Monitoring of hydroecosystems of the Gulf of Finland in the areas of sediment removal and general approach to typication of bottom communities

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Environmental Consulting Agency "ECOPROJECT" performs an environmental support of the operations on excavation of ferrous-manganese burs in the Gulf of Finland. One of the fields is situated in the interior part of the Gulf of Vyborg. The deposit is located within the accumulative plain at depths of 10-27 m.

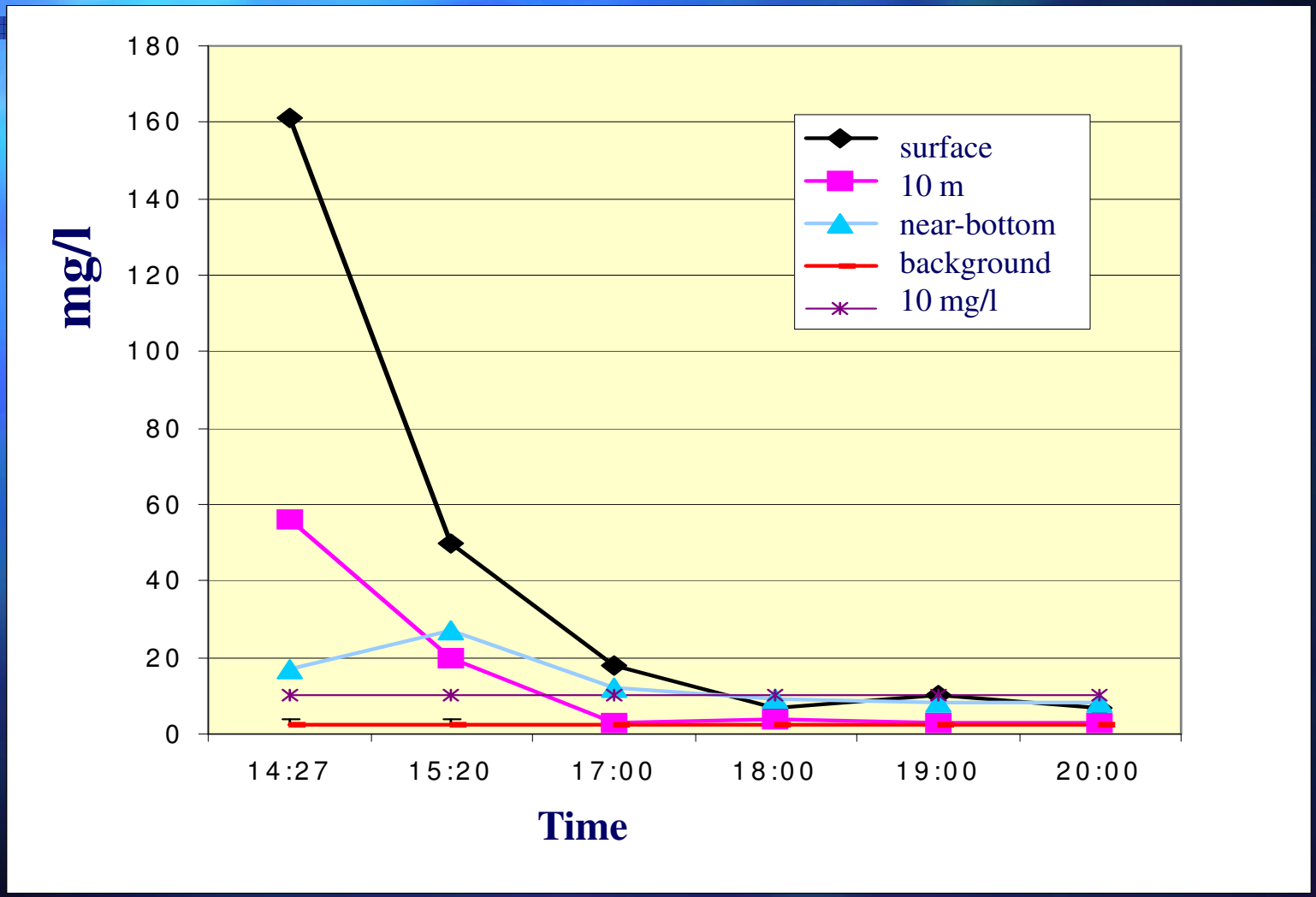
The excavation is performed using «LAUWER» dredge pump. The burs are laid in a top layer of bottom sediments. Bottom sediments are represented by sandy aleuropelite and they easily change to suspended condition during damping.

Observations in turbidity spot

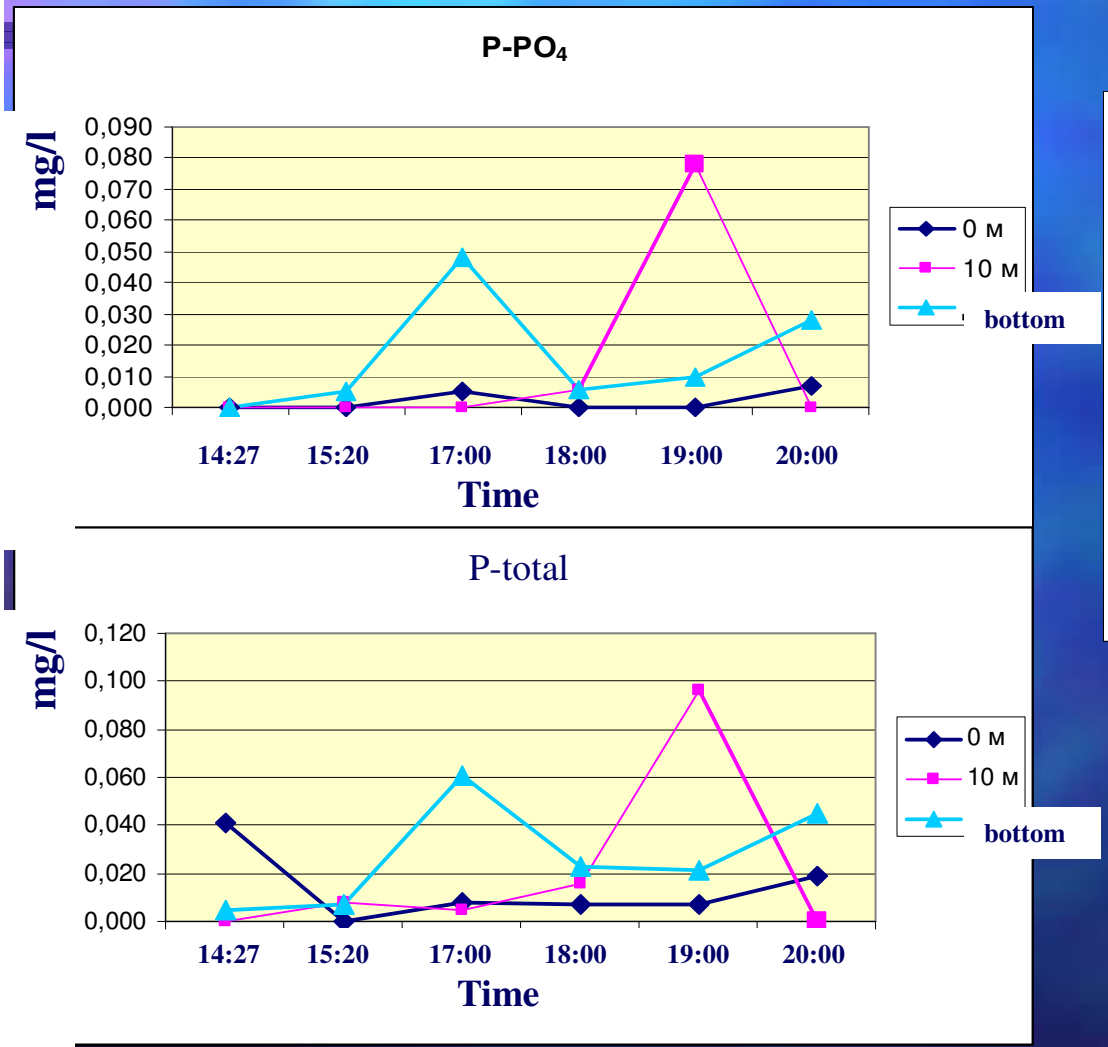
Main types of impact on hydroecosystem:

- Mechanical damage of a top layer of bottom sediments and direct soil sampling;
- Increase of amount of a suspension in water;
- Redistribution of a dredge in water with its subsequent sedimentation (soil damping);
- Enrichment of top levels of water column with biogenic elements due to their coming from natural horizons;
- Possibility of coming of some heavy metals and other contaminants contained in natural horizons and bottom sediments in concentrations, which exceed MPC, to surface waters

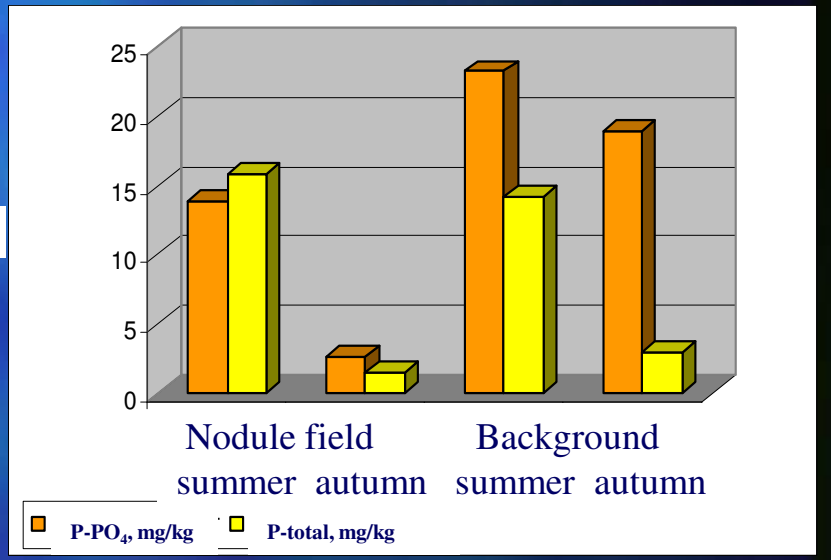
Data on the dynamics of change of dredge concentrations shows that in 3.5 hour after finishing the excavation concentrations of suspended matters decrease to 10 mg/l – i.e. the level, below which the damage to fish resources due to impacts on food reserves is not considered.



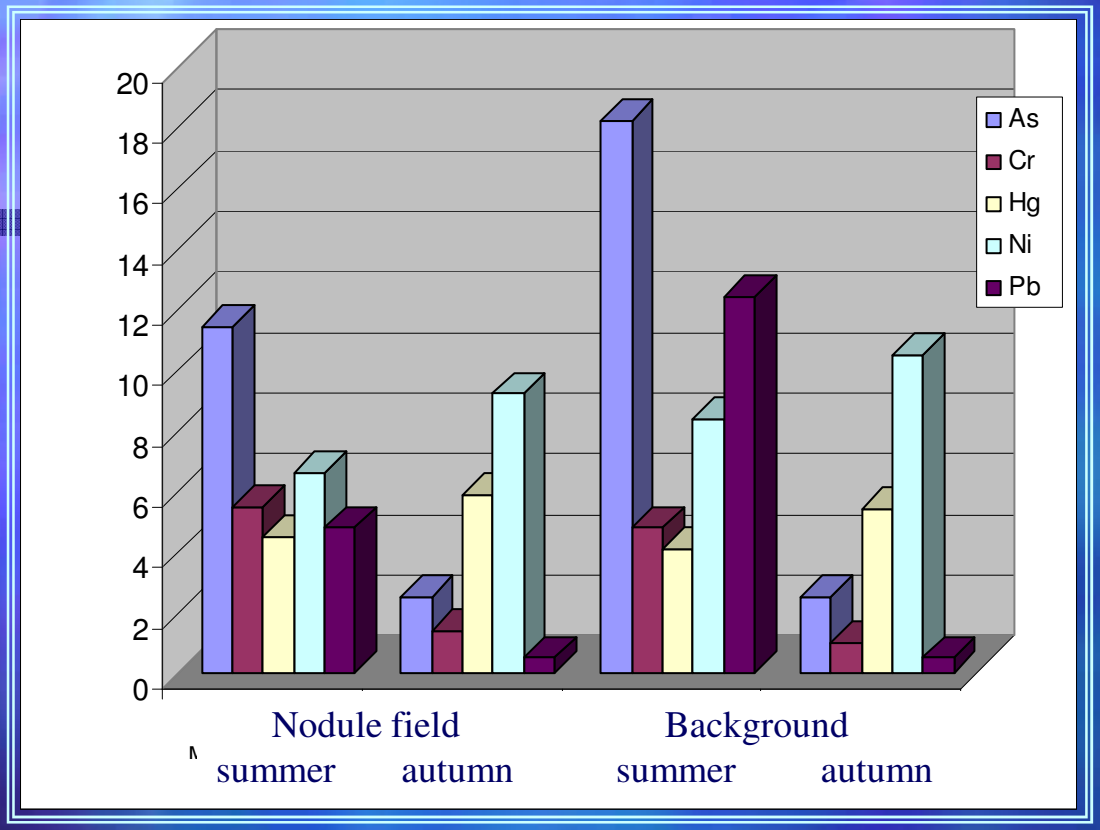
Insignificant trends in increasing of all forms of phosphorus in the entire water column were monitored. It is possible that it relates to coming of phosphorus from bottom sediments. Exceeding the Maximum Permissible Concentrations (MPC) during sludge discharge was not registered for none of biogenic elements.



Phosphorus in the water in the turbidity spot, mg/l



Phosphorus in the bottom sediments, mg/kg



Analysis of the composition of bottom sediments by class of pollution with heavy metals in compliance with the requirements of Regional Standard showed that bottom sediments in the field's area must be evaluated:
- by class of content of Ni, Cr, Pb and Cd – low polluted (I pollution class),
- by concentration of As and Hg – moderately polluted (II pollution class),

Pollution of bottom sediments in the area of excavation of ferrous-manganese burs, taking into account the low concentrations identified for most of metals and other contaminants, is insignificant. In geochemical respect, main consequences of the impact concern with local increase of concentrations of some chemical elements in water.

PHYTOPLANKTON

In June 2005 in all 90 algae species were detected in the phytoplankton. The blue-greens (31 taxa), green algae (21 taxa), diatoms (18 taxa) and dinoflagellates (11 taxa) had the greatest species diversity. Other systematic groups had no decisive value in the phytoplankton diversity of study area.

Comparison the phytocenosis of background and extraction sites and dumping (Serensen similarity coefficient) showed separation of data at 66-79% level of similarity.

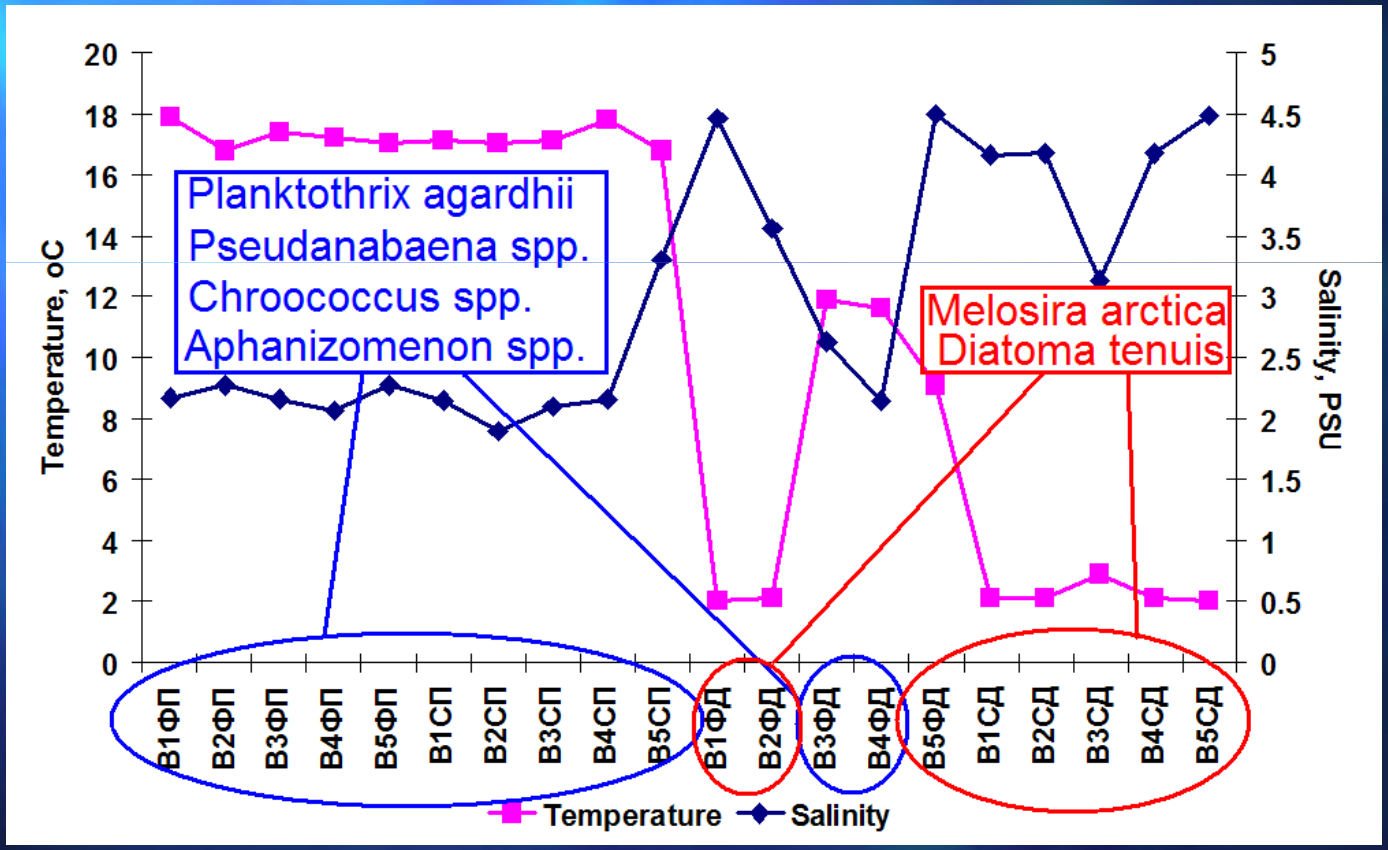


Fig. 1 - Dominant phytoplankton complex of background and extraction sites in the Eastern part of the Gulf of Finland, June 2005.

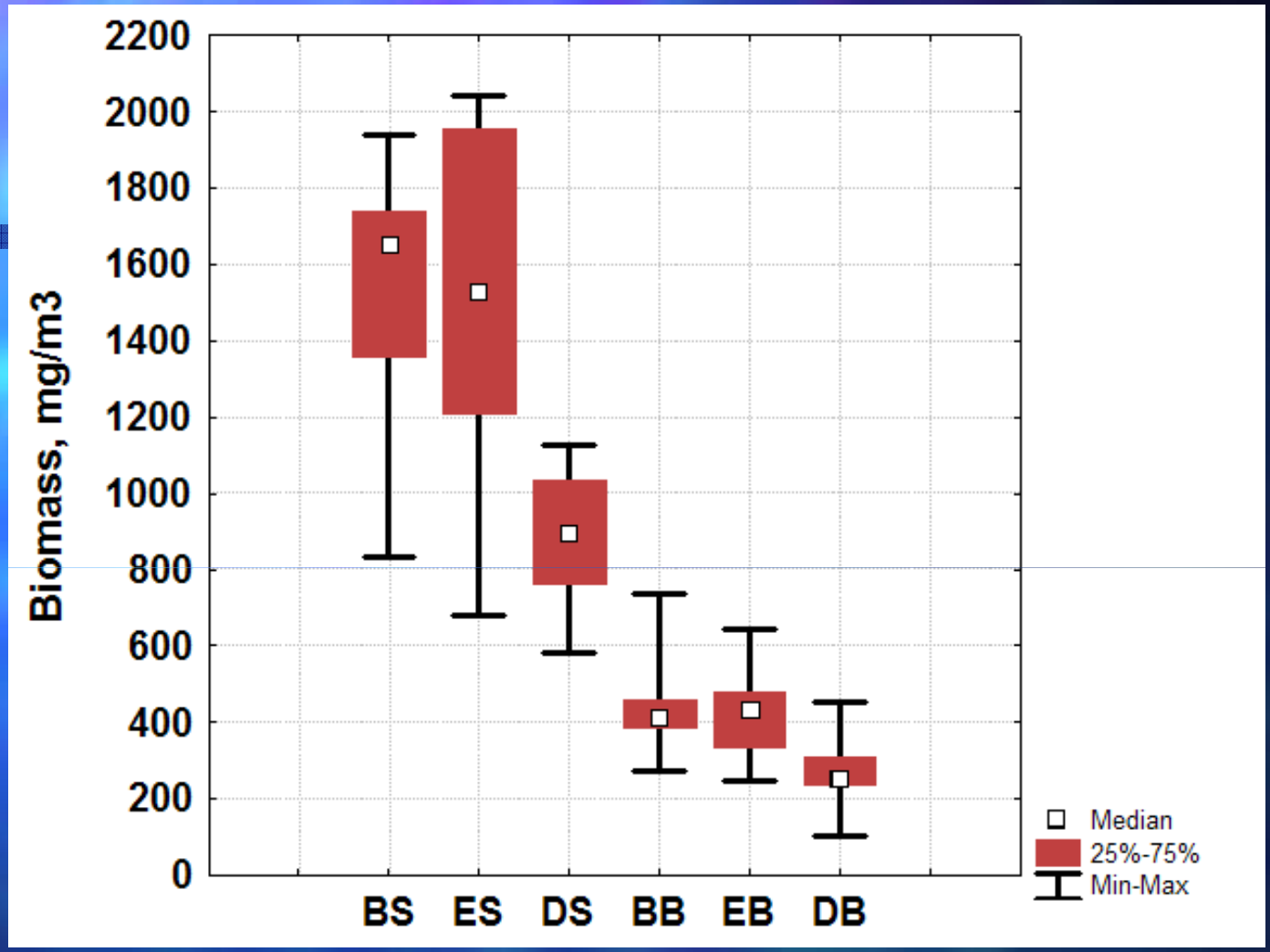
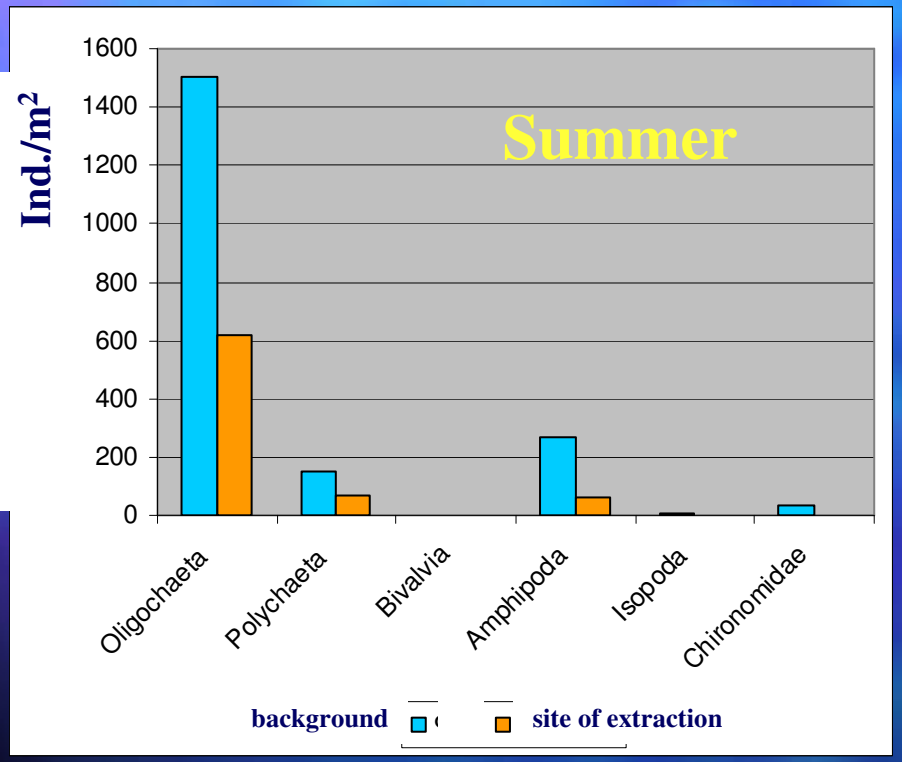


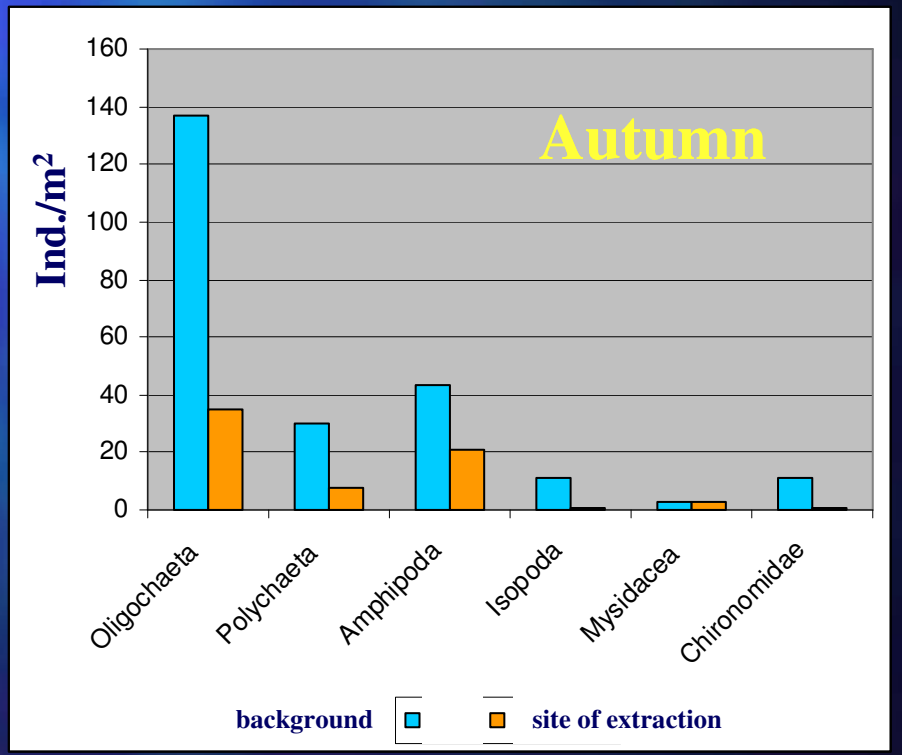
Fig. 2 – Phytoplankton biomass in background (B) and extraction (E) sites and dumping (D) (S – surface; B – botton).

Share of died Cladocera in the turbidity spot

Species	Share of died Cladocera, %
Bosmina coregoni	15.0±3.4
Evadne nordmanni	8.8±3.6
Podon polyphemoides	7.4±1.8

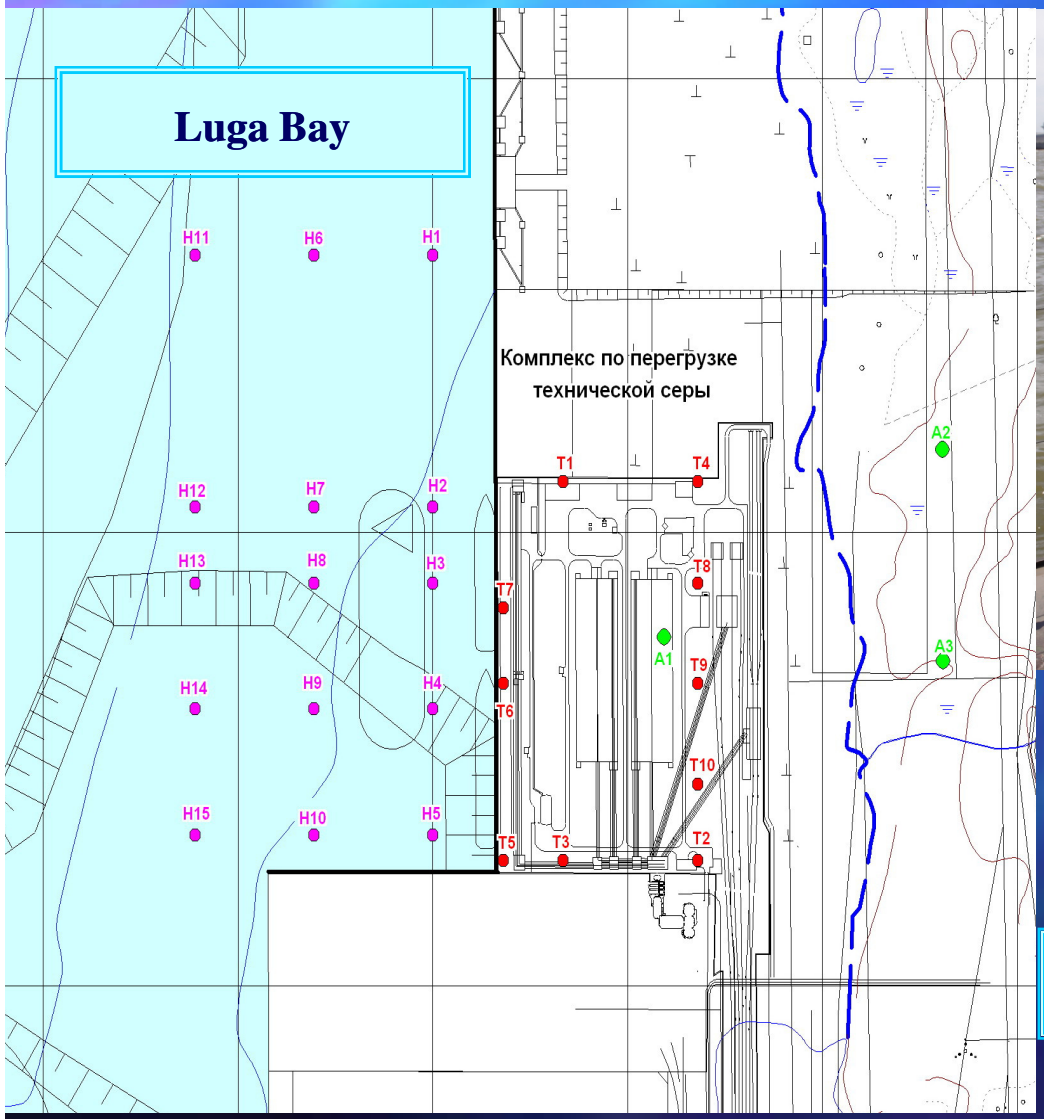
Abundance of benthic invertebrates





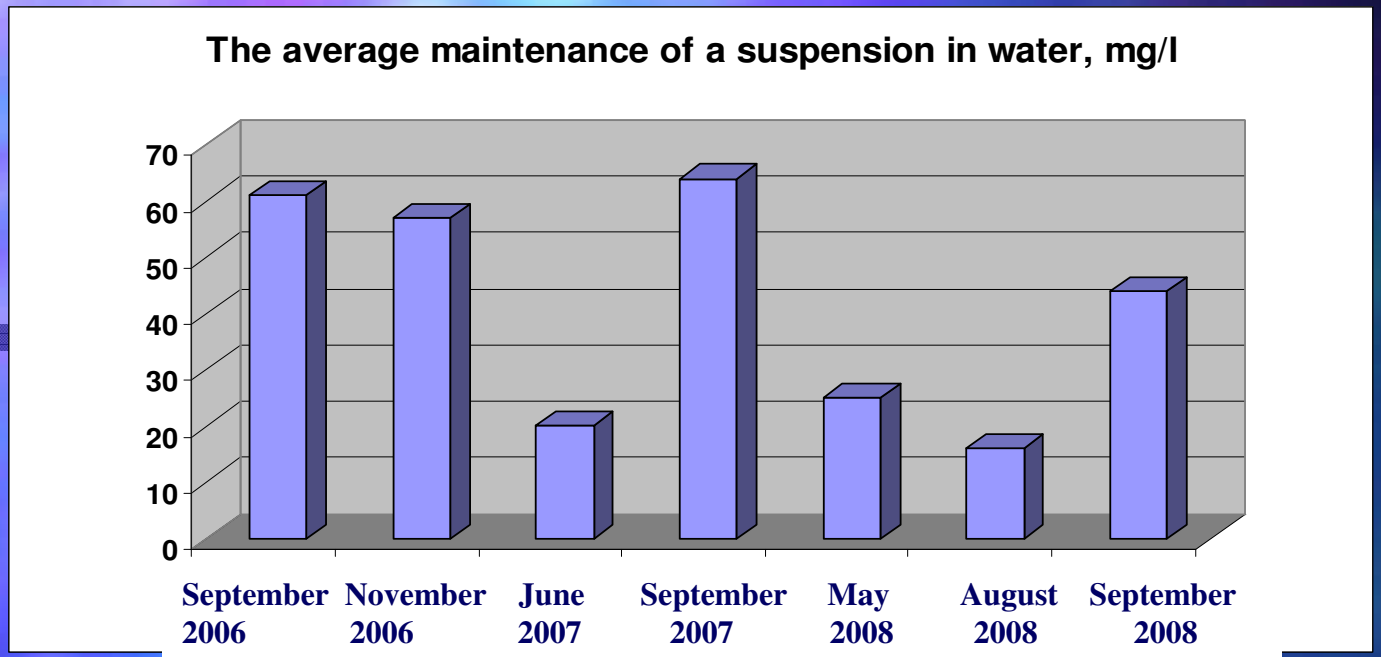
- Transformation of environment caused by the process of nodule extraction lead to short-term changes in phytoplankton structure and to increased mortality in some zooplankton group.
- In long term, the sediment excavation and dumping strongly affected benthic organisms at the nodule field. Many-fold decrease in both benthic invertebrate abundance and diversity was observed in the dredging area.

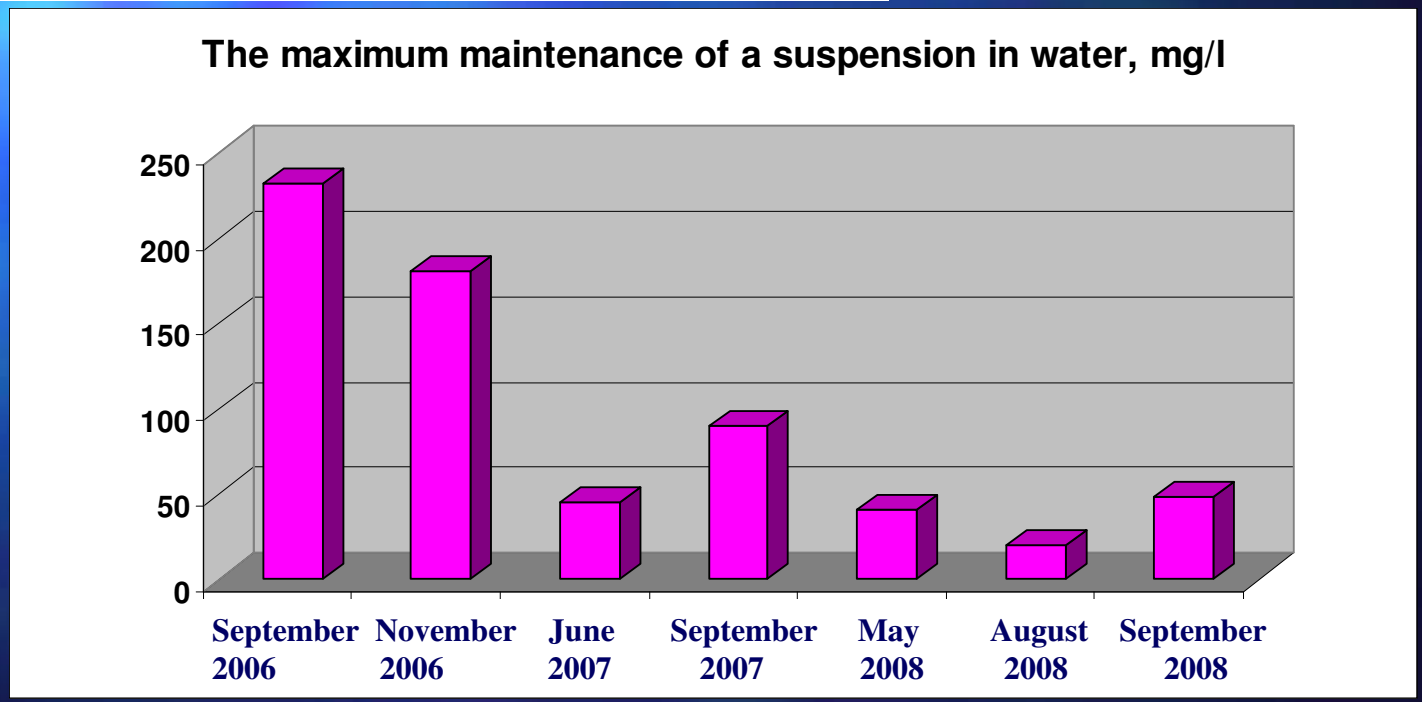
Environmental Consulting Agency “ECOPROJECT” performs an environmental support of the operations on formation of Technical Sulphur Transfer Terminal’s site located in the port “Ust-Luga”



Layout of environmental monitoring stations

- The site of the Terminal is produced using sand excavated during dredging operations in water area of Luga Bay
- Dredging operations were performed with help of dredge pumps in water area by the Terminal's moorings
- The operations performed resulted in increasing the depth in adjacent areas of Luga Bay from 2 - 5 m to 14 - 16 m


The average maintenance of a suspension in water, mg/l
70
60
50
40
30
20
10
0
September 2006
November 2006
June 2007
September 2007
May 2008
August 2008
September 2008


The maximum maintenance of a suspension in water, mg/l
250
200
150
100
50
0
September 2006
November 2006
June 2007
September 2007
May 2008
August 2008
September 2008

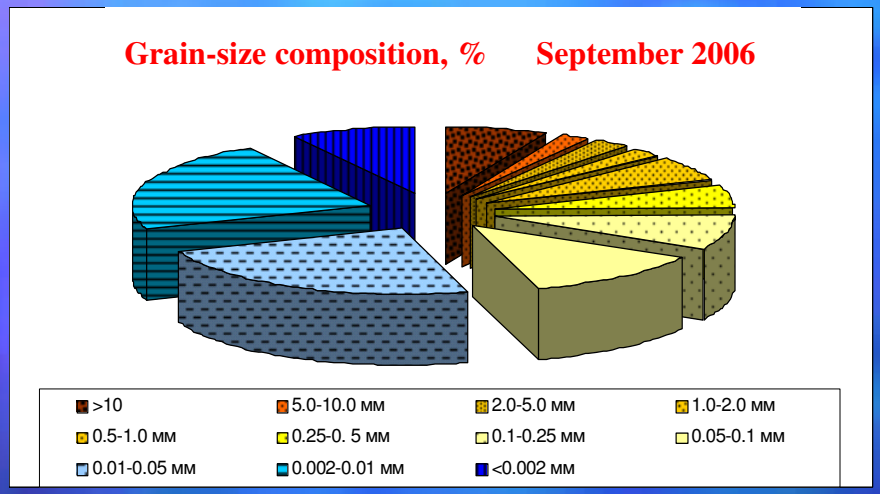
Average content of biogenic elements and oil hydrocarbons in water of a monitoring site

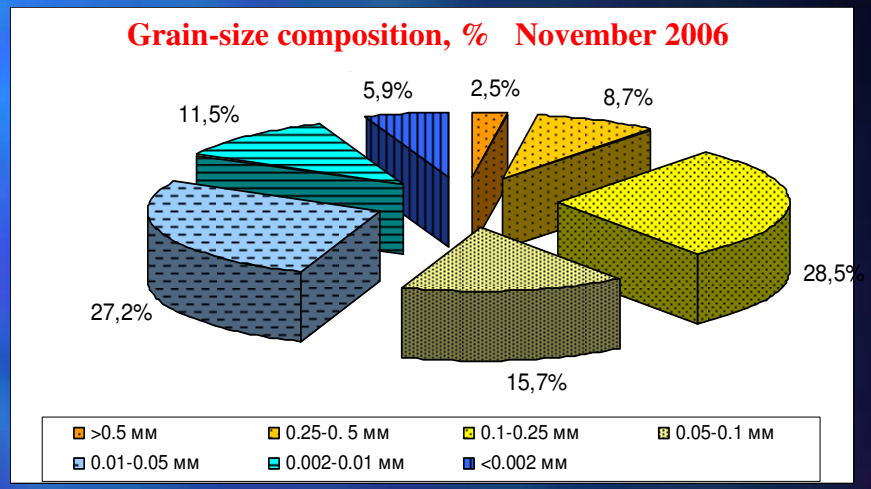
	September 2006	September 2007	September 2008	September 2009	MPC
O_2, mg/l	9.9	8.4	6.9	9.4	6.0
BOD_5, mgO_2/l	0.53	2.75	0.81	0.75	2.0
$P\text{-}PO_4$, mg/l	0.031	0.014	0.053	0.051	0.065
$N\text{-}NH_4$, mg/l	0.063	0.128	0.206	<0.02	0.39
$N\text{-}NO_2$, mg/l	0.023	<0.005	0.052	0.008	0.02
$N\text{-}NO_3$, mg/l	0.044	0.024	0.025	0.083	9.1
Oil hydro-carbons, mkg/l	46.1	<20	<20	33	50

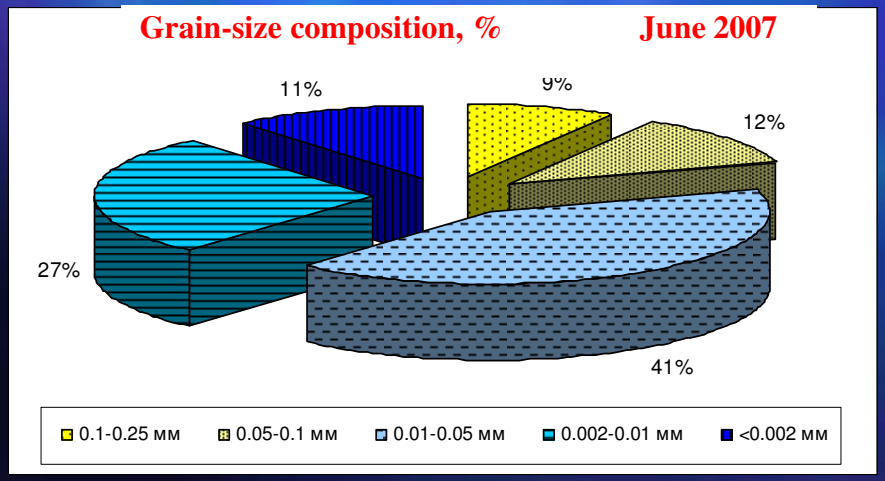
Average content of metalls in water of a monitoring site, mkg/l

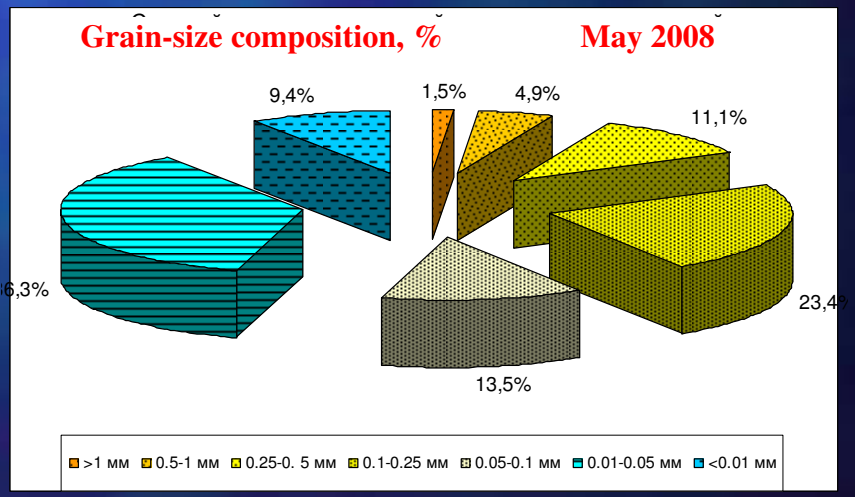
Metalls	September 2006	September 2007	September 2008	September 2009	MPC
Cr	<2	<2	17	<2	70
Pb	<0.05	1.92	<0.05	0.38	10
Cu	<1	3.26	<1	1.58	5
Cd	<0.1	<0.1	<0.1	<0.1	10
Hg	<0.03	<0.03	<0.03	<0.01	0.1
Zn	6.7	11.3	17.5	154	50
Ni	<3	<3	17	<3	10
Fe	3.8	8.96	256	90	50

Change of grain-size composition of bottom sediments from September 2006 until May 2008









Average content of metalls in water of a monitoring site, mg/kg dry weight

Metalls	September 2006	September 2007	May 2008	September 2009
Cr	10.2	11.4	<0.5	43.3
Pb	9.4	9.1	2.4	8.0
Cu	20.0	19.5	2.2	31.0
Cd	0.19	0.24	0.09	0.16
Hg	0.008	0.004	<0.003	0.009
Zn	48.5	39.0	7.6	101
Ni	17.6	13.5	6.1	16.6

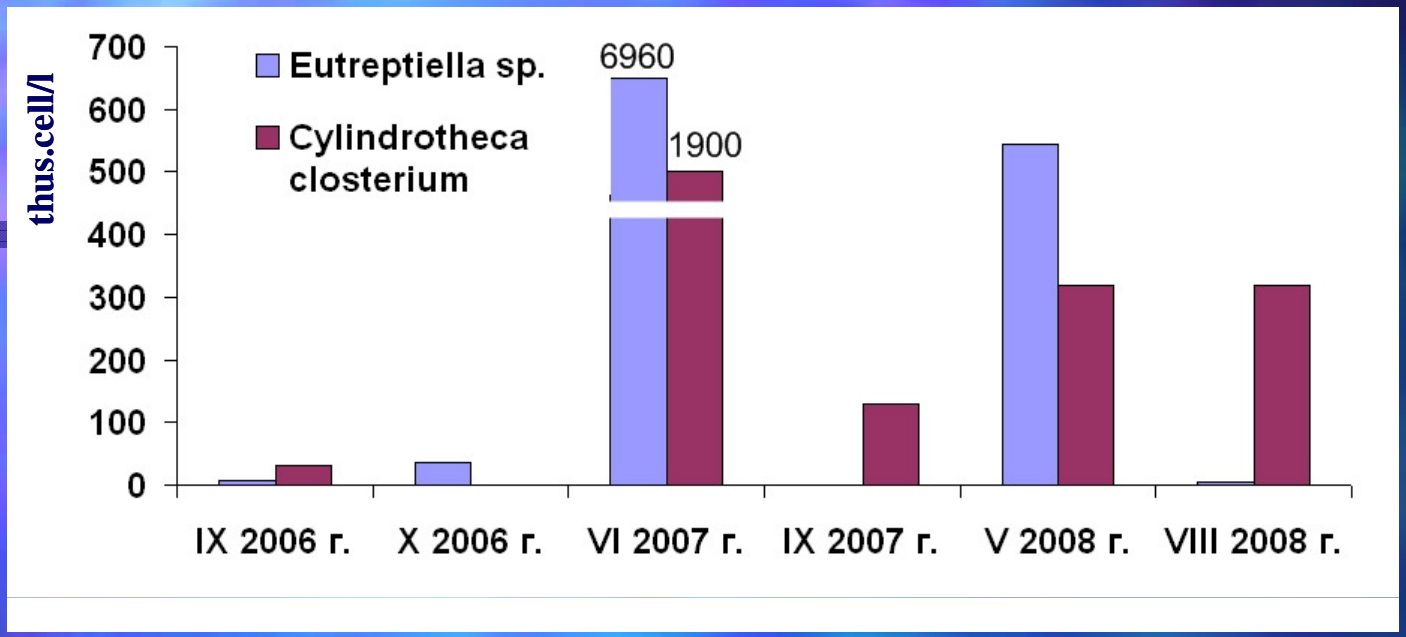
Dominant phytoplankton

	2006		2007		2008	
	IX	X	VI	IX	V	VIII
cyanopjytes						
Aphanizomenon flos-aquae	+	+		+		
Woronichinia compacta	+	+		+		
Oscillatoria spp.				+		
Pseudanabaena limnetica	+					
Planktothrix agardhii						+
cryptophytes						
Cryptomonas spp.	+	+				
diatoms						
*Actinocyclus octonarius**				+		
*Cylindrotheca closterium**			+	+	+	+
Diatoma tenue					+	
*Melosira arctica**					+	
*Skeletonema costatum**						+
euglenophytes						
*Eutreptiella sp.**		+	+		+	

dominating on the:
"+" на ≤20% stations;
"+" на >50% stations

* brackish species

Dynamics of dominant phytoplankton



Cylindrotheca closterium

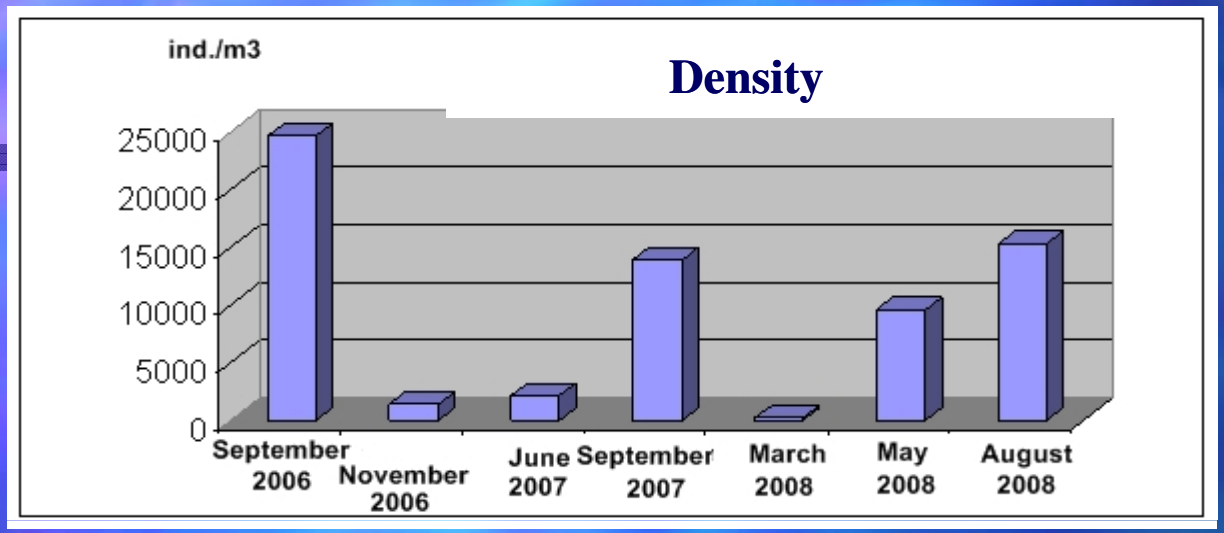
June, 2007 was exceptional with vegetation bloom of indicator species of organic pollution Eutreptiella spp. and Cylindrotheca closterium

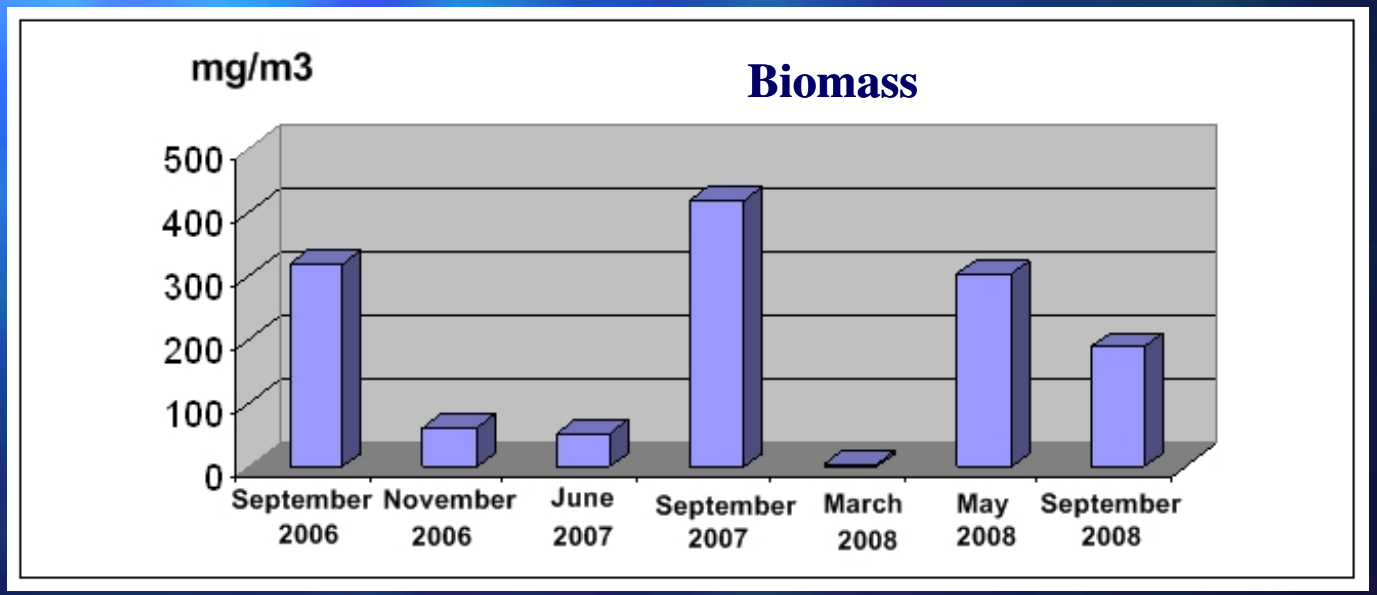
Eutreptiella sp.

Dominating species of zooplankton

	2006		2007		2008		
	IX	XI	VI	IX	III	V	VIII
Rotifera			+			+	+
Daphnia longispina				+	+		+
Bosmina longirostris	+						+
Acartia bifilosa	+			+			
Eurytemora affinis	+	+	+	+	+	+	+
Limnocalanus macrurus						+	
Cyclops vicinus							+
Larvae *Polychaeta*		+	+			+	

Dynamics of zooplankton

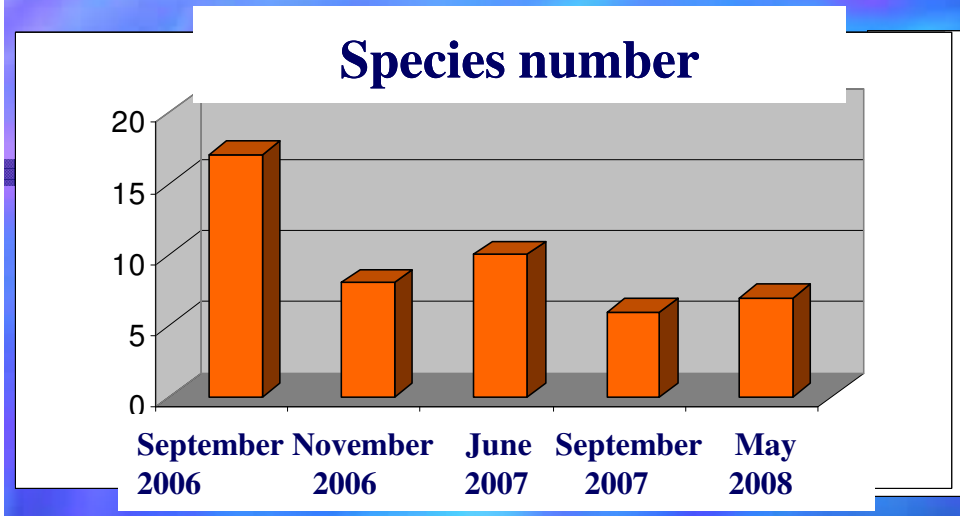


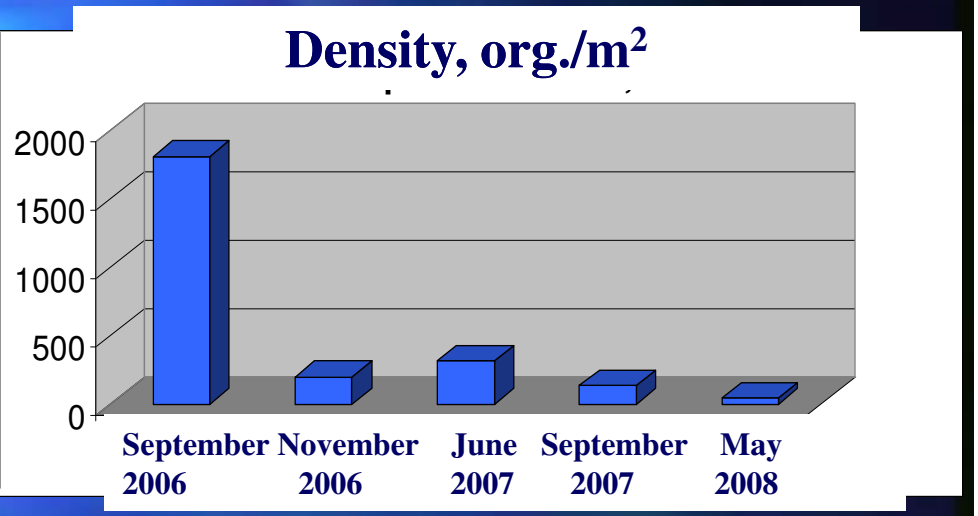


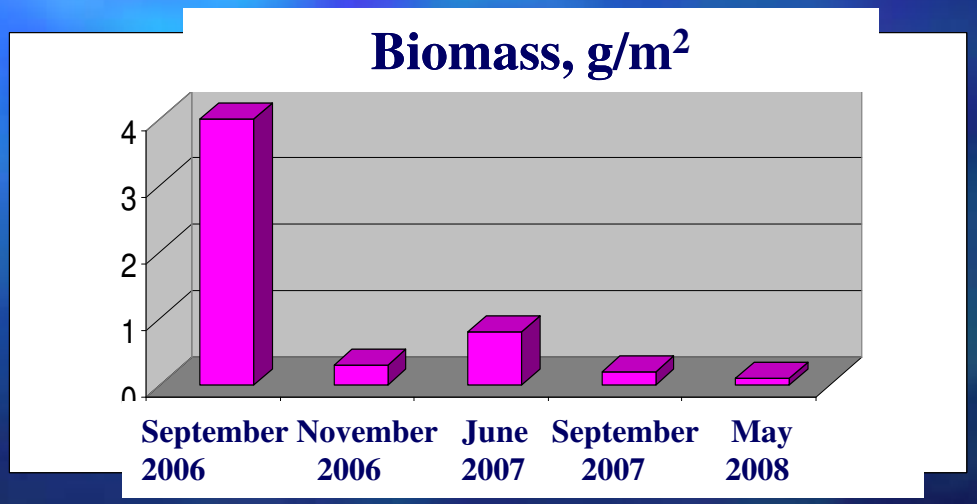
Dominating species of benthic invertebrates

	2006		2007		2008
	IX	XI	VI	XI	V
Balanus improvisus (Crustacea)	+			+	+
Gmelinoides fasciatus (Crustacea)	+	+			
Corophium volutator (Crustacea)			+		+
Gammarus duebeni (Crustacea)					+
Gliptotendipes paripes (Chironomidae)	+				
Lipiniella arenicola (Chironomidae)		+			
Procladius sp. (Chironomidae)		+	+	+	
Chironomus sp. (Chironomidae)				+	
Marenzelleria viridis (Polychaeta)		+	+	+	
Oligochaeta var.				+	+

Dynamics of benthic invertebrates







Impact on benthos communities

- Species diversity of macrobenthos as compared to situation in 2006 decreased in more that two times due to extinction of some crustacean and molluscs.
- Parameters of abundance, index of Shannon's species diversity and Balushkina's chiromonids index in July-September 2007 allow describing the studied area of Luga Bay with respect to macrozoobenthos structure as unfavourable.
- Soil excavation and significant increase of depth in the area of dredging operations lead to reconstitution of the structure of bottom coenoses, with predominant development of oligochaetes and chiromonid larvae – eurybiontic forms with wide ecological valence, typical for soft soils.

Main adverse effects of impacts during formation of territory of port terminals and dredging operations on ecosystem of Luga Bay:

- Increase of amount of a dredge and eutrophic components in water.
- Excavation of top layer of bottom sediments, damage to sedimentation process, degradation of bottom communities.
- Direct rejection of a coastal zone.

Thank you for your attention!