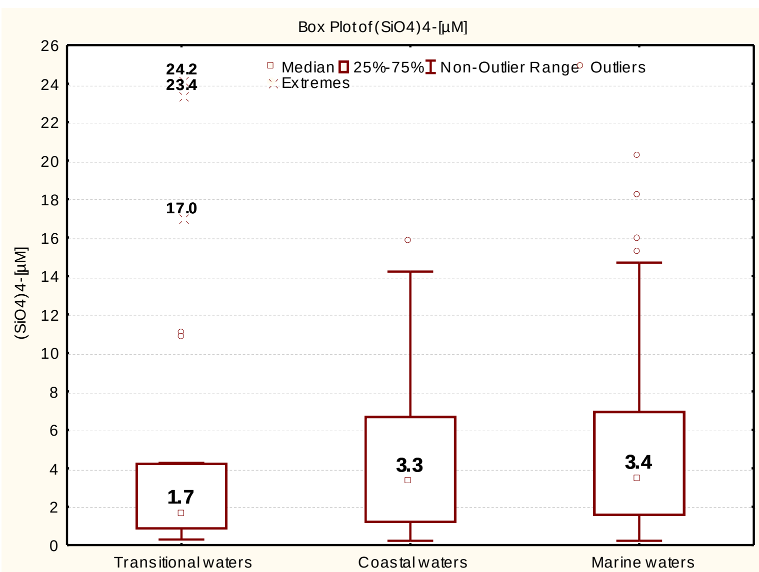



**Fig. 1.1.1.2.8. Distribution of the seawater dissolved silicate concentrations at the Romanian coast in May and July - 2011**

Since the main source of silicates in the Romanian Black Sea coast waters is the river input, the lower flows of the Danube in 2011 influenced the decrease of the mean concentrations down to levels 2-3 times lower than those of the reference period, respectively the 1960s (Fig. 1.1.1.2.9).

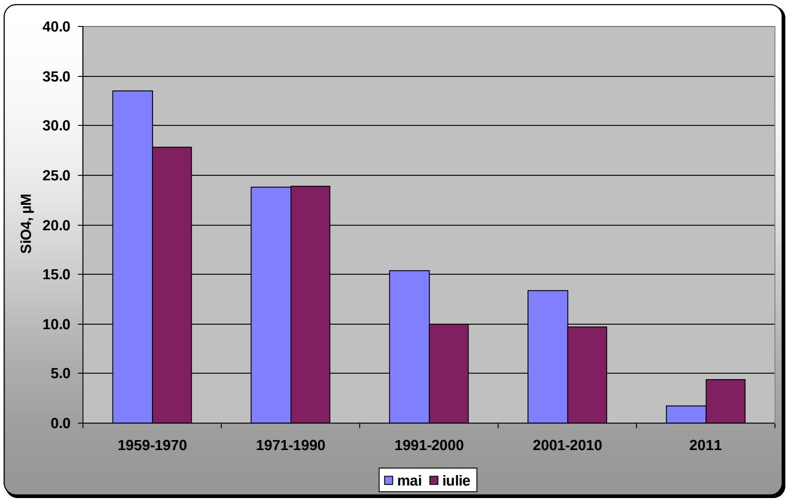
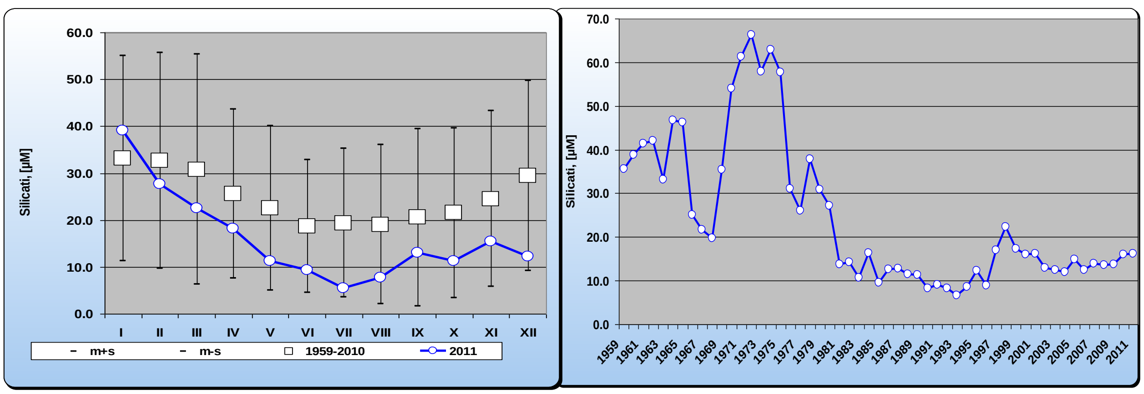



**Fig. 1.1.1.2.9. Comparison between the multiannual monthly means (May and July) of surface waters silicate concentrations from the Romanian Black Sea 1959-2011**

Although the monthly means of 2011 are framing within the specific range of the 1959-2010 period, they are significantly different (*t test, confidence 95%, p=0.0120, t=2.7395, df=22, Std. Dev.=3.179*) due to concentration levels still lower compared to the 1960s (Fig. 1.1.1.2.10 a).




(**a**) (**b**)

**Fig. 1.1.1.2.10. Comparison between multiannual (a) and annual means of seawater silicate concentrations in Constanța between 1976-2010 and in 2011**

The seawater silicate annual mean concentrations range within 6.7 µM (1993) and 66.3 µM (1972) (median 16.3 µM, std. dev. 16.8 µM) and, in 2011, the mean value 16.1 µM (Fig. 1.1.1.2.10b).

***

Thus, as concerning the **general indicators**, the following aspects resulted:

The surface seawater **temperature** frames within the specific variability range along the Romanian coast. The thermocline set in the warm season could contribute to water masses stratification and to the limitation of nutrient resuspension from sediments.

The Black Sea water **transparency** oscillated in the warm season between 0.5 - 10.8 m. The transparency distribution points out high variability in marine waters, which are still under river influence in the northern area.

The surface seawater **salinity** frames into the specific variability range along the Romanian coast, under the main influence of river freshwater input.

During the study period, surface seawaters were **well oxygenated** along the entire littoral in all three water bodies. In the water column there were some concentrations below the allowed limit both for the ecological state, as well as for human impact area activity pursuant to Order 161/2006 - "Regulatory Document on the Classification of Surface Water Quality with the View to Determining the Ecological State of Water Bodies". There were no anoxic events.

The seawater **pH** ranged within normal values.

The **eutrophication indicators** point out the fact that:

Seawater **phosphates** $\mathbf{(PO4)^{3-}}$ recorded concentrations within the range „undetectable" - 7.30 µM. Extreme values were determined nearby the Constanţa South Waste Water Treatment Plant. For the studied period, phosphate concentrations record values similar to the reference period of the 1960s.

Seawater **nitrates** $\mathbf{(NO3)^{-}}$ had concentrations between 1.08 - 70.97 µM, with the highest values recorded in May near the Constanţa South Wastewater Treatment Plant. However, unlike phosphates, the main nitrate source seems to be river input.

The nitrate monthly mean concentrations from May and July are still comparable to the intense eutrophication period, being the dominant form of inorganic nitrogen compounds. The effects of this nutrient input are of lesser intensity due to phosphate decreasing concentrations, limiting factors of phytoplankton proliferation.

The influence of the Constanţa South Wastewater Treatment Plant on coastal waters was also found for **ammonium**, which recorded an extreme concentration in May, exceeding the maximum allowed limit both for the ecological state, as well as for human impact area activity pursuant to Order 161/2006.

**Silicates** $\mathbf{(SiO4)^{4-}}$ showed decreasing concentrations, values ranging within 0.3 - 24.2 µM, higher under the Danube's direct influence and in the water column.

Since the main source of silicates in the Romanian Black Sea waters is the river input, the lower flows of the Danube in 2011 influenced the decrease of the mean concentrations down to levels 2-3 times lower than those of the reference period, respectively the 1960s.

Generally, in 2011, at the Romanian Black sea coast, apart from natural variability, two main nutrient sources were identified: river input and the anthropogenic contribution of the Constanța South Wastewater Treatment Plant.

**Chlorophyll *a***

Chlorophyll *a* is one of the most commonly determined biochemical parameters, being an indicator of vegetal biomass and primary productivity. Due to its importance in the marine ecosystem and also because it can be more easily measured than phytoplankton biomass, chlorophyll *a* was enlisted for the "eutrophication" domain of the EU Water Framework Directive, representing one of the impact parameters to be monitored.

The chlorophyll *a* content determined for the coastal waters from Constanța ranged between 0.23 and 33.9 µg/l. Its seasonal variation showed the first peak during winter (18.03 µg /l, in January), corresponding to the development of the diatom *Thalassiosira parva*, species characteristic for the cold season (Fig. 1.1.1.2.11). A second peak occurred in March, once with the vegetation of the diatom *Skeletonema costatum*. After late spring, generally characterized by low concentrations of chlorophyll *a*, the summer peak was recorded (33.9 µg/l in July), produced by the large-sized species *Cerataulina pelagica*.

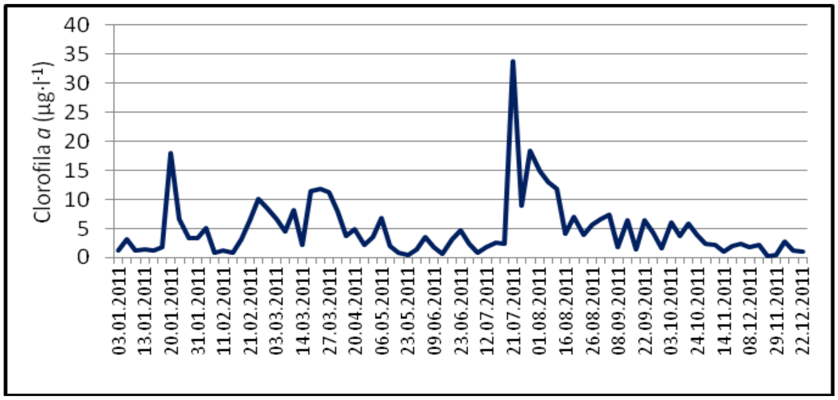



**Fig. 1.1.1.2.11. Seasonal variation of chlorophyll *a* in Romanian waters during 2011**

Analyzing the spatial distribution of chlorophyll *a* in May, a rather large variability was noted in front of the Danube mouths and on the East-Constanța profile. Thus, the values of this parameter ranged between 2.73 to 47.03 µg·l$^{-1}$, the highest being found in front of the Danube Delta (Sulina 10 m - 47.03 µg·l$^{-1}$ and Mila 9 5 m - 40 µg·l$^{-1}$). Otherwise, normal values were recorded for this period, the lowest ones being recorded in offshore waters, in the stations Cazino (CZ 30 m - 5.63 µg·l$^{-1}$), Sf. Gheorghe (SG 30 m - 5, 65 µg·l$^{-1}$) and Portiţa (PO 30 m - 6.89 µg·l$^{-1}$) (Fig. 1.1.1.2.12).

During summer, the spatial variability of chlorophyll *a* was reduced, the parameter values not exceeding 10 µg/l, except for the Constanţa area, where the maximum values were registered (EC2 surface layers - 16.73 µg/l and 5 m layer - 20.17 µg/l). For the rest, the chlorophyll *a* values ranged within normal limits, being higher than 5 µg/l in the northern Romanian littoral, due to the influence of the high input of nutrients and organic matter from the Danube.

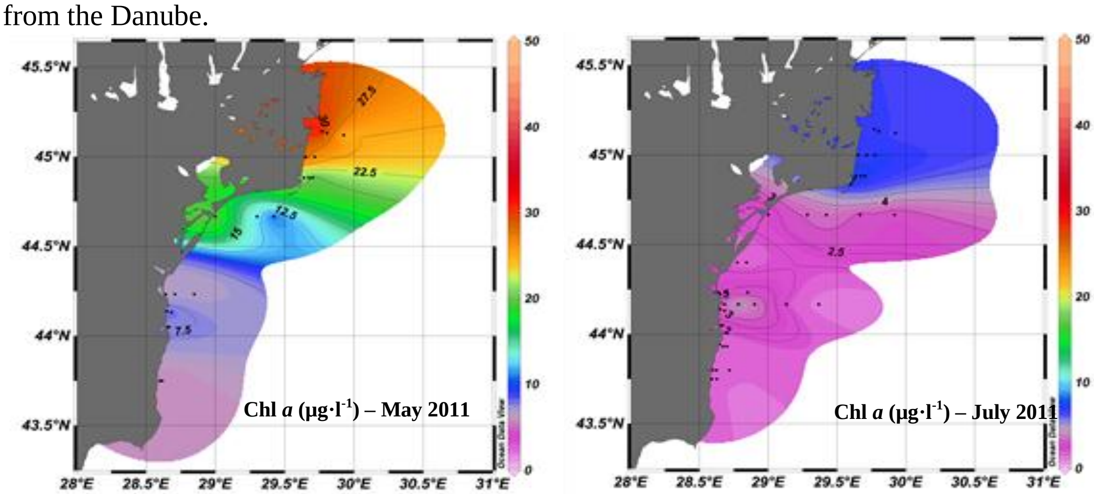



**Fig. 1.1.1.2.12.**
**The spatial distribution of the chlorophyll *a* in the Romanian waters in 2011**

In 2011, the mean annual chlorophyll *a* concentrations registered a value almost two times lower than in 2010 (4.91 to 9.51 µg/l ), but below the annual mean determined for the period 2001-2010 (6.27 µg/l), confirming the trend of the ecological status recovery of the Romanian Black Sea coastal waters registered in the past years.

### 1.1.1.3. Contamination Indicators
### 1.1.1.3.1. *Heavy Metals*

Coastal areas represent complex and dynamic systems, subjected to natural or anthropogenic influences. Heavy metal contamination of coastal areas can be correlated directly with urban or industrial sources such as factories, power plants, port facilities, sewage treatment plants. The influence of rivers is also significant, being a major source of metals, especially in particulate form, extreme hydrological events (floods) increasing this contribution. Atmospheric flows of metals, both natural and anthropogenic, are also considered to be an important input for European seas, both at coastal and river basin level.

Physico-chemical and hydrodynamic conditions in coastal areas affect the transport routes and distribution of these elements. Metals in seawater may suffer reactions of complexation, ion exchange or precipitation, followed by accumulation in sediments, from where metals can then return in the water column. Coastal sediments have a lower degree of variability compared with the water column. However, metals in sediment are not permanently fixed. Variation in physical-chemical parameters (pH, salinity, redox potential and concentration of organic ligands) causes the release of metals from sediment in the water column. High concentrations of metals in the environment affect biota by their ability to bioaccumulate, transferring along the food chain and finally to human consumers.

The monitoring of heavy metals in 2011 was conducted by analyzing samples of seawater (surface horizon), surface sediment and biota collected during the two research surveys (May and July) 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, 13 transects).

#### *Transitional, Coastal and Marine Waters*

The heavy metal concentrations determined during the year 2011 in the monitoring stations were within the following variation ranges: 0.24 - 68.70 µg/L copper; 0.02 - 1.35 µg/L cadmium; 0.01 - 51.97 µg/L lead; 0.01 - 30.59 µg/L nickel; 0.01 - 22.94 µg/L chromium. In relation to environmental quality standards for seawater recommended by national legislation (Order 161/2006), the concentrations of cadmium, nickel and chromium were within the allowed limits, while for copper and lead about 25% of samples exceeded the limits (30 µg/L Cu and 10 µg/L Pb, respectively) (Fig. 1.1.1.3.1.1).

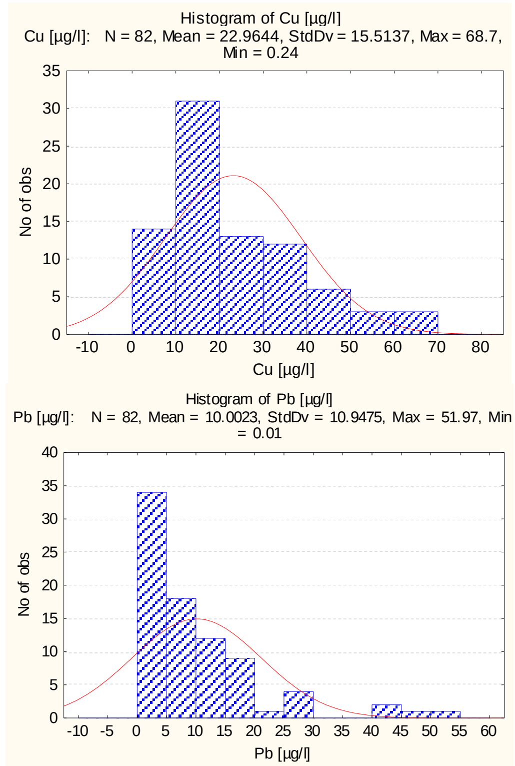
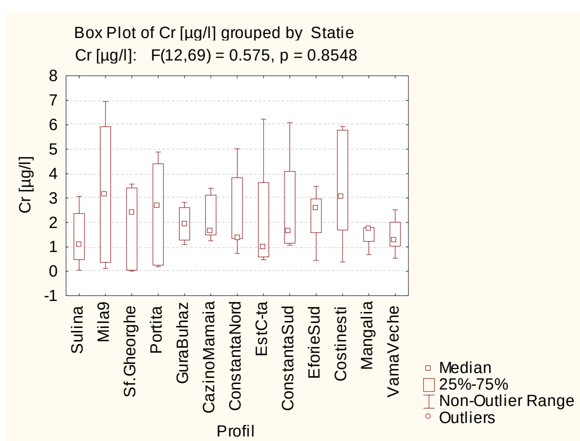



**Fig. 1.1.1.3.1.1.**
**Histograms of heavy metal concentrations in seawater samples investigated in 2011**

Regarding the differences in spatial distribution, higher values of copper (median, percentile 25 and 75) were recorded in Constanța South (harbor aquatory, wastewater treatment plant outflow), while Gura Buhaz and East Constanța were characterized by reduced values of the above mentioned parameter. High concentrations of copper, outside the normal variation (outliers), were measured in Constanța North and Eforie South (probably under the influence of discharges from wastewater treatment plants), but also in the area under river influence (Portița). The median values for chromium were higher in front of the Danube Delta and in the southern extremity of the coastal zone, in Eforie South - Costineşti



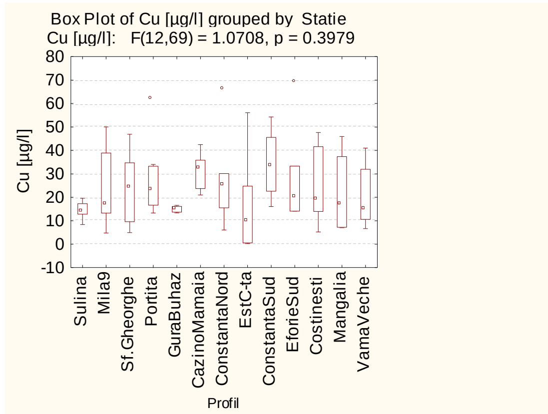



**Fig. 1.1.1.3.1.2.**
**Spatial distribution of heavy metal concentrations in seawater along the 13 transects of the national monitoring network in 2011**

The trends of heavy metals in marine waters over the past five years recorded different behaviors, depending on the investigated element. Thus, copper and lead show a slight increase in 2011, while cadmium values are reduced in comparison with previous years (2007-2010). Nickel and chromium concentrations measured in 2011 were within the ranges observed in the period 2007 to 2010 (Fig. 1.1.1.3.1.3).

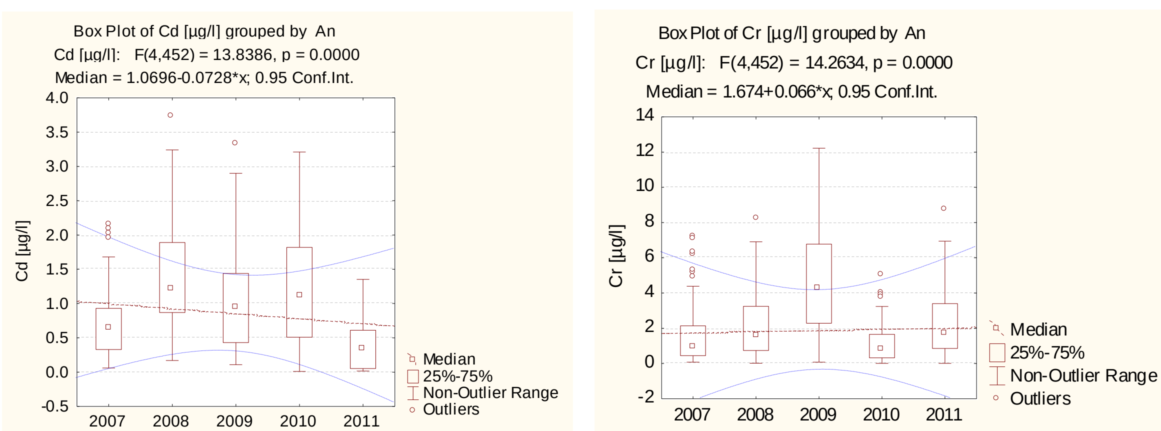



**Fig. 1.1.1.3.1.3. Trends of heavy metal concentrations in seawater during 2007 - 2011**

***Sediments***

The distribution of heavy metal in sediments is influenced by natural and anthropogenic contributions and depends of the mineralogical and granulometric characteristics of sediments. Sediments with finer texture and a higher organic matter content tend to accumulate higher concentrations of heavy metals in comparison with coarse sediments.

The heavy metal concentrations determined during the year 2011 in sediment samples were included in the following areas of variation: 3.29 - 98.87 µg/g copper; 0.01 - 9.63 µg/g cadmium; 1.18 - 134.98 µg/g lead; 0.94 - 211.73 µg/g nickel; 4.76 - 170.34 µg/L chromium. In relation to marine sediment quality standards recommended by national legislation (Order 161/2006: 40 µg/g Cu; 0.8 µg/g Cd; 85 µg/g Pb; 35 µg/g Ni; 100 µg/g Cr), it was noted that some individual concentrations measured in sediments slightly exceeded the limits, a higher share being recorded for cadmium and nickel, and a reduced one for lead and chromium (Fig. 1.1.1.3.1.4).

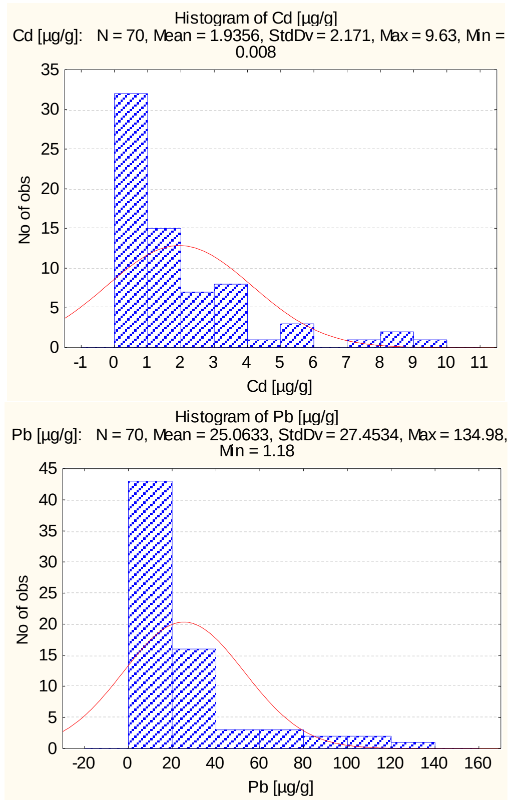



**Fig. 1.1.1.3.1.4. Histograms of heavy metal concentrations in marine sediments investigated in 2011**

The spatial distribution in different geographical areas showed a high variability, depending on the element, sediment type, distance from the shore and the influence of anthropogenic sources. Significant differences were observed especially for copper, nickel and chromium, these elements showing increased accumulations in front of the Danube mouths (Sulina - Portița) and in the Constanța South port, compared to neighboring areas. Cadmium had a more uniform distribution along the coast, still the higher median value was recorded in the Constanța South port. Normal values for most elements were noted in the central sector (East Constanța) and the southern extremity (Vama Veche) (Fig. 1.1.1.3.1.5).

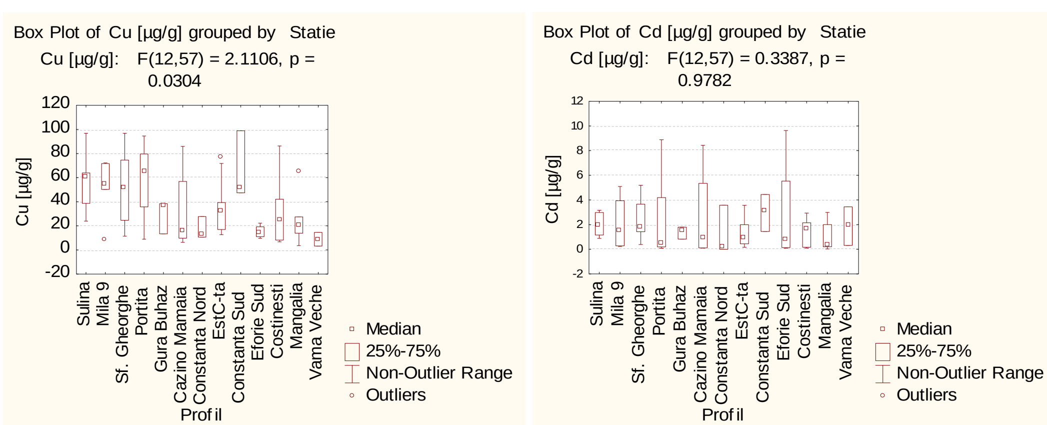



**Fig. 1.1.1.3.1.5. Spatial distribution of heavy metals in sediments along the 13 profiles from the national monitoring network in 2011**

The trends of heavy metals in marine sediments during the past five years underline the fact that the values measured in 2011 fall within the variation ranges from 2007 to 2010 (Fig. 1.1.1.3.1.6).

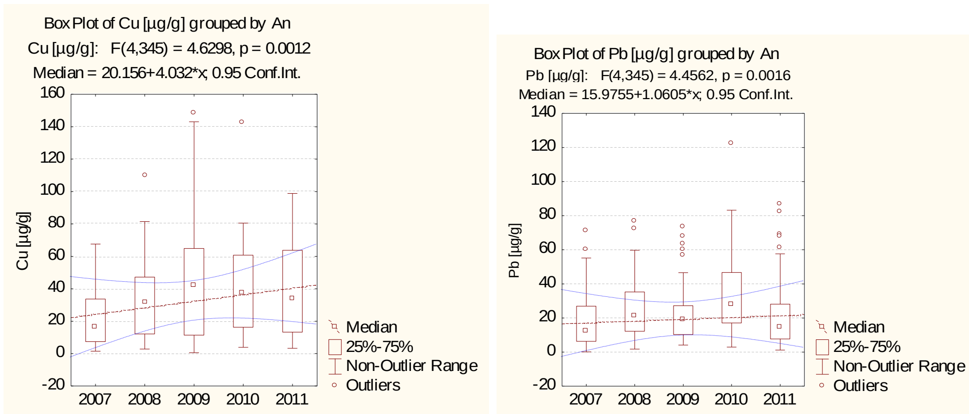



**Fig. 1.1.1.3.1.6. Trends of heavy metal concentrations in marine sediments during 2007 - 2011**

### *Marine Organisms*

The bioaccumulation of heavy metals in the tissues of marine mollusks investigated in 2011 (*Mytilus galloprovincialis*, *Rapana venosa*, *Scapharca inequivalvis*) was characterized by the following average values and variation ranges: 8.78 ± 8.59 µg/g s.p. Cu (1.90 - 24.52 µg/g s.p. Cu); 0.85 ± 0.91 µg/g s.p. Cd (0.14 - 3.74 µg/g s.p. Cd); 1.45 ± 1.19 µg/g s.p. Pb (0.02 - 4.26 µg/g s.p. Pb); 0.81 ± 0.46 µg/g Ni (0.01 - 1.91 µg/g s.p. Ni); 0.76 ± 0.45 µg/g s.p. Cr (0.19 - 1.94 µg/g s.p. Cr). Most samples showed values within the normal range of variability, although there were situations in which the measured concentrations were slightly increased, depending on the element, species or location of sampling.

Some interspecific differences in the bioaccumulation of heavy metals were observed, i.e. higher values (median, percentile 25 and 75) for copper and lead in *Rapana*, compared to the species of bivalve mollusks, which in turn had the tendency to store more nickel. (Fig. 1.1.1.3.1.7.).

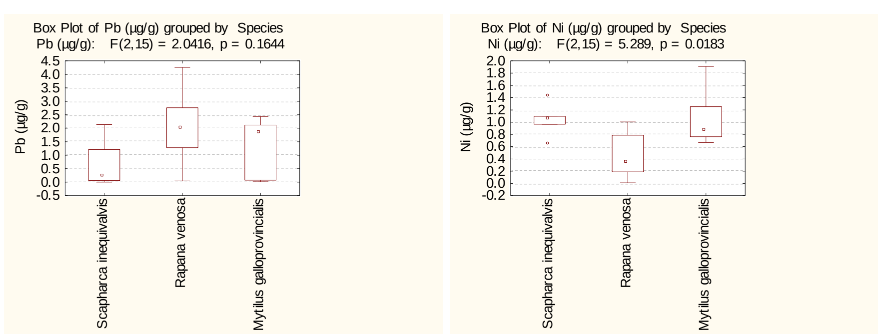



**Fig. 1.1.1.3.1.7. Interspecific differences in the bioaccumulation of heavy metals in marine mollusks**

The evolution of heavy metal bioaccumulation in *Mytilus galloprovincialis* in recent years showed a slight decrease for cadmium in 2011, while the other elements varied within the limits of variability observed in the period 2007 - 2010 (Fig. 1.1.1.3.1.8.).

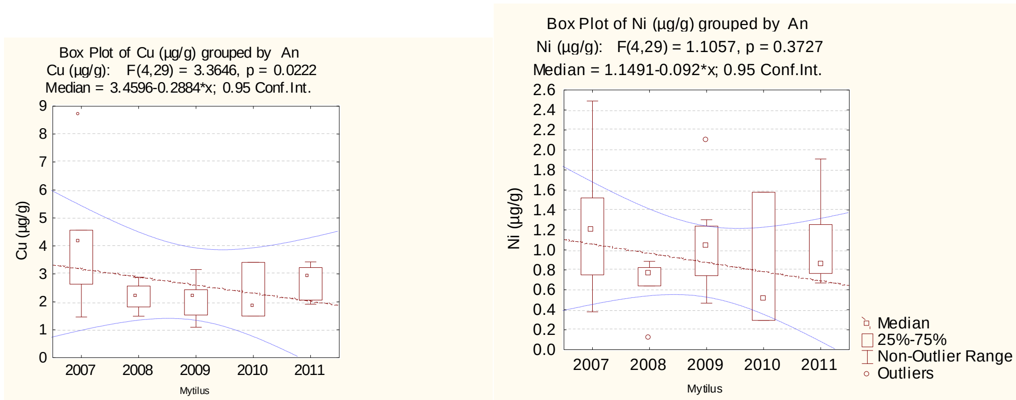



**Fig. 1.1.1.3.1.8. Trends of heavy metal concentrations in *Mytilus galloprovincialis* during 2007 - 2011**

Thus, is results that:

- the distribution of metals in waters and sediments from the transitional, coastal and marine areas highlighted the differences between different sectors of the coast, generally being reported slightly elevated concentrations in some coastal areas subject to different anthropogenic pressures (ports, sewage discharges), but also in the marine area under the influence of the Danube;

- the concentrations of most heavy metals in water, sediment and biota were generally included within the variation range of average annual values (2007 - 2010), although some trends of decreasing or, in other cases, increasing, were observed for certain elements/matrices.

### 1.1.1.3.2. Total Petroleum Hydrocarbons (TPHs)

During May - July 2011, the analysis of organic pollutants was carried out on a total 80 water and 69 sediment samples, taken from a network of 44 stations located between Sulina and Vama Veche.

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); 20 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.

In 2011, low TPH values (< 200 µg/l) were recorded in all water bodies (Fig. 1.1.1.3.2.1.). Concentrations varied within the range 10.9 - 407.5 µg/l, with an average of 103.1 µg/l. The box plot of TPHs (µg/l) grouped by typology of water bodies (Fig. 1.1.1.3.2.2.) shows significant differences between the values of the three water bodies with high level in coastal waters. The petroleum hydrocarbon pollution level recorded in 2011 is significantly lower (t test: 95% confidence interval, $p<0.0001$, $t=8.33$, $df = 517$, st. dev. = 41.13) compared to the period 2006-2010 (Fig. 1.1.1.3.2.3).

The concentration of total petroleum hydrocarbons in sediment samples ranged from 4.2 to 316.8 µg/g, with an average of 66.6 µg/g (for 69 samples). High concentrations within the range of 100.0 - 320.0 µg/g were determined in 20% of sediment samples in both the northern (Sulina - 20.30 m, - 20.30 Mila 9, St. Gheorghe - 30 m stations) and in the southern (South Constanța - 20 m, North Constanța - 20 m stations) sectors. The pollution level recorded in 2011 is significantly lower (t test: 95% confidence interval, $p <0.0102$, $t=2.61$, $df=107$, st. dev. =17.58) compared to 2010 (Fig. 1.1.1.3.2.4.).

In 2011 continued the downward trend of petroleum hydrocarbons recorded in the past period, both in water and sediment.

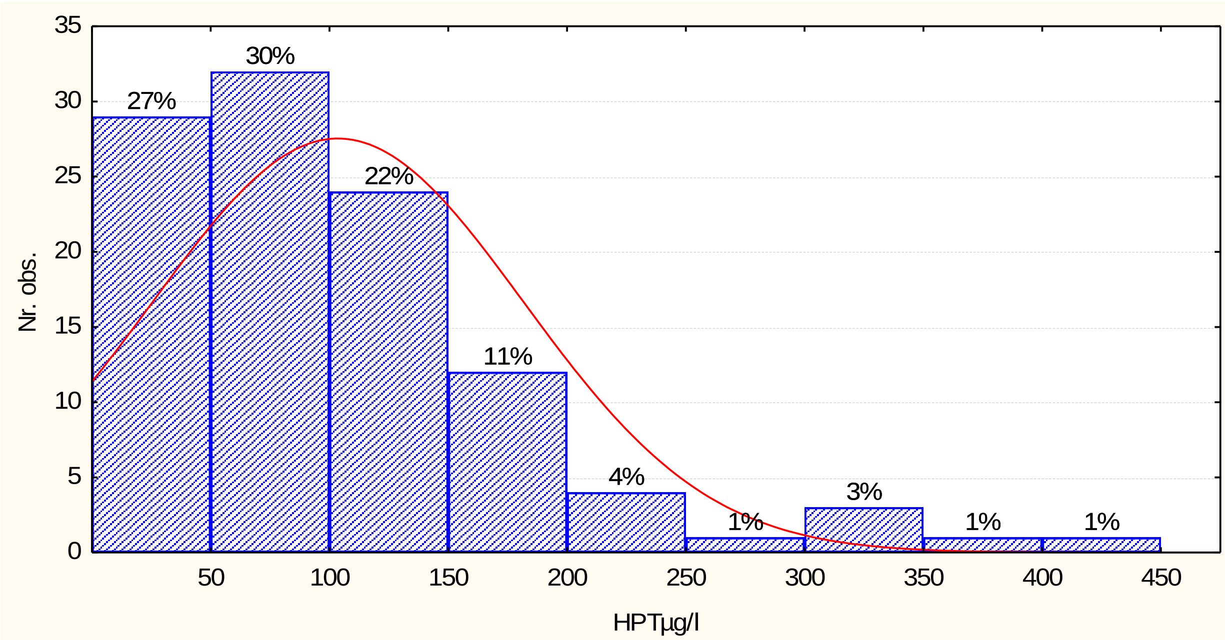



**Fig. 1.1.1.3.2.1. TPH histogram (µg/l) of water from the Romanian sector of the Black Sea in 2011**

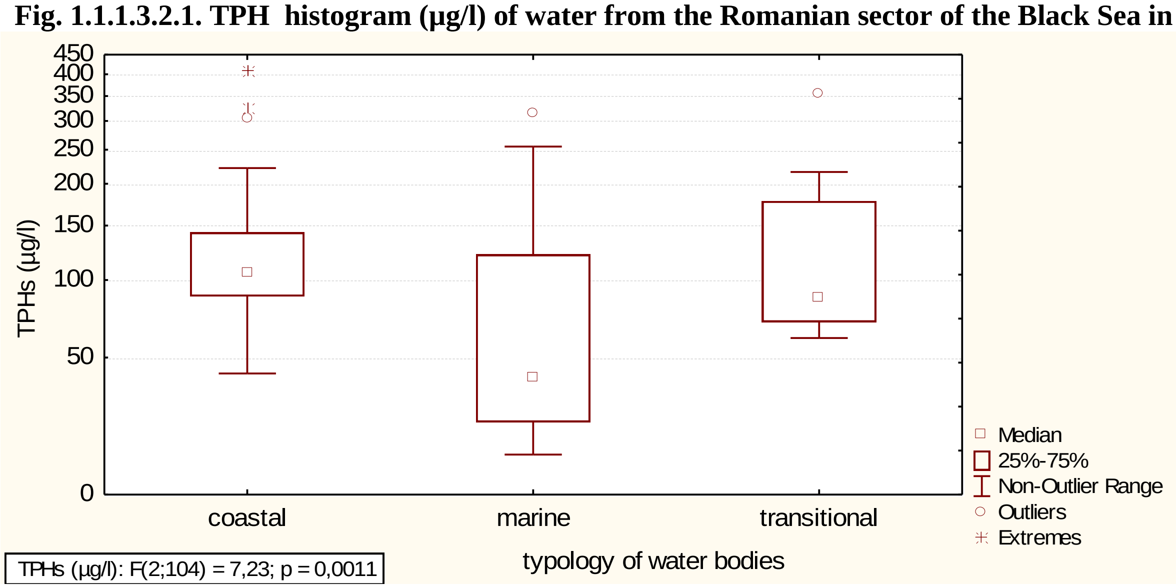



**Fig. 1.1.1.3.2.2. Box plot of TPHs (µg/l) in transitional, marine and coastal waters in 2011**

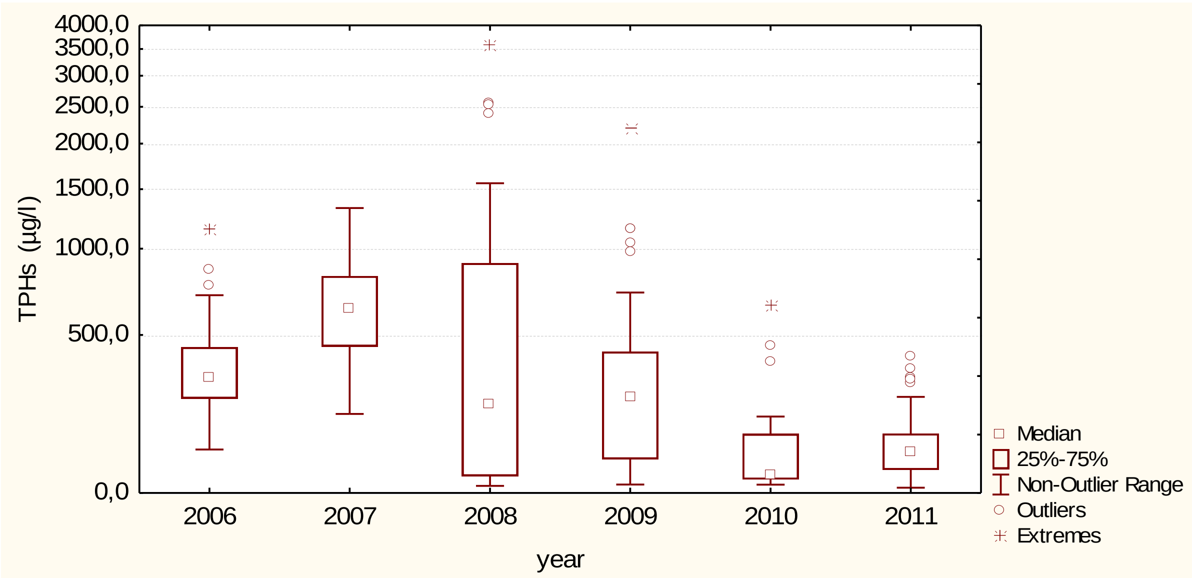



**Fig. 1.1.1.3.2.3. Box plot of TPHs (µg/l) in water grouped by year 2011 compared to 2006-2010**

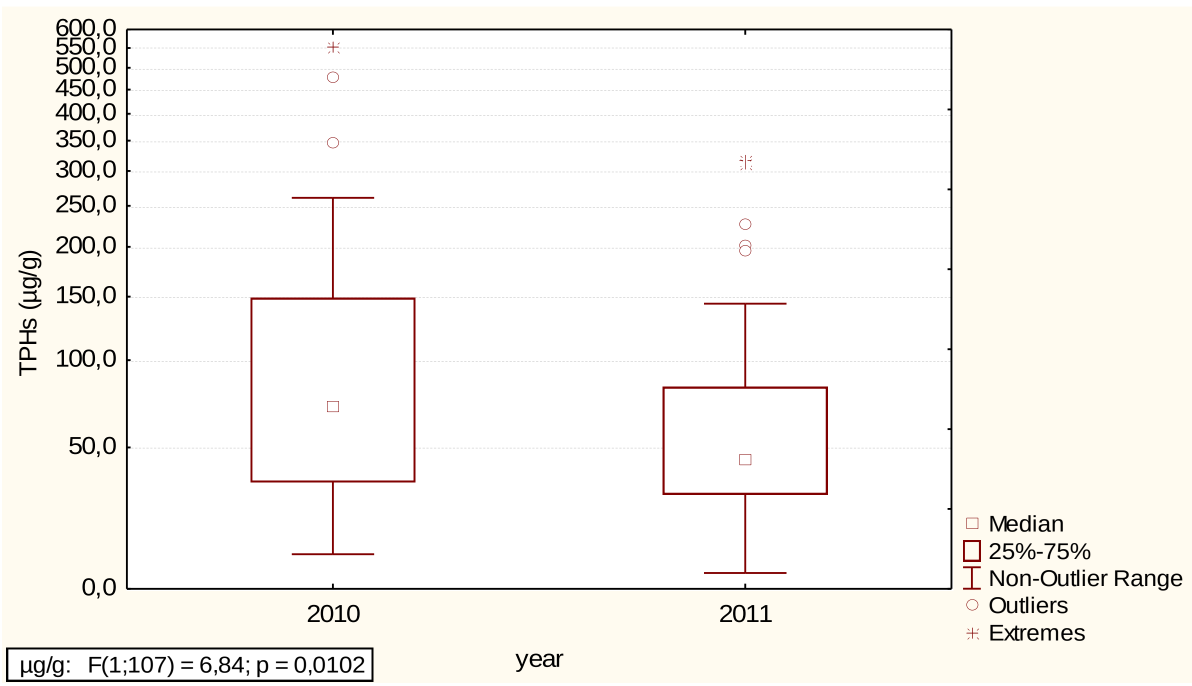



**Fig. 1.1.1.3.2.4. Box plot of of TPHs (µg/g) in sediments grouped by year 2011 compared to 2010-2011**

### 1.1.1.3.3. Polynuclear Aromatic Hydrocarbons (PAHs)

PAH monitoring during May-July 2011, by water and sediment samples, 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 in 90% of all samples taken from the area between Sulina - Vama Veche.

The total content of polynuclear aromatic hydrocarbons - ΣPAH (µg/l) in water ranged from 0.0580 to 4.3194 µg/l, with an average of 1.270 µg/l. High concentrations of ΣPAH (µg/l) were determined in coastal and marine waters of South Constanța - 5 m, Vama Veche - Mangalia - 5 m, 40 m stations. The box plot of ΣPAH (µg/l) grouped by typology of water body shows significant differences between the values of the three water bodies, with high level in marine waters (Fig. 1.1.1.3.3.1.). The pollution level of polynuclear aromatic hydrocarbons recorded in 2011 is comparable to that of 2010 and significantly lower (t test: 95% confidence interval, p <0.0001, t=8.33, df=517, st.dev. =41.13) compared to the pollution level in 2006-2009 (Fig. 1.1.1.3.3.2).

Anthracene is the dominant pollutant in all water bodies, with concentrations within the range of 0.010 - 3.556 µg/l, the highest values were recorded in marine waters (Fig. 1.1.1.3.3.3).

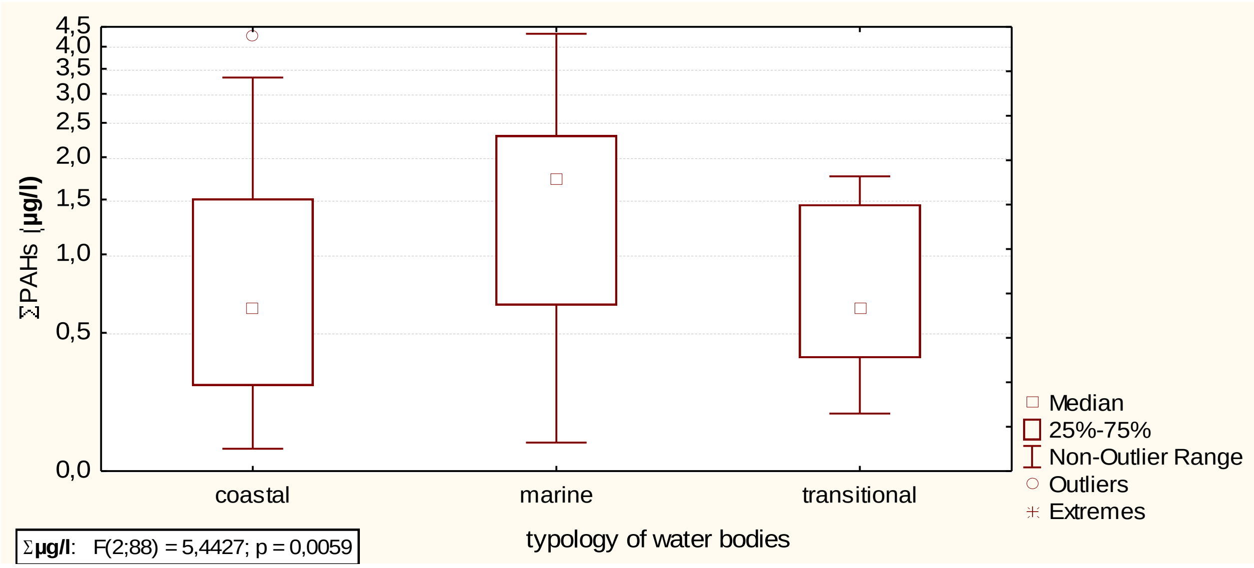



**Fig. 1.1.1.3.3.1. Box plot of ΣPAH (µg/l) in transitional, marine and coastal waters in 2011**

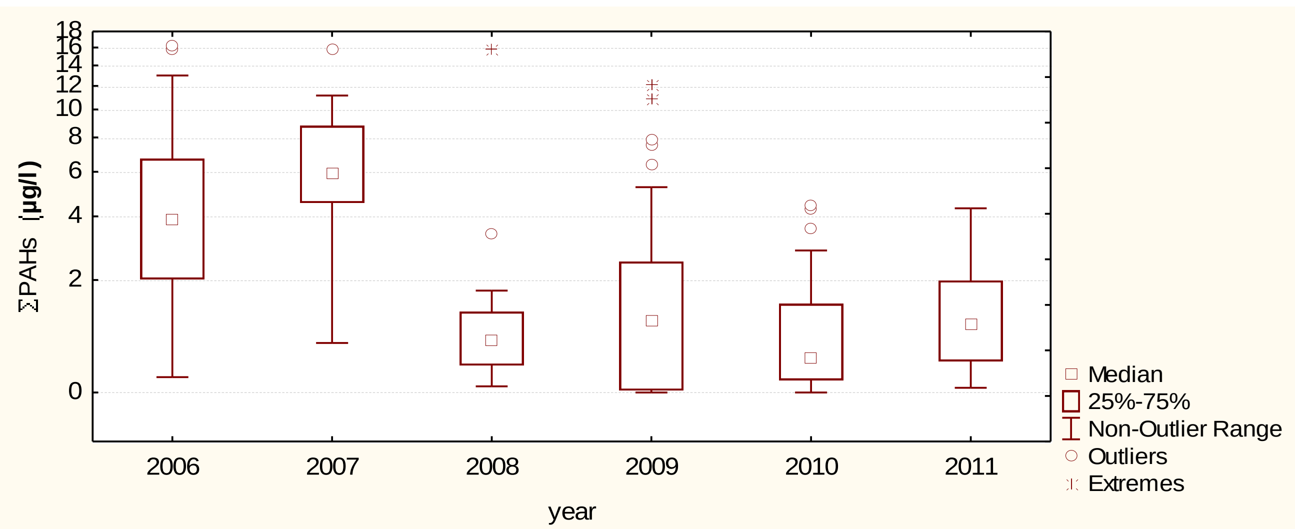



**Fig. 1.1.1.3.3.2. Box plot of ΣPAH (µg/l) in seawater in 2011 compared to the period 2006-2010**

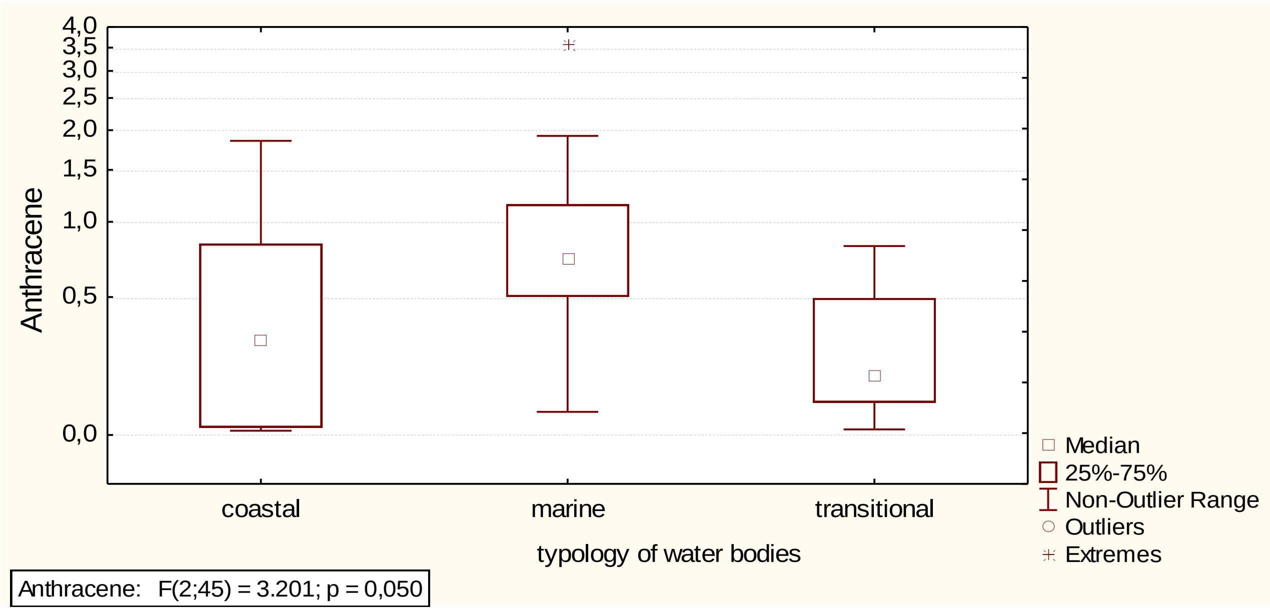



**Fig. 1.1.1.3.3.3. Box plot of anthracene (µg/l) in transitional, marine and coastal waters in 2011**

In sediments, ΣPAH concentrations (µg/g) showed values within the range 0.093 - 4.476, with an average of 1.097. The pollution level of polynuclear aromatic hydrocarbons recorded in 2011 is significantly higher (t test, 95% confidence interval, $p < 0.0313$, $t = 2.18$, $df = 97$, st. dev. = 0.193) compared to 2010 (Fig. 1.1.1.3.3.4.).

38% of the mean concentrations of compounds showed values within the range 0.0046 -0.0200 µg/g and for the remaining pollutants averages varied from 0.0200 - 0.5772 µg/g.

The monitoring of PAHs in sediments indicates a high level of pollution for the following compounds: naphthalene, fluoranthene, anthracene, pyrene, indeno (1,2,3-c, d) pyrene, benzo [a] pyrene, and phenanthrene (Fig. 1.1.1.3.3.5.). Significant concentrations for the 16 priority hazardous organic contaminants were recorded both in sediments collected from the northern sector (Mila 9 - 30 m) and in the southern sector (South Constanța - 5 m, Mangalia - 5 m and Vama Veche - 20 m - 5 m).

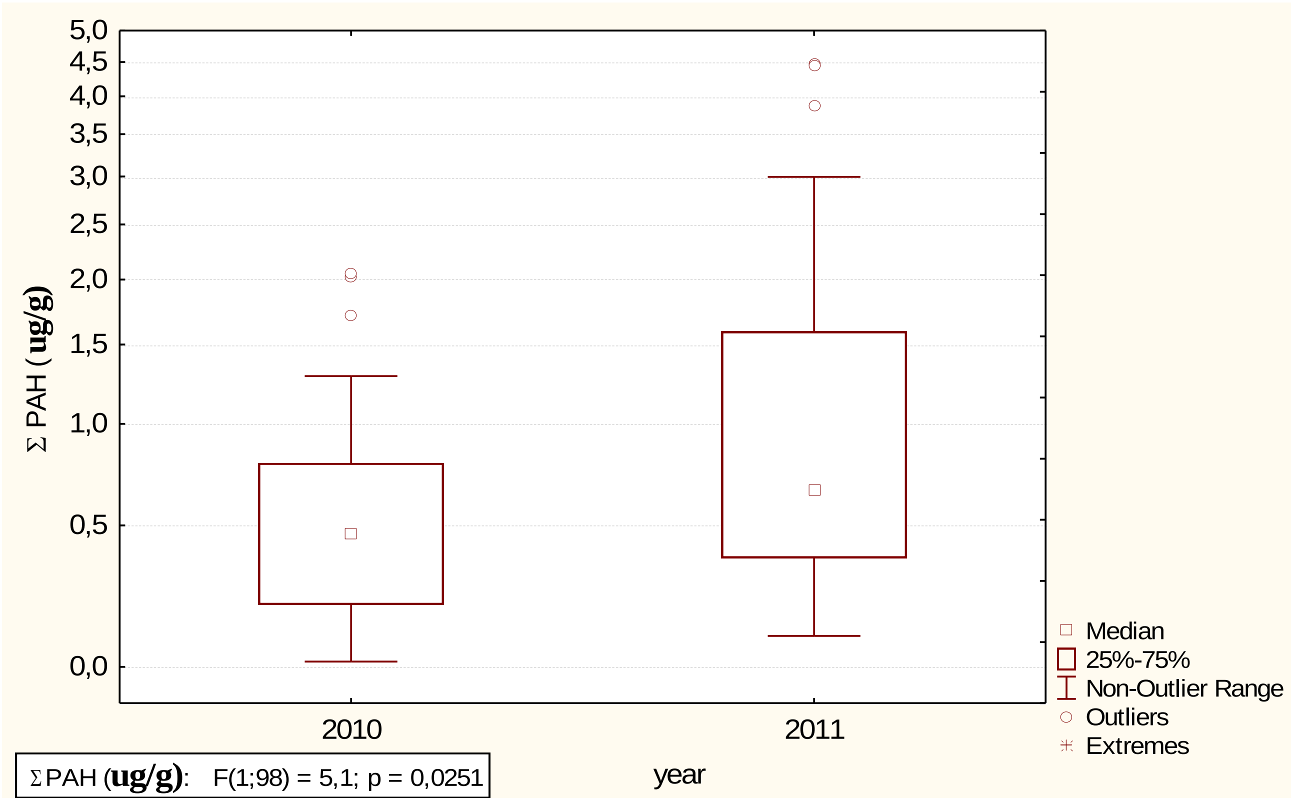
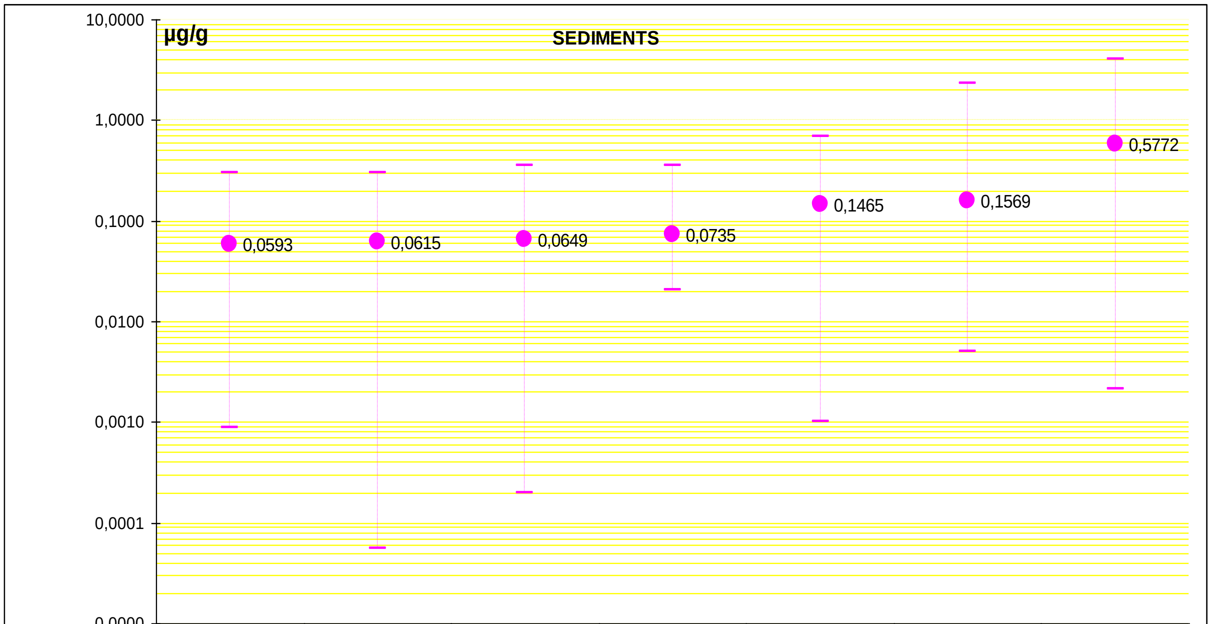



**Fig. 1.1.1.3.3.4. Box plot of ΣPAHs (μg/g) in sediments in 2011 compared to 2010**




| | Phenanthrene | Benzo[a]pyrene | Indeno(1.2.3-c.d)pyrene | Pyrene | Anthracene | Fluoranthene | Naphtalene |
|---|---|---|---|---|---|---|---|
| max. µg/g | 0,2995 | 0,3004 | 0,3530 | 0,3507 | 0,6875 | 2,2944 | 3,9760 |
| mean -2011 µg/g | 0,0593 | 0,0615 | 0,0649 | 0,0735 | 0,1465 | 0,1569 | 0,5772 |
| min. µg/g | 0,0009 | 0,0001 | 0,0002 | 0,0203 | 0,0010 | 0,0050 | 0,0021 |

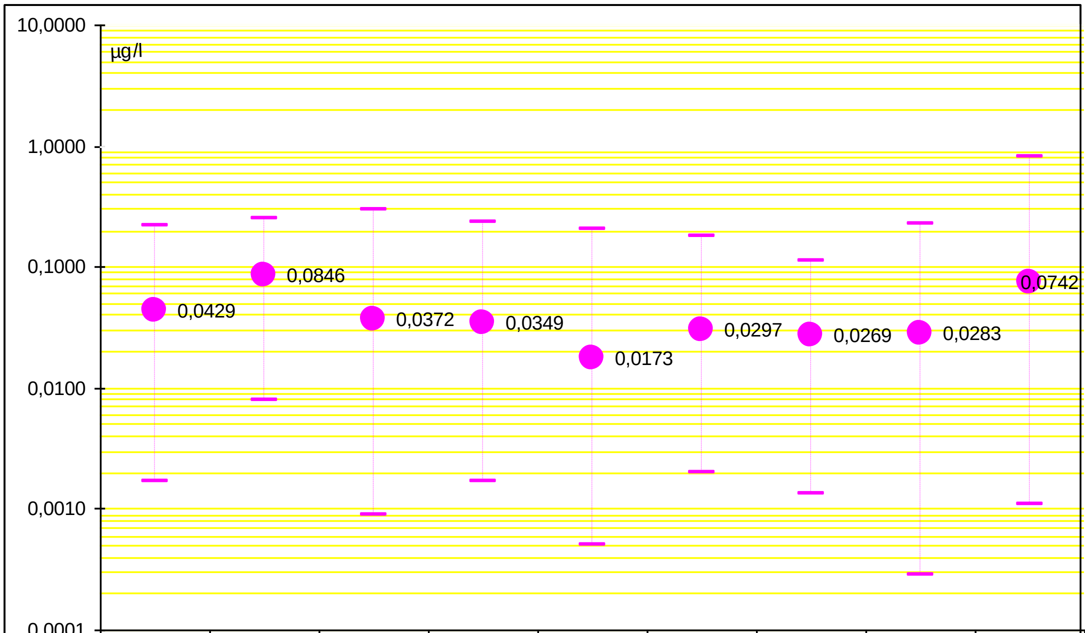
**Fig. 1.1.1.3.3.5. The average, maximum and minimum concentrations (µg/g) of the dominant polynuclear aromatic hydrocarbons in sediments in 2011**

Thus, in 2011, the monitoring of polynuclear aromatic hydrocarbons in water and sediments shows average values within the range characteristic of the period 2006-2010. The exception is anthracene, that indicates a high pollution level in all investigated environmental components.

### 1.1.1.3.4. Organochlorine Pesticides

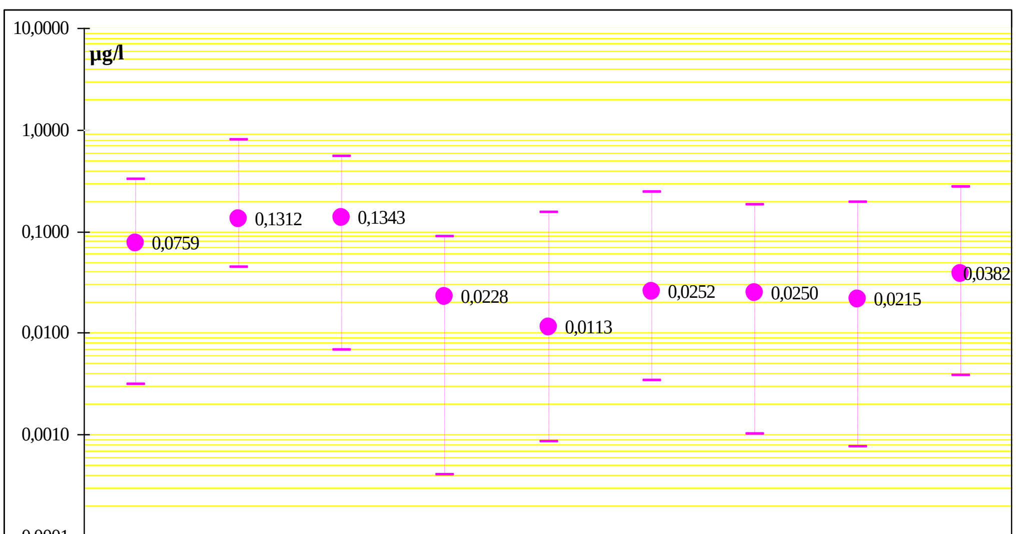
The total content of the nine investigated compounds (HCB, lindane, heptachlor, aldrin, dieldrin, endrin, p,p' DDE, p,p' DDD, p,p' DDT) in water and sediment samples frames within the following ranges: 0.0149 -1.7516 in water (Σµg/l) and 0.0084 - 0.8497 in sediment (Σµg/g).

The average values of individual compunds varied between 0.0173 and 0.0846 µg/l in coastal waters, 0.0113 and 0.1343 µg/l in marine waters, 0.0055 and 0.1182 µg/l in transitional waters. The highest values were detected for p,p' DDT (0.807 µg/l) in coastal waters ((Fig. 1.1.1.3.4.1.), lindane and hepachlor in marine waters (0.7785 µg/l and 0.5357 µg/l. respectively) (Fig. 1.1.1.3.4.2.), p,p' DDE (0.4994 µg/l) and lindan (0.3929 µg/l) in transitional waters ((Fig. 1.1.1.3.4.3.). The highest total content of organochlorine pesticides was detected in marine waters in the Sulina and Sfântu Gheorghe sampling points (1.7516 and 1.3234 µg/l, respectively) and in coastal waters in the Vama Veche sampling point (1.2527 µg/l).



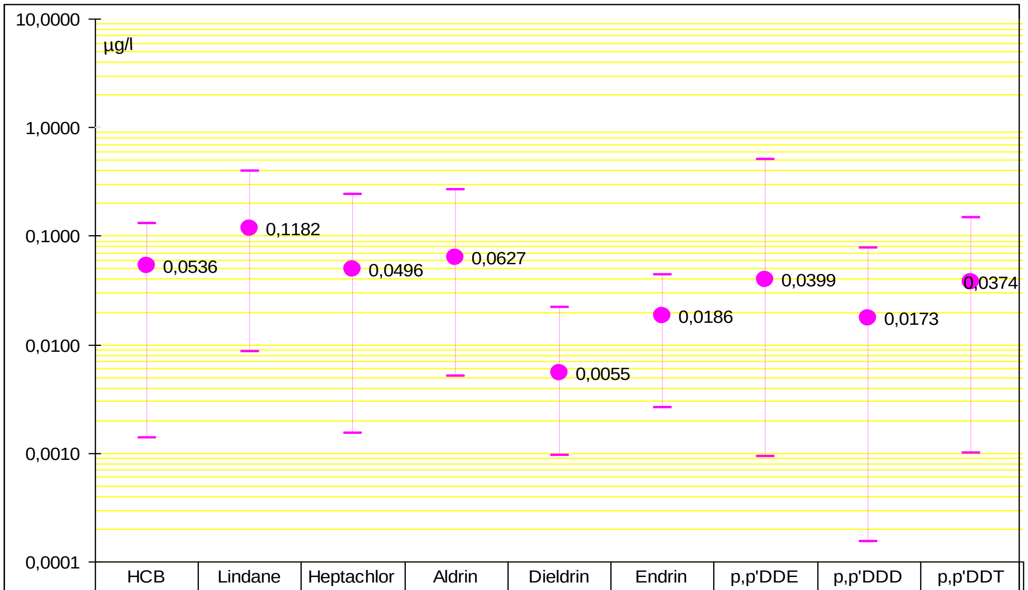

| | HCB | Lindane | Heptachlor | Aldrin | Dieldrin | Endrin | p,p'DDE | p,p'DDD | p,p'DDT |
|---|---|---|---|---|---|---|---|---|---|
| max. µg/l | 0,2160 | 0,2498 | 0,2911 | 0,2334 | 0,2064 | 0,1791 | 0,1126 | 0,2275 | 0,8076 |
| mean µg/l | 0,0429 | 0,0846 | 0,0372 | 0,0349 | 0,0173 | 0,0297 | 0,0269 | 0,0283 | 0,0742 |
| min. µg/l | 0,0017 | 0,0077 | 0,0009 | 0,0017 | 0,0005 | 0,0020 | 0,0013 | 0,0003 | 0,0011 |

**Fig. 1.1.1.3.4.1. Average, maximum and minimum values of organochlorine pesticides in coastal waters in 2011**




| | HCB | Lindane | Heptachlor | Aldrin | Dieldrin | Endrin | p,p'DDE | p,p'DDD | p,p'DDT |
|---|---|---|---|---|---|---|---|---|---|
| max. µg/l | 0,3273 | 0,7785 | 0,5357 | 0,0877 | 0,1532 | 0,2422 | 0,1818 | 0,1919 | 0,2688 |
| mean µg/l | 0,0759 | 0,1312 | 0,1343 | 0,0228 | 0,0113 | 0,0252 | 0,0250 | 0,0215 | 0,0382 |
| min. µg/l | 0,0031 | 0,0437 | 0,0067 | 0,0004 | 0,0008 | 0,0034 | 0,0010 | 0,0008 | 0,0038 |

**Fig. 1.1.1.3.4.2. Average, maximum and minimum values of organochlorine pesticides in marine waters in 2011**




| | HCB | Lindane | Heptachlor | Aldrin | Dieldrin | Endrin | p,p'DDE | p,p'DDD | p,p'DDT |
|---|---|---|---|---|---|---|---|---|---|
| max. µg/l | 0,1300 | 0,3929 | 0,2374 | 0,2623 | 0,0220 | 0,0432 | 0,4994 | 0,0777 | 0,1465 |
| mean µg/l | 0,0536 | 0,1182 | 0,0496 | 0,0627 | 0,0055 | 0,0186 | 0,0399 | 0,0173 | 0,0374 |
| min. µg/l | 0,0014 | 0,0086 | 0,0015 | 0,0051 | 0,0009 | 0,0026 | 0,0009 | 0,0002 | 0,0010 |

**Fig. 1.1.1.3.4.3. Average, maximum and minimum values of organochlorine pesticides in transitional waters in 2011**

In sediments, the average values of individual compounds belonged to the range 0.008 - 0.0335 µg/g. Significant concentrations were detected for aldrin: 22% of samples had values within in the range 0.05-0.60 µg/g. Some high pollutant values were detected in sediment samples from the sampling points Mila 9 - 20 m (0.8497 -Σµg/g) and Constanţa South - 5 m (0.7148 -Σµg/g).

80-85% of the sediment samples had individual compound concentrations below 0.0500 µg/g (Fig. 1.1.1.3.4.4.). Compared to the period 2006-2010, the values followed the downward tendency observed in the past years (Fig. 1.1.1.3.4.5.).

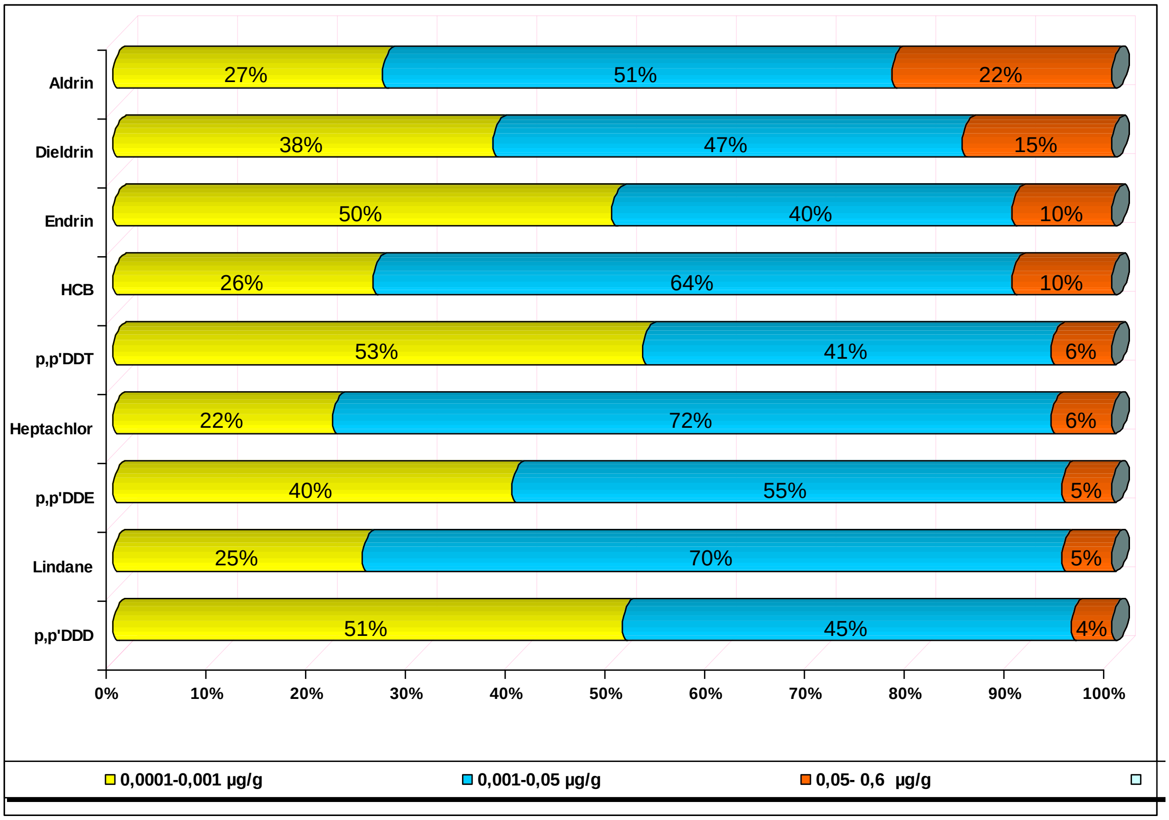
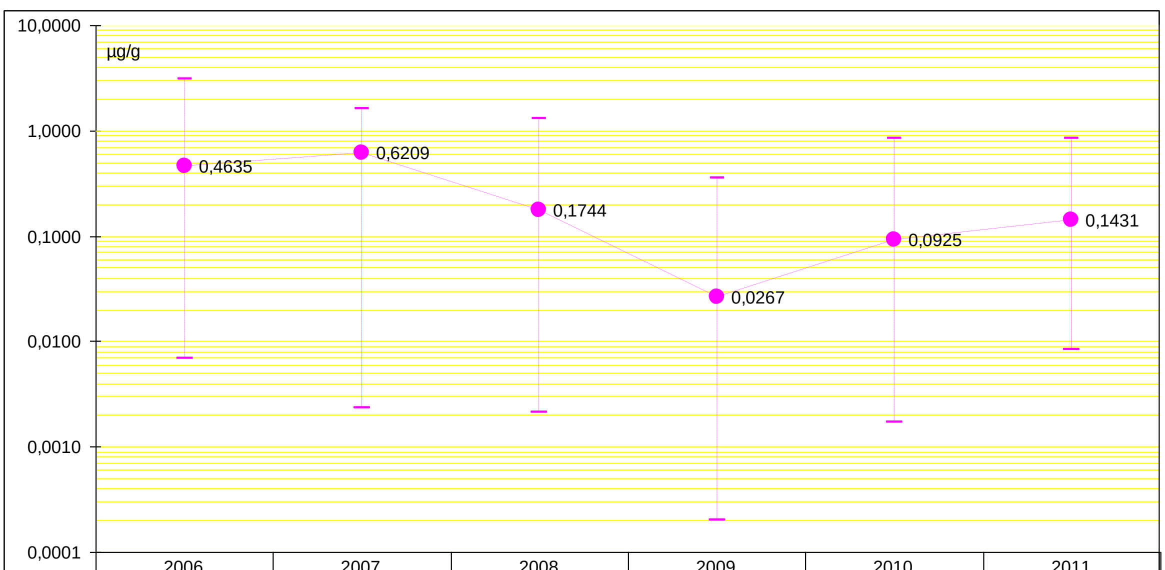



**Fig. 1.1.1.3.4.4. Percentage distribution of concentration ranges for the total content (µg/g) of organochlorine pesticides, in sediments, in the Sulina - Vama Veche area, in 2011**




| | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|
| max. µg/g | 3,0841 | 1,6289 | 1,2894 | 0,3504 | 0,8355 | 0,8497 |
| mean µg/g | 0,4635 | 0,6209 | 0,1744 | 0,0267 | 0,0925 | 0,1431 |
| min. µg/g | 0,0069 | 0,0023 | 0,0021 | 0,0002 | 0,0017 | 0,0084 |

**Fig. 1.1.1.3.4.5. Total content of organochlorine pesticides - Σ (µg/g), in sediments, in 2011, compared to 2006 - 2010 in the Sulina - Vama Veche area**

In conclusion, in 2011, the organochlorine pesticides monitoring revealed high individual values for: p,p' DDT, lindane, p,p' DDE and aldrin. Average values varied between the same limits as during 2006 - 2010.

### 1.1.1.3.5. Microbiological load

**The microbiological load,** a state indicator of contaminants in the marine environment, was good in the Romanian Black Sea bathing water during 2011; the concentrations of enteric bacteria [total coliforms (TC), faecal coliforms (FC), faecal streptococci (FS)] were generally found varying below the limits of the National Regulations and EC Bathing Water Directive and the values indicating the level of faecal pollution of bathing seawater (Fig. 1.1.1.3.5.1).

The frequency of exceeding mandatory and guide values registered in 2011 in some bathing areas (6% for TC and FS) was lower in comparison with the last year (2010), mainly due to not observing the general sanitary-hygienic norms by tourists during the hot summer season of 2011, with high shallow coastal seawater temperature (more than 29°C) and increased air temperature.

The situation identified during the summer season of 2011 reflects an evolution of bathing seawater quality greatly dependent on the particular hydro-meteorological conditions of the last four years (2008 - 2011), characterized by extremely hot weather in summer, with increased values of shallow coastal seawater temperature.

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

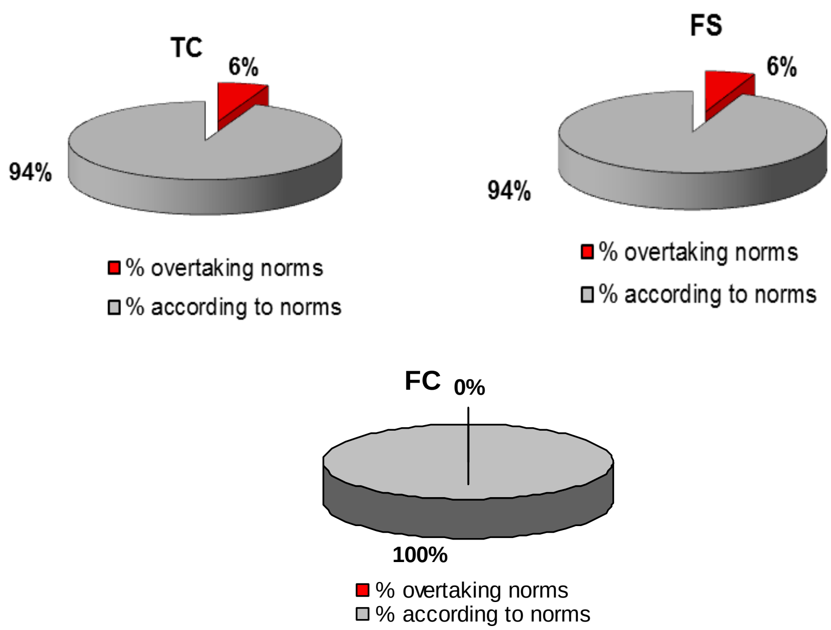



**Fig. 1.1.1.3.5.1. The percentage (%) of Romanian coastal bathing waters (Mamaia and Neptun sites) overtaking the mandatory and guide values (95 % < 10,000 per 100 ml mandatory value for TC; 95 % < 2,000 per 100 ml mandatory value for FC and 100 per 100 ml mandatory value for FS) of the National Regulations and EC Bathing Water Directive (2008/56/EEC), during June-September 2011**

# CHAPTER 2 - NATURE AND BIODIVERSITY CONSERVATION, BIOSECURITY

## 2.1. Marine Habitats

**The number of Community interest marine habitats** (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 submerged marine caves) with 28 sub-types.

In 2011, we did not develop particular research dedicated to marine habitats; some information was obtained during underwater explorations made within other projects. So, in two Natura 2000 marine sites, ROSCI0269 Vama Veche - 2 Mai and ROSCI0094 Underwater sulphur seeps from Mangalia, habitat mapping was made during 2011. The identified types were the following:

**<u>ROSCI0237 Submerged methanogenic carbonate structures of Sf. Gheorghe</u>**

1. **1110-9: Sandy muds and muddy sands bioturbated by *Upogebia*:** form a continuous belt on muddy sands. It is encountered in the western part, covering almost two thirds of the site area;

2. **1170-2: *Mytilus galloprovincialis* biogenic reefs:** built up on mussel banks whose shellw have accumulated in time, forming a hard substrate, protruding from the surrounding sediments, on which live mussel colonies attach themselves;

3. **1180-1: Methanogenic carbonate structures:** are spread starting with the 10 m isobath and continue well below the edge of the continental shelf. The highest density is reported off the Danube Delta. They occur as carbonate gritstone plates or pavements, starting with the 10 m depth, and as hills or fortright or ramified columns starting with the 40-50 m depth.

**<u>ROSCI0066 Danube Delta - marine area</u>**

1. **1110-2 Hydraulic dunes of medium sands:** the habitat comprises average grain mobile sands which, subject to strong currents and waves, forming submerged sand bars or hydraulic dunes, parallel with the dominant current direction. By sand accumulation in time, such structure may become emerged, as moving islands of permanent sand bars. The fauna is highly variable in time and space, due to sediment instability. Biodiversity is low, yet the populations of the occurring species are abundant. Indicative examples of such habitats are the Sahalin Island off the Sf. Gheorghe mouth and the related submerged dunes, as well as the emerged sand bar tending to close the Musura Bay.

2. **1110-3 Shallow fine sands:** at the Romanian coast, this habitat type occurs from the Danube mouths to Vama Veche, wherever there are sandy beaches. The substrate comprises fine earthy (flinty) or biogenic sands, mixed with shells and pebbles, from the shore down to the 5-6 m isobath. To the north (from Sulina to Constanța), where the influence of the Danube freshwater is felt, this habitat shelters the biocoenosis of fine sands with *Lentidium mediterraneum*. In addition to dominant species, the mollusks *Mya arenaria, Cerastoderma glaucum* and *Anadara inaequivalvis,* the crustaceans *Crangon crangon, Liocarcinus vernalis* and fish *Platichthys flesus* and *Pegusa lascaris* are also typical;

3. **1110-4 Well-sorted sands:** this habitat is located immediately after shallow fine sands, from 5-6 m down to 8-10 m deep to the north (from Sulina to Constanța) and 20-25 m deep to the south. The substrate

comprises homogenous granulometry sands, less affected by wave movement. The silt content of the sediment increases with depth. The typical species are the mollusks *Chamelea gallina, Tellina tenuis, Anadara inaequivalvis, Cerastoderma glaucum, Cyclope neritea, Nassarius nitidus;* the crustaceans *Liocarcinus vernalis* and *Diogenes pugilator*, the fish *Gymnammodytes cicerelus, Trachinus draco, Uranoscopus scaber, Pomatoschistus sp.*;

4. **1110-7 Danube mouths „camca":** this habitat is scarcely encountered in shallow sheltered areas of the Danube Delta shore. The camca is a thick vegetal detritus suspension of continental origin, formed mainly of chopped reed (*Phragmites*) debris, but remnants from other plants may also occur. Due to stagnation and decomposition, the hypoxic and anoxic conditions determine the setting-up of the fauna comprising polichaet and nematode worms, sometimes amphipod crustaceans;

5. **1110-9 Sandy muds and muddy sands bioturbated by *Upogebia*:** this habitat forms a continuous belt along the Romanian coast, on sandy shores between 10-30 m deep. The substrate is riddled by the numerous galleries of the thalassinide decapode crustacean *Upogebia pusilla*, which penetrate 0.2-1 m deep, depending on sediment consistency. The *Upogebia* populations are extremely dense (100-300 ind./$m^2$) and cover large areas; the biofiltration, bioturbation and sediment resuspension of sediments created by these crustaceans have a significant influence on the ecosystem. The indicative species is the the thalassinide decapode crustacean *Upogebia pusilla*, which feeds filtering the plankton and organic suspensions in the water flow that it continuously pumps through its galleries. The density of bivalve mollusks is low in this habitat, due to the feeding competition and the predation of planktonic larvae and post-larvae by *Upogebia*. Other species, mainly "messmates" inhabitting the *Upogebia* galleries, are enabled;

6. **1110-10 Soft eutrophic muds dominated by polychaetes - *Nephthys, Melinna, Capitella*:** the substrate is formed of very fine alluvial muds, with loose consistency, rich in detritus and organic matter. Under these circumstances, the fauna is dominated by polichaet worms: *Melinna palmata, Nephthys hombergii, Alitta succinea, Heteromastus filiformis*. The bivalve mollusks constantly present in this environment are either endobenthic species with long siphons (*Abra alba, Abra prismatica*), or endobenthic species with short siphons and high volume/mass ratio, helping them to immerse in the soft sediment (*Acanthocardium paucicostatum, Parvicardium exiguum, Papillicardium papillosum, Cerastoderma glaucum*). Seldom, high abundances of *Mytilus galloprovincialis* juveniles are recorded, which attach themselves on the *Melinna* polichaet tubes, yet they do not survive long enough to exceed 30-40 mm in length;

7. **1130 Estuaries (estuarine waters):** the mouths of the Danube, along with the Musura and Sahalin bays and the related Black Sea waters down to the 20 m isobath are classified as estuarine waters. The waters of the Danube mouths are significantly influenced by the freshwater input. The mixture of fresh and marine water causes he precipitation of fine sediments, while currents frequently liquefy and transport such sediments. This habitat comprises the mid-littoral, infra-littoral and circa-littoral, being characterized by low salinity of the surface layer and upstream penetration of a deep marine water layer. These waters shelter typical estuarine plant and animal communities. Thus, in spite of the absence of tides and the lack of the typical estuary shape, these variable salinity waters are an estuarine habitat, similar to the one in the Baltic Sea. The characteristic species are the mollusks *Abra segmentum, Cerastoderma glaucum, Mya arenaria, Hydrobia* spp., the polichaet worms *Hediste diversicolor, Capitella capitata* and the crustaceans *Corophium* sp., *Dikerogammarus* sp;

8. **1140-1 Supralittoral sands with or without fast-drying drift lines:**

   Occurring on all beaches of the Romanian coast. The habitat occupies the portion of the rocky shores or beaches that is covered by waves only during storms. Deposits are composed of plants (tree trunks, pieces of wood and swamp land plant debris, algae, leaves), animal (dead aquatic animals, insects, drowned land animals) or anthropogenic (solid waste) and dense a foam derived from marine plankton. The fauna is made up mainly of crustaceans and isopode insects;

9. **1140-3 Midlittoral sands:** The habitat occupies the shore sand, on which the waves break. Depending on the sea choppiness, 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. The species characteristic for the beaches in the south part of the Romanian littoral (Eforie, Costineşti, Mangalia, Vama Veche) is the bivalve *Donacilla cornea*, while for the beaches on the Danube Delta shore - the amphipode *Euxinia maeoticus*;

10. **1170-1 *Ficopomatus enigmaticus* biogenic reefs:** This habitat is found in sheltered waters, but with a slight wave current, preferably with variable salinity. Port enclosures and channels connecting the sea and delta are the places where it is easiest to find. The reefs are built by the polichaet tube worm *Ficopomatus enigmaticus* whose calcareous tubes grow crowded and cemented between them on any hard substrate, including strains of *Phragmites* reeds. They are similar to biogenic reefs built by the polichaet tube worms *Serpula vermicularis* on the Atlantic coast of Europe, the difference being that *Ficopomatus* prefers waters sheltered of the waves, with a slight current and variable salinity. The fauna is extremely diverse, contrasting with the surrounding sedimentary areas.

11. **1170-2 *Mytilus galloprovincialis* biogenic reefs:** mussel reefs occur on sedimentary substrate (mud, sand, gravel), most often between the 35 and 60 isobaths. They are spread along the entire Romanian coast, between the above mentioned isobaths. *Mytilus galloprovincialis* biogenic reefs are built up on mussel banks whose shell accumulated in time, forming a hard substrate, protruding from the surrounding sediments (mud, sand, gravel or mixtures), on which live mussel colonies attach themselves. Among all sedimentary substrate habitats of the Black Sea, this particular habitat shelters the highest species diversity, due to its expansion at various depths and the great number of micro-habitats in the mussel reef matrix, offering living conditions for a large number of species.

## 2.2. State of Natural Protected Areas

### Marine Protected Areas

In 2011, NIMRD took again into custody the „Marine Littoral Aquatory Vama Veche - 2 Mai" reserve (overlapping ROSCI0269 Vama Veche - 2 Mai), for five years, starting with December 13, 2011, by Agreement no. 306, between the Ministry of Environment and Forests and NIMRD.

Also, for a good exertion of the custody, the Institute made an agreement with the municipality of the Limanu Village and the NGO „Association for Preserving the Inter-Community Traditions in 2 Mai and Vama Veche".

The new Management Plan of the reserve shall be elaborated within the SOP Environment project "Integrated Management of Marine Natura 2000 Sites (SCI) at the Romanian Coast", developed by the University of Agronomical Sciences and Veterinary Medicine Bucharest. NIMRD is actively involved in this project, by participating as Custodian to the public debates regarding the Management Plan.

Also in 2011, the Institute continued, within a project financed by the Nucleus Program of the Scientific Research Authority, the mapping of European habitats in the marine sites ROSCI0237 Submerged methanogenic carbonate structures Sf. Gheorghe (Fig. 2.2.1.) and ROSCI0066 Danube Delta - marine zone (Fig. 2.2.2.), the data being translated into GIS format.

In order to assess the conservation state of marine sites, distinct activities of assessing each habitat type, through an adequate methodology, are necessary.

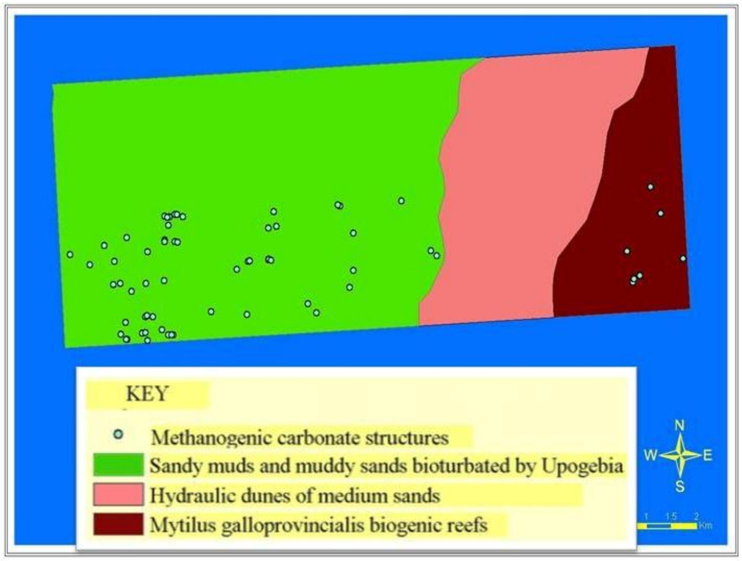



**Fig. 2.2.1 The distribution of Natura 2000 habitats in ROSCI0237**

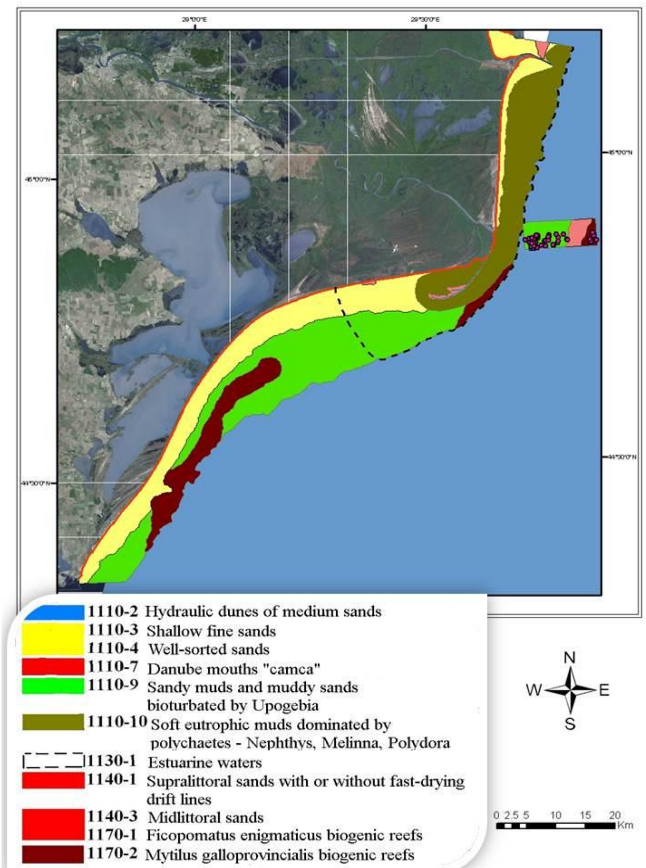



**Fig. 2.2.2. The distribution of Natura 2000 habitats in ROSCI0066**

Also in 2011, the research within the project „Integrated Management of Marine Natura 2000 Sites (SCI) at the Romanian Coast" continued, having as objective the insurance of the background for an efficient management of marine sites within the Natura 2000 ecological network, with the aim of conserving the biodiversity, the marine habitats and the flora and fauna species of European or national importance. For this project, NIMRD provided „Services of Species Inventory by Scientific Fishing” and “Services of Determining the Dynamics of the Populations by Tagging and Recapture”.

Pursuant to Emergency Ordinance no. 57 of June 20, 2007 regarding the regime of natural protected areas, the conservation of natural habitats, of wild flora and fauna (Official Gazette no. 442 of June 29, 2007), as amended and supplemented, and also pursuant to the European Directives 79/409/EEC and 92/43/EEC, 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 (Custodian SC EURO LEVEL);
- ROSCI0269 - Vama Veche - 2 Mai: Site of Community Importance, according to the 92/43/EEC Habitats Directive, adopted through 2009/92/EC Decision, which overlaps the Vama Veche - 2 Mai Marine Reserve, natural protected area of national importance - 5,272 ha (Custodian NIMRD);
- ROSCI0094 - The Sulphur Seeps in Mangalia (362 ha): site of Community importance, according to Habitats Directive 92/43/EEC, established by Decision 2009/92/EC - 362 ha (Custodian NIRD GEOECOMAR);
- ROSCI0197 - Submerged beach from Eforie North - Eforie South: site of Community importance, according to the Habitats Directive 92/43/EEC, established by Decision 2009/92/EC - 141 ha (Custodian SC EURO LEVEL);
- ROSCI0273 - Marine area from Cape Tuzla: site of Community importance, according to the Habitats Directive 92/43/CEE, established by Decision 2009/92/EC - 1,738 ha (Custodian NIRD GEOECOMAR);
- ROSCI0237 - Submerged methanogenic carbonate structures Sf. Gheorghe: site of Community importance, according to the Habitats Directive 92/43/EEC, established by Decision 2009/92/EC - 6.122 ha (Custodian NIRD GEOECOMAR);
- ROSCI0066 - Danube Delta - marine zone: site of Community importance, according to the Habitats Directive 92/43/EEC, established by Decision 2009/92/CE, overlapping the marine area of Danube Delta Biosphere Reserve - natural protected area of national and international importance - 121.697 ha (Custodian DDBRA).

In 2011, at NIMRD’s proposal, two new marine sites (SCIs) were declared, by Order of the Environment and Forests Minister no. 2387/2011, amending the Order of the Environment and Sustainable Development Minister no. 1964/2007 regarding the natural protected area regime of the sites of Community importance, as part of the European ecological network Natura 2000 in Romania. These are:

- ROSCI0281 - Cape Aurora (No custodian yet);
- ROSCI0293 - Costineşti - 23 August (No custodian yet).

## 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 the Littoral and Coastal Zone

##### 2.3.1.1.1. Coastal Processes

Field measurements were made during the common campaign carried out with the Maritime Hydrographic Directorate. The gaugings consisted in shore line measurements and the equipment used comprised - GIS class GPS devices (GeoXH, ProXH, Juno - NIMRD) and geodetic class (Leika - MHD) GPS devices. The field campaigns were realized in the same period for each section (May-June for Sulina-Ciotica, September for Zăton-Periboina, November for Periboina-Cape Midia and October for the southern part of the littoral). For the Mamaia area, the measurements were made during each season.

The graphical representations obtained based on field measurements were realized in an application of the 9.3/10 ArcGIS data assimilation system. The ArcGIS spatial analysis techniques were developed on representations of spatial data (GPS data/data obtained by digitization) in a plane model/referenced configuration, which allowed the assessment of the geomorphological dynamics of coastal areas, the results being represented/overlay, for comparison with the data from 2010 and 2011.

The results of the measurement were significantly influenced by the exceptional conditions of 2010 and 2011 - spring flood in 2010 and drought in 2011, when the sea level dropped (decreased) and the shoreline advanced. During September and November - when a part of the field measurements were made, the sea level was extremely low (9.64 cm in September and 1.82 cm in November), compared to 25.98 cm and 26.92 cm in 2010 during the same months. Considering the results of the measurements and taking into account the sea level data, an atypical situation for the 2010-2011 period was recorded, the accretion processes being more intense than erosion (Photo 2.3.1.1.1.1).

**a. 2010**

**b. 2011**

**Photo 2.3.1.1.1.1. Zăton-Perişor area, comparison between 2010 (erosion) and 2011 (accretion)**

The following results were found in the deltaic and lagoon area (Fig. 2.3.1.1.1.2 and Fig. 2.3.1.1.1.3):

- Sulina area - advancement of the shoreline by 7-10 m (up to 80 m south of the Sulina dike);
- Gârla Împuțită - Casla Vădanei - retreat of shoreline by 5-10 m up to 70 m in the Sonda Canal area;
- Sf. Gheorghe - Sahalin - advancement of the shoreline by 10-20 m; in the central area of the peninsula, the shoreline retreated by 10 up to 40 m, while in the southern part the accretion processes are predominant;
- The Ciotica-Perişor-Gura Portiţei area was relatively stable;

- Portița-Vadu - the shoreline retreated by up to 12 m near the Portița Lighthouse, 10-12 m at Gura Periboina, 20-25 m near Edighiol and up to 30 m in the Chituc Sandbank area and advanced in the Vadu area up to 10-12 m; these areas are intercalated with accretion zones (the width of beach increased because of low the sea level in 2011 and the gentle slope of the beach).

For the northern sector, the accretion surface represented ~60 ha and erosion ~50 ha. The advancement of the shoreline on distances > 10 m was registered on 35% of the total measured length, the retreat more than 10 m on ~ 25% and dynamic balance (+/- 10 m) on 40%. (Fig. 2.3.1.1.1.1.)

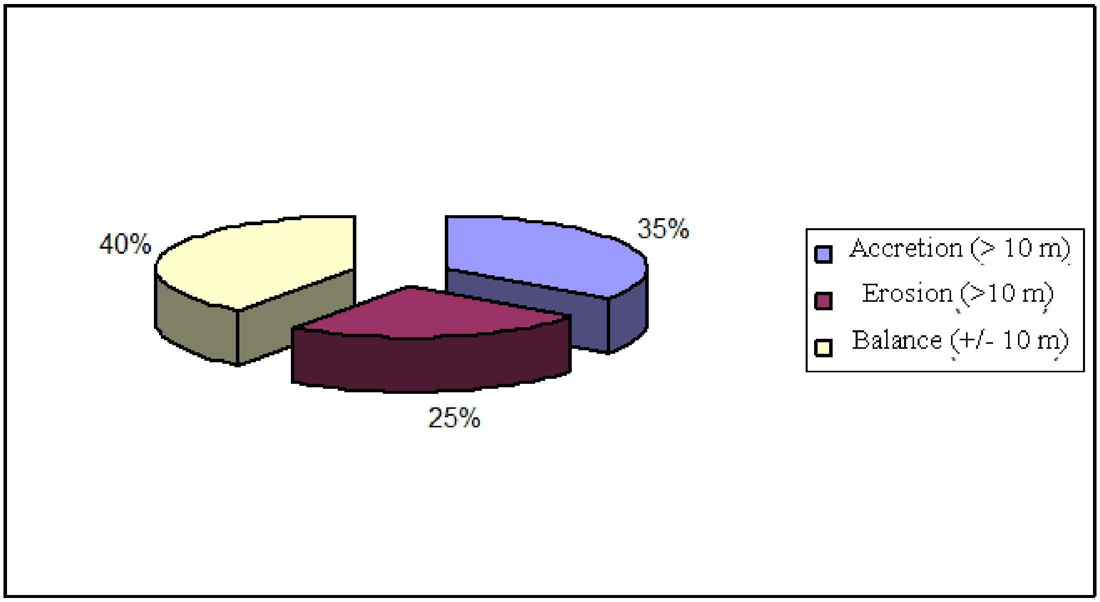



**Fig. 2.3.1.1.1.1. Coastal processes (erosion/dynamic balance/accretion) on the coast between Sulina - Cape Midia, 2010-2011**

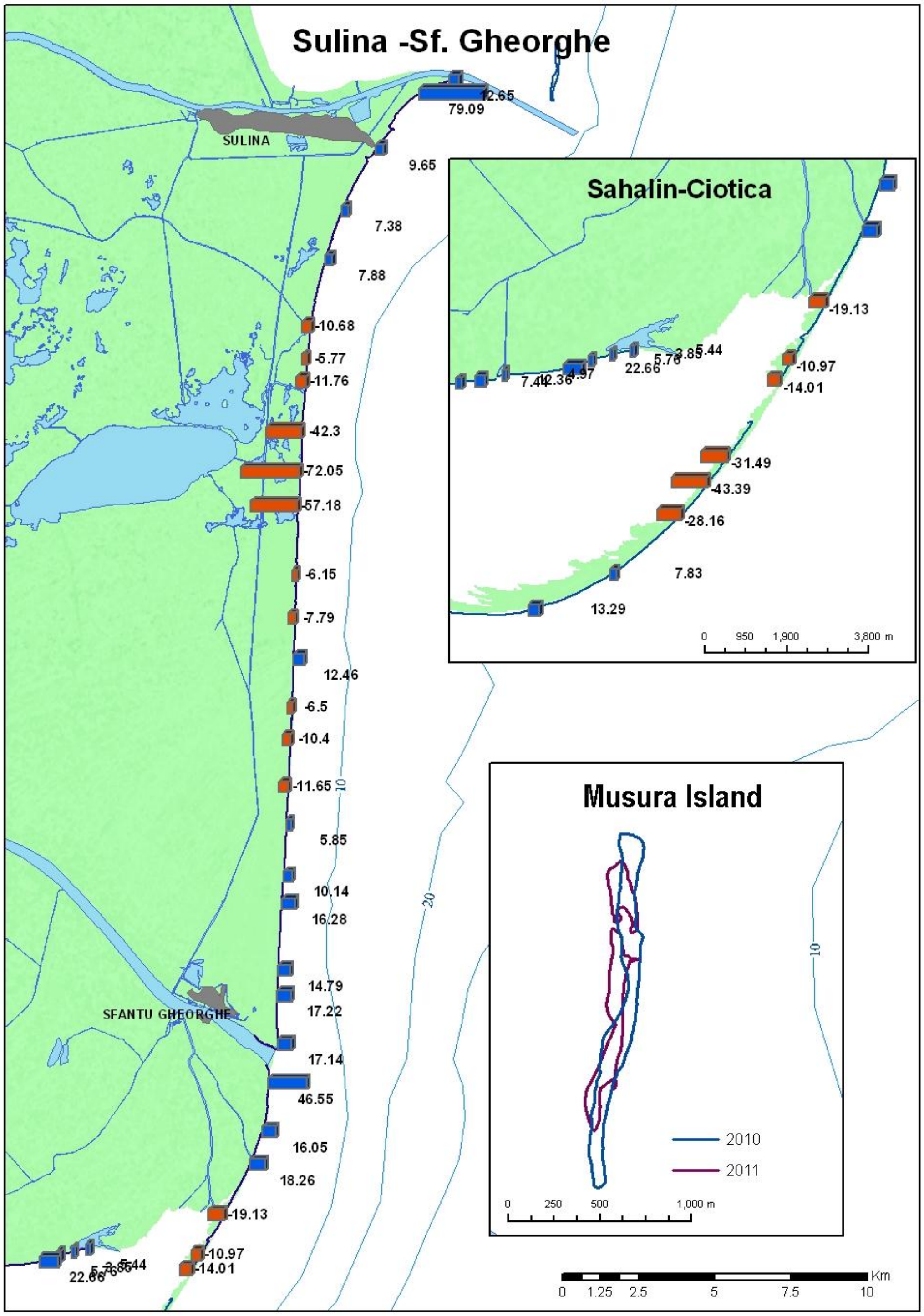



**Fig. 2.3.1.1.1.2. Accretion/Erosion 2010-2011**

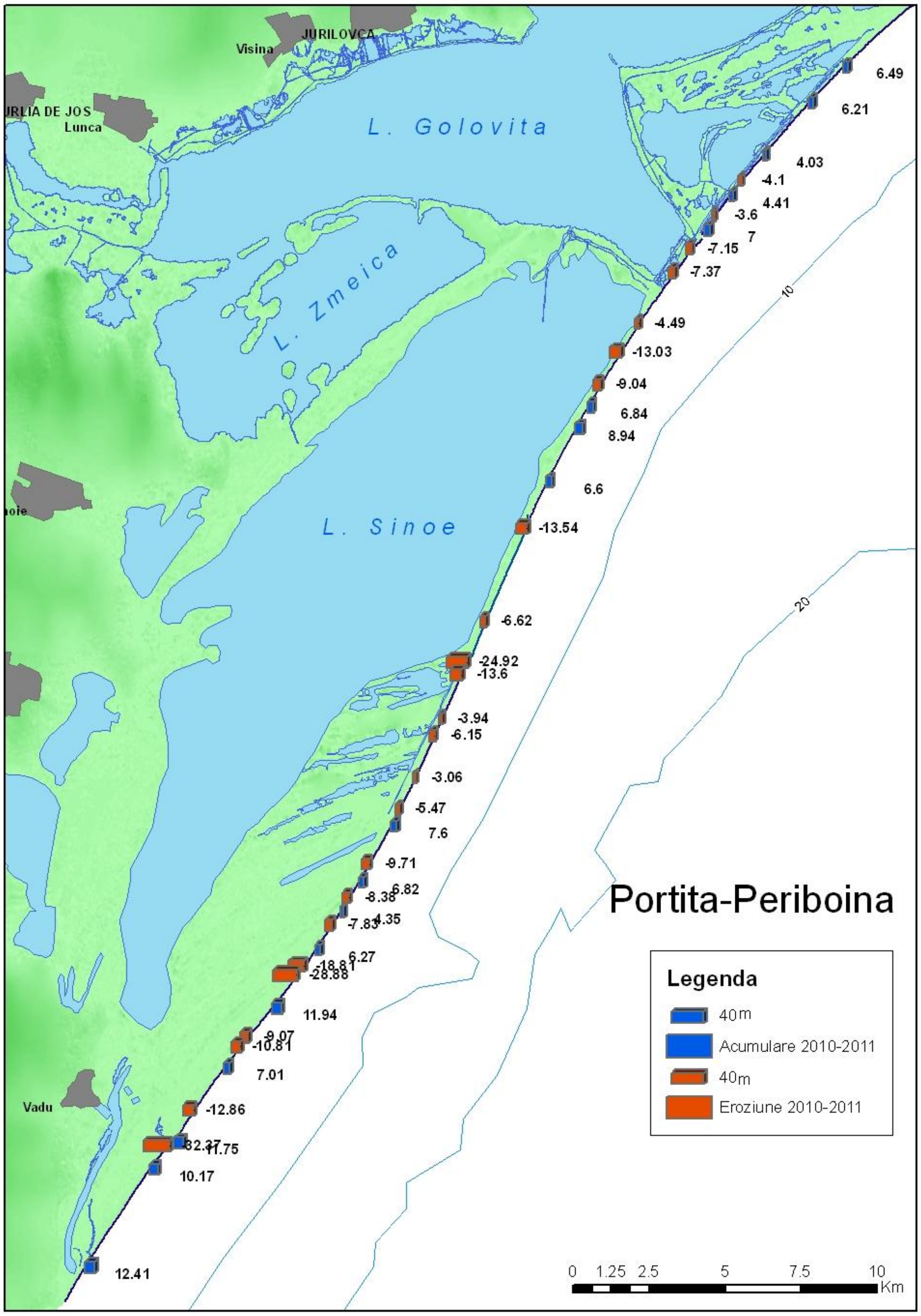



**Fig. 2.3.1.1.1.3. Accretion/Erosion 2010-2011**

In the southern part of the littoral, the accretion processes also predominated (Fig. 2.3.1.1.1.5.):

- the Mamaia area - the advancement of shoreline by 2 up to 13 m;
- Eforie North - advancement of the shoreline up to 7 m, however, in the Eforie South area, the retreat was up to 7-8 m;
- in the extreme southern part of the coast (Costinești-Vama Veche) - the accretion processes were predominant, the shoreline advanced by 10 m up to 13 m in the Olimp-Neptun and Vama Veche area.

Determinations based on the rate of changes on the sea-land contact border helped to assess the magnitude of coastal processes (erosion/dynamic balance (equilibrium)/ accretion) for beach sectors, by grouping them into 7 classes (class range 5 m), as follows: HE - High erosion (more than - 12 m), ME - Medium erosion (12.5 to 7.6 m), LE - Low erosion (-7.6 to -2.6 m), DE (Dynamic equilibrium/balance +/- 2.5 m), LA - Low accretion (2,6 to 7.5 m), MA - Medium accretion (7.6 - 12.5 m) and HA - High accretion (more than 12.5 m) (Fig. 2.3.1.1.1.4).

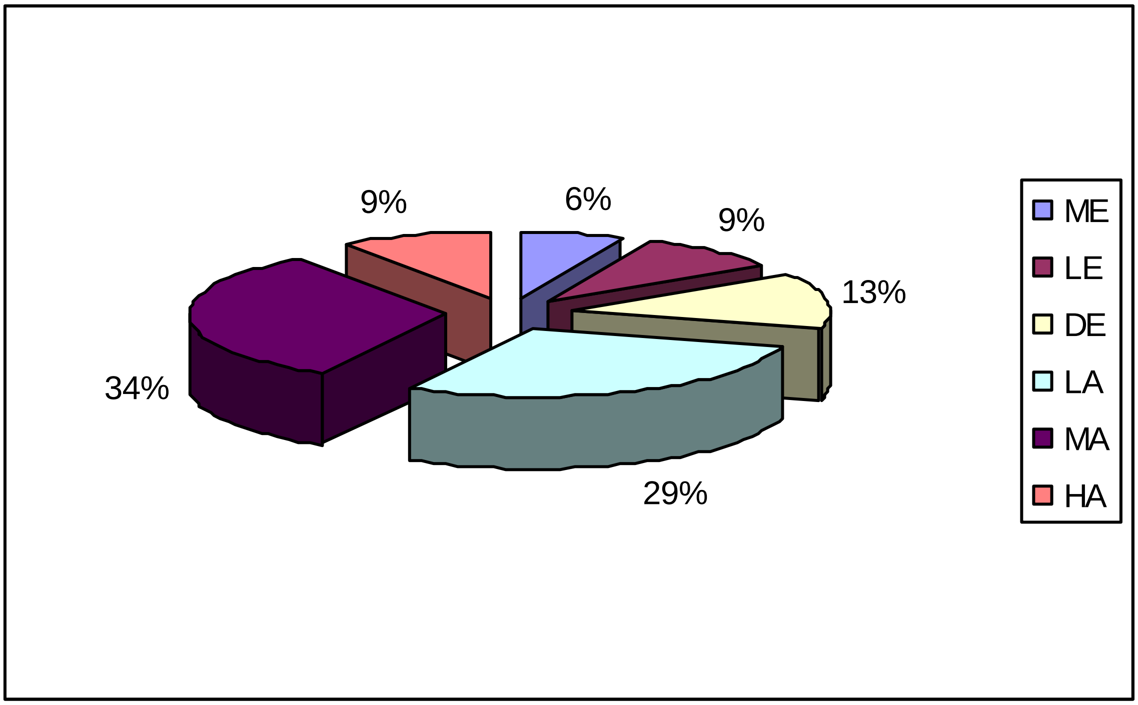



**Fig. 2.3.1.1.1.4. Share of coastal processes (erosion/dynamic equilibrium/accretion) on the Năvodari-Vama Veche coast sector, 2010-2011**

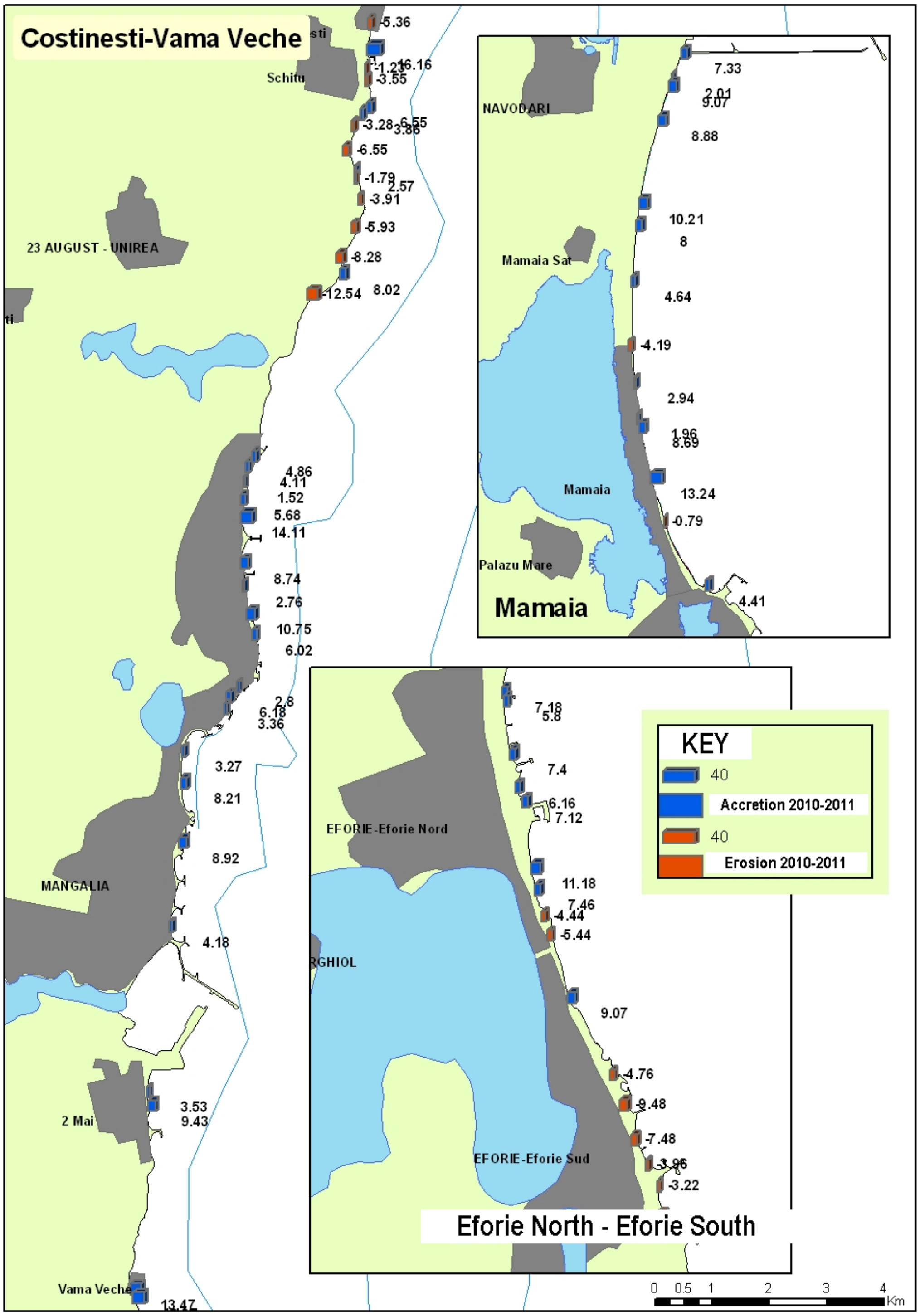



**Fig. 2.3.1.1.1.5. Accretion/Erosion 2010-2011**

**2.3.1.1.2. Sea level**

**Sea level**, as one of the indicators of the coastal zone state, recorded during 2011 a constantly positive deviation from the long term monthly averages, except for December, when the monthly average was 6.9 cm below the long term average for this month (Fig. 2.3.1.1.2.1.). The annual trend was a decreasing one, from 40.8

cm in January to 6.5 cm in December. The annual average was only + 5.7 cm higher than the long term annual average (1933 - 2010).

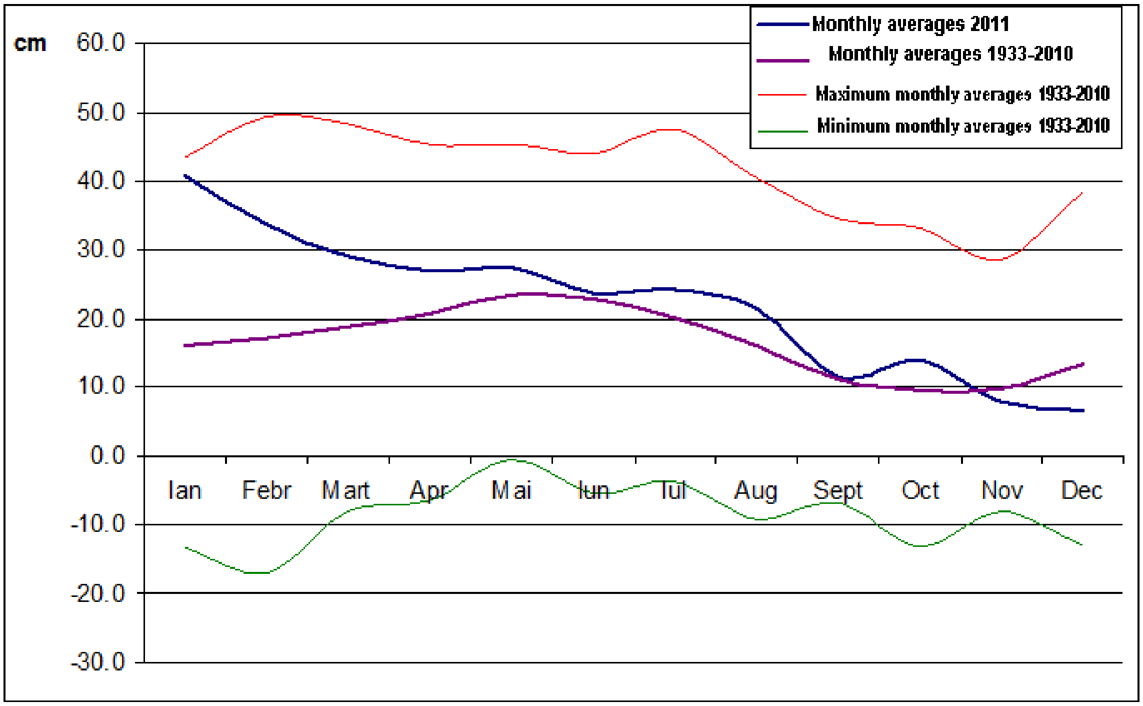



**Fig. 2.3.1.1.2.1. Black Sea level fluctuations at the Romanian coast in 2011**

### 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 component, as an indicator of the eutrophication status, was made as a follow-up of the analysis of samples collected in April and July, on the profiles Sulina, Mila 9, Sf. Gheorghe, Portița, Gura Buhaz, Cazino, Constanța, Eforie South, Costinești, Mangalia and Vama Veche, on the 5, 20 and 30 m isobaths. In November, the collection was performed only on the East Constanţa profile, down to the 30 m isobath; bi-weekly samples were collected also from the Cazino-Mamaia Station, in order to record any blooming phenomenon.

The composition of the phytoplankton comprised 173 species, with varieties and forms belonging to 7 taxonomic groups (Bacillariophyta, Dinoflagellata, Chlorophyta, Cyanobacteria, Chrysophyta, Cryptophyta and Euglenophyta). The highest number of species (112) was identified in transitional waters (Fig. 2.3.1.2.1.1), where marine species were joined by freshwater and freshwater-brackish water species.

In **April**, the diatoms were dominant in the coastal and marine waters (38-43%), followed by dinoflagellates (28%). In transitional waters, the number of species belonging to cyanobacteria was almost two times higher than the dinoflagellates.

In **July**, the dinoflagellates were dominant throughout the entire study area, their proportion ranging between 31 and 42, the maximum number of species (42) occurring in coastal waters. In transitional waters, the presence of a large number of chlorophytes and cyanobacteria was noted, close to that of diatoms, whose dominance as the secondary group was established only for coastal and marine waters.

In **November**, a higher species diversity was noted in coastal waters (63 species) compared to the offshore marine waters (41 species), due to the diatoms (36%), dinoflagellates (30%) and cyanobacteria (24%); in offshore waters, the diatoms and the dinoflagellates participated with almost equal percentages (44 or 42), but cyanobacteria were completely absent. The last three groups (Chrysophyta, Euglenophyta and Cryptophyta) were underrepresented in the phytoplankton community, both in coastal and offshore waters, their proportion varying between 1 and 10.

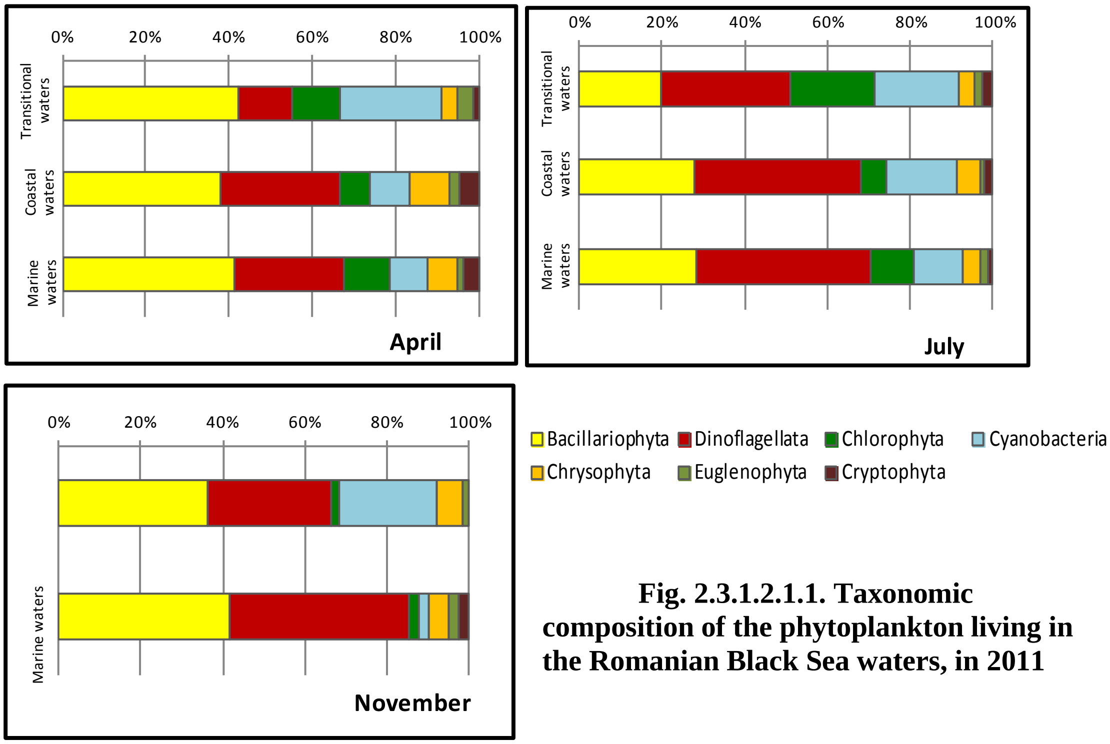



**Fig. 2.3.1.2.1.1. Taxonomic composition of the phytoplankton living in the Romanian Black Sea waters, in 2011**

The abundances in density and biomass of the phytoplankton, assessed for April, July and November 2011, were characterized by seasonal, spatial and temporal variability, the densities ranging between 0.005 and $15.4 \cdot 10^6$ cells$\cdot l^{-1}$ and the biomass between 0.002 and 16.06 g$\cdot m^{-3}$. Taking into considerations the different types of water, the distribution of phytoplankton quantities (Fig. 2.3.1.2.1.2) showed variations of up to four orders of magnitude between numerical abundances, the maximum being recorded in transitional and marine waters, in spring (maximum density $9.2 \cdot 10^6$ cells$\cdot l^{-1}$ in marine waters) and autumn (maximum density $2.2 \cdot 10^6$ cells$\cdot l^{-1}$). In summer, the maximum developments occurred in waters up to one nautical mile away from the shore (up to $3.1 \cdot 10^6$ cells$\cdot l^{-1}$).

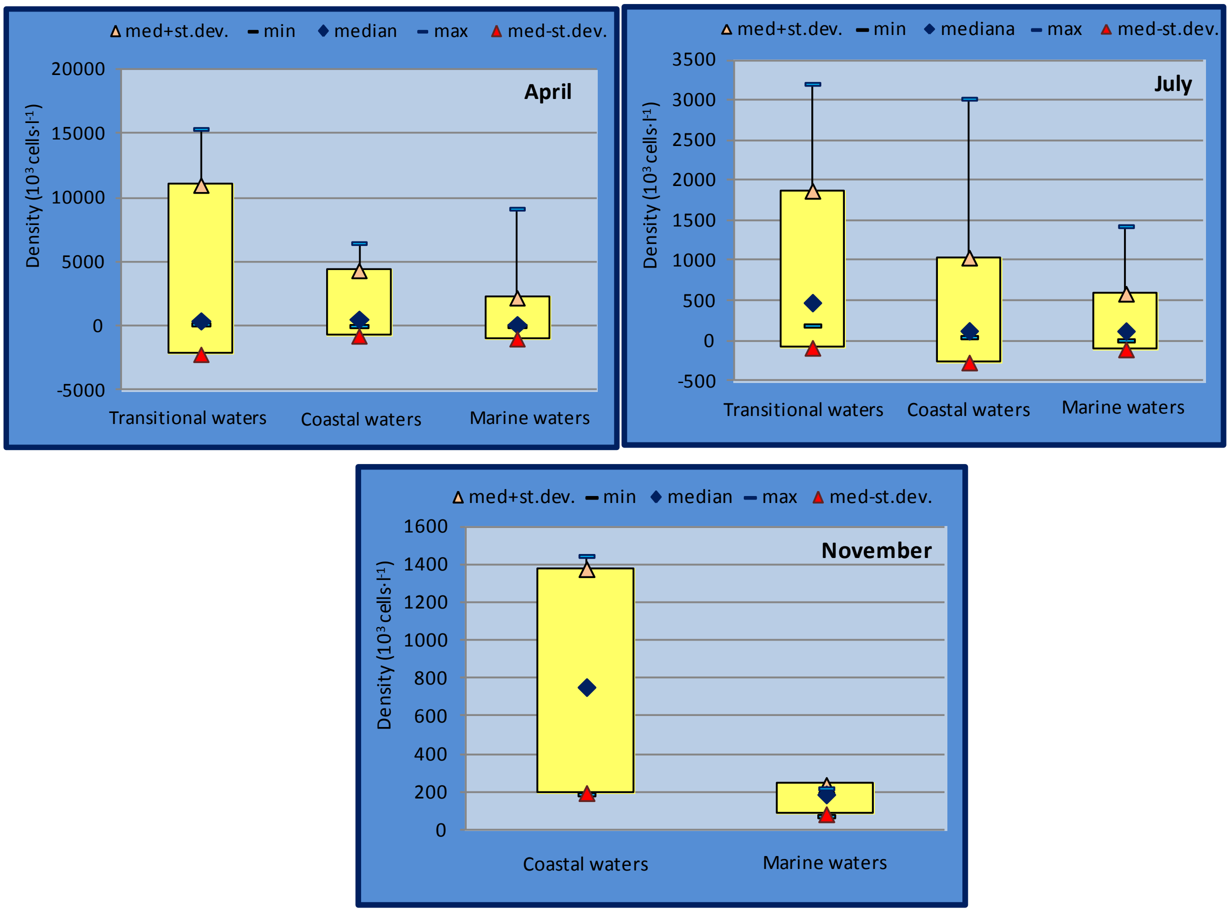



**Fig. 2.3.1.2.1.2. Distribution of the phytoplanktonic densities (cells·l$^{-1}$) in the Romanian transitional, coastal and marine waters, in 2011**

In terms of the quantitative structure of phytoplankton in **April**, the diatoms were absolutely dominant in density, representing on average 80%. In biomass, the diatoms were also dominant, their proportion increasing to the southern littoral (from 65% to approx. 72%). In **July**, the diatoms were the dominant group both in density and biomass, their proportion slightly decreasing to the southern part of the coast (from 83% to 65% in density); the dinoflagellates produced higher developments in marine waters compared to the coastal waters up to one nautical mile. In **November**, the most important development of dinoflagellates was identified, reaching proportions of 45 in density and 54 in biomass, the most notably participating species being *Heterocapsa triquetra*, *Prorocentrum micans*, *Ceratium fusus*, *Peridinium depressum*, *Scrippsiella trochoidea*.

The results of analyses on the phytoplankton from the shallow waters of the Mamaia Bay show that, despite the large seasonal variations in environmental conditions, regular cyclical changes, both as concerning the dominant species and also the most frequent species, were registered.

Although a common species throughout the year, yet characteristic for the winter and spring seasons, the diatom *Skeletonema costatum* was the dominant species, with maximum densities produced in March and April, namely $9.2 \cdot 10^6$ cells·l$^{-1}$ and $10.9 \cdot 10^6$ cells·l$^{-1}$, respectively. In summer, the plankton characteristics changed, the leading forms becoming the dinoflagellates *Prorocentrum minimum* ($920 \cdot 10^3$ cells·l$^{-1}$), *Gymnodinium splendens* ($300 \cdot 10^6$ cells·l$^{-1}$), *Peridinium quinquecorne* ($260 \cdot 10^3$ cells·l$^{-1}$), *Katodinium rotundatum* ($220 \cdot 10^3$ cells·l$^{-1}$). The dominant species was the flagellate *Eutreptia lanowii*, whose maximum development ($920 \cdot 10^3$ cells·l$^{-1}$) occurred in June (Fig. 2.3.1.2.1.3). From August to September, the characteristic species for the summer season kept vegetating, the most representative species being *Chaetoceros similis* f. *solitarus*, *Chaetoceros similis, E. lanowii*, *Ch. socialis*, *Cerataulina pelagica*, *Cyclotella caspia*, *P. minimum*, and *Hillea fusiformis* and *Scrippsiella trochoidea*.

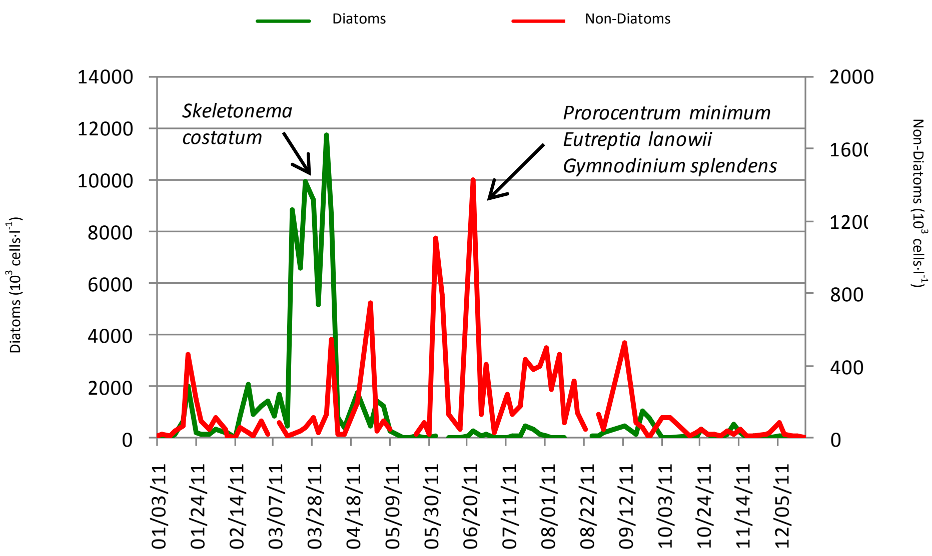



**Fig. 2.3.1.2.1.3. Dynamics of the phytoplankton from the shallow waters from the Mamaia Bay, in 2011**

Compared to 2010, the phytoplanktonic community living the waters of the Mamaia Bay had a weaker development, the average density of 2011 being two times lower ($1.2 \cdot 10^6$ cells·l$^{-1}$ compared to about $2.6 \cdot 10^6$ cells·l$^{-1}$), which demonstrates the general downward trend of this phytocoenosis abundances, as a consequence of the mitigation in the eutrophication process.

### 2.3.1.2.2. Algal blooms

**Algal blooms**, as an indicator of the eutrophication impact on the marine environment, showed a decreasing trend both in the number of events and also in the number of blooming species. Thus, during 2011, only three species produced developments over one million cells per liter. Out of these, the species *Skeletonema costatum* produced a little higher phenomenon in April, in the northern waters from the Portiţa site ($15.2 \cdot 10^6$ cells·l$^{-1}$) and a somewhat lower one in the shallow waters from the Mamaia Bay, where the density peak ($10.9 \cdot 10^6$ cells·l$^{-1}$) was recorded in April. The species began to develop ever since February, getting over several vegetative cycles, the maximum densities being achieved in March and April, then its population gradually diminished until May.

Another two diatoms, *Thallassiosira parva* and *Cerataulina pelagica*, reached densities higher than 1 million cells per liter, the first one ($1.6 \cdot 10^6$ cells·l$^{-1}$) in the shallow waters from the Mamaia Bay, in January, and the second one ($2.15 \cdot 10^6$ cells·l$^{-1}$) in northern waters, in July.

### 2.3.1.2.3. Zooplankton

In 2011, the **zooplankton** is characterized on the basis of two sets of samples collected in May and July. Zooplankton was dominated by the trophic component in May and the non-trophic component in July (Fig. 2.3.1.2.3.1 and 2.3.1.2.3.2).

The non-trophic zooplankton recorded lower values than in 2010, the maximum values of abundance and biomass from 2011 being registered in July, in the Portița 4 Station (22,153 ind.m$^{-3}$ and 1,384.5 mg.m$^{-3}$) (Fig. 2.3.1.2.3.2).

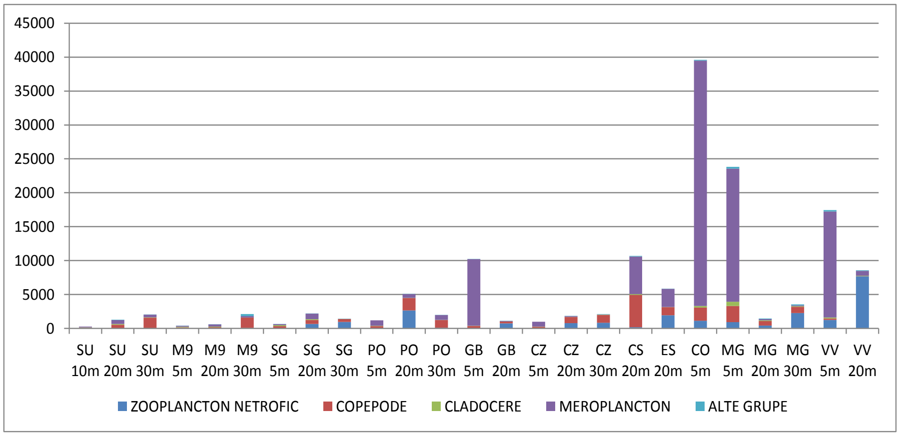



**Fig. 2.3.1.2.3.1. Evolution of total zooplankton abundance (ind.m$^{-3}$)**

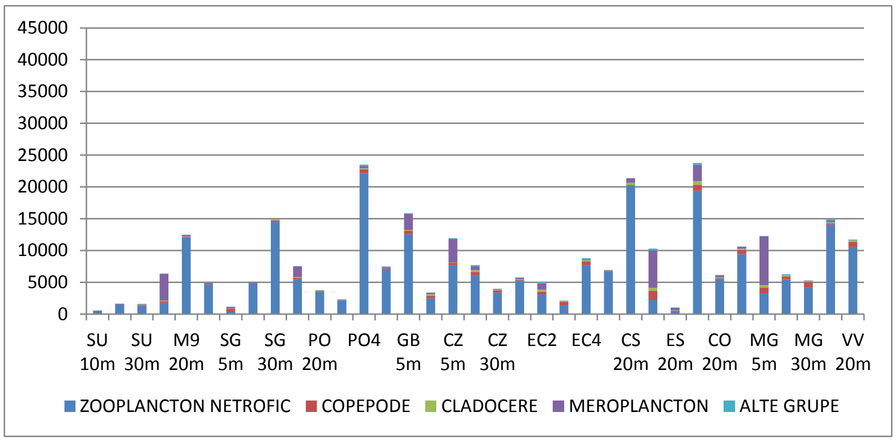



**Fig. 2.3.1.2.3.2. Evolution of total zooplankton abundance (ind.m$^{-3}$) in July 2011**

The trophic component registered its peak development on the shore of the southern part of the Romanian littoral on the Costinești profile, in May, where the abundance reached 38,442 ind.m$^{-3}$ (Fig. 2.3.1.2.3.1). Throughout the year, the trophic component was dominated by copepods in terms of both biomass and densities.

The qualitative structure of the zooplankton was represented by 27 taxa, belonging to 12 taxonomic groups.

The dinoflagellate *Noctiluca scintilans*, the copepods *Acartia clausa*, *Pseudocalanus elongatus*, *Paracalanus parvus*, the cladoceran *Pleopis polyphemoides*, the appendicular *Oikopleura dioica* and the chetognates *Parasagitta* were constantly present in the samples analyzed. In the water off the Danube mouths, several freshwater species were identified (*Daphnia cuculata*, *Bosmina longirostris*, *Moina sp.*), as a follow-up of the Danube water input.

Among exotic species, the ctenophors *Mnemiopsis leidyi*, *Beroe ovata* and the cyclopoid *Oithona brevicornis* were the only species registered in 2011. Among the species included in the Red Data Book, only *Centropages ponticus, Pontella mediterranea* and *Oithona nana* were identified.

#### 2.3.1.2.4. Phytobenthos

The qualitative and quantitative analyses were performed after collecting a number of 45 phytobenthic samples during the summer season 2011, when there were a higher specific diversity and quantitative richness. The samples were taken from the stations considered representative regarding the algal flora: Năvodari, Eforie South, Costineşti, Mangalia, 2 Mai and Vama Veche. 25 taxa were identified, assigned to various phyla as follows: 10 species belonging to the phylum Chlorophyta, 4 species - phylum Phaeophyta (*Cystoseira barbata*, *Punctaria latifolia* - in early summer as an epiphyte, at 3 m depth), 9 species belonging to the phylum Rhodophyta and 2 phanerogams (*Zostera noltii* and *Potamogeton pectinatus*).

*Cystoseira barbata* was identified along the Mangalia - Vama Veche belt. At Mangalia, *Cystoseira barbata* is well developed, with a rich epiphytic flora (formed by *Ceramium rubrum, C. elegans, Polysiphonia denudata, Ulva intestinalis, Cladophora laetevirens*). The recovery of the *Cystoseira* population at 2 Mai must be reported, as it is known that, in the past, there was a well developed field in this area. The favorable environmental conditions and the presence of a hard favorable substrate led to the regeneration of this key species for the aquatic ecosystem around this station. The tall specimens of *Cystoseira* form real underwater thickets, which provide shelter for various larvae and fish juveniles and also feeding and spawning sites for a large number of species. The average fresh biomasses developed by *Cystoseira barbata* are appreciable: (5,900 g/m$^2$ wet weight, reaching almost 12,000 g/m$^2$ w.w. at a depth of 2-3 m). At Vama Veche the *Cystoseria* field (between 1-3 m) is well developed as well, with a rich epiphytic flora during the summer season and high wet biomasses (the highest were registered between 2-3 m, where environmental conditions are more stable - about 36,000 g/m$^2$ w.w.). The dominant associated field species was *Ulva lactuca.* Along Mangalia to Vama Veche, a high productivity due to perennial species is registered, thereby a better water oxygenation and a higher specific diversity (Fig. 2.3.1.2.4.1.).

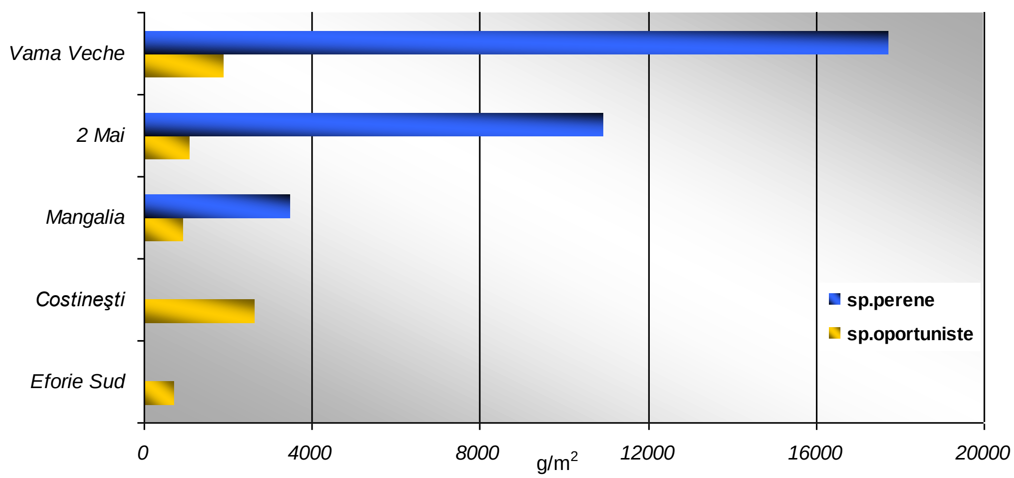



**Fig. 2.3.1.2.4.1. Average biomass values for opportunistic and perennial species along studied sampling sites**

At Mangalia, between 1-3 m deep, there is a sandy substrate where a *Zostera noltii* meadow is located, with specimens epiphyted by *Ceramium rubrum, C. elegans* and *Acrochaetium savianum*, in summer. Compared to previous years, it appears that in Mangalia both *Cystoseira barbata* and *Zostera noltii* have continued the regeneration process, so the *Cystoseira* field and *Zostera* meadow are formed of well developed specimens, with a rich epiphytic flora and associated fauna (Fig. 2.3.1.2.4.2.). The study carried out in 2011 led to the identification of a new *Zostera noltii* meadow in Năvodari, yet with smaller dimensions compared to the one in Mangalia. Here was also reported the phanerogam *Potamogeton pectinatus* epiphyted by *Cladophora vagabunda* and *Acrochaetium savianum.* These two large areas of *Potamogeton* and *Zostera* represent shelter to a rich fauna consisting of bivalves, gastropods, polichaetes and hatches are deposited on the leaves of such phanerogams. Their ecological value is due to the protection they provide to invertebrates and fish juveniles.

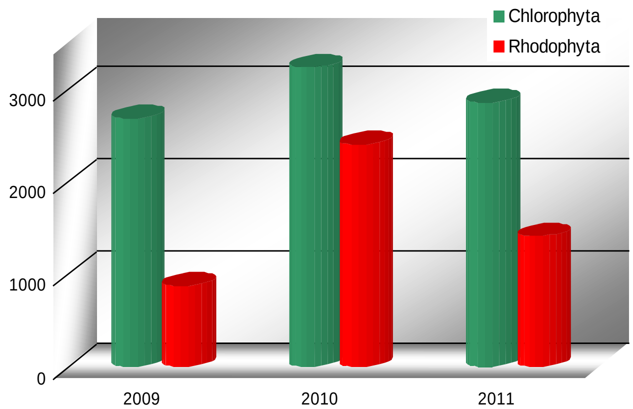



**Fig. 2.3.1.2.4.2. *Cystoseira barbata* and Fig. 2.3.1.2.4.3. Fresk wet biomass of the dominant *Zostera noltii* - Mangalia, June 2011 groups in summer 2009-2011**

In 2011, the red alga *Lomentaria clavellosa* was identified at 2 Mai. Its presence both in 2010 and 2011 indicates a slight regeneration of the algal flora from the quality point of view. It is also mentioned the presence of the perennial encrusted red alga *Hildenbrandia rubra*, on the shallow rocks from the northern sector. Among the opportunistic species, *Cladophora* dominated from the quantity point of view. Thus, in the upper horizons (0-2 m - where favorable environmental conditions exist - temperature, nutrients etc.), fresh biomasses exceeded 2,000 g/m$^2$ (2,260 g/m$^2$ w.w. at Costineşti). Among red algae, the species *Ceramium* sp., *Callithamnion corymbosum*, *Polysiphonia denudata* (1,670 g/m$^2$ w.w.) had a constant presence throughout the summer season (Fig. 2.3.1.2.4.3).

As in previous years, in 2011, throughout the summer season, macroalgae deposits were formed along the seashore. The dominant species from such deposits were those of *Cladophora*, *Ulva* (especially *Ulva prolifera*, *Ulva intestinalis*, *Ulva compressa*), *Bryopsis plumosa* and, among red algae - *Ceramium* species (especially *Ceramium rubrum*). Due to waves and storms during summer, algae were removed from the substrate, floating at water surface or forming an algal belt along the beaches.

### 2.3.1.2.5. Zoobenthos

**Zoobenthos**, as an eutrophication status indicator, still showed a constant evolution, in terms of species diversity. The qualitative assessment of all monitored areas led to the record of 53 macrozoobenthic species, the faunistic panel keeping the characteristics of previous years. The multiannual number of species evolution present in the Romanian water sectors revealed a slight, but continuous tendency towards qualitative balancing, if we compare this state with the 1990s, when the benthic fauna was represented by a maximum of 28 species (Fig. 2.3.1.2.5.1.).

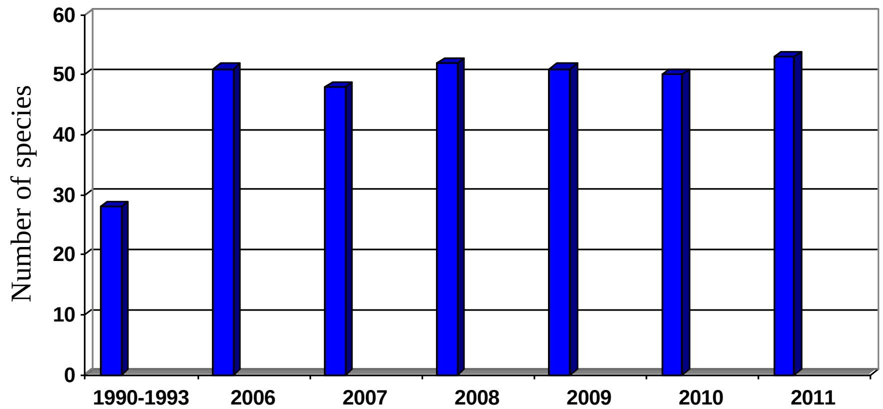



**Fig. 2.3.1.2.5.1. Evolution of number of species in the Romanian water sectors (Sulina-Vama Veche)**

Quantitatively, in transitional (the Sulina-Portița profiles) and coastal waters (the Cazino Mamaia profile) an increase of about 1.6 times of numerical abundance, respectively of 1.7 times at biomass level, compared to the values registered in 2010, was reported. The numerical dominance was attributed to the presence of species with a large ecological valence, such as the polichaete species *Polydora cornuta, Neanthes succinea* and the tubiculous amphipod *Ampelisca diadema*.

In the southern sector of the coast (Eforie South - Vama Veche), the values of the numerical abundance obtained (2,508 ind./$m^2$) were 2.6 times smaller compared to the assessment of 2010, yet with comparable values of biomasses in the two analyzed years, namely 84 g/$m^2$ . Compared to the 2009 assessment, when the biomass indicator registered an average of 327 g/$m^2$, during the last two years, the weight contribution of mollusks to the biomass increase was reduced by about four times.

In marine waters, on the East Constanța sector, the quantitative indicator of density registered an increase over five times, which was more obvious at 47 m depths.

The assessment of the response of benthic communities to the anthropogenic pressure on the marine environment quality was performed by using the specific biotic index (AMBI and M-AMBI). The results of the average values obtained for water bodies investigated in 2010-2011 were characterized by a moderate quality state, with a slight tendency towards a good condition in areas less affected by eutrophication, mainly in the southern sector.

For the benthic communities' recovery, there is the need for a longer period of improved environmental conditions, taking into account the fact that species with a low tolerance degree, the sensitive ones, 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 at 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 on the involvement of specialists in species identification. Between 1996 - 2010, on average, 200 - 300 species were identified annually. In 2011, over 325 species of the groups mentioned above were identified.

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 2011, i.e. 26/325, 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.

### 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 220 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 (9%), 56 invertebrates (25 %), 141 fish (64%) and 4 mammals (2%) (Fig. 2.3.1.3.1.).

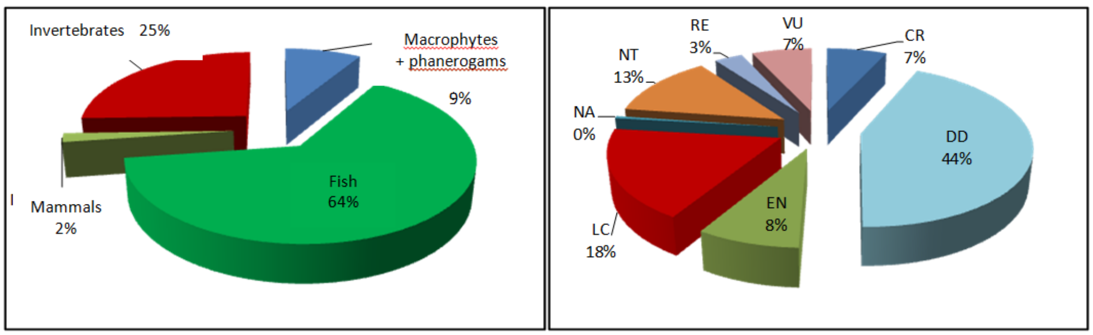



**Fig. 2.3.1.3.1. The main marine organisms' categories in the Red List (left) and the IUCN categories they are included in (IUCN, v. 3.0, 2003, 2004, 2006)**

Regarding the macrophytes and phanerogams included in the Red List, two species were identified in 2011 - *Cystoseira barbata* (a perennial brown alga) and *Zostera noltii* (a marine eelgrass). Both species have a high ecological value for the marine environment and are considered to be key species. These species represent shelter to a wide faunistic variety and support for the development of epiphytes. *Cystoseira barbata*, an endangered species (EN), was identified along Mangalia - 2 Mai - Vama Veche. The *Cystoseira* population from Vama Veche is well represented, with strong epiphyted specimens during the summer season. In 2 Mai, *Cystoseira* appears to be in a recovery process compared to the previous years and thick bunches were identified in Mangalia. *Zostera noltii* forms a meadow in Mangalia. In Năvodari was identified a new area where this marine eelgrass forms discontinous populations. In this case, the IUCN classification includes six categories: (RE, CR, EN, VU, LC, DD): one species (5%) considered extinct in the region (RE), 3 (16%) - critically endangered, 7 (37%) - endangered, 3 (16%) - vulnerable (VU), 2 (11%) with low concern (LC) and 3 (16%) data defficient (DD) (Tab. 2.3.1.3.1).

**Tabel 2.3.1.3.1. Sozologic status of the species in the Red List updated in 2011**

| Group of species | Status pursuant to IUCN categories v. 3.1, 2001 and v.3.0, 2003 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | RE | CR | EN | VU | NT | LC | DD | NA | Total |
| Macrophytes | 1 | 3 | 7 | 3 | 0 | 2 | 3 | 0 | 19 |
| Invertebrates | 6 | 12 | 6 | 7 | 3 | 7 | 14 | 1 | 56 |
| Fish | 0 | 0 | 2 | 5 | 25 | 31 | 78 | 0 | 141 |
| Mammals | 0 | 0 | 3 | 0 | 0 | 1 | 0 | 0 | 4 |
| TOTAL | 7 | 15 | 18 | 15 | 28 | 41 | 9 | 1 | 220 |

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. 2.3.1.3.1.). Among the four calanoid copepod species *Anomalocera patersoni, Labidocera brunescens, Pontella mediterranea* and *Oithona nana*, in 2011, two were reported (*Pontella mediterranea* and *Oithona nana*).

Of the benthic invertebrates in the Red List, 5 were identified in 2011, among which we mention: *Donax trunculus* (**VU**), *Pitar rudis* (**CR**), *Calyptrea chinensis* (**VU**), *Upogebia pussila* (**LC)** *Apseudopsis ostroumovi* (**LC**).

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. 2.3.1.3.1.). Among the 30 species identified in 2011, 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 2011, dolphins were not the object of a special monitoring program. 52 dolphins were found stranded on the shore, of which 45 individuals of *Phocoena phocoena*, 4 of *Tursiops truncatus* and 3 *Delphinus delphis*. It must be noticed that 90% of the stranded dolphins come from illegally installed turbot gillnets. 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 Fishing Stocks

#### 2.3.2.1. Marine Living Resources Indicators

In 2011, 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 trap nets), but also at 20-60 m depths/gillnets and long lines). Additionally, we mention the small-scale coastal fishing.

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

► ***Evolution of the state indicators:***

● the **stock biomass** for the main fish species (Table 2.3.2.1.1) indicates:

**- for sprat**, which usually had a natural fluctuation, almost normal biomass and actually a relatively good stock were estimated, as in the past 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 Black Sea;

- for ***whiting***, the biomass was estimated at 21,000 tons, almost three times higher 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 1,150 tons, similar to the previous year, yet smaller than for the period 2008-2009 and close to the period 2005-2007;

- for ***dogfish,*** there was a 10,000 tons biomass, approximately equal to the one estimated in 2010, but four-five times higher than in 2009 (2,500 tons);

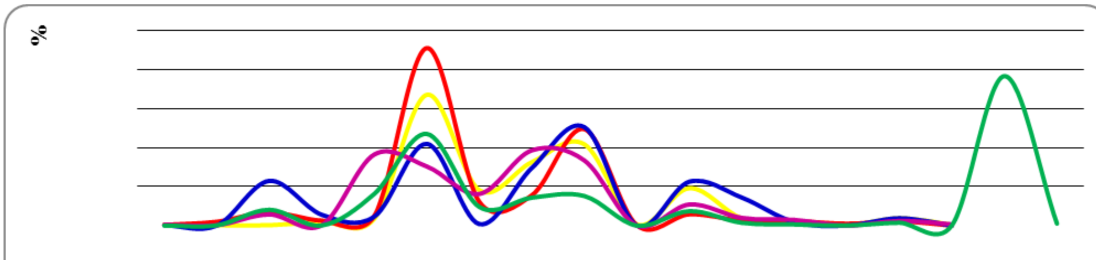
**Table 2.3.2.1.1. Stock value (tons) for the major fish species in the Romanian Black Sea**

| Species | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|
| **sprat** | 45,000 | 14,750 | 60,000 | 61,916 | 60,059 | 59,643 | **60,000** |
| **whiting** | 8,000 | 7,000 | 6,000 | 8,659 | 11,846 | 20,948 | **21,000** |
| **anchovy** | 19,000 | 20,000 | 20,000 | 20,000 | - | - | **-** |
| **goby** | 600 | 600 | 600 | 500 | - | 500 | **500** |
| **turbot** | 1,080 | 1,150 | 1,300 | 2,356 | 1,500 | 1,149 | **1,147** |
| **dogfish** | **1,650** | **2,000** | **4,300** | **1,450** | **2,500** | **13,051** | **10,000** |

● 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 Danube 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. 2.3.2.1.1).

► ***Evolution of the pressure indicators:***

● The **fishing effort** continues the trend of reduction reported since 2000. Thus, in 2011, in the case of active fishing (using the pelagic trawl), only two vessels were active and in passive fishing 41 crafts (below 6 m), 156 boats (6-12 m) and one vessel (18-24 m) were active. In fishing with fixed gear, practiced along the Romanian coast, were used: 15 trap nets, 3,169 turbot gillnets, 1,618 shad gillnets, 256 goby gillnets, 3 beach nets, 40 mullet gillnets, 297 dogfish gillnets, 6 horse mackerel gillnets, 297 long liners, 320 cages and 256 handlines;




| | Sand smelt | Garfish | Horse mackerel | Caspian shad | Danube shad | Sprat | Whiting | European anchovy | Turbot | Kilka | Goby spp. | Grey mullet | Red mullet | Bluefish | Dogfish | Sole commun | rapana | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2007 | 0.20 | 0.10 | 0.10 | 1.00 | 1.80 | 33.60 | 9.10 | 16.30 | 20.90 | 0.30 | 9.60 | 1.90 | 1.20 | 0.10 | 1.90 | 0.20 | | 1.70 |
| 2008 | 0.20 | 1.00 | 3.40 | 1.30 | 2.50 | 45.60 | 6.10 | 7.80 | 24.80 | 0.10 | 2.90 | 1.30 | 1.20 | 0.50 | 1.10 | 0.00 | | 0.20 |
| 2009 | 0.10 | 0.00 | 11.50 | 2.80 | 2.30 | 21.00 | 0.40 | 14.80 | 25.30 | 0.00 | 11.30 | 7.20 | 0.90 | 0.00 | 1.90 | 0.00 | | 0.50 |
| 2010 | 0.20 | 0.11 | 2.87 | 0.10 | 18.27 | 15.19 | 8.14 | 19.33 | 16.74 | 0.00 | 5.43 | 1.98 | 1.47 | 0.03 | 1.22 | 0.35 | | 8.57 |
| 2011 | 0.00 | 0.08 | 4.07 | 0.04 | 8.15 | 23.56 | 4.80 | 7.18 | 7.61 | 0.00 | 3.71 | 0.72 | 0.29 | 0.02 | 0.74 | 0.10 | 38.41 | 0.52 |

**Fig. 2.3.2.1.1. The catch structure (t) of the main fish species in the Romanian marine sector during 2007-2011**

● **the total catch** continued the downturn after 2000, from over 2,000 tons between 2001-2002, to 1,390-1,940 tons between 2003-2006 and 500 tons in the last five years (2007- 2010), namely 435 t/2007, 444 t/2008, 331 t/2009, 258 t/2010 and 568 t/2011 (Figure 2.3.2.1.2.). The low level of catches in the past years 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 influence of hydro-climatic conditions on fish populations, as well as the increase of production costs and the lack of an appropriate market for fishery products;

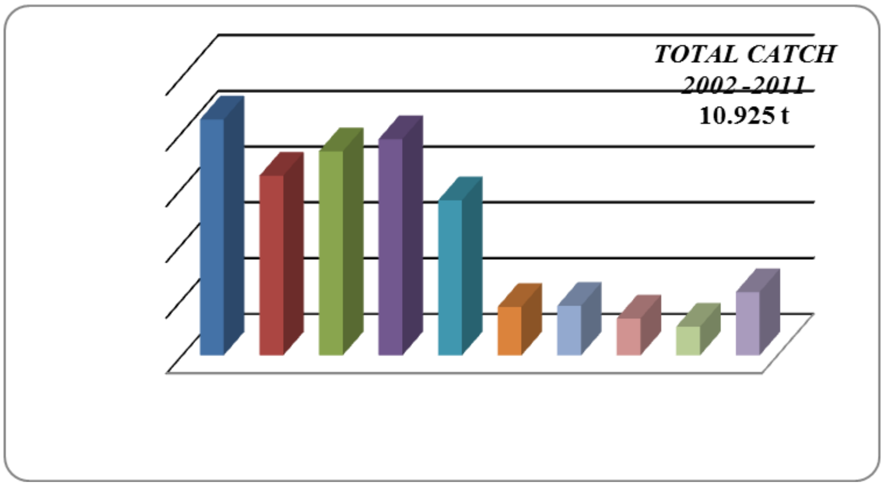



**Fig. 2.3.2.1.2. Total catches (t) made in the Romanian sector of the Black Sea, between 2002 - 2011**

● the **Total Admissible Catch (TAC)** of the main fish species caught between 2007-2011 remained at the same level (Table 2.3.2.1.2).

**Table 2.3.2.1.2. The value of the TAC (Total Admissible Catch) for main fish species in the Romanian Black Sea**

| Species | TAC (tons) | | | | |
|---|---|---|---|---|---|
| | **2007** | **2008** | **2009** | **2010** | **2011** |
| sprat | 10,000 | 10,000 | 10,000 | 3,443 | 3,443 |
| whiting | 500 | 500 | 500 | 600 | 600 |
| goby | 200 | 100 | 100 | 100 | 100 |
| turbot | 50 | 50 | 50 | 43.2 | 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 continues 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 2000-2010, except for sprat, which stands a rejuvenation of the schools, 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 1,017.26 kg/month, 87.29 kg/day respectively, with an effort made by 15 trap nets and 874 days and a total catch of 76,296 kg;
- with fixed gear/turbot gillnets, it was 13.65 kg/gillnet, 82.38 kg/day and 277.23 kg/boat, with an effort made by 3,169 turbot gillnets, 525 days, 156 boats and a total catch of 43,248 kg;
- with active fishing gear/pelagic trawl, 130.9 t/vessel, 2.91 t/day, 1.07 t/trawl and 0.83 t/hour, with an effort made by only one vessel, 45 fishing days, 123 hauls and 158 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 the legal and institutional framework for the 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. Maritime Spatial Planning

During 2011, the Maritime Spatial Planning (MSP - *comprehensive process of adaptation, integration, ecosystem approach to land use, based on scientific data and analysis of current activities and uses for the protection and sustainable use of the coastal and marine areas for future generations*) studies and research were continued and developed.

The objectives realized in 2011 implied the scientific and technical support for the elaboration of the Action Plan necessary for the integrated marine strategy and policies case studies of the central and southern coast, main cities, resorts and marine protected areas: Mamaia Bay, Eforie North, Eforie South, Vama Veche.

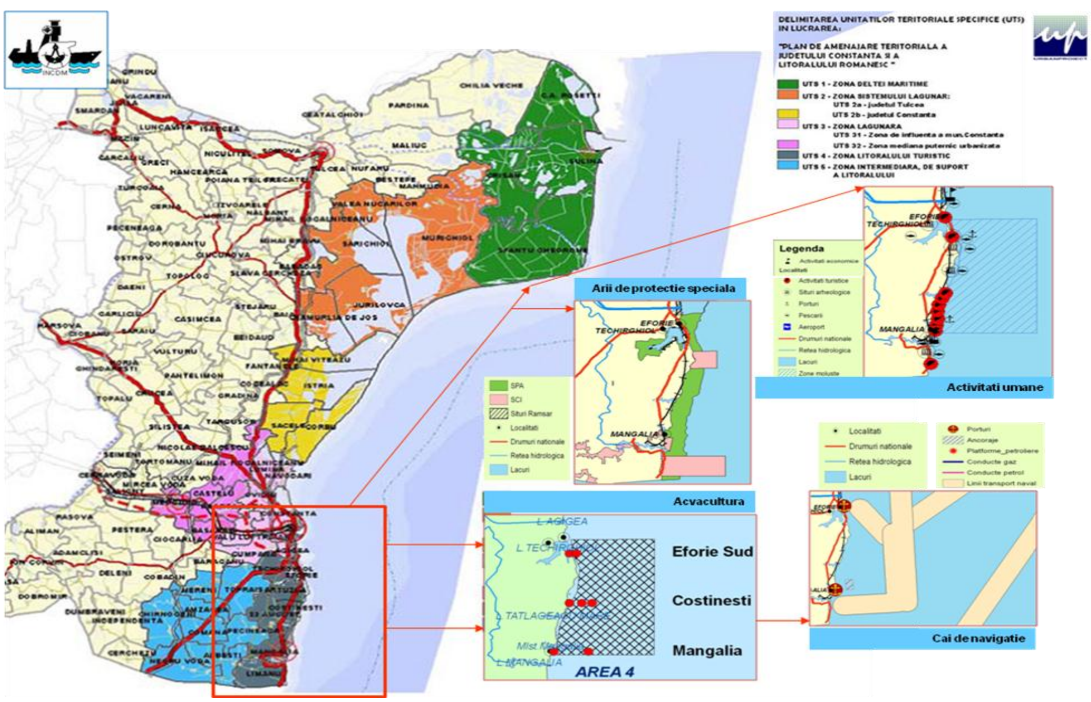



**Fig. 2.3.3.1. Study area. Integrated theme map**

The studies were substantiated upon: collecting various information concerning the ecological aspects and human pressures and uses, including the assessment of their impact; describing the specific MSP steps (10) towards integrated spatial planning pursuant to European Directives and maritime policies; simple zonal approach of activities and resource use with the view to minimizing the impact on the marine environment.

The modern methods used and organizing the data on GIS informational support allowed the creation of new theme and integrated maps (Fig. 2.3.3.2.-9), enabling the information flow at local, regional, national and international level.

The case studies approached concern the sub-lagoon area, the highly anthorpogenic mid coastal area, the influence area of the Constanța City, the tourist littoral area, the intermediate, support area (Fig. 2.3.3.2.-10). They are all under the double and direct influence of natural continental and anthropogenic factors (new building areas, traffic communication routes, railways, tourist activities, shore consolidation works) and marine factors (erosion, eutrophication/algal blooms and mining and leisure activities, oil platforms, oil pipelines, shipping, anchorages etc.). All the above are located, surrounded or represented by settlements, SPAs, SCIs, RAMSAR sites etc.

Case Study 1. Mamaia area: it is a space complex exclusively for tourism-municipal planning-leisure, of international interest, comprising areas undergoing land arrangement (currently and in the future), with double access to the coastal zone, lake (Natura 2000 site/SCI) and sea, affected, to certain extents, by coastal erosion and industrial impact, against which there are protection plans already drawn-up (Fig. 2.3.3.2.-1). NIMRD has performed studies for identifying the barren areas and specific biodiversity under the impact of traditional hydro-technical constructions, as well as for elaborating ecological rehabilitation solutions.

Case Studies 2 and 3. Eforie North and South, as hydropathic-tourist resorts, currently have coastal arrangement plans, for shore consolidation and urban protection, areas with leisure harbor activities, constructions erected in risk areas, conflicting activities, airports, national roads, hydrological networks, unique Community interest protected areas (Lake Techirghiol) and land, ecological follow-ups (Fig. 2.3.3.2.-6).

As shipping routes and maritime exploitations are located at considerable distance from the shore, they impact solely on natural resources in the offshore area. The activities carried out in the maritime area have a predictable effect on the marine environment and living organisms, in case of assessing the emissions and the effect of potentially hazardous substances transportation.

Case Study 4. Mangalia - Vama Veche: this case study focused on an area of great industrial and specific tourism interest. Tourist activities, harbor activities, coastal lakes, mollusk population areas (suitable for exploitation or aquaculture), aquaculture or multicultural interest sites, wrecks, traditionally unstable climate areas, traditionally unstable hydrological areas (waves, floods, droughts etc.), traditionally unstable wind areas (strong winds, storms etc.) have been identified. In the extreme southern area, marine activities are limited, due to the protected area status of the zone, focused mainly on fisheries (Fig. 2.3.3.2-9).

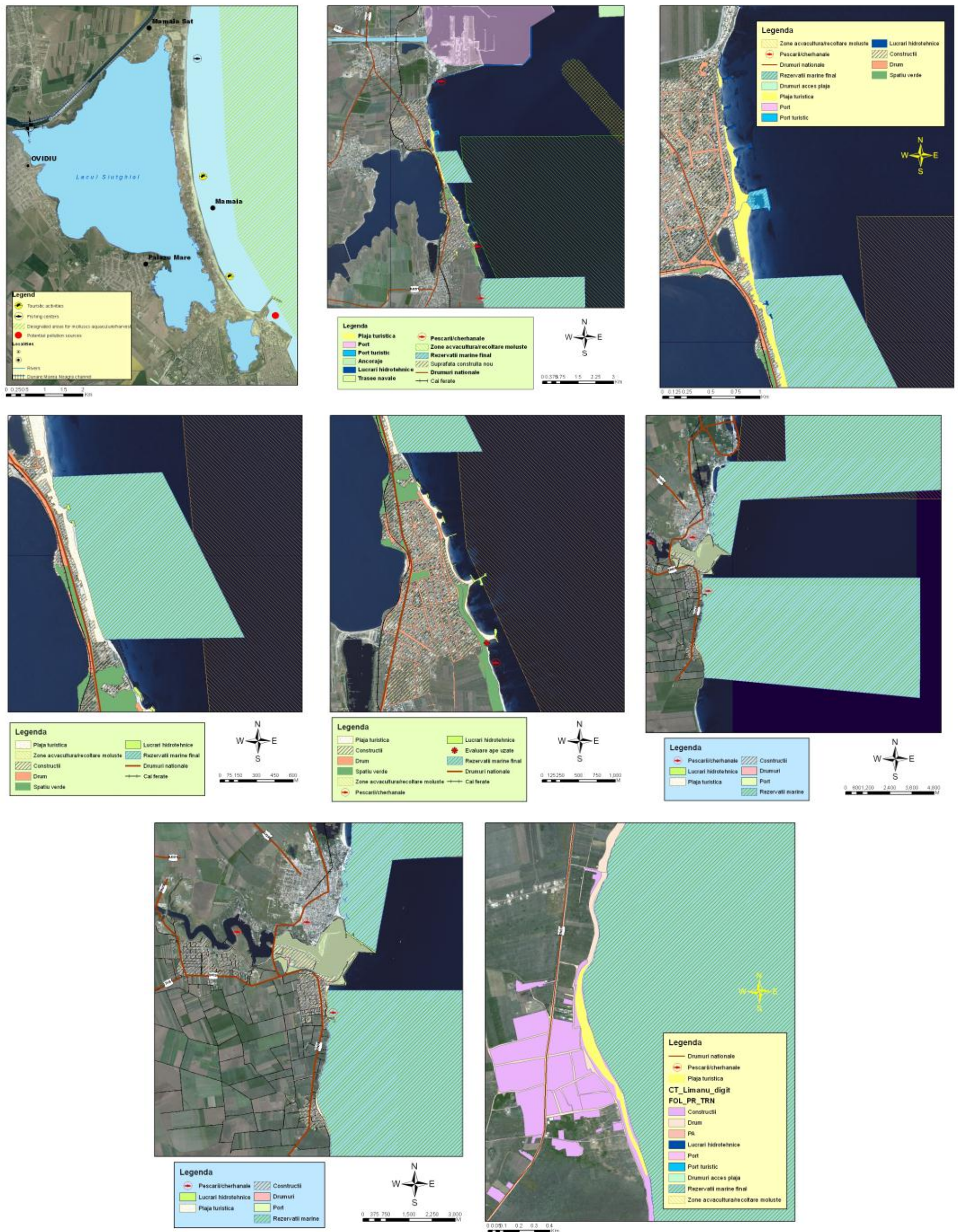



**Fig. 2.3.3.2.** ***1-9*****. Mamaia, Eforie North, Eforie South, Mangalia, Vama Veche**

The assessment of the main functions and economic activities, meant to evaluate the type of relationships (conflict, negotiation, compatibility) in the study areas (Năvodari, Mamaia, Constanţa, Eforie North and South, Limanu and Mangalia) were focused on the main activities and coastal and marine uses: harbor activity, tourist activity, land and marine protected areas, waste discharge or storage areas, shipping routes, fisheries, coastal protection, tourism, leisure, services, land military zones.

The elaborated plans need to be updated with other geo-referenced and impact details relating to agriculture, forestry, wind power parks, inland water transportation, land military activities, urbanization, land heritage protection, marine resources extraction, coastal and beach protection activities, leisure activity and protection of the marine heritage.

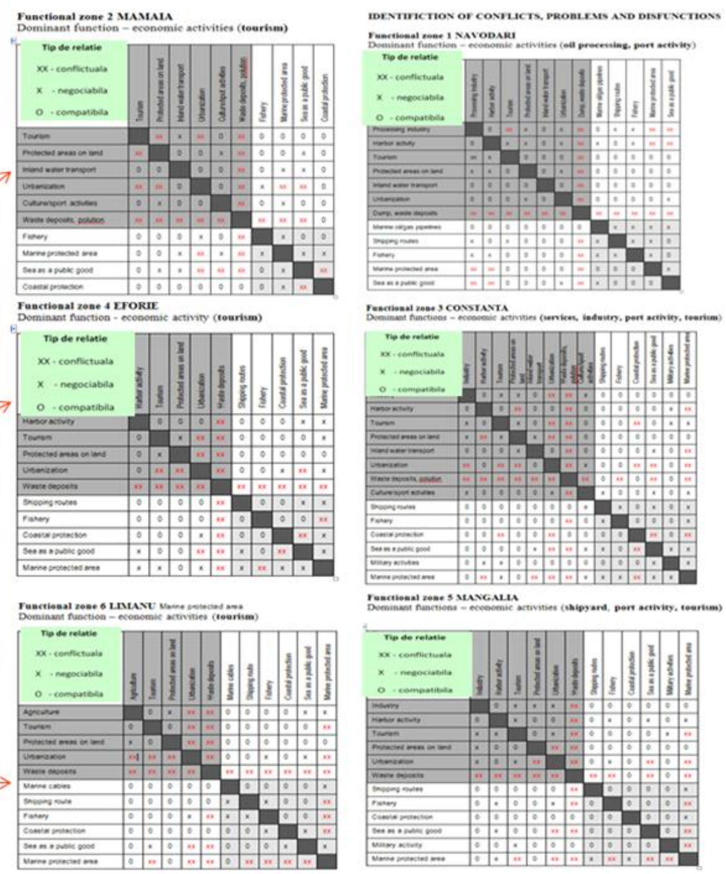




**Fig. 2.3.3.2.-10 - Coastal zone; Fig. 2.3.3.2.-11-16 - Conflict matrices in the studied coastal areas**

The maritime activities carried out at and off the Romanian littoral were limited and little known in relation to the coastal area, as the Romanian coast has an unique geographical status, typical open sea, with an instability degree. The MSP action plan drawn-up points out the management objectives of the studied areas, aiming at: sustainable development; conservation of important species and ecosystems, including landscape issues as well; increasing tourism attraction by expanding the holiday season; developing eco-tourism, promoting natural, traditional, historical and cultural values of the region; creating opportunities for the development of the local economy; strengthening the administrative capacity; setting the appropriate mechanisms for the promotion of the tight collaboration among all stakeholders in the reference area.

MSP provides expertise and knowledge in elaborating long-term scenarios, as integral part of a vision created in agreement with coastal management requirements (ICZM).

The results obtained in 2011 contribute to the validation of the current knowledge on natural processess, coastal land structure, certain industrial, harbor, tourist issues, characteristic for the maritime area. The progress recorded and NIMRD's contribution in the field of MSP are essential mainly for tracing the shore line, effective upon the establishment of the construction area from the shore line towards the land zone and the delimitation of private property from state property.

### 2.3.4. Anthropogenic Pressures

The continuous assessment of the traditionally unstable natural conditions risks and impact is constantly completed with information about the human impact with negative influence on the coast, in ecological and economical ways. The main anthropogenic pressures identified at the Romanian coastal zone, with significant environmental impact, come from the development of socio-economic activities. The following activities are listed below (Fig. 2.3.4.1.).:

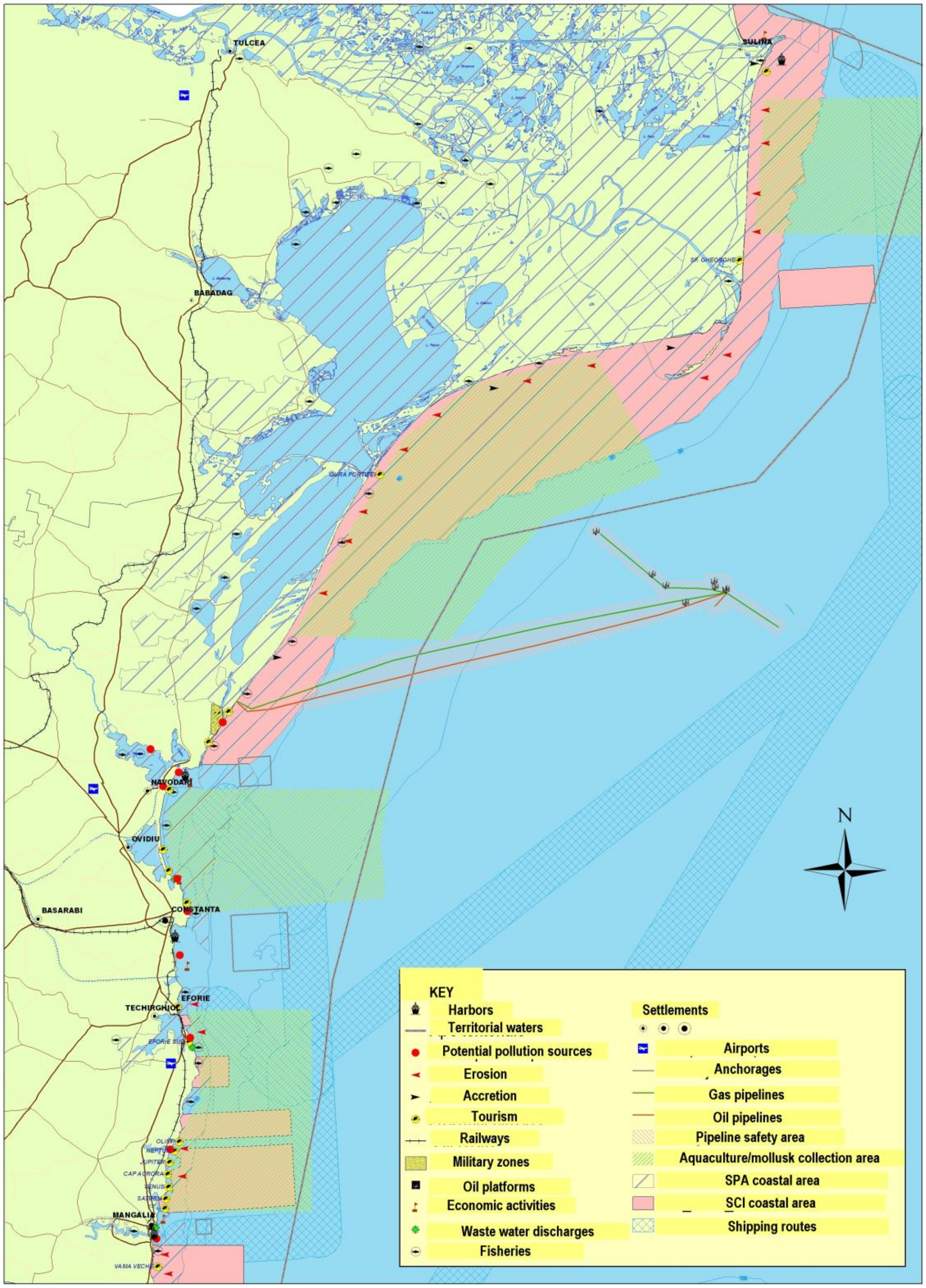



**Fig. 2.3.4.1. Integrated map of maritime activities at the Romanian coast**

- Tourism and leisure;
- Agriculture and food industry;
- Harbors and navigation. Shipping industry;
- Shipbuilding;
- Expansion of the existing tourism ports upgraded by dredging activities;

- Construction of neighborhoods (holiday homes) in tourism areas;
- Petrochemical industry, refineries;
- Mining: for minerals, sand in shallow coastal areas;
- Nuclear power industry;
- Manufacturing industry;
- Airport and aviation;
- Military and defense activities.

The key environmental issues identified in 2011 in the Romanian coastal zone, as a result of anthropogenic factor, are identified as follows:

- Changes recorded in the seawater mineralization due to the long-term process of turning fresh done by the Danube and intensified salinity variations, especially during uncontrolled flooding;
- Sediment dynamics at the Chilia-Sulina mouths of the Danube (Musura Bath closing/clogging);
- Water/air pollution;
- Solid waste pollution from diffuse sources in tourism areas, beaches, bathing areas;
- Uncontrolled break of the littoral Chituc Sandbank (eastern side) during unpredictable storms;
- Coastal erosion, increased in the tourism areas (Mamaia, Eforie etc.);
- Implementation of protection solutions against beach erosion;
- Construction of a pontoon in the Mamaia area;
- Extraction of natural resources/beach sand (in Mamaia, Eforie Nord, Mangalia);
- Shipping and road transport in coastal areas. Executions and traffic increasing on technological roads for coastal protection (in the North Constanța, Tuzla, Costinești areas);
- Seawater intrusion/infiltration in coastal aquifers;
- Areas of impact on habitats and species endangering - by cliffs terracing, implementing coastal protection works and coastal habitats clogging based on ground and building materials, in different coastal areas (Eforie North and South, Tuzla, Costinești, Tatlageac, Olimp);
- Urban sprawl/covering beaches areas with constructions (Mamaia area);
- Development of uncontrolled tourism construction and of the tourism recreation and leisure activities over the capacity of environmental acceptance;
- Overcrowding of the population in the coastal zone, during the summer season;
- Excessive exploiting of the fish stocks;
- Oil pollution produced by vehicles/ATVs/old boats, entering directly on the beach;
- Construction/operation of sewage treatment plants and also settlements without sewage/wastewater treatment facilities.

Studies which can be planned to be associated with other risks and hazards in the coastal zones are earthquake management, flood management, toxic waste spill response, insecticide impact, biotechnology hazard release into the community, chemical hazard to community during the drought periods, desertification and land degradation, climatic changes (global warming), landslide and mudslide risk assessment, tornadoes etc.

**CONCLUSIONS**

The state and trends in the Romanian marine and coastal environment were monitored in 2011 in terms of physical, chemical and biological parameters, compared to the reference period of the 1960s 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.

The mean value of seawater temperature for 2011 - 12.5°C interrupts the temperature increasing trend of the past years. In all water types, the minimum values for seawater transparency are below 2 m, the allowed value both for the ecological state, as well as for human activity impact area. The salinity of transitory, marine and coastal waters in the Romanian littoral area recorded values ranging between 1.72 - 18.91 PSU (mean value 15.68 PSU). The pH of coastal waters in the Constanța area recorded mean monthly values ranging between 8.02 in December and 8.30 in June. On the long term, the monthly averages of phosphates for 2011 vary significantly from the multiannual mean value for 1960-2010, due to the low values reported in 2011. The mean value for 2011, 12.54 µM, remains within the characteristic range of the reference period. The nitrates recordered, during the studied period, values ranging betwen 1.08-70.97 µM. The multinannual monthly mean concentrations (May and Juy) of nitrates shows high values, comparable with those reported during the eutrophication period. The silicates recorded concentrations ranging between 0.3-24.2 µM, with higher values in summer, in the water column. As the main silicate sources in the Romanian Black Sea waters are represented by river input, the low Danube flow in 2011 determined the drop of silicate concentrations in the Romanian Black Sea waters. In 2011, the mean chlorophyll *a* content in coastal waters recored a value almost twice lower compared to 2010 (4.91 µg/l compared to 9.51µg/l), yet under the annual average determined for the period 2001-2010 (6.27 µg/l), thus confirming the recovery state of the ecological state of the coastal ecosystem in the Romanian Black Sea waters, reported in the past years.

The evolution trends of heavy metals in marine waters in the past 5 years record various behaviors, depending on the investigated elements. Thus, copper and lead displayed a slightly increasing tendency in 2011, while the figures for cadmiun are low compared to previous years (2007-2010). The concentrations of nickel and chromium in 2011 framed within the variation ranges reported during 2007-2010. The evolution trends of heavy metals in marine sediments in the past 5 years point out the fact that the values measured in 2011 frame within the variation ranges for 2007-2010. The evolution of the heavy metal bioaccumulation levels in *Mytilus galloprovincialis* in the past years reveals a slight diminishment trend for cadmium in 2011, while the other elements are within the variability limits observed during 2007-2010.

In 2011, low values (< 200 µg/l) of the Total Petroleum Hydrocarbon contents (TPH) (µg/l) were recorded in water. The petroleum hydrocarbon pollution level in sediments recorded in 2011 is significantly lower. The monitoring of the polynuclear aromatic hydrocarbons (PAHs) in water and sediments reveals mean values within the characteristic limits for 2006-2010. Anthracene is an exception, revealing high values in all environmental components investigated. The monitoring of organochlorine pesticides showed high values for the following pollutants: p,p' DDT, lindane, p,p' DDE and aldrine. The mean values ranged within the same variation limits as for the period 2006-2010.

The microbiological load was fair in 2011 in the bathing area, the enocountered enteric bacteria concentrations (total coliforms/TC, faecal coliforms/FC, faecal steptococci/FS) ranging benerally below the limits provided the the National Regulations and the European Community Directives, values reflecting the degree of faecal pollution of marine bathing waters.

The number of Community interest habitats (as defined in the Habitats Directive - 92/43/EEC) was assessed 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 submerged marine caves), with 28 sub-types.

In 2011, through the Order of the Ministry of Environment and Forests no. 2387/2011 amending the Environment and Sustainable Development Minister's Order no. 1964/2007 on establishing the protected area status of Community importance sites, as part of the Natura 2000 European ecological network, Romania approved the designation of two new sites, under the Habitats Directive: ROSCI0281 Cape Aurora, RO0293 Costinești-23 August.

Based on determinations of the sea-shoreline contact modification rhythms, the assessment of the coastal processes extent was assessed. The sea level, as one of the indicators of the coastal zone state, presented, during 2011, a constantly positive deviation from the long term monthly averages, except for December, when the monthly average was 6.9 cm below the long term average for this month. The annual trend was a decreasing one, from 40.8 cm in January to 6.5 cm in December 2011.

The phytoplankton composition included 173 species, with varieties and forms belonging to 7 taxonomic groups. The largest number of species (112 species) was identified in transitional waters, where marine species were joined by freshwater and fresh-brackish water species. Algal blooms, as an indicator of the eutrophication impact on the marine environment, showed a decreasing trend both in the number of events and also the number of blooming species. During 2011, only three species produced developments over one million cells per liter. The non-trophic zooplankton recorded lower values compared to the previous year, the peak development stage occurring in July, in station Portița 4. The trophic component recorded the maximum development values in the shore area of the southern littoral, on the Costinești profile, in May.

Phytobenthos: during 2011, 25 macroalgal taxa were identified, classified as follows: 10 belonging to the phylum Chlorophyta, 4 species belonging to the phylum Phaeophyta, 9 species belonging to the phylum Rhodophyta and 2 to Phanerogama. The zoobenthos still showed a constant evolution, in terms of species diversity. The qualitative assessment of all monitored areas led to the record of 53 macrozoobenthic species, the faunistic panel keeping the characteristics of previous years. Among the multiannual number of species evolution present in the Romanian water sectors, a slight but continuous tendency towards qualitative balancing was observed, if compared to the 1990s period. The Red List of macrophyte, invertebrate, fish and mammal species, state indicator for biodiversity in the Romanian Black Sea sector, was entirely updated in 2008 and just for fish in 2009.

The state of marine fishery stocks: the stock biomass for the main fish species indicates: for sprat, which generally had a natural fluctuation, the biomass is almost normal and a fair stock, the biomass being estimated similarly to the past 5 years to approx. 60,000 tons. For whiting, the biomass was estimated to 21,000 tons, almost three times higher than estimations during 2005-2008. For turbot, the biomass was estimated at approx. 1,150 tons, equal to the previous year. For dogfish, the biomass was approximately 10,000 tons, about equal to the one estimated in 2010. 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 Danube shad). The fishing effort continues the trend of reduction reported since 2000. The Total Admissible Catch (TAC) of the main fish species caught during 2007-2011 remained at the same level.

During 2011, the **Maritime Spatial Planning** studies and research were continued and developed. The objectives realized in 2011 implied the scientific and technical support for the elaboration of the Action Plan necessary for the integrated marine strategy and policies case studies of the central and southern coast, main cities, resorts and marine protected areas: Mamaia Bay, Eforie North, Eforie South, Vama Veche.

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***The synthesis of the data for 2011, as 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.***