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SUBMARINER Report 2/2013:

Identification of algae species in the Curonian Lagoon

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Abstract

For the purpose of SUBMARINER project, the checklist of the phytoplankton species found in the Curonian Lagoon in 2005–2010 was compiled. In total, about 526 species were identified and their seasonal occurrences are provided. Most of the species found in the Lagoon belongs to the fresh-to-brackish (42 %) and fresh water (37 %) ecological groups. Also, there are 86 species, which originally inhabit the brackish water environment of the Baltic Sea and occur in the Lagoon only during the sea water inflows. Their distribution in the Lagoon is limited to the northern zone from the outlet to ca. 22 km inside the Lagoon. The phytoplankton biomass varies in a wide range during the year, but remains high all through the vegetation season. Three peaks of blooms may be distinguished: 1st peak, caused by diatoms occurs in April–May, species of genera *Aulacoseira*, *Stephanodiscus*, *Diatoma tenuis* and *Asterionella formosa* became dominant; 2nd – in July–August and 3rd – in October caused by cyanobacteria *Aphanizomenon flos-aquae*, *Planktothrix agardhii*, and species of *Anabaena* and *Microcystis* genera. During the summer the biomass of cyanobacteria is the greatest at the intensive bloom level, and reached hyperbloom conditions (> 100 mg L^{-1}). The green algae do not reach high biomass as diatoms or cyanobacteria species, but like cyanobacteria, they are most abundant in the summer time. Other phytoplankton groups do not develop in high numbers and their biomass rarely exceed 1 mg L^{-1}. At least 30 phytoplankton species found in the Lagoon are potentially toxic, of them: 21 belong to cyanobacteria, 4 - to dinophytes, 3 - to greens and 2 - to prymnesiophytes. According to similarity of phytoplankton structure, three zones were defined in the Lagoon: the Nemunas river mouth area, the central part and northern Lagoon's parts. For each zone, characteristic seasonal complexes of species were identified and their quantitative parameters (number of species, abundance, biomass, and biodiversity indexes) were calculated.

URL

The report is available for download at the SUBMARINER project's website at
http://publications.submariner-project.eu

Cover Photos

Shutterstock (sea picture); Irina Olenina (phytoplankton photos)

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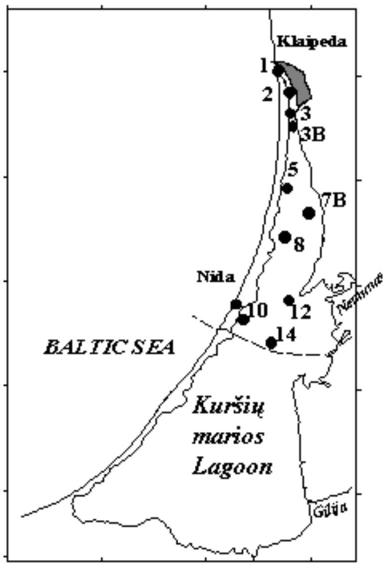
1. Materials and methods

Plankton microalgae

Collection of phytoplankton samples

The material used for this work was collected at 10 monitoring stations in the Lithuanian part of the Curonian Lagoon in 2005-2010 within the framework of environmental monitoring program performed by the Marine Research Department, Klaipėda (Fig. 1).

Figure 1. Sheme of the phytoplankton sampling sites in the Lithuanian waters of the Curonian Lagoon



Phytoplankton samples were taken from the water surface layer (0-0.5 m depth) monthly three monitoring stations (2, 5 and 12) and with varying frequency (monthly during the vegetation period only or seasonally) at other stations (Table 1). During the study period, 300 quantitative samples of phytoplankton were analysed.

Treatment of phytoplankton samples

Phytoplankton samples were treated according to the standard HELCOM (1988) methods using the light inverted microscope (magnification x100 and x400) and applying the Utermöhl technique (1958). The abundance of phytoplankton species was expressed in terms of cells, colonies, coenobiums and 100 µm filaments according to HELCOM Combine-manual (http://www.helcom.fi/Monas/CombineManual2/PartC/Frame.htm); the best fitting geometric shape and matching equation was used for phytoplankton species biomass calculation (Olenina et al., 2006). Valid names of the phytoplankton taxa were based on the recent Checklist of Baltic Sea Phytoplankton Species (Hällfors, 2004 and PEG_BIOVOL, 2010) with few exceptions.

Table 1. Phytoplankton sampling sheme in the Curonian Lagoon in 2005-2010

Stations	2005	2006	2007	2008	2009	2010
1	May, Aug., Oct.		May, Aug., Nov.			
2	Jan.-Dec.	Jan.-Dec.	Jan.-Dec.	Jan.-Dec.	Jan.-Dec.	Apr.-Nov.
3	May, Aug., Oct.		May, Aug., Nov.			
3B	Jan.-Dec.		Jan.-Dec.			
5	Jan.-Dec.	Jan.-Dec.	Jan.-Dec.	Jan.-Dec.	Jan.-Dec.	Apr.-Nov.
7B			May-Sep.	July	May.-Sep.	
8			Feb., May, Aug., Nov.			
10	May, Aug., Oct.	Feb.	May, Aug., Nov.		Aug., Oct.	May, Aug., Oct.
12	Jan.-Dec.	Jan.-Dec.	Jan.-Dec.	Jan.-Dec.	Jan.-Dec.	Apr.-Nov.
14	Apr.-Oct.	May.-Dec.	Jan.-Dec.		May, Aug., Oct.	May, Aug., Oct.
Total # of samples	**67**	**45**	**78**	**37**	**43**	**30**

Identification of phytoplankton groups according to the salinity preference

The species were characterized in relation to their salinity preference according to literature data (Николаев, 1951; Edler et al., 1984; Snoeijs, 1993; Snoeijs and Vilbaste, 1994; Snoeijs and Potapova, 1995; Zetterberg, 1995; Snoeijs and Kasperovičienė, 1996).

Toxicity of phytoplankton species

Potentially toxic species, which according to the literature data are known to produce phytotoxins were identified using the following references: Huges et al., 1958; Kononen, 1992; Larsen, Moestrup, 1989, 1992; Gentile, Maloney, 1969; Gorham et al., 1964; Carmichael, 1981; Sivonen 1990; Sivonen et al., 1990; Sivonen et al., 1990; Телитченко, Гусев 1964; Горюнова, Демина, 1974; Смирнов, Феоктистова, 1963, 1965; Барашков и др., 1968; Кондратьева и др., 1975.

Level of algae blooms

The intensity of the algae blooms was evaluated according to the Reimers (Реймерс, 1990) scale:

a) "weak" bloom (algal biomass varies from 0.5 to 0.9 mg L^{-1});

b) "medium" bloom (1.0 - 9.9 mg L^{-1});

c) "intensive" bloom (10.0 - 99.9 mg L^{-1});

d) "hyperbloom" (> 100.0 mg L^{-1}).

Zonation of the Curonian Lagoon according to the phytoplankton structure

Areas within the Curonian Lagoon with similar phytoplankton structure were identified using the cluster analysis method (according to relative abundance of species, %; 1-Pearson r, pair-group average linkage). The areas distinguished were characterized by dominant (more than 10 % of total abundance) species.

2. Species diversity of plankton microalgae

2.1. Short characteristic of the environmental conditions in the Curonian Lagoon

The Curonian Lagoon is the largest coastal lagoon in the Baltic Sea. It is an enclosed shallow (mean depth 3.7 m) lagoon, separated from the Baltic Sea by narrow (1-3 km) sandy Curonian Spit and connected to the Baltic Sea by the narrow (width 400-600 m) Klaipeda Strait. The drainage area of the lagoon is 62 times larger than its water plane (1,584 km^2). The area of the Lithuanian part of the Lagoon is approximately 413 km^2, the average depths there is 3.8 m with maximum 12-13 m in the harbor area of the Klaipeda Strait. The southern and central parts of the Lagoon are fresh water due to discharge from Nemunas (98% of total) and other rivers, while the northern, narrower area is oligohaline, slightly influenced by the Baltic Sea waters, with irregular salinity fluctuations from 0 to 8 PSU. The duration and extent of the seawater inflows depend on the wind-caused rises in water level in the coastal zone of the Sea (Zaromskis, 1996). The most common are 1-2 days inflows of the Baltic Sea waters, and brackish water inflows are most frequent and prolonged from August to October, when 70% of the total annual inflows from the Sea occur (Pustelnikovas, 1998).

From December till February, the lagoon is usually covered by ice. The water temperature shows a typical boreal pattern, with highest values 23–25 °C in July and August (Fig. 1, Table 2). The Lagoon is also known as a highly eutrophied water body (Povilanskas and Rascius 1994; Olenina & Olenin, 2002). During recent decades, substantial anthropogenic changes occurred in the Lagoon itself and also in its large drainage area. One of the most important and serious consequences is the ongoing eutrophication: the total phosphorus content has increased 3–4-fold and total nitrogen 5-fold from the 1950s to the 1990s (Žaromskis 1996). Recent nutrient content in the Lagoon is characteristic for highly eutrophied waters: the dissolved inorganic nitrogen (DIN) concentration varies from 0.012 to 3.22 mg l^{-1}; the phosphate concentration varies 0.001–0.282 mg l^{-1} (unpublished monitoring data, Table 2). Algal blooms are regular annual phenomena in the Lagoon (Olenina & Olenin, 2002).

Figure 1. Seasonal dynamics of water temperature (°C) in the surface 0-1m layer of the Curonian Lagoon in 2005-2009

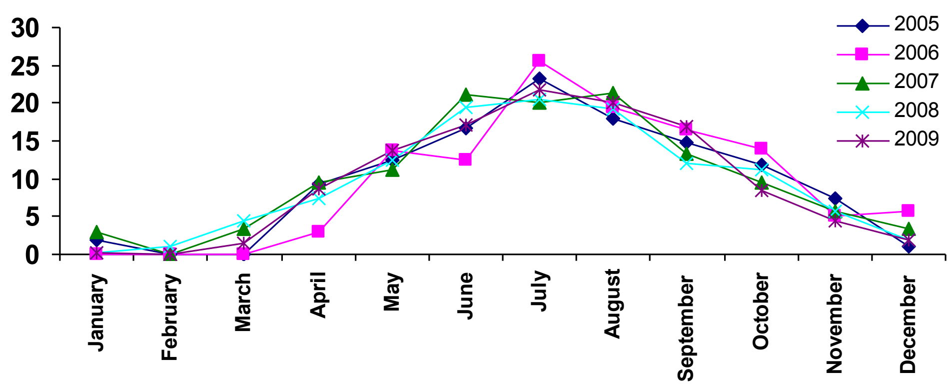


Table 2. Environmental conditions in the Curonian Lagoon in 2005-2009

Parameters	T°C	pH	NO_3, mg/l	NO_2, mg/l	NH_4, mg/l	N_{total}, mg/l	PO_4, mg/l	P_{total}, mg/l	SiO_4, mg/l	O_2, mg/l	O_2%	DIN, mg/l
range	0-25.5	7.4-10.2	0.01-3.12	0.0004-0.093	0.005-0.64	0.31-3.63	0.001-0.28	0.01-0.47	0.01-7.0	4.5-17.5	45-198	0.01-3.22
average± st. dev.	9.7-7.6	8.6± 0.5	0.64± 0.71	0.01± 0.01	0.09± 0.08	1.49± 0.67	0.02± 0.03	0.08± 0.05	1.54± 1.51	11.2± 2.2	99± 19	0.73± 0.73

2.2. Taxonomic inventory

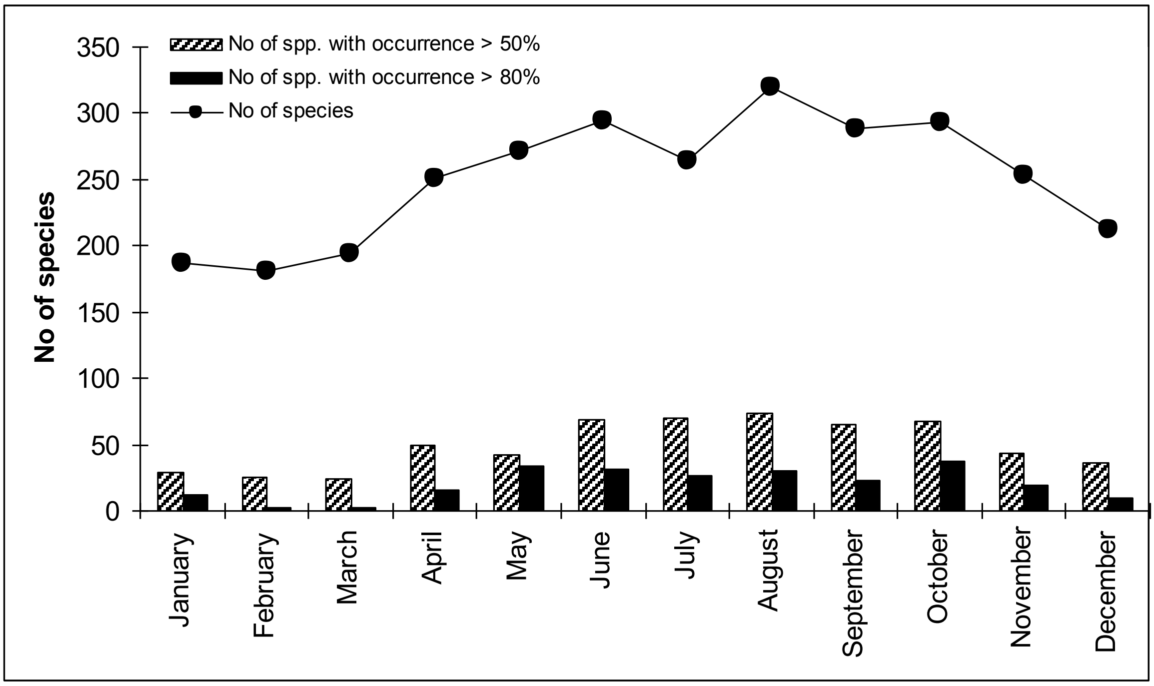
First studies of the Curonian Lagoon phytoplankton were performed already in 1927-1936 by German scientist H. Schmidt-Ries (1940) and were continued only after the WW II by a Lithuanian researcher S. Ūselytė (Уселите, 1959). In 1974-1987 the studies were continued by Krylova (Крылова, 1980) and Jankavičiutė (Янкавичюте, 1990). Regular monitoring of the Curonian Lagoon phytoplankton was started in 1984 (Оленина, 1996). The complete check-list of the phytoplankton species ever registered in the Curonian Lagoon contains over 870 species (unpublished data).

For the purpose of SUBMARINER project, the checklist of the phytoplankton species found in the Curonian Lagoon in recent (2005-2010) years was compiled (Annex 1). In total, 526 plankton microalgae species and higher taxa were identified (Table 3). There are three most abundant groups of phytoplankton in the Lagoon: green algae (153 species), diatoms (128) and cyanobacteria (106). In recent years, ca. 200-300 species have been recorded in plankton monthly. Most of these species occur rather rarely and in very low numbers (Figure 2). Smaller amount of species (from 20 to 70) occur in more than in a half of seasonal samples. Finally, there is a groups of most frequent species (their number varies from 2 to 38 monthly) which occur nearly in all samples (occurrence >80%) (Fig. 2).

Table 3. The number of species in the taxonomic groups of the phytoplankton of the Curonian Lagoon in 2005-2010

Alage group	No of species
Cyanophyceae	106
Cryptophyceae	21
Dinophyceae	39
Chrysophyceae	14
Synurophyceae	9
Diatomophyceae	128
Xanthophyceae	7
Prasinophyceae	5
Euglenophyceae	14
Chlorophyceae	153
Charophyceae	19
Prymnesiophyceae	2
Ciliophora	1
Ebriidea	1
Craspedophyceae	2
Flagellates (undetermineds)	1
incertae sedis	4
Total	**526**

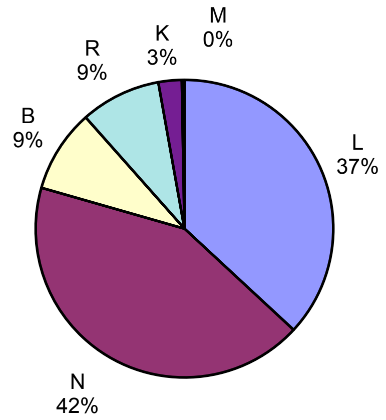
Figure 3. Seasonal dynamics of the species richness of the Curonian Lagoon phytoplankton in 2005-2010.



2.3. Ecological groups of the Curonian Lagoon phytoplankton

Most of the species found in the Lithuanian waters of the Curonian Lagoon belong to the fresh-to-brackish (42%) and fresh water (37%) ecological groups (Olenina, 1998, Fig. 4). The significant role of the brackish water algae in the Lagoon can be explained by influence of brackish waters from the Baltic Sea. In 1980s and 1990s the waterways of (Klaipeda port area) have been deepened substantially that resulted 12-15% increase of the Sea water inflows in the northern part of the Lagoon (in August in 1.8 fold and in October-November in 2.6 - 3.1 fold more that in May) (Gailiušis et al., 1996). Following that, in summer and autumn, since the end of 1980s the abundance of “marine”, “marine - brackish” and “brackish” species (i.e. the Sea water indicators) shows clear increase with maximum in summer 1994 and autumn 1996 (according to the phytoplankton data 1980-1996).

Figure 2. Ratio between the different ecological groups of phytoplankton of the northern part of the Curonian Lagoon (from Olenina, 1998)



M - **marine**
R - **marine-brackish**
B - **brackish**
N - **limnic-brackish**
L - **limnic**
K - **marine-brackish-limnic**

There are 86 species of microalgae, which originally inhabit the brackish water environment of the Baltic Sea and occur in the Lagoon's phytoplankton only during the sea water inflows (Table 4). Their distribution in the Lagoon is limited to the zone from the outlet to ca. 22 km inside the Lagoon (stations 1, 2, 3, 3B, 5).

Other species marine and brackish origin show more or less seasonal occurrence in the Curonian Lagoon; some of them dominate the phytoplankton, forming >10% of biomass in different seasons, e.g.: *Thalassiosira levanderii* in winter; *T. levanderii, Chaetoceros wighamii* and *Heterocapsa rotundata* in spring; *S. costatum, Cylindrotheca closterium* and *Heterocapsa triquetra* in summer; *Prorocentrum minimum* and *Coscinodiscus granii* in autumn (Olenina, 1998).

Yet another group of marine and brackish water species occur in the northern part of the Lagoon nearly all year round: cyanobacteria *Limnothrix planctonica*, cryptophytes *Plagioselmis prolonga*, *Teleaulax acuta*, *T. amphioxeia,* prymnesiophytes *Chrysochromulina* spp., chrysophyte *Pseudopedinella tricostata,* euglenophyte *Eutreptiella* spp. and diatom *Skeletonema costatum* (Table 4).

Table 4. Phytoplankton marine origin species seasonal occurrence in the Curonian Lagoon.

SPECIES	**MONTHS**											
CYANOPHYCEAE	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**
Anabaena lemmermannii					■	■	■	■	■	■		■
Cyanodictyon balticum		■										
Lemmermanniella pallida	■					■		■				
Lemmermanniella parva								■				
Limnothrix planctonica	■	■		■	■	■		■	■	■	■	■
Nodularia spumigena												
CRYPTOPHYCEAE												
Hemiselmis virescens				■						■		
Plagioselmis prolonga	■	■	■	■	■	■	■	■	■	■	■	■
Teleaulax acuta	■	■	■	■	■	■	■	■	■	■	■	■
Teleaulax amphioxeia	■	■	■	■	■	■	■		■	■	■	■
DINOPHYCEAE												
Alexandrium cf. tamarense						■			■			
Amphidinium										■		
Amphidinium crassum						■						
Amphidinium sphenoides					■	■				■		

Amylax triacantha												
Ceratium hirundinella												
Cladopyxis claytonii												
Dinophysis acuminata												
Glenodinium danicum												
Gonyaulax spinifera												
Gymnodinium fuscum												
Gymnodinium sanguineum												
Gymnodinium simplex												
Gymnodinium vestificii												
Gyrodinium spirale												
Heterocapsa rotundata												
Heterocapsa triquetra												
Oblea rotunda												
Peridiniella catenata												
Preperidinium meunieri												
Prorocentrum minimum												
Protoperidinium												
Protoperidinium bipes												
Protoperidinium brevipes												
Protoperidinium conicum												
Protoperidinium pellucidum												
Pyrophacus horologicum												
Scrippsiella												
Scrippsiella cf. trochoidea												
Scrippsiella hangoei												
Woloszynskia halophila												
PRYMNESIOPHYCEAE												
Chrysochromulina												
Pleurochrysis carterae												
CHRYSOPHYCEAE												
Apedinella radians												
Dinobryon balticum												
Dinobryon faculiferum												
Pseudopedinella elastica												
Pseudopedinella pyriforme												
Pseudopedinella tricostata												
DIATOMOPHYCEAE												
Achnanthes taeniata												
Actinocyclus octonarius v. octonarius												
Actinocyclus octonarius v. tenellus												
Cerataulina pelagica												
Chaetoceros ceratosporus v. ceratosporus												
Chaetoceros danicus												
Chaetoceros decipiens												
Chaetoceros gracilis												
Chaetoceros impressus												
Chaetoceros lorenzianus												
Chaetoceros minimus												
Chaetoceros similis												
Chaetoceros spp.												
Chaetoceros tenuissimus												
Chaetoceros throndsenii v. throndsenii												
Chaetoceros wighamii												
Coscinodiscus granii												
Cyclotella choctawhatcheeana												
Dactyliosolen fragilissimus												
Entomoneis paludosa												
Skeletonema costatum												
Surirella crumena												
Tabularia tabulata												
Thalassiosira baltica												
Thalassiosira levanderii												
EUGLENOPHYCEAE												

Eutreptiella spp.	■	■	■	■	■	■	■	■	■	■	■	■
PRASINOPHYCEAE												
Pseudoscourfieldia marina						■						
Pyramimonas	■	■	■		■	■	■	■	■	■	■	■
Pyramimonas virginica								■	■	■		
CHLOROPHYCEAE												
Oocystis submarina	■	■		■	■	■	■	■	■	■	■	
CRASPEDOPHYCEAE												
Craspedophyceae		■								■	■	
Monosiga										■		■
EBRIIDEA												
Ebria tripartita		■			■	■		■	■	■		
INCERTAE SEDIS												
Telonema antarcticum				■		■						■
Telonema subtile				■		■		■	■	■	■	
CILIOPHORA												
Mesodinium rubrum				■	■	■	■	■	■	■	■	

2.4. Seasonal dynamics of the Curonian Lagoon phytoplankton

The phytoplankton abundance and biomass varies in a wide range during the year, but remain high all through the vegetation season (Table 5, Fig. 5). Low numbers are common in February and March, while high abundance and biomass are usual for July until October and three peaks of blooms (in spring, summer and autumn) may be distinguished. These peaks are caused by different groups of species (Fig. 6).

Table 5. Seasonal range of phytoplankton abundance and biomass in the Curonian Lagoon in 2005-2010

	Abundance range, 10^3cells L^{-1}	**Biomass range, µg L^{-1}**
Winter	220 - 20680	130 - 13220
Spring	1670 - 61400	210 - 34000
Summer	1050 - 52000	670 - 95800
Autumn	290 - 57500	270 - 85000

Figure 3. Seasonal dynamics of total phytoplankton abundance (left) and biomass (right) in 2005-2010

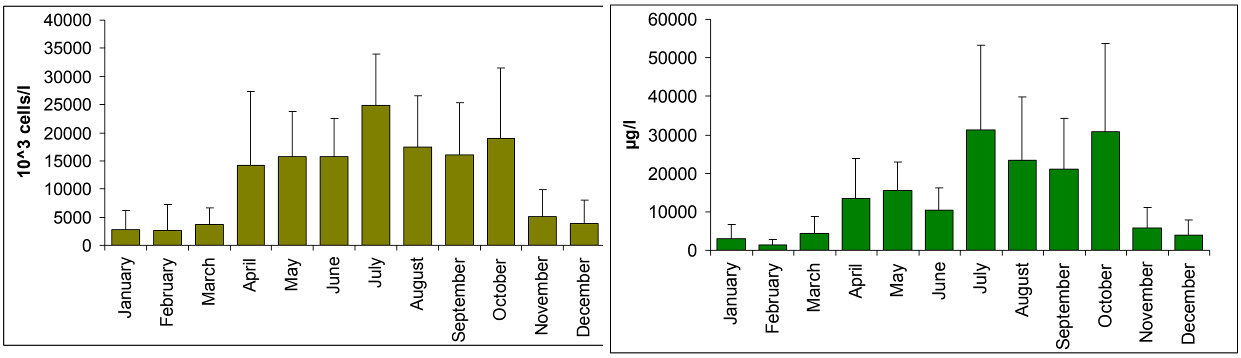
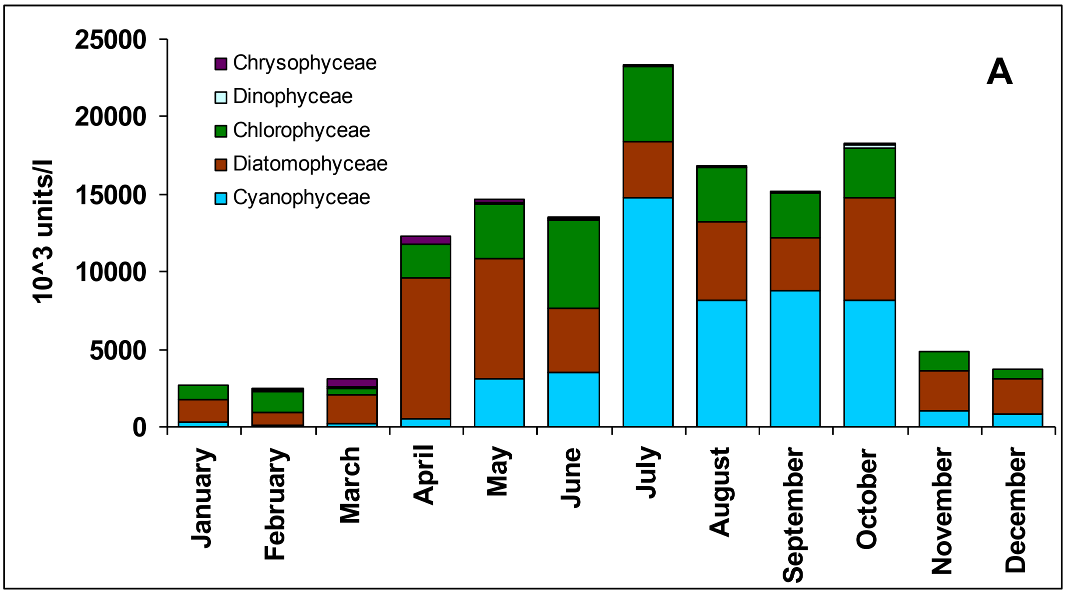
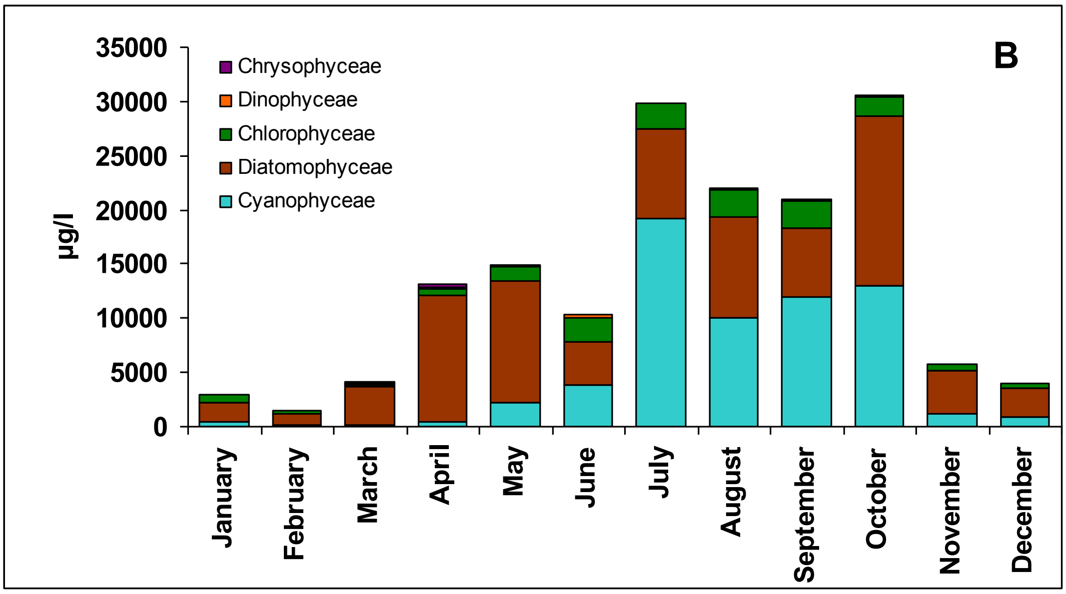


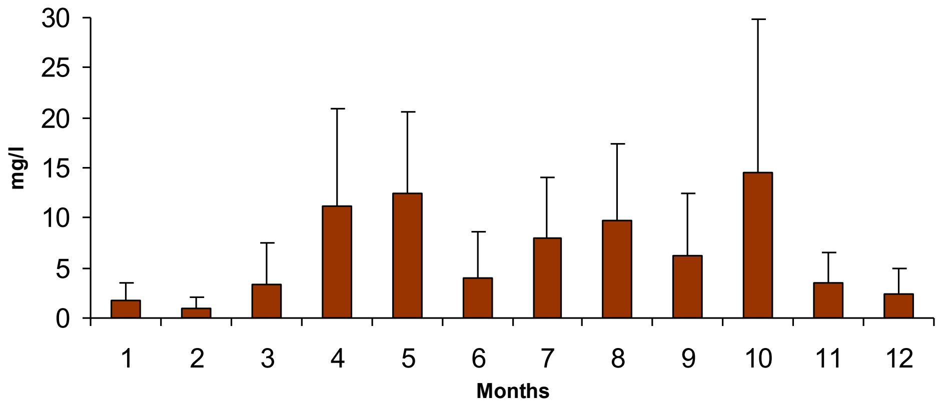
Figure 4. Seasonal dynamics of the Curonian Lagoon main phytoplankton group abundance (A) and biomass (B) in 2005-2010 (month average data)





The first peak, caused mostly by diatoms occurs in April-May. This group usually dominates planktonic algae (this is especially noticeable in terms of biomass) during the coldest period of the year from December to March, and with increase of water temperature in April they undergo ~3-4-fold increase in numbers (Fig. 7).

Figure 5. Seasonal dynamics of DIATOMOPHYCEAE biomass in the Curonian Lagoon in 2005-2010



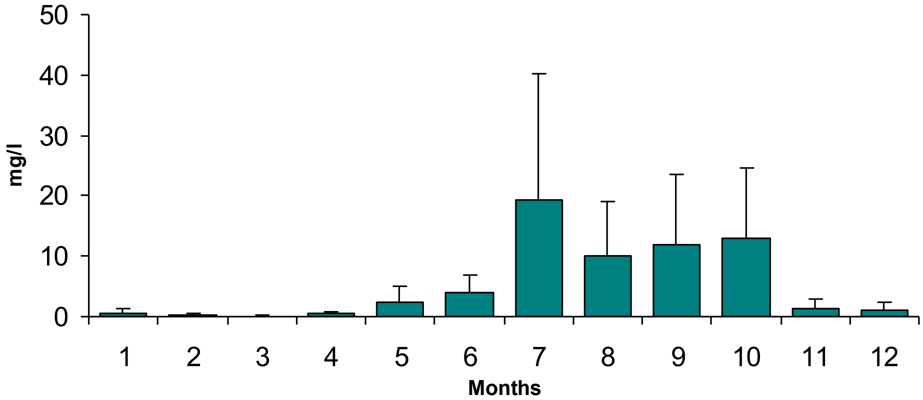
In cold time of the year the most abundant diatoms are *Staurosira construens* v. *construens, S. construens* v. *venter, Fragilaria heidenii* and *Fragilariforma virescens* (Table 5), while in spring the diatoms *Aulacoseira islandica, Stephanodiscus hantzschii, S. minutulus, S. rotula*, *Diatoma tenuis* and *Asterionella formosa* became dominant (Table 6). Another group of diatoms reach their abundance maximum in the summer-autumn period: *Actinocyclus normanii* in July-October and *Stephanodiscus binderanus* in August-October (Table 5).

Table 6. Period of dominance and maximal biomass of the Curonian Lagoon DIATOMOPHYCEAE phytoplankton species in 2005-2010

SPECIES	MONTHS											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Staurosira construens v. construens	1.1										0.01	
Staurosira construens v. venter	0.3	0.3									0.5	1.1
Fragilariforma virescens	1.7		0.22		5.78						1.2	1.1
Fragilaria heidenii	0.6	0.3									0.1	2.0
Diatoma tenuis			0.1	4.3	10.2	1.5						
Asterionella formosa	0.2		0.1	5.6	2.3							1.1
Aulacoseira islandica		0.5	2.9	2.4	1.9	2.6		1.9			0.5	0.1
Stephanodiscus hantzschii		1.8	1.7	5	5.5	6.8	1.7	2.6	2.8	2.4	1.0	0.1
Stephanodiscus minutulus			0.9	18.2								
Stephanodiscus rotula	2.2	0.9	5.2	24.2	12.9	2					2.7	1.7
Stephanodiscus binderanus								4.9	3.0	3.7		
Actinocyclus normanii	0.7	0.3	0.5	0.5	3.8	4.6	18.9	11.4	11.6	50.5	1.8	1.3

The second peak starts in the beginning of July and is caused by the blue-greens (Fig. 8).

Figure 6. Seasonal dynamics of the Curonian Lagoon cyanobacteria biomass in 2005-2010.

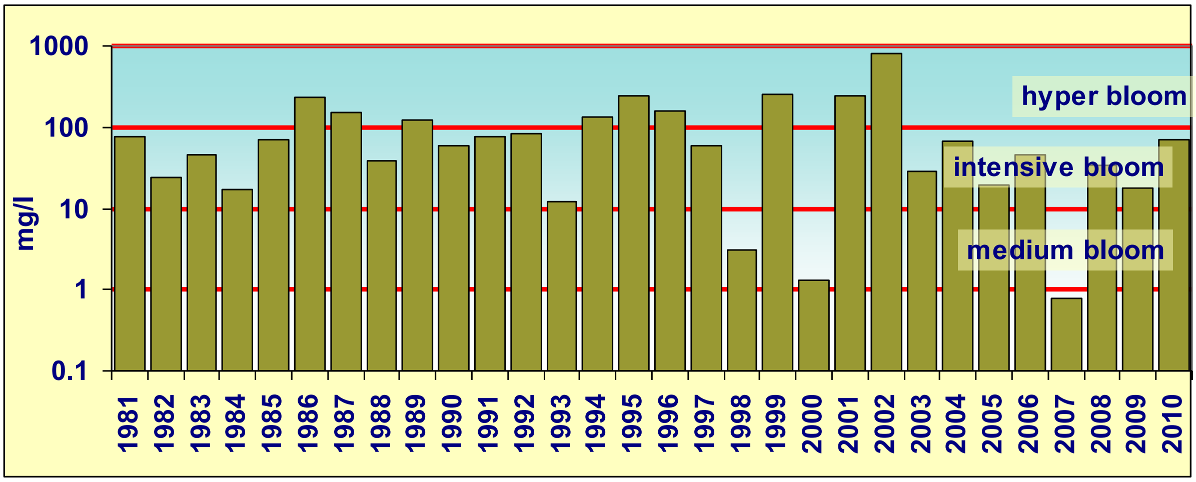


The most abundant Cyanophyceae species are listed in the Table 7. High biomass of *Planktothrix agardhii* can appear already in the end of May and hold out until the end of October. *Aphanizomenon flos-aquae* is constantly present in the phytoplankton throughout the year, but rapidly increases in abundance (100–1000-fold) when the water temperature reaches 20 °C. Its bloom usually lasts until the end of October/beginning of November, when the water temperature falls down to 9–6 °C. During the two recent decades, the biomass of *A. flos-aquae* in the summer period was the greatest at the intensive bloom level, and during some seasons, it reached hyperbloom conditions (biomass > 100 mg/l, Fig. 9).

Table 7. Period of dominance and maximal biomass of the Curonian Lagoon CYANOPHYCEAE phytoplankton species in 2005-2010

SPECIES	MONTHS											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Anabaena flos-aquae							5.9	1.7	10.1			
Aphanizomenon flos-aquae						2.0	68.8	15.4	19.5	18.2	2.4	2.7
Planktothrix agardhii					10.8	8.3	2.8	38.8	28.6	27.3		0.1
Microcystis viridis								1.8	1.2	4.4	1.4	0.7
Microcystis wesenbergii								3.2	2.7	3.6	0.7	
Limnothrix redekei					1.3	5.8						

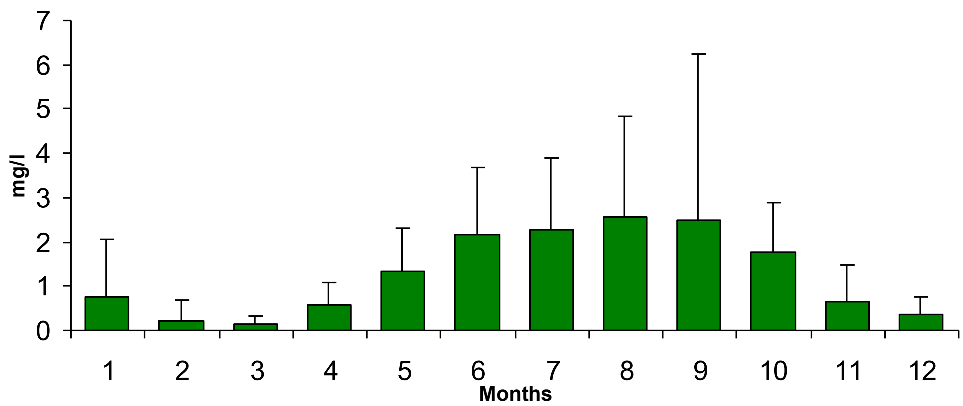
Figure 7. Long-term dynamics of maximum *Aphanizomenon flos-aquae* biomass in the Curonian Lagoon.



The mass development of *Anabaena flos-aquae* is shorter and usually lasts from July to September; species of genus *Microcystis* can be observed among dominants mostly in August-October. Also, there is a one species of cyanophytes - *Limnothrix redekei* in the Lagoon's phytoplankton, which could be abundant in May and beginning of June.

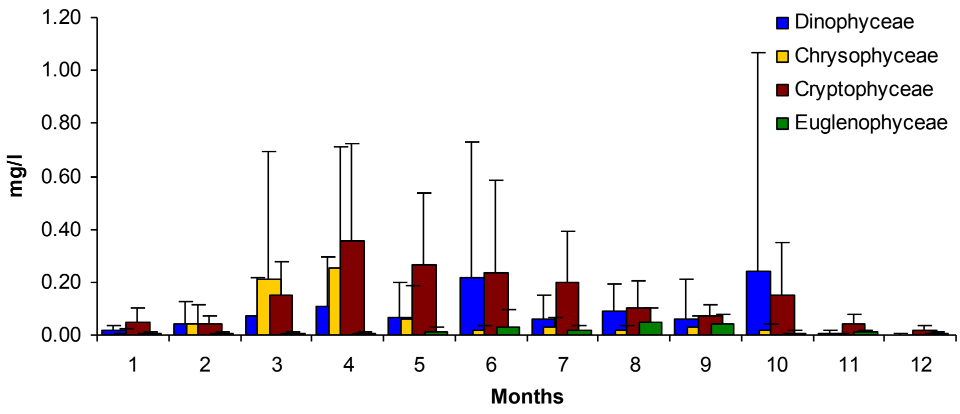
The green algae (CHLOROPHYCEAE) in the Curonian Lagoon do not reach such high biomass as diatoms or cyanobacteria species, but like CYANOPHYCEAE, they are most abundant in the summer time (Fig. 10).

Figure 8. Seasonal dynamics of green microalgae biomass of the Curonian Lagoon in 2005-2010.



Other phytoplankton groups do not develop in high numbers comparable with diatoms, blue-greens and green algae and their biomass rarely exceed 1 mg L^{-1} (Fig. 11).

Figure 11. Seasonal ranges of biomass of less abundant phytoplankton groups in the Curonian Lagoon in 2005-2010



2.5. Potentially toxic species

According to the literature data there are 30 potentially toxic species in the Curonian Lagoon (or 6 % of the total species richness), of them: 21 belong to CYANOPHYCEAE, 4 to DINOPHYCEAE, 3 to CHLOROPHYCEAE and 2 to PRYMNESIOPHYCEAE (Table 8).

These species become toxic while reaching a certain concentration, which believed to be 250 mg L^{-1} for some freshwater planktonic algae (Водоросли, 1989). In the Curonian Lagoon only some of cyanobacteria can reach such biomass, they are: *Aphanizomenon flos-aquae*, *Planktothrix agardii, Microcystis* and *Anabaena* genera. Their biomass during the hot summers usually exceeds 100 mg L^{-1} and often approaches the critical values. It is known that *A. flos-aquae* do not tolerate intensive currents and vertical mixing of water, therefore calm periods in summer are most suitable for its rapid development. *A. flos-aquae* bloom continues till the end of October - beginning of November, when water temperature drops down to 6-9 °C. The highest *A. flos-aquae* biomass recorded in the open waters of the Lagoon was 791 mg L^{-1}, while in a small sheltered inlet it reached nearly 2000 mg/l (unpublished monitoring data). *Microcystis* and *Anabaena* species usually accompany *A. flos-aquae* blooms, but their total biomass never exceeds 20-40 mg L^{-1} (Оленина, 1997; unpublished monitoring data). Sometimes mass development of cyanobacteria coincides with fish kills in the Lagoon.

Table 8. Potentially toxic species of the Curonian Lagoon and the Lithuanian coastal zone of the south-eastern Baltic Sea

Species	Group	Toxicity	Toxins in / or harmful effect through	Distribution	Reference for toxicity
Regular blooms					
Aphanizomenon flos-aquae	CYA	HT	Water	Whole Lagoon area	Schantz et al., 1975; Кондратьева и др., 1975; Gentile, Maloney, 1969
Nodularia spumigena	CYA	HT	Water	Northern part of the Lagoon	Larsen, Moestrup, 1989, 1992
Occasional blooms					
Anabaena *-flos-aquae* *-spiroides -*	CYA	HT	Water	Whole Lagoon area Northern part of the Lagoon	Gorham et al., 1964; Carmichael, 1981; Телитченко, Гусев

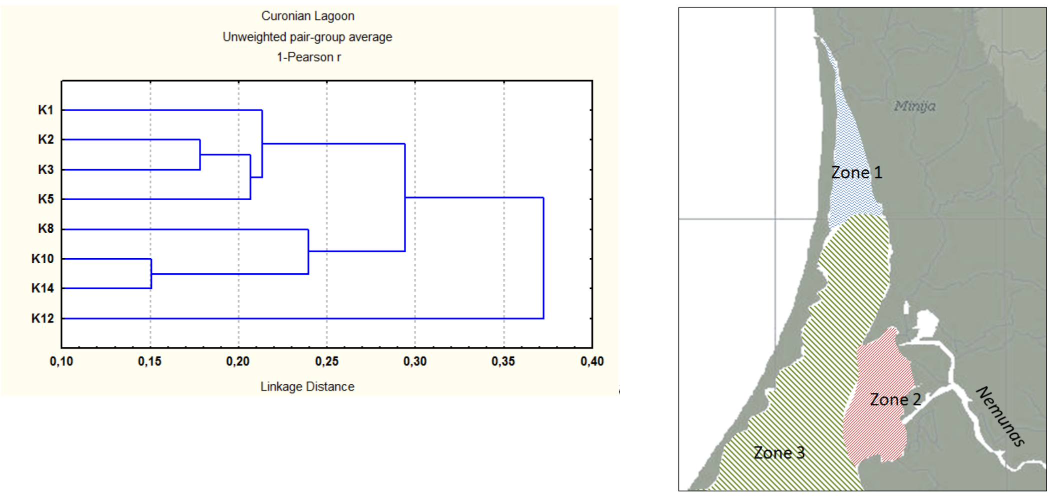
lemmermannii					1964, 1965 Sivonen et al.,1990
Microcystis *-aeruginosa* *-viridis* *-wesenbergii*	CYA	HT	Water	Whole Lagoon area	Huges et al., 1958; Кондратьева и др., 1975; Смирнов, Феоктистова, 1963, 1965
Prorocentrum minimum	DIN	?	Mussels	Northern part of the Lagoon	Larsen, Moestrup, 1989, 1992
Regularly in plankton but not in bloom amounts					
Planktothrix agardhii	CYA	HT	Water	Curonian Lagoon, Baltic Sea	Sivonen, 1990 Skulberg, 1996
Chrysochromulina spp.	PRIMN	IC	Fish	Northern part of the Lagoon	Larsen, Moestrup, 1989, 1992
Anabaena *-affinis* *-circinalis* *-mendotae* *-planctonica* *-smithii* *-solitaria* *-variabilis*	CYA	HT	Water	Whole Lagoon area	Sivonen et al.,1990 Sivonen et al.,1992 Skulberg, 1996
Coelosphaerium kuetzingianum	CYA	HT	Water	Whole Lagoon area	Смирнов, Феоктистова, 1963
Snowella lacustris	CYA	HT	Water	Whole Lagoon area	Kononen, 1992 Skulberg, 1996
Woronichinia *-compacta* *-naegeliana*	CYA	HT	Water	Whole Lagoon area	Кондратьева и др., 1975
Dinophysis *-acuminata* *-acuta* *-norvegica*	DIN	DSP	Mussels	Northern part of the Lagoon	Larsen, Moestrup, 1989, 1992
Coelastrum microporum	CHL		Water	Whole Lagoon area	Барашков и др., 1968, 1971
Desmodesmus communis (Syn. *Scenedesmus quadricauda)*	CHL		Water	Whole Lagoon area	Горюнова, Демина, 1974; Смирнов, Феоктистова, 1965
Scenedesmus obliquus	CHL		Water	Whole Lagoon area	Горюнова, Демина, 1974; Смирнов, Феоктистова, 1965
Occasionally in plankton in low numbers					
Microcystis botrys	CYA	HT	Water	Whole Lagoon area	Skulberg, 1996
Prymnesium parvum	PRY	IC	Water	Northern part of the Lagoon	Larsen, Moestrup, 1989, 1992

3. Seasonal complexes of phytoplankton and their distribution (based on 1984-2010 data)

3.1. Zonation of the Lithuanian waters based on phytoplankton structure

Due to interaction of different water masses (Baltic Sea water inflows, riverine outflow of the river Nemunas and limnic water masses of the southern part of the Lagoon) the study area is characterized by a rather complicated hydrological structure (Žaromskis, 1994). The water masses are unstable in their boundaries and show a great seasonal and synoptical variability. This instability is reflected in the abundance, species composition, diversity and structure of phytoplankton. According to the numerical classification methods, three phytoplankton zones were identified in the Curonian Lagoon and two in the Lithuanian coastal waters of the Baltic Sea (Fig. 12).

Figure 9. Zonation of the study area based on numerical classification of phytoplankton communities. Distribution of station see at Fig. 1.



Zone 1 (The northern part) is situated within ca. 20-22 km inside the Lagoon (st. K1, K2, K3, K5). It is distinguishable by the presence of the marine Baltic Sea species among the dominants: *Pseudopedinella tricostata, Thalassiosira levanderii* in winter; *T. levanderii, Chaetoceros wighamii* and *Heterocapsa rotundata* in spring; *Skeletonema costatum, Cylindrotheca closterium* and *Heterocapsa triquetra* in summer; and *Prorocentrum minimum* and *Coscinodiscus granii* in autumn. Inside this group, the stations (K1, K2, K3) located in the Klaipėda Strait area are those most influenced by the marine waters.

Zone 2 (Avandelta). This area is situated in front of the mouth of the river Nemunas (st. K12) and is mostly influenced by the riverine input. The area is characterised by the dominance of diatoms during all seasons, by especially *Stephanodiscus hantzschii*.

Zone 3 (Lagoon Proper). This zone belongs to the largest "open Lagoon" area which strectches from Lithuanian to the Russian part of the water body (st. K8, K10, K14 – in the Lithuanian part). This area is in least extent subjected either to the Sea or to the rivers influence and can be characterised by the dominance of the diatoms *S. hantzschii* and *Fragilaria spp*. in winter; *S. hantzschii, Diatoma tenuis, Asterionella formosa* in spring, blue-greens *Aphanizomenon flos-aquae, Microcystis aeruginosa* and *Anabaena spp*. in summer and mostly *A. flos-aquae, Planktonema lauterbornii, Fragilaria virescens,* and *S. hantzschii* in autumn. A boundary between the northern part of the

Lagoon and the Lagoon Proper is situated approximately in 35-40 km from the Sea inside the Lagoon, in the area aroud station K8.

3.2. Characterization of phytoplankton in the identified zones

The main characteristics of the phytoplankton in the identified zones are presented in tables 9-13. The most important species are listed in the order according to the frequency of their dominance.

Table 9. Characterization of main zones identified by phytoplankton structure

Zone	Location and abiotic conditions	Phytoplankton characteristics
Northern part	Northern part of the Curonian Lagoon influenced by the inflows of the sea water (st. K1, K2, K3, K5)	Presence of the most abundant marine origin species among the Lagoon's dominants.
Avandelta	Central part of the Curonian Lagoon directly influenced by the discharge of Nemunas (st. K12).	Diatom *Stephanodiscus hantzchii* permanently dominate (not only in spring and autumn, but during summer season too).
Lagoon Proper	Central part of the Curonian Lagoon directly do not influenced by the discharge of Nemunas or sea water inflows (st. K8, K10, K14)	The open area is least subject to the Sea's or the river's influence; therefore its phytoplankton is to be regarded as the own Lagoon's phytoplankton. The area is characterised by the highest phytoplankton biomasses during summer blooms.

Table 10: The main characteristics of winter phytoplankton in the identified zones

Zone	Dominant species	Diversity index	Number of species per sample		Abundance, mln cells L^{-1}		Biomass, mg L^{-1}	
		Margaleff	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
Delta	*Stephanodiscus hantzschii* *Melosira varians* *Cryptomonadales spp.* *Limnothrix redekei* *Planktonema lauterbornii*	5.39±1.41	15-68	39±13	0.06-21.6	2.2±4.7	0.1-11.2	1.7±3.1
Lagoon Proper	*Stephanodiscus hantzschii* *Fragilaria construens var. venter* *Planktonema lauterbornii* *Cryptomonadales spp.* *Aphanizomenon flos-aquae*	6.38±2.34	33-55	44±11	0.5-2.5	1.6±0.8	1.4-5.5	3.1±2.0
Northern Lagoon	*Stephanodiscus hantzschii* *Fragilaria construens var. venter* *Planktonema lauterbornii* *Aulacoseira islandica* *Cryptomonadales spp.* *Pseudopedinella tricostata* *Thalassiosira levanderii*	5.18±1.92	18-72	48±13	0.2-7.6	1.9±1.8	0.2-1.7	3.7±4.3

Table 11: Main characteristics of spring phytoplankton in the identified zones

Zone	Dominant species	Diversity index	Number of species per sample		Abundance, mln cells L^{-1}		Biomass, mg L^{-1}	
		Margaleff	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
Delta	*Stephanodiscus hantzschii* *Stephanodiscus minutulus* *Diatoma tenuis* *Asterionella formosa* *Limnothrix redekei* *Melosira varians*	6.99±1.60	25-96	52±16	0.3-222.9	18.6±35.4	3.6-48.5	26.0±16.6
Lagoon Proper	*Stephanodiscus hantzschii* *Diatoma tenuis* *Asterionella formosa* *Cryptomonadales spp.* *Skeletonema subsalsum* *Aulacoseira islandica*	8.31±1.74	19-99	59±19	1.7-30.2	10.5±7.0	8.0-40.5	22.6±12.7
Northern Lagoon	*Stephanodiscus hantzschii* *Diatoma tenuis* *Asterionella formosa* *Cryptomonadales spp.* *Thalassiosira levanderii* *Chaetoceros wighamii* *Heterocapsa rotundata*	7.66±1.61	17-99	56±17	0.2-67.4	10.7±11.9	0.7-7.7	21.5±21.3

Table 12: The main characteristics of summer phytoplankton in the identified zones

Zone	Dominant species	Diversity indexes	Number of species per sample		Abundance, mln cells L^{-1}		Biomass, mg L^{-1}	
		Margaleff	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
Delta	*Aphanizomenon flos-aquae* *Stephanodiscus hantzschii* *Planktonema lauterbornii* *Planktothrix agardhii* *Microcystis aeruginosa*	6.99±1.50	22-97	60±21	3.2-96.8	19.3±16.5	5.4-88.8	48.3±29.1
Lagoon Proper	*Aphanizomenon flos-aquae* *Microcystis aeruginosa* *Anabaena spp.* *Planktonema lauterbornii* *Actinocyclus normanii f. subsalsa* *Fragilaria virescens*	6.67±2.00	17-88	49±19	2.0-87.1	19.8±21.7	5.6-181.0	107.9±49.7
Northern Lagoon	*Aphanizomenon flos-aquae* *Microcystis aeruginosa* *Planktonema lauterbornii* *Planktothrix agardhii* *Skeletonema costatum* *Skeletonema subsalsum* *Heterocapsa triquetra* *Cryptomonadales spp.*	6.69±2.33	10-94	55±19	0.6-95.7	15.4±15.6	0.5-295.8	34.1±48.2

Table 13. The main characteristics of autumn phytoplankton in the identified zones

Zone	Dominant species	Diversity indexes	Number of species per sample		Abundance, mln cells L^{-1}		Biomass, mg L^{-1}	
		Margaleff	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
Delta	*Aphanizomenon flos-aquae* *Stephanodiscus hantzschii* *Planktothrix agardhii* *Planktonema lauterbornii* *Cryptomonadales spp.*	6.96±0.87	6-91	49±19	0.08-86.1	10.8±16.0	0.4-161.2	39.6±58.9
Lagoon Proper	*Aphanizomenon flos-aquae* *Planktonema lauterbornii* *Fragilaria virescens* *Stephanodiscus hantzschii* *Scenedesmus quadricauda*	7.04±0.93	19-69	42±13	2.1-125.3	11.7±22.1	5.1-27.5	16.0±8.5
Northern Lagoon	*Aphanizomenon flos-aquae* *Stephanodiscus hantzschii* *Skeletonema subsalsum* *Aulacoseira islandica* *Planktonema lauterbornii* *Skeletonema costatum* *Coscinodiscus granii* *Prorocentrum minimum*	6.86±1.54	14-106	45±22	0.01-405.6	14.4±39.7	0.6-795.4	43.8±122.1

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Annex

Table A-1. Check-list of the Curonian Lagoon phytoplankton species and their seasonal occurrence in 2005-2010.

ALGAE GROUPS	MONTHS	January	February	March	April	May	June	July	August	September	October	November	December
	No OF SAMPLE PER MONTH	17	18	17	21	27	22	22	29	22	25	20	20
	SPECIES LATINE NAMES	Species occurrence in the samples, %											
Cyanophyceae	*Anabaena affinis*							14	34	27			
Cyanophyceae	*Anabaena berezovskii*										4		
Cyanophyceae	*Anabaena cf. miniata*									5			
Cyanophyceae	*Anabaena circinalis*								7				
Cyanophyceae	*Anabaena compacta*				5		5	27	17	41	8		
Cyanophyceae	*Anabaena crassa*				19	26	57	82	72	45	28	10	6
Cyanophyceae	*Anabaena curva*										4		
Cyanophyceae	*Anabaena flos-aquae*	6			14	33	38	86	76	77	68	30	6
Cyanophyceae	*Anabaena heterospora*							5					
Cyanophyceae	*Anabaena lemmermannii*					11	57	27	24	41	24		6
Cyanophyceae	*Anabaena macrospora*								17	5			
Cyanophyceae	*Anabaena mendotae*				5	22	52	41	62	5	4		6
Cyanophyceae	*Anabaena perturbata*										4		
Cyanophyceae	*Anabaena planctonica*					7	19	50	3	41	4		
Cyanophyceae	*Anabaena sigmoidea*							9	62				
Cyanophyceae	*Anabaena smithii*								21				
Cyanophyceae	*Anabaena spiroides*				14	22	29	36		59	24		
Cyanophyceae	*Anabaena spp.*					19	14	18	3	14	8	15	6
Cyanophyceae	*Anabaena torulosa*									9			
Cyanophyceae	*Anabaenopsis elenkinii*								14				
Cyanophyceae	*Anabaenopsis spp.*			12	5					5			
Cyanophyceae	*Aphanizomenon capricorni*								3				
Cyanophyceae	*Aphanizomenon flos-aquae*	47	28	35	38	81	76	100	97	91	100	80	72
Cyanophyceae	*Aphanizomenon gracile*	18		12	14	37	43	41	52	50	40	10	
Cyanophyceae	*Aphanizomenon issatschenkoi*					7	10	27	79	59	28		
Cyanophyceae	*Aphanocapsa*					4	5		10				6

Cyanophyceae	*Aphanocapsa conferta*					4		9	3	9			
Cyanophyceae	*Aphanocapsa delicatissima*	12		12	19	63	81	95	86	82	72	45	28
Cyanophyceae	*Aphanocapsa elachista*	18	11	12	5	19	19	27	28	32	24	25	33
Cyanophyceae	*Aphanocapsa elegans*				5	4	5	9	7				
Cyanophyceae	*Aphanocapsa holsatica*				5	7	24	9	21	18	40	20	6
Cyanophyceae	*Aphanocapsa incerta*	76	39	24	48	96	90	95	97	95	100	65	61
Cyanophyceae	*Aphanocapsa planctonica*			6			10	14	3	9	8		
Cyanophyceae	*Aphanocapsa pulchra*	6						9	10	9	16		
Cyanophyceae	*Aphanocapsa reinboldii*	6	6		5	4	5	5	7	5	4		
Cyanophyceae	*Aphanothece bachmannii*					7				5			
Cyanophyceae	*Aphanothece clathrata*	35	22	24	67	85	67	64	69	45	56	30	28
Cyanophyceae	*Aphanothece elabens*									5			
Cyanophyceae	*Aphanothece minutissima*				5	4	24	14	14	14	12	15	17
Cyanophyceae	*Aphanothece paralleliformis*				14	30		18	7	9	4	5	
Cyanophyceae	*Aphanothece smithii*						5						
Cyanophyceae	*Aphanothece spp.*			6	5	15	24	14	24	9	20		
Cyanophyceae	*Chroococcales*											5	
Cyanophyceae	*Chroococcus*							9					
Cyanophyceae	*Chroococcus aphanocapsoides*	6			5	7	5	18	7	18	4	10	17
Cyanophyceae	*Chroococcus cumulatus*										4		
Cyanophyceae	*Chroococcus dispersus*							14	7	14	8	5	11
Cyanophyceae	*Chroococcus distans*	12	6					5		5		10	17
Cyanophyceae	*Chroococcus limneticus*	53	50	29	52	63	86	68	93	77	92	85	72
Cyanophyceae	*Chroococcus microscopicus*							5	14		8		
Cyanophyceae	*Chroococcus minutus*			6	10	11	19	50	45	19	20	5	6
Cyanophyceae	*Chroococcus turgidus*						5	14	3	5	4		
Cyanophyceae	*Coelomoron pusillum*			12			5	5	7				
Cyanophyceae	*Coelosphaerium kuetzingianum*	6				15	24	9	38	23	28	10	22
Cyanophyceae	*Coelosphaerium minutissimum*	18							3	5	4		6
Cyanophyceae	*Cyanodictyon*								3				
Cyanophyceae	*Cyanodictyon balticum*		6			4							
Cyanophyceae	*Cyanodictyon filiforme*								3				
Cyanophyceae	*Cyanodictyon imperfectum*		6	12	19	22	19	73	72	55	12	20	11
Cyanophyceae	*Cyanodictyon planctonicum*	18	6	6	38	93	95	91	45	50	24	10	6
Cyanophyceae	*Cyanodictyon reticulatum*	18	11	6	24	74	81	100	93	82	80	45	44
Cyanophyceae	*Cyanodictyon tubiforme*						5	9		5	4		
Cyanophyceae	*Cyanophyceae*										12	10	
Cyanophyceae	*Eucapsis*			6									
Cyanophyceae	*Eucapsis alpina*	6				7			10		8	5	
Cyanophyceae	*Eucapsis minuta*		6										
Cyanophyceae	*Gomphosphaeria aponina*			6				18	38	9	12		

Cyanophyceae	*Lemmermanniella pallida*	6					10		14				
Cyanophyceae	*Lemmermanniella parva*								3				
Cyanophyceae	*Limnothrix planctonica*	24	17		43	30	19		14	14	20	15	28
Cyanophyceae	*Limnothrix redekei*	65	67	59	86	96	81	59	55	77	68	75	67
Cyanophyceae	*Lyngbya sp.*											5	
Cyanophyceae	*Merismopedia glauca*			6		15	10	32	21	36	12	5	11
Cyanophyceae	*Merismopedia punctata*	6	6			7	14	18	34	27	8	5	6
Cyanophyceae	*Merismopedia tenuissima*						5		21	5	4	5	
Cyanophyceae	*Merismopedia warmingiana*		11	6				14	14	14		5	
Cyanophyceae	*Microcystis aeruginosa*	41	22		5	41	57	91	93	73	88	50	22
Cyanophyceae	*Microcystis botrys*					4	5	9	7	5		5	
Cyanophyceae	*Microcystis flos-aquae*	12	11		10	30	38	50	45	59	56	45	28
Cyanophyceae	*Microcystis ichtyoblabe*	6			5			5	7		8		6
Cyanophyceae	*Microcystis novacekii*					7							
Cyanophyceae	*Microcystis viridis*	53	28	24	19	48	67	73	83	86	76	60	56
Cyanophyceae	*Microcystis wesenbergii*	35	28	6	38	56	67	86	97	82	88	75	50
Cyanophyceae	*Nodularia spumigena*								3				
Cyanophyceae	*Oscillatoria limosa*				5	4	10					5	6
Cyanophyceae	*Pannus*					11	10		3	5			
Cyanophyceae	*Pannus spumosus*								3				
Cyanophyceae	*Phormidium*	24	11	6	5	7		18	14	18	8	5	17
Cyanophyceae	*Planktolyngbya*	6		6	10	7	14	9	7	5	20	15	6
Cyanophyceae	*Planktolyngbya contorta*								3	5	4		
Cyanophyceae	*Planktolyngbya limnetica*	12							7				
Cyanophyceae	*Planktothrix agardhii*	59	22	41	76	100	100	64	97	100	100	90	67
Cyanophyceae	*Pseudanabaena acicularis*						5	9	3		4		
Cyanophyceae	*Pseudanabaena limnetica*	35	22	12	33	26	57	27	59	55	28	30	17
Cyanophyceae	*Pseudanabaena mucicola*									5			
Cyanophyceae	*Radiocystis geminata*	18	11	6	24	19	52	45	41	36	44	20	22
Cyanophyceae	*Rhabdoderma lineare*			6			10	14	10	9			
Cyanophyceae	*Romeria*					26	29	5	10	14			
Cyanophyceae	*Romeria elegans*						24	9	14				
Cyanophyceae	*Snowella*						5	5					
Cyanophyceae	*Snowella lacustris*	47	11	18	33	52	57	86	52	55	68	40	39
Cyanophyceae	*Snowella litoralis*	6	17			4	24	14	10	14	16	5	11
Cyanophyceae	*Snowella septentrionalis*	24	28	24	43	44	43	7	28	32	32	25	33
Cyanophyceae	*Woronichinia compacta*	47	33	24	67	96	81	100	83	68	92	65	67
Cyanophyceae	*Woronichinia elorantae*							5					
Cyanophyceae	*Woronichinia naegeliana*	18			5	15	19	23	28	36	36	25	17
Cryptophyceae	*Campylomonas reflexa*	59	50	53	43	33	24	32	17	23	28	20	22
Cryptophyceae	*Cryptomonadales*	18	17	12	29	26	29	50	38	32	36	20	6

Cryptophyceae	*Cryptomonas*	47	11	6	24	19	19	9	24	9	4	5	28
Cryptophyceae	*Cryptomonas curvata*			12	29	19	19	14		5	32	25	11
Cryptophyceae	*Cryptomonas gracilis*			24	24	26	14	9	3	14	4		6
Cryptophyceae	*Cryptomonas marssonii*		6	18	24	30	24	14	20	5	28		6
Cryptophyceae	*Cryptomonas anas*							5					
Cryptophyceae	*Cryptomonas rostrata*	41	56	59	62	22	29		10	14	16		11
Cryptophyceae	*Cryptomonas rostratiformis*	35	28	35	38	22	19	5	3		8	5	
Cryptophyceae	*Cryptomonas obovata*	6	6	12	5	4	5	82	72	9		5	
Cryptophyceae	*Cryptomonas ovata*	82	72	71	90	89	62			45	80	35	39
Cryptophyceae	*Cryptomonas platyuris*	29	11	24	24	22	10	14			16	5	
Cryptophyceae	*Cryptophyceae*										12	10	
Cryptophyceae	*Hemiselmis virescens*				5						4		
Cryptophyceae	*Komma caudata*	59	62	35	71	85	81	95	83	86	84	75	73
Cryptophyceae	*Plagioselmis prolonga*	24	44	59	29	19	14	5	7	14	24	35	28
Cryptophyceae	*Rhodomonas lacustris v. lacustris*	6		12		22	19	18	28	27	36	5	11
Cryptophyceae	*Rhodomonas spp.*					4	5						
Cryptophyceae	*Teleaulax acuta*	65	72	65	81	74	33	18	17	45	52	70	33
Cryptophyceae	*Teleaulax amphioxeia*	18	28	18	10	15	19	5		14	16	35	22
Cryptophyceae	*Teleaulax spp.*			12									6
Dinophyceae	*Alexandrium cf. tamarense*						5			5			
Dinophyceae	*Amphidinium*										4		
Dinophyceae	*Amphidinium crassum*						5						
Dinophyceae	*Amphidinium sphenoides*					11	14				8		
Dinophyceae	*Amylax triacantha*						10						
Dinophyceae	*Ceratium hirundinella*				10	22	14	45	52		4		
Dinophyceae	*Cladopyxis claytonii*										4		
Dinophyceae	*Dinophyceae*										8	10	
Dinophyceae	*Dinophysis acuminata*						14		3				
Dinophyceae	*Glenodinium*	6	6		14		5	14	10	14	4		
Dinophyceae	*Glenodinium danicum*					4				5			11
Dinophyceae	*Gonyaulax spinifera*				5								
Dinophyceae	*Gymnodiniales*	12	28	6	33	26	24		3	9	20	10	6
Dinophyceae	*Gymnodinium*	24	22	53	62	41	43	32	38	9	52	10	
Dinophyceae	*Gymnodinium fuscum*				5								
Dinophyceae	*Gymnodinium sanguineum*					4							
Dinophyceae	*Gymnodinium simplex*				5	4	14			5	12		
Dinophyceae	*Gymnodinium vestificii*									5			
Dinophyceae	*Gyrodinium*		6			11	5	5		5		5	
Dinophyceae	*Gyrodinium spirale*					7							
Dinophyceae	*Heterocapsa rotundata*		17			19	19		14	23	12	25	
Dinophyceae	*Heterocapsa triquetra*						24		10	5	4		

Dinophyceae	*Oblea rotunda*					4	14		3				
Dinophyceae	*Peridiniales*				5								
Dinophyceae	*Peridiniella catenata*		6			15	5			9	8		
Dinophyceae	*Peridiniopsis polonicum*	47	61	47	76	44	48	45	66	64	40	10	
Dinophyceae	*Preperidinium meunieri*						10	5		5			
Dinophyceae	*Prorocentrum minimum*					4				5	12	10	
Dinophyceae	*Protoperidinium*				10		19	9	17	9	8		
Dinophyceae	*Protoperidinium bipes*						5						
Dinophyceae	*Protoperidinium brevipes*					7	10						
Dinophyceae	*Protoperidinium conicum*						5						
Dinophyceae	*Protoperidinium pellucidum*						5						
Dinophyceae	*Pyrophacus horologicum*						5	5	3				
Dinophyceae	*Scrippsiella*		6										
Dinophyceae	*Scrippsiella cf. trochoidea*						5						
Dinophyceae	*Scrippsiella hangoei*		11	6		4							
Dinophyceae	*Woloszynskia halophila*		11	6									
Dinophyceae	*Wolozscynskia*			6									
Prymnesiophyceae	*Chrysochromulina*	47	6		5	15	29	14	14	32	12	5	6
Prymnesiophyceae	*Pleurochrysis carterae*			6			5						
Chrysophyceae	*Apedinella radians*									5			
Chrysophyceae	*Chrysococcus*	24	44	35	24						8		
Chrysophyceae	*Chrysophyceae*				10		5				8	5	
Chrysophyceae	*Dinobryon*			12		4							
Chrysophyceae	*Dinobryon balticum*				10	11	5						
Chrysophyceae	*Dinobryon bavaricum*					19	24	23	3				
Chrysophyceae	*Dinobryon divergens*	6	28	18	67	52				5	32		
Chrysophyceae	*Dinobryon faculiferum*						14	5	3				
Chrysophyceae	*Kephyrion*		11										
Chrysophyceae	*Ochromonas sp.*				5						4		
Chrysophyceae	*Pseudopedinella elastica*								3				
Chrysophyceae	*Pseudopedinella pyriforme*			6	5	11	19	5	7	5			6
Chrysophyceae	*Pseudopedinella tricostata*	24	22	18	5	19	24	14	14	14	8		
Chrysophyceae	*Uroglena*			12	14	4							
Synurophyceae	*Mallomonas*	12	17	6	33	19	5	5	14	5	8		6
Synurophyceae	*Mallomonas acaroides*			6	10								
Synurophyceae	*Mallomonas akrokomos*	6	17	18	24							5	
Synurophyceae	*Mallomonas caudata*	12	22	6	14								
Synurophyceae	*Mallomonas pulchella*			6									
Synurophyceae	*Mallomonas tonsurata*				14		5	5	7	5			
Synurophyceae	*Syncrypta polyochla*	6											28
Synurophyceae	*Synura*	41	44	29	48	22	5	5	7	9	16		6

Synurophyceae	*Synura uvella*	6	6	12	33	4					4		6
Diatomophyceae	*Achnanthes*												6
Diatomophyceae	*Achnanthes taeniata*				10	4	5		3				
Diatomophyceae	*Actinocyclus normanii f. normanii*				5	11		9	7	18	8		22
Diatomophyceae	*Actinocyclus normanii f. subsalsus*	88	44	47	52	81	81	82	90	95	100	95	67
Diatomophyceae	*Actinocyclus octonarius v. octonarius*						14		3	5	4	15	11
Diatomophyceae	*Actinocyclus octonarius v. tenellus*			6						5		5	6
Diatomophyceae	*Amphora ovalis*	12	6	12	14	11		9			4		17
Diatomophyceae	*Amphora spp.*	18	6	6	5	15	10	18	10	5	16	20	28
Diatomophyceae	*Asterionella formosa*	94	89	82	100	96	86	64	66	64	96	100	94
Diatomophyceae	*Asterionella gracillima*				24	15	24						
Diatomophyceae	*Aulacoseira*							5					
Diatomophyceae	*Aulacoseira ambigua*				14	4						10	
Diatomophyceae	*Aulacoseira granulata v. angustissima*	12	17	18			19	50	62	50	80	45	61
Diatomophyceae	*Aulacoseira granulata v. granulata*	76	44	47	52	63	67	55	76	77	100	90	56
Diatomophyceae	*Aulacoseira islandica ssp. helvetica*					4							
Diatomophyceae	*Aulacoseira islandica ssp. islandica*	88	39	76	76	70	71	32	45	36	60	65	72
Diatomophyceae	*Aulacoseira italica*	41	17	24	29	30	14	23	28	18	28	5	17
Diatomophyceae	*Aulacoseira italica v. tenuissima*	12				4							
Diatomophyceae	*Caloneis amphisbaena*			6									
Diatomophyceae	*Caloneis silicula*	6								9			
Diatomophyceae	*Centrales spp.*	6	22	24	38	56		23	28	23	20	25	17
Diatomophyceae	*Cerataulina pelagica*			24								10	
Diatomophyceae	*Chaetoceros ceratosporus v. ceratosporus*		6				14						
Diatomophyceae	*Chaetoceros danicus*									9		10	
Diatomophyceae	*Chaetoceros decipiens*										4		
Diatomophyceae	*Chaetoceros gracilis*								3				
Diatomophyceae	*Chaetoceros impressus*									5			
Diatomophyceae	*Chaetoceros lorenzianus*									5	12	10	
Diatomophyceae	*Chaetoceros minimus*						5			5			
Diatomophyceae	*Chaetoceros similis*						5						
Diatomophyceae	*Chaetoceros spp.*											5	
Diatomophyceae	*Chaetoceros tenuissimus*					4	10		3				
Diatomophyceae	*Chaetoceros throndsenii v. throndsenii*								3				
Diatomophyceae	*Chaetoceros wighamii*						5				8		
Diatomophyceae	*Cocconeis placentula v. placentula*	6		6	5	4		5			8		28
Diatomophyceae	*Coscinodiscus granii*	6		6					3	9	4	25	
Diatomophyceae	*Cyclostephanos dubius*			12	19	7	10						
Diatomophyceae	*Cyclotella*	6		6	5			5		9	8	5	6
Diatomophyceae	*Cyclotella choctawhatcheeana*								14	23		10	
Diatomophyceae	*Cyclotella comta*	6											

Diatomophyceae	*Cyclotella meneghiniana*	24	11		14	48	71	64	72	82	92	35	28
Diatomophyceae	*Cyclotella radiosa*	12	6		24	30	29	5	14	14	56	10	11
Diatomophyceae	*Cylindrotheca closterium*		6	12	5	7	14	9	14	23	4		
Diatomophyceae	*Cymatopleura elliptica*		11	18	14	11	14	9	10	18	16	10	6
Diatomophyceae	*Cymatopleura solea*	12	22	18	71	63	14	9	21	27	36	10	17
Diatomophyceae	*Cymbella*				5								6
Diatomophyceae	*Cymbella lanceolata*		6	6	14							5	6
Diatomophyceae	*Dactyliosolen fragilissimus*									5		10	6
Diatomophyceae	*Diatoma tenuis*	65	61	76	90	100	100	73	66	68	80	55	61
Diatomophyceae	*Diatoma vulgaris v. vulgaris*			6	5	4							6
Diatomophyceae	*Diatomophyceae*											10	
Diatomophyceae	*Diploneis didyma*			6			5		3	5			
Diatomophyceae	*Diploneis smithii v. dilatata*									5			
Diatomophyceae	*Diploneis smithii v. pumila*									5			
Diatomophyceae	*Entomoneis paludosa*				5								
Diatomophyceae	*Eucocconeis flexella v. alpestris*											5	
Diatomophyceae	*Eunotia lunaris*		6		5								22
Diatomophyceae	*Fragilaria brevistriata*						5						
Diatomophyceae	*Fragilaria capucina v. vaucheriae*	6		6	5							50	
Diatomophyceae	*Fragilaria crotonensis*	29		12	24	59	57	68	59	41	52	80	39
Diatomophyceae	*Fragilaria heidenii*	76	56	59	90	81	86	59	83	73	68	5	89
Diatomophyceae	*Fragilaria inflata*												6
Diatomophyceae	*Fragilaria istvanffyi*							5	93		8	5	
Diatomophyceae	*Fragilariforma virescens*	100	61	82	62	89	100	82	28	77	96	100	94
Diatomophyceae	*Gomphonema*	6	6	6						5	4	5	17
Diatomophyceae	*Gomphonema olivaceum v. olivaceum*				10								
Diatomophyceae	*Gyrosigma acuminatum*		6			7							11
Diatomophyceae	*Gyrosigma attenuatum*	6		6	14	19	24	27	17	14	32		
Diatomophyceae	*Melosira varians*	18	61	41	43	22	5	9	10	5	8	20	28
Diatomophyceae	*Meridion circulare v. circulare*		6	18	52	26	10	9	17		12	10	11
Diatomophyceae	*Navicula*	29	17	24	52	41	24	5	14		32	35	33
Diatomophyceae	*Navicula capitata v. capitata*		6	6		11	5	5	10				6
Diatomophyceae	*Navicula capitata v. hungarica*			6	5						4		11
Diatomophyceae	*Navicula cryptocephala*	6	11	18	24	15	10	5			4	15	22
Diatomophyceae	*Navicula lesmonensis*				10	11	5	5				5	6
Diatomophyceae	*Navicula meniscus*				5	7	5		3				
Diatomophyceae	*Navicula platystoma*						5						
Diatomophyceae	*Navicula reinhardtii*		6	6	10	7	5		3		4		22
Diatomophyceae	*Navicula rhynchocephala*	6	6		5	4			3	5		5	11
Diatomophyceae	*Navicula tripunctata*			6	5							5	6
Diatomophyceae	*Navicula vanhoeffenii*					7							

Diatomophyceae	*Nitzschia*			18	48	15		9	14		16	5	6
Diatomophyceae	*Nitzschia acicularis v. acicularis*	12	22	29	86	96	71	77	55	45	52	20	28
Diatomophyceae	*Nitzschia calida*	18	22	18	24	7					8	15	6
Diatomophyceae	*Nitzschia palea*	6	17	41	57	30	14	18	14	5	16	10	17
Diatomophyceae	*Nitzschia paleacea*	35	17	6	14	22	38	50	72	36	56	25	39
Diatomophyceae	*Nitzschia recta*											5	
Diatomophyceae	*Nitzschia sigmoidea*			12	5		5				12		17
Diatomophyceae	*Nitzschia vermicularis*										4	5	
Diatomophyceae	*Pennales*		6	6	10				3		12		
Diatomophyceae	*Phaeodactylum tricornutum*			6									
Diatomophyceae	*Pinnularia viridis*			6									
Diatomophyceae	*Pseudostaurosira elliptica*									5	4		
Diatomophyceae	*Rhoicosphenia abbreviata*	6		12	5			5	3		4		17
Diatomophyceae	*Skeletonema costatum*	12	22		10	15	29	9	17	23	8	20	11
Diatomophyceae	*Skeletonema subsalsum*	82	44	41	57	78	48	55	76	77	100	100	67
Diatomophyceae	*Staurosira construens v. binodis*					4							
Diatomophyceae	*Staurosira construens v. construens*	35	28	41	52	37	24	27	48	55	60	55	61
Diatomophyceae	*Staurosira construens v. venter*	59	39	41	43	85	86	64	72	59	96	100	89
Diatomophyceae	*Stephanodiscus binderanus*	12	6	6		4	10	23	38	32	40	15	22
Diatomophyceae	*Stephanodiscus hantzschii*	100	78	76	100	100	90	86	83	91	100	100	94
Diatomophyceae	*Stephanodiscus minutulus*	12	6	35	33	19	19	18	21	23	28		6
Diatomophyceae	*Stephanodiscus neoastraea*	24		12	5						16	10	11
Diatomophyceae	*Stephanodiscus rotula*	100	67	76	90	93	71	45	62	68	100	90	89
Diatomophyceae	*Stephanodiscus spp.*	12			5	4			3				
Diatomophyceae	*Surirella*					7			7			5	
Diatomophyceae	*Surirella biseriata*				14			5			8		
Diatomophyceae	*Surirella capronii*	6			10	11				5			6
Diatomophyceae	*Surirella cf. elegans*								3				
Diatomophyceae	*Surirella crumena*	12	22	35	57	26	5			5	4	15	11
Diatomophyceae	*Surirella linearis*								7			5	
Diatomophyceae	*Surirella minuta*	6	28	41	67	11				5	8	10	22
Diatomophyceae	*Surirella robusta*				10	4	5	5	10		8	10	
Diatomophyceae	*Synedra acus v. acus*	53	72	65	100	100	95	73	86	82	60	45	33
Diatomophyceae	*Synedra berolinensis*		17	6	38	63	67	45	45	45	60	15	
Diatomophyceae	*Synedra parasitica*								3	5			
Diatomophyceae	*Synedra sp.*					4							
Diatomophyceae	*Synedra ulna v. ulna*	12	28	35	71	89	14	27	34	41	44	50	11
Diatomophyceae	*Tabellaria fenestrata*	12	22	18	19	33	19		3		4	30	
Diatomophyceae	*Tabellaria fenestrata v.asterionelloides*	6											
Diatomophyceae	*Tabularia fasciculata*			12	5	4		5	7		4		
Diatomophyceae	*Tabularia laevis*				5								

Diatomophyceae	*Tabularia tabulata*					4			3				
Diatomophyceae	*Thalassiosira baltica*	6		6	10	15	19		3	5	4	20	6
Diatomophyceae	*Thalassiosira lacustris*	12		18	14	26	14	23	41	23	32	20	39
Diatomophyceae	*Thalassiosira levanderii*		17	6		4	14			5	8	5	11
Diatomophyceae	*Thalassiosira spp.*			12					3	14		15	11
Diatomophyceae	*Fragilaria capucina v. capucina*	24	6	6	19	37	29	23	21	9	40	25	
Xanthophyceae	*Centritracus belenophorus*											5	
Xanthophyceae	*Goniochloris contorta*						10						
Xanthophyceae	*Goniochloris fallax*						10	9	7	5	4		
Xanthophyceae	*Goniochloris mutica*				5		5	9	10	14	8	5	
Xanthophyceae	*Goniochloris smithii*								3				
Xanthophyceae	*Pseudostaurastrum limneticum*					7	10	18	14			10	
Xanthophyceae	*Xanthophyceae sp.*								3			5	
Rhaphidophyceae	*cf. Pseudochattonella farcimen*						5		7			5	
Euglenophyceae	*Carteria sp.*	35	11		14		38				4		
Euglenophyceae	*Euglena acus*	12	6	24		4			3		4	5	6
Euglenophyceae	*Euglena ehrenbergii*						5						
Euglenophyceae	*Euglena spp.*	12	11	6	14	15	24	9	10	5	12	20	6
Euglenophyceae	*Euglena viridis*						5	9		5	8	5	
Euglenophyceae	*Eutreptiella spp.*	12	6	12	14	11	38	5	14	14		25	11
Euglenophyceae	*Lepocinclis*		6				5		17	14	4		
Euglenophyceae	*Lepocinclis ovum*					11	14	14	7		8		
Euglenophyceae	*Leucocryptos marina*		6	12		4		5	10	5	4	10	
Euglenophyceae	*Phacus*					4							
Euglenophyceae	*Phacus pleuronectes*										4		
Euglenophyceae	*Phacus pyrum*				5		5					15	
Euglenophyceae	*Phacus tortus*												6
Euglenophyceae	*Trachelomonas*		6		5				14	9		5	6
Prasinophyceae	*Micromonas pusillum*						5				28		
Prasinophyceae	*Nephroselmis*	6			5	7	14		17	14			
Prasinophyceae	*Pseudoscourfieldia marina*						5						
Prasinophyceae	*Pyramimonas*	6	17	6		26	24	5	14	27	12	30	17
Prasinophyceae	*Pyramimonas virginica*								7	9	4		
Charophyceae	*Closterium*					4				9			11
Charophyceae	*Closterium acerosum*	12	11	6	29	33	33	32	24	41	44	25	33
Charophyceae	*Closterium aciculare*	29	28		14	22	38	50	69	32	52	45	39
Charophyceae	*Closterium acutum v. acutum*	29	28	12	19	59	57	50	79	82	84	35	44
Charophyceae	*Closterium gracile*									5	8		
Charophyceae	*Closterium lineatum*								3				
Charophyceae	*Closterium moniliferum*								3				
Charophyceae	*Closterium parvulum*				19	4	5		3	5		10	

Charophyceae	*Closterium pronum*								3		8	5	6
Charophyceae	*Closterium strigosum*					7	5		24	18	4	10	6
Charophyceae	*Cosmarium gracile*				10	4		9					
Charophyceae	*Cosmarium meneghinii*							5					
Charophyceae	*Cosmarium spp.*			6	10	48	33	45	24	18	32	20	22
Charophyceae	*Elakatothrix gelatinosa*							5					
Charophyceae	*Elakatothrix genevensis*	18	22	24	48	59	57	45	59	27	40	40	22
Charophyceae	*Koliella longiseta f. longiseta*	18	50	76	100	96	43	14	10	27	40	30	22
Charophyceae	*Mougeotia spp.*	35	22	18	19	48	67	50	86	73	80	50	39
Charophyceae	*Staurastrum*	18	11	6	14	56	71	55	72	55	64	35	28
Charophyceae	*Staurastrum gracile*											10	
Chlorophyceae	*Actinastrum hantzschii*	6	6		52	78	76	59	90	77	56	15	11
Chlorophyceae	*Ankistrodesmus falcatus*				5	22	38	45	28	9	24	15	
Chlorophyceae	*Ankistrodesmus fusiformis*	12	6		19	37	57	27	38	45	36	20	22
Chlorophyceae	*Ankyra*						5		3				
Chlorophyceae	*Asterococcus limneticus*											5	
Chlorophyceae	*Basichlamys sacculifera*									14			
Chlorophyceae	*Botryococcus*							9	3	5	16		
Chlorophyceae	*Botryococcus braunii*			6							8		
Chlorophyceae	*Chlamydocapsa ampla*				5								
Chlorophyceae	*Chlamydocapsa planctonica*											10	6
Chlorophyceae	*Chlamydomonas spp.*	100	67	76	95	63	62	50	59	45	44	20	17
Chlorophyceae	*Chlorococcales*	12			14	11	5	5	10	9	4	5	
Chlorophyceae	*Chlorogonium maximum*	18	11		19		10						
Chlorophyceae	*Chlorogonium minimum*	6			14	15	5		3	5			
Chlorophyceae	*Chlorophyceae*				5	4					12	5	
Chlorophyceae	*Choricystis chodatii*	6	6		24	41	24	14	38	14	32	15	17
Chlorophyceae	*Choricystis coccoides*				10	11		9					
Chlorophyceae	*Closteriopsis longissima*							5	3	9	4		
Chlorophyceae	*Coelastrum astroideum*	18	11	12	19	63	86	100	100	73	76	50	50
Chlorophyceae	*Coelastrum cambricum*								17				6
Chlorophyceae	*Coelastrum indicum*	6											
Chlorophyceae	*Coelastrum microporum*	12		12	29	37	19	14	24	9	12	5	11
Chlorophyceae	*Coelastrum sphaericum*								3				
Chlorophyceae	*Coelastrum reticulatum*	6							7	5			
Chlorophyceae	*Coenochloris*					4			10			5	
Chlorophyceae	*Coenochloris ovalis*						5	5	3	9	8	5	
Chlorophyceae	*Coenocystis planctonica*							5			4		6
Chlorophyceae	*Coenocystis sp.*												6
Chlorophyceae	*Coenocystis subcylindrica*		6	6				5					
Chlorophyceae	*Crucigenia lauterbornii*				10						4		

Chlorophyceae	*Crucigenia quadrata*	24	22	29	29	85	90	77	69	64	72	50	44
Chlorophyceae	*Crucigenia tetrapedia*			6	5		33	32	28	18	16	45	11
Chlorophyceae	*Crucigeniella apiculata*		6	6		4	38	50	62	68	40	15	17
Chlorophyceae	*Crucigeniella pulchra*										4		
Chlorophyceae	*Crucigeniella crucifera*		6						7		4		
Chlorophyceae	*Crucigeniella rectangularis*					7	5	5	7	5			
Chlorophyceae	*Dactylosphaerium jurisii*				5		5				4		11
Chlorophyceae	*Desmodesmus*								3		4		
Chlorophyceae	*Desmodesmus abundans*	18	44	24	57	56	71	77	76	77	80	85	56
Chlorophyceae	*Desmodesmus armatus v. armatus*	65	56	65	62	81	95	82	100	86	100	85	89
Chlorophyceae	*Desmodesmus armatus v. bicaudatus*	6	11	6	10	30	62	41	28	45	44	35	17
Chlorophyceae	*Desmodesmus bicellularis*	59	67	53	81	93	95	68	90	68	64	55	44
Chlorophyceae	*Desmodesmus communis*	100	83	59	95	100	100	100	93	100	100	100	94
Chlorophyceae	*Desmodesmus denticulatus v. denticulatus*	24	44	18	38	48	57	50	52	59	80	40	56
Chlorophyceae	*Desmodesmus hystrix*												6
Chlorophyceae	*Desmodesmus intermedius*	12	17	18	52	59	48	68	69	59	60	50	28
Chlorophyceae	*Desmodesmus opoliensis v. carinatus*						10	9	3	5	12	10	
Chlorophyceae	*Desmodesmus opoliensis v. opoliensis*	47	50	24	71	100	81	77	93	100	92	85	89
Chlorophyceae	*Desmodesmus ovalternus*						10			5			
Chlorophyceae	*Desmodesmus quadricauda f. setosus*							5					
Chlorophyceae	*Desmodesmus sempervirens*	12	6		5	4	19	9	14	14		5	
Chlorophyceae	*Desmodesmus spinosus*	35	6	12	19	30	19	18	24	14	20	5	17
Chlorophyceae	*Dichotomococcus curvatus*		6		29	37	14	14	3	9	12	10	
Chlorophyceae	*Dictyosphaerium ehrenbergianum*					7	38	45	17	23	28	5	
Chlorophyceae	*Dictyosphaerium elegans*										4	5	6
Chlorophyceae	*Dictyosphaerium pulchellum*	47	22	29	71	100	95	86	93	86	100	65	56
Chlorophyceae	*Dictyosphaerium subsolitarium*						10	5	7	9	4	5	
Chlorophyceae	*Dimorphococcus lunatus*								3				
Chlorophyceae	*Diplochloris lunata*				5								
Chlorophyceae	*Eudorina elegans*	6	11		19	26	10	32	24	5	28	5	
Chlorophyceae	*Eutetramorus globosus*					4							
Chlorophyceae	*Eutetramorus planctonicus*					4							
Chlorophyceae	*Franceia ovalis*					15	33	27		9	8	5	6
Chlorophyceae	*Gloeocystis*								3				
Chlorophyceae	*Golenkinia radiata*	6			14	11	33	27	14	5	4	5	6
Chlorophyceae	*Gonium sociale*					15	14	23	7	18	12	10	
Chlorophyceae	*Granulocystis ruzickae*								7				
Chlorophyceae	*Granulocystopsis coronata*									5			
Chlorophyceae	*Keratococcus braunii*											5	
Chlorophyceae	*Kirchneriella contorta*	6	11		33	37	24	41	41	23	24		

Chlorophyceae	*Kirchneriella lunaris*	6			10	15	33	36	10	14	20	15	11
Chlorophyceae	*Komarekia rotundata*							5					
Chlorophyceae	*Lagerheimia ciliata*				10			5	3				
Chlorophyceae	*Lagerheimia citriformis*	6			5	11	48	41	17	9	24	5	11
Chlorophyceae	*Lagerheimia genevensis*			6	38	67	38				8		
Chlorophyceae	*Lagerheimia longiseta v. longiseta*					19	33	23	14	9	8	20	11
Chlorophyceae	*Lagerheimia subsalsa*	12	11	6	19	15	38	32	17	14	16	5	
Chlorophyceae	*Lagerheimia wratislaviensis*				5	11	14						
Chlorophyceae	*Lobomonas ampla*								3				
Chlorophyceae	*Micractinium pusillum*	29	17	24	71	93	76	73	66	86	80	45	11
Chlorophyceae	*Microspora tumidula*									5			
Chlorophyceae	*Microspora*								3	5		5	
Chlorophyceae	*Monoraphidium arcuatum*	24		18	48	67	33		17	14	92	15	
Chlorophyceae	*Monoraphidium contortum*	59	56	53	81	100	100	23	76	82	40	90	56
Chlorophyceae	*Monoraphidium griffithii*	29	17	6	29	48	48	68	41	41		45	22
Chlorophyceae	*Monoraphidium irregulare*	29	6	12	10	4	10	36	14	18		10	
Chlorophyceae	*Monoraphidium komarkovae*	29	39	6	43	89	57	5	66	50	92	40	33
Chlorophyceae	*Monoraphidium minutum*			6				64			4	5	6
Chlorophyceae	*Monoraphidium mirabile*										4	10	
Chlorophyceae	*Nephrochlamys subsolitaria*								3				
Chlorophyceae	*Nephrocytium*								3				
Chlorophyceae	*Nephrocytium agardhianum*							9	10				
Chlorophyceae	*Oocystis*	24	11	18	19	30	57	50	38	23	20	5	6
Chlorophyceae	*Oocystis borgei*	35	28	29	57	74	81	77	93	73	96	60	28
Chlorophyceae	*Oocystis elliptica*						5			5			
Chlorophyceae	*Oocystis lacustris*	35	6	18	38	81	90	86	90	82	80	60	61
Chlorophyceae	*Oocystis marssonii*						5	5			4		
Chlorophyceae	*Oocystis naegelii*	6							3	5	4		
Chlorophyceae	*Oocystis parva*											5	
Chlorophyceae	*Oocystis pelagica*						5						
Chlorophyceae	*Oocystis rhomboidea*			6	24	33	38	45	34	41	36	15	17
Chlorophyceae	*Oocystis solitaria*	24			10	19	19	32	48	23	48	20	22
Chlorophyceae	*Oocystis submarina*	12	6		10	11	14	18	17	23	12	20	
Chlorophyceae	*Pandorina morum*				24		33	27	38	23	12	5	
Chlorophyceae	*Pediastrum biradiatum*				5	11	24	23	28	14	20	5	11
Chlorophyceae	*Pediastrum boryanum v. boryanum*	82	44	53	81	100	100	100	100	100	100	85	89
Chlorophyceae	*Pediastrum duplex v. duplex*	18	17	18	33	74	100	91	100	82	88	70	72
Chlorophyceae	*Pediastrum duplex v. gracillimum*											5	
Chlorophyceae	*Pediastrum integrum*						5		3	5			
Chlorophyceae	*Pediastrum kawraiskyi*		6							9	4		6
Chlorophyceae	*Pediastrum simplex*	6			5		10	9	38	23	12	15	11

Chlorophyceae	*Pediastrum tetras*		6	6	10	15	14	14	31	23	32	10	11
Chlorophyceae	*Planctonema lauterbornii*	88	61	65	57	85	100	95	97	95	96	95	78
Chlorophyceae	*Planctosphaeria gelatinosa*							5	3				
Chlorophyceae	*Pseudosphaerocystis lacustris*			6	10	19	10	9		23	12		
Chlorophyceae	*Quadricoccus ellipticus*	6		6	14	22	29	27	52	50	36	15	11
Chlorophyceae	*Radiococcus*						10	5					
Chlorophyceae	*Raphidocelis*	6	6		24	11	5	14	14	9	4	5	
Chlorophyceae	*Rayssiella hemisphaerica*								3				
Chlorophyceae	*Scenedesmus*						5	9	3				
Chlorophyceae	*Scenedesmus acuminatus*		11	12	33	67	90	55	72	73	56	60	28
Chlorophyceae	*Scenedesmus acuminatus v. elongatus*									5	4		6
Chlorophyceae	*Scenedesmus acutiformis*						5	5	3	9			
Chlorophyceae	*Scenedesmus arcuatus*										4		
Chlorophyceae	*Scenedesmus arcuatus v. elongatus*								3				
Chlorophyceae	*Scenedesmus balatonicus*									5	4		
Chlorophyceae	*Scenedesmus caudato-aculeolatus*								3				
Chlorophyceae	*Scenedesmus dimophus*						5						
Chlorophyceae	*Scenedesmus disciformis*						10	14		9			
Chlorophyceae	*Scenedesmus ellipticus*	12	6	6	29	48	76	86	93	77	68	55	28
Chlorophyceae	*Scenedesmus obliquus*	6	17	12	52	93	52	50	48	55	64	40	50
Chlorophyceae	*Scenedesmus obtusus*	6	22	6	5	26	57	68	31	27	60	25	22
Chlorophyceae	*Scenedesmus verrucossus*										4	5	
Chlorophyceae	*Schroederia setigera*		17	12	19	26	38	86	59	27	32	5	11
Chlorophyceae	*Schroederiella papillata*											5	
Chlorophyceae	*Selenastrum bibraianum*					4	5	18	7	9		5	6
Chlorophyceae	*Selenastrum gracile*					4	29	14	24	9	8	5	
Chlorophyceae	*Sphaerellopsis fluviatilis*							5	3				
Chlorophyceae	*Sphaerocystis schroeteri*	12	17		33	41	57	55	52	55	44	25	17
Chlorophyceae	*Tetrachlorella alternans*					4	5	5	3	5		5	
Chlorophyceae	*Tetraëdron caudatum*			6	10	15	48	45	28	32	20	5	
Chlorophyceae	*Tetraedron hastatum v. triangulare*									5			
Chlorophyceae	*Tetraëdron minimum*	6	11			7	24	27	38	27			11
Chlorophyceae	*Tetraëdron triangulare*								3				
Chlorophyceae	*Tetrastrum*											5	
Chlorophyceae	*Tetrastrum elegans*				10	26	24	9	7	14	8	10	6
Chlorophyceae	*Tetrastrum multisetum*								3				
Chlorophyceae	*Tetrastrum staurogeniaeforme*	59	67	59	71	96	95	91	90	82	96	70	61
Chlorophyceae	*Tetrastrum triacanthum*								3				
Chlorophyceae	*Tetrochlorella alternans*		6										
Chlorophyceae	*Treubaria triappendiculata*				29	44	38	27	21	23	20		
Chlorophyceae	*Westella botryoides*	6	6	12		15	24	27	14	23	20		

Chlorophyceae	*Willea irregularis*	12	6		10	26	52	41	52	32	28	25	6
Craspedophyceae	*Craspedophyceae*		6								4	5	
Craspedophyceae	*Monosiga*										8		6
Ebriidea	*Ebria tripartita*		6			7	10		3	5	12		
INCERTAE SEDIS	*Bodo spp.*										4		
INCERTAE SEDIS	*Katablepharis ovalis*	18		18	10		10	9	17	41	36	30	28
INCERTAE SEDIS	*Telonema antarcticum*				5		5						6
INCERTAE SEDIS	*Telonema subtile*				5		14		3	18	8	10	
Flagellates	Flagellates		6	24	10	11			7	5	8	10	
Ciliophora	*Mesodinium rubrum*				10	11	14	5	10		4	10	

Improving the Baltic Sea environment and economies: Innovative approaches to the sustainable use of marine resources

The Baltic Sea Region faces enormous challenges including new installations, fishery declines, excessive nutrient input, the effects of climate change as well as demographic change. But novel technologies and growing knowledge also provide opportunities for new uses of marine ecosystems, which can be both commercially appealing and environmentally friendly. Through increased understanding and promotion of innovative and sustainable new uses of the Baltic Sea, SUBMARINER provides the necessary basis for the region to take a proactive approach towards improving the future condition of its marine resources and the economies that depend on them.

Activities

Compendium

Describing current and potential future marine uses

- Comprehensive inventory of current and new uses
- Strengths, weaknesses, opportunities and threats to the BSR
- Environmental and socioeconomic impacts
- State and availability of technologies
- Market potential
- Gaps and obstacles in the legal framework

BSR Roadmap

Recommending necessary steps across all disciplines to promote beneficial uses and mitigate against negative impacts

- Research topics
- Institutional and network initiatives
- Legal changes (e.g. spatial plans)
- Environmental regulations
- Economic incentives

Regional Strategies

Testing new uses in real conditions

- Feasibility studies for new uses
- Technological and financial needs
- Impacts on environmental and socioeconomic conditions within the area
- Specific legal constraints

BSR Network

Bringing relevant players together

- Business cooperation events
- Network structure (incl. membership, mission, independent finances, business plan, etc.)
- Virtual information and exchange platform
- Regional, national and BSR-wide roundtables and seminars on new marine uses

Partners

Poland

- **Lead Partner:** The Maritime Institute in Gdańsk
- Gdańsk Science and Technology Park

Germany

- Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
- Norgenta North German Life Science Agency
- Kieler Wirkstoff-Zentrum am GEOMAR | Helmholtz Centre for Ocean Research Kiel
- University of Rostock
- BioCon Valley Mecklenburg-Vorpommern e.V.

Denmark

- ScanBalt
- Lolland Energy Holding

Sweden

- Royal Institute of Technology (KTH)
- The Royal Swedish Academy of Sciences
- Trelleborg Municipality

Estonia

- Tallinn University of Technology
- Entrepreneurship Development Centre for Biotechnology & Medicine

Lithuania

- Klaipeda University Coastal Research and Planning Institute
- Klaipeda Science and Technology Park

Latvia

- Ministry of Environmental Protection and Regional Development of the Republic of Latvia
- Environmental Development Association

Finland

- Finnish Environment Institute – SYKE

Project Duration

October 2010 – December 2013

Project Budget

- ERDF Co-Finance: € 2.8 million
- Partners' contribution: € 0.8 million
- Total Project Budet: € 3.6 million

SUBMARINER
Sustainable Uses of Baltic Marine Resources

www.submariner-project.eu