Multiple stressors impact on the ecosystem of Peter the Great Bay (Japan/East Sea)

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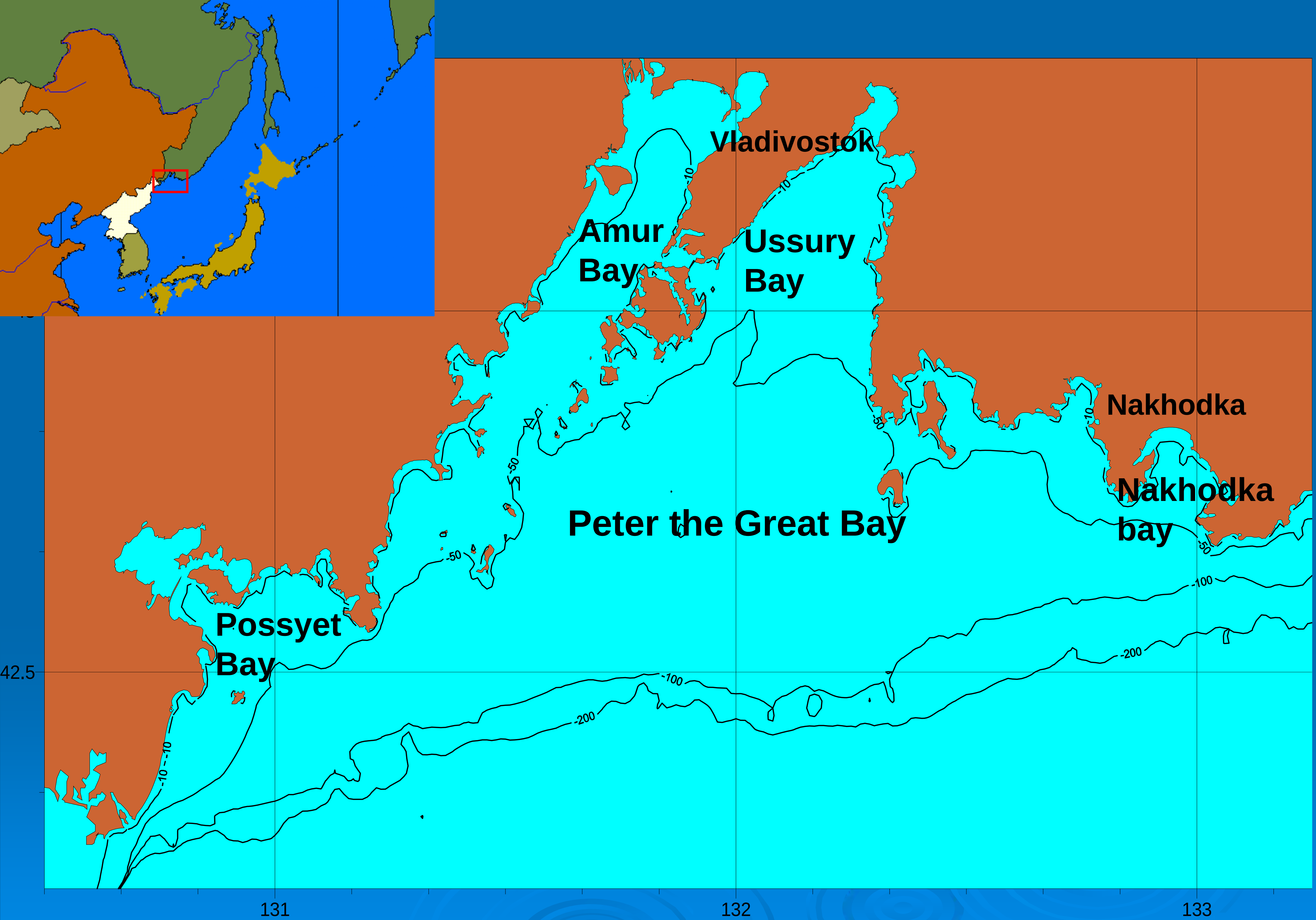
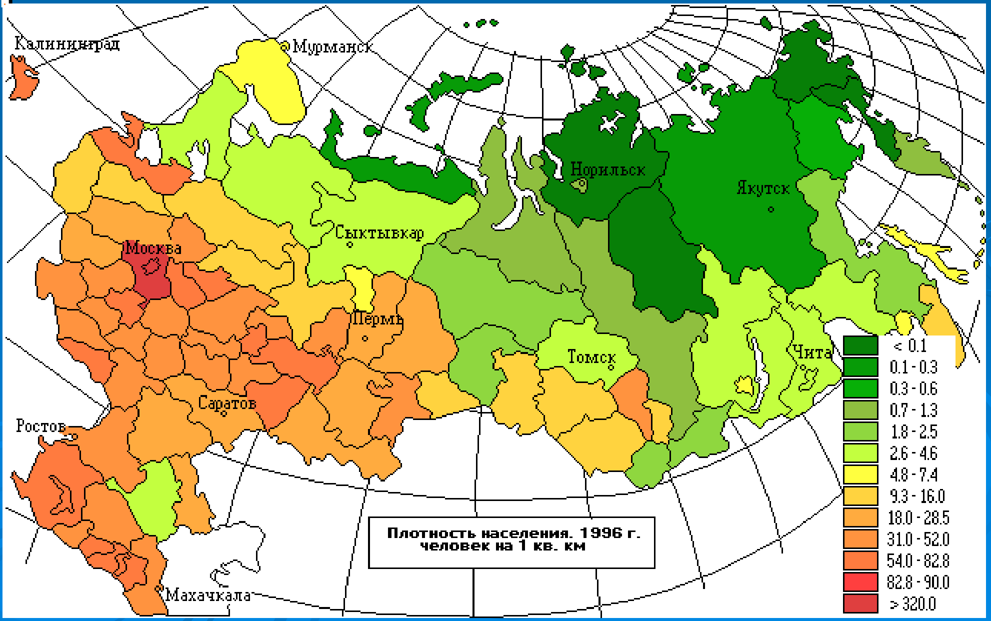


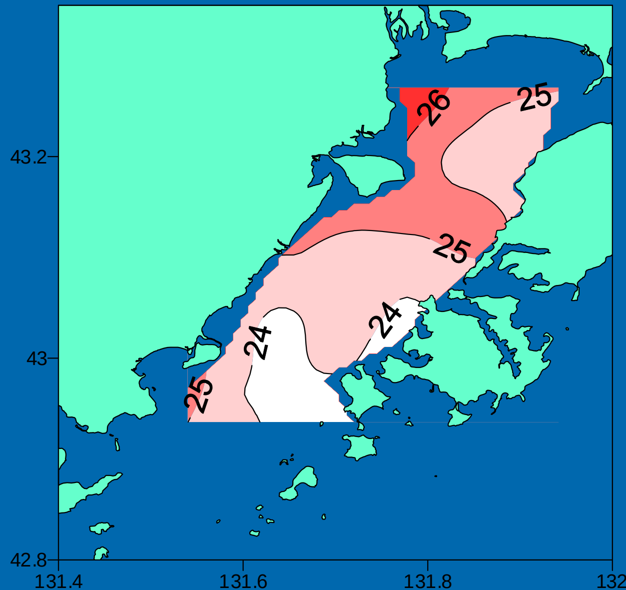
Vladivostok
Amur Bay
Ussury Bay
Nakhodka
Nakhodka bay
Peter the Great Bay
Possyet Bay
-10
-50
-100
-200
42.5
131
132
133


Far Eastern State Marine Reserve
Amursky Bay
Vladivostok
Ussurisky Bay
Russki Is.
Popov Is.
Reineke Is.
De-Livrona Is.
Bolshoy Pelis Is.
Kalevala Bay
Syvuchia Bay
Furugelma Is.
Peter The Great Bay

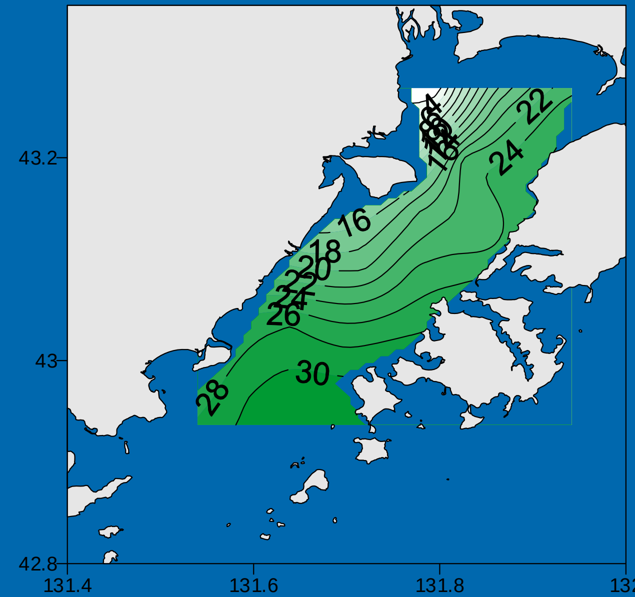
- The density of population in the Russian Far East is low, 120 persons per 100 sq. km   in average.
- The maximal density is in Primorye, on the south of the district, coastal zone of Peter the Great Bay, approximately 1600 persons per 100 sq. km.



Sea surface temperature (oC) in the Amur Bay on August 16-18, 2010

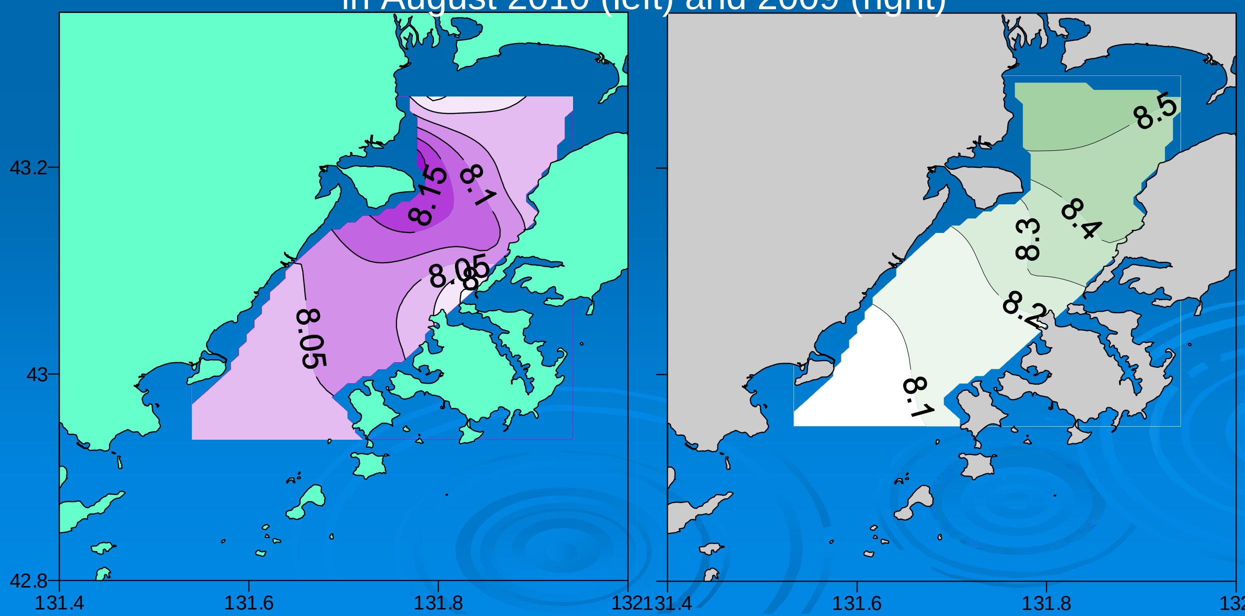


Sea surface salinity (psu) in the Amur Bay on August 16-18, 2010



Hydrogen ion exponent (pH) at the sea surface in the Amur Bay

in August 2010 (left) and 2009 (right)



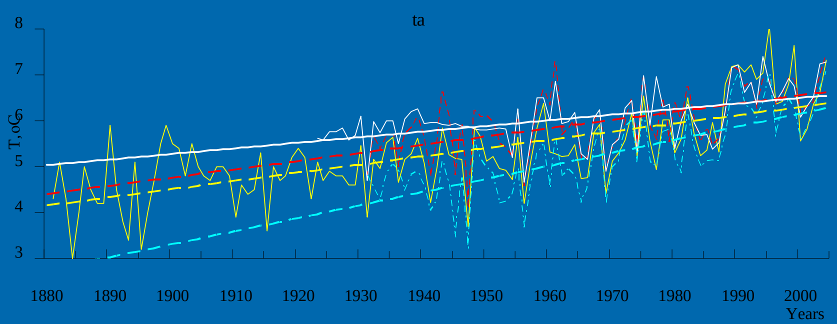
(courtesy of

V. Rachkov,

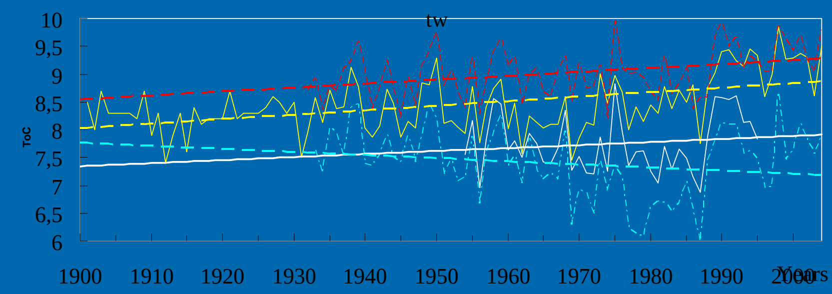
TINRO)

Year-to-year fluctuations of air temperature and SST according the data of 4 meteorological stations in Peter the Great Bay
—— Vladivostok - - - Possyet ---- Gamov – · ·– Nakhodka

Air T, °C



SST, °C



Increase of SST and air temperature in Peter the Great Bay from 1934 to 2009

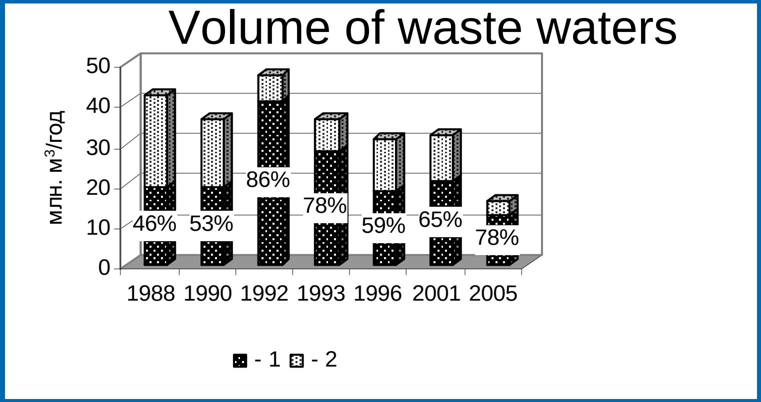
Stations	SST	Air T
Possyet	**0.59**	**1.33**
Gamov	**0.37**	**0.81**
Vladivostok	**0.96** **0.79***	**1.85** **1.68***
Tokarevsky	**0.15**	**1.70**
Nakhodka	**-0.22**	**2.07**

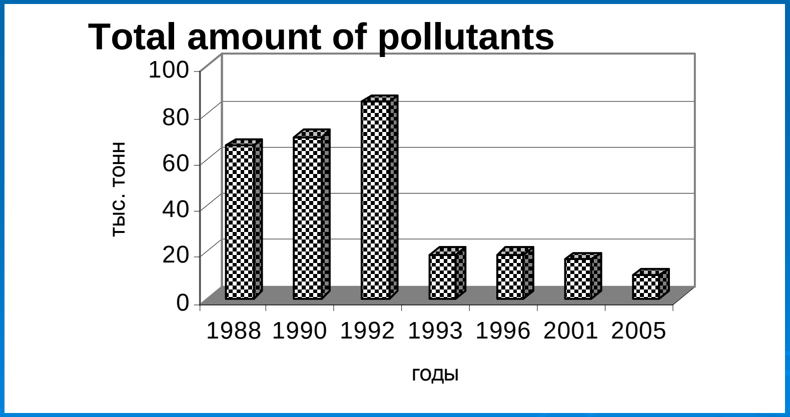
* – 1909–2008

Gayko, 2009

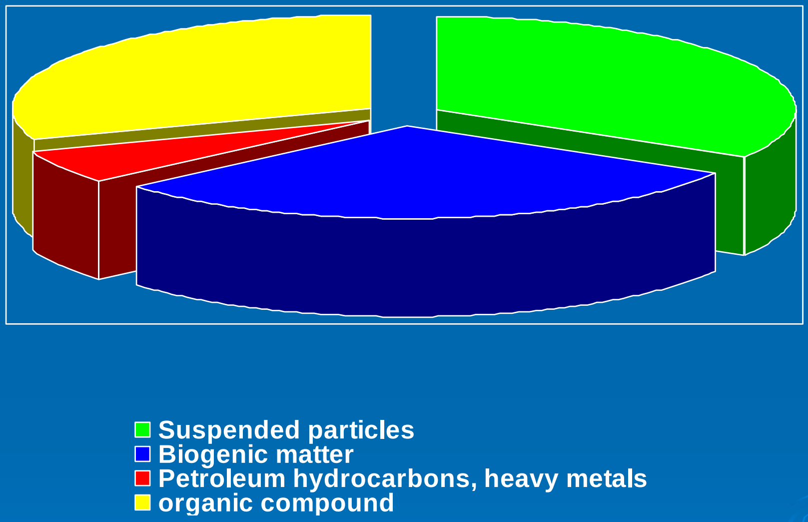
Pollutant discharge to Amur bay

(1988 - 2005)





The main components of waste waters



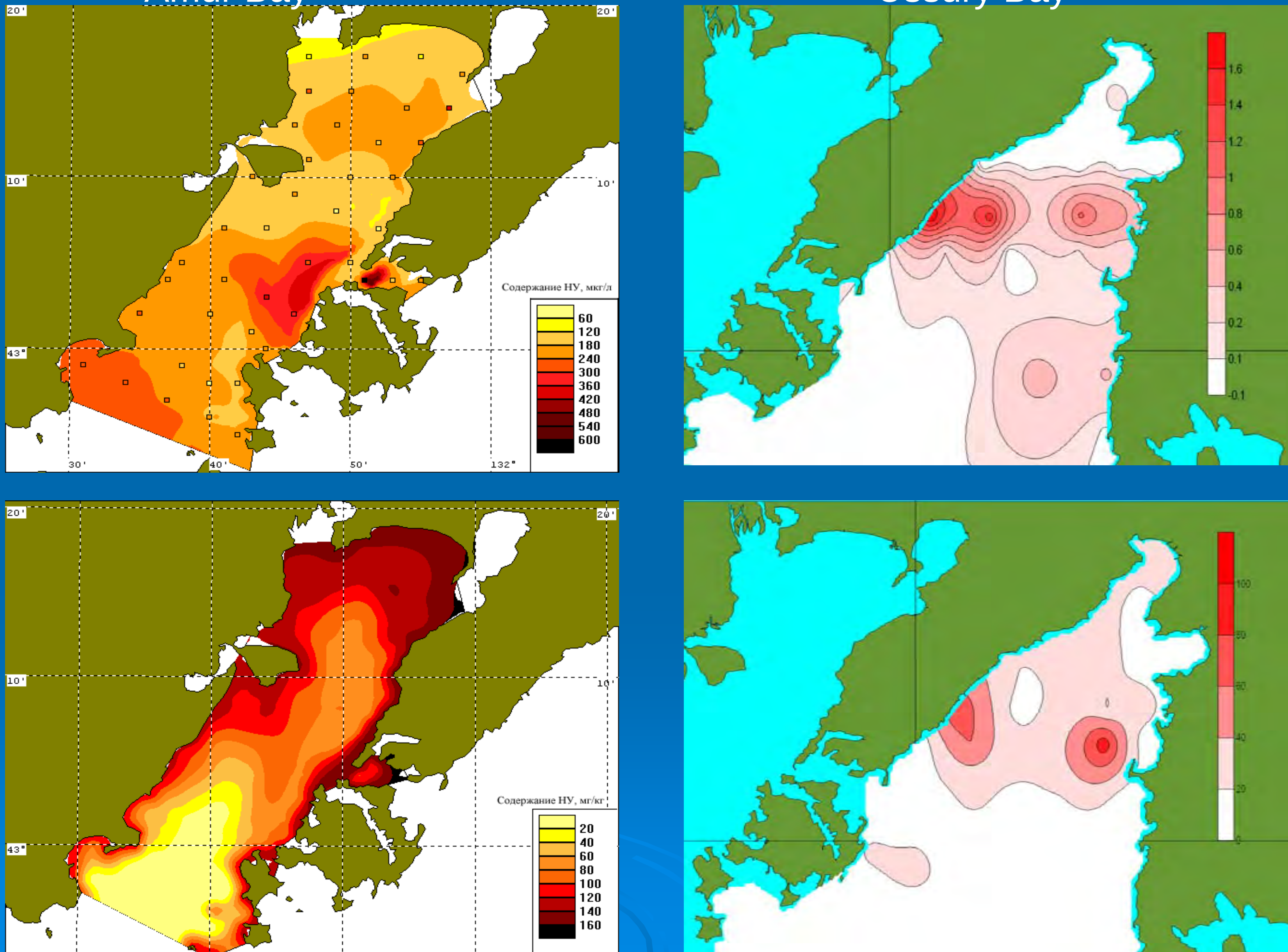
(Nigmatulina, 2008)

Distribution of petroleum hydrocarbons in seawater (1) and bottom sediments (2)

Amur Bay | Ussury Bay

1

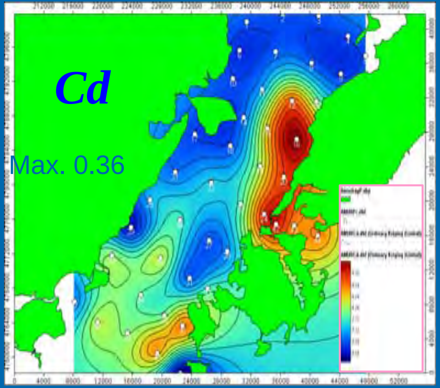
2

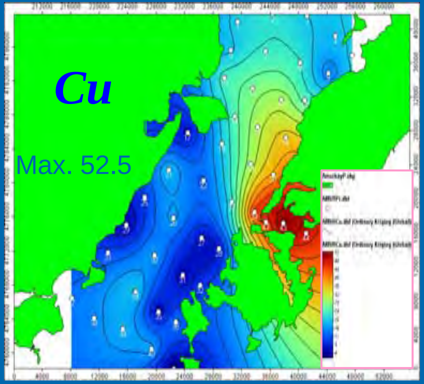


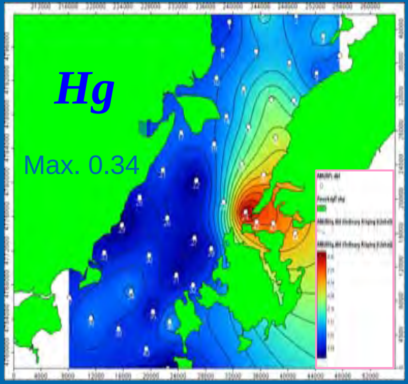
Chernyaev et al., 2006, 2008

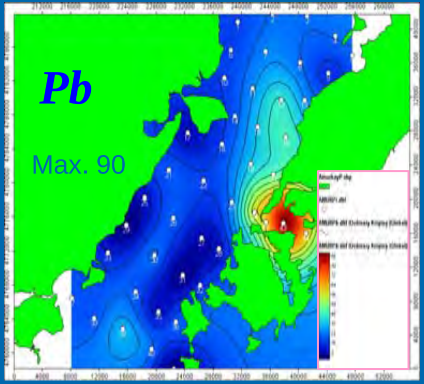
Spatial distribution of toxic metals: Cd, Cu, Hg, Pb in the bottom sediments of Amur Bay (1) and Ussury Bay (2), mg/kg dry wt

1

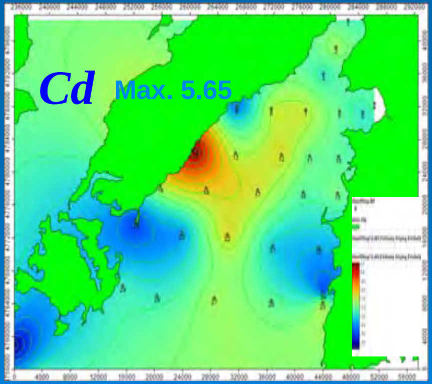


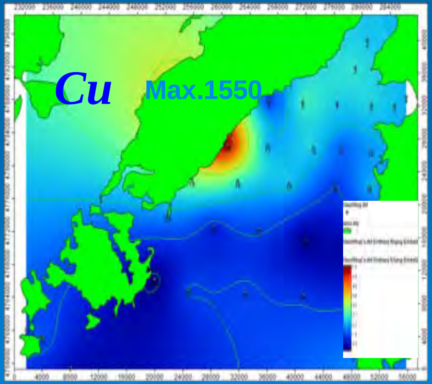


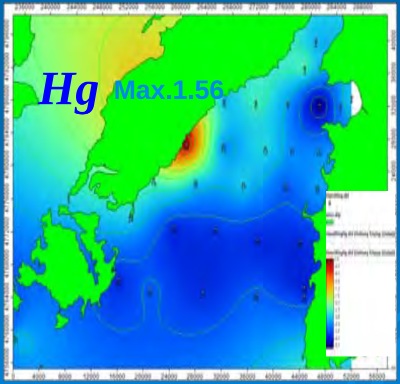


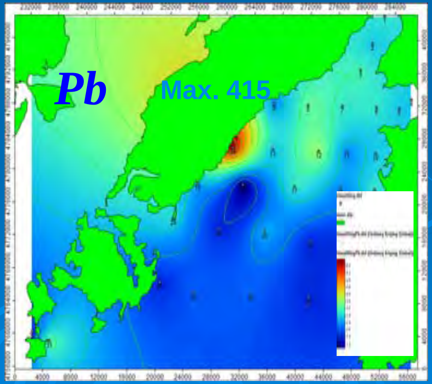


2

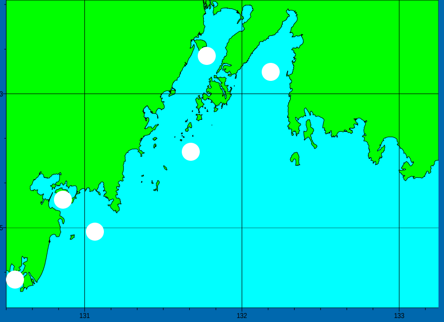


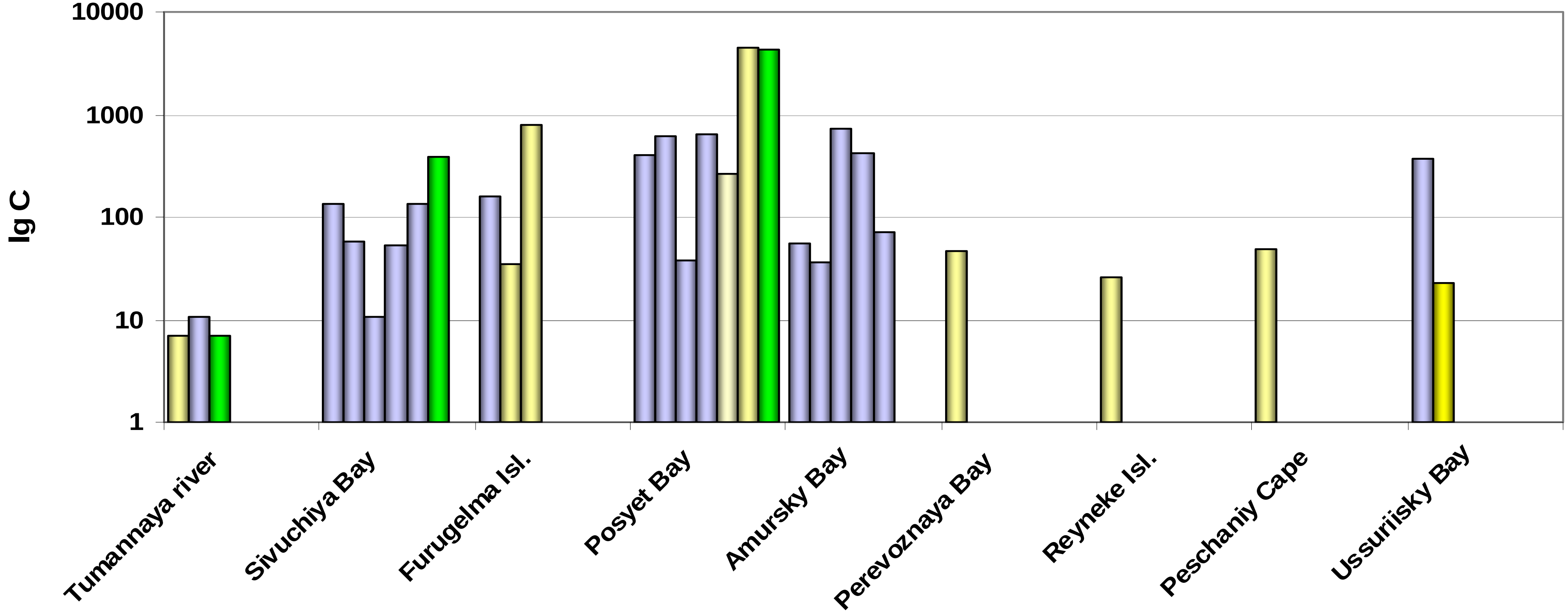






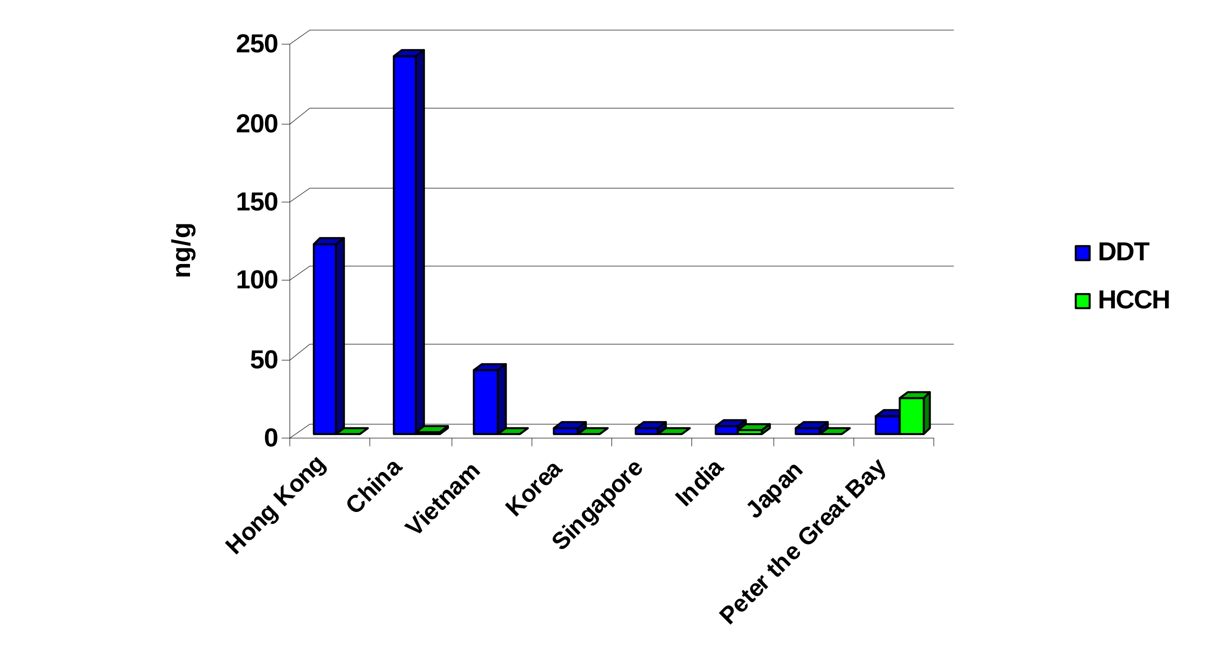
Organochlorine pesticides in mollusks, fish and seabirds from Peter the Great Bay





molluscs fish Sea gulls

Data of Mussel Watch program on OCP content in mussels from Asia-Pacific region (Monirith et al., 2004).



Peter the Great Bay (PGB) – our data. Total OCP content in mussels from Peter the Great Bay is lower then in mussels from Hong Kong, China and Vietnam. Normally HCCH level in soft tissues of mussels from PGB was higher then DDT content, on the contrary to mussels from other countries of Asia-Pacific region where DDT is dominated pesticides.

Non-indigenous species

- 45 species of microalgae, 24 species of zooplancton, 22 species of meroplancton, 10 taxa of meiofauna, 24 species of microscopic fungi, and 28 strains of bacteria were revealed in the seawater of the port of Vladivostok and ballast waters of the vessels of Russian-Japanese and Russian-Chinese lines (Zvyagintsev, Selifonova, 2008) .
- 11 non-indigenous fish species were registered in the estuary of Razdolnaya river input to the Peter the Great Bay (Kolpakov et al., 2008), as a result of aquaculture activity mainly. Share of non-indigenous species in fish community during the summer and fall varied from 7 to 30 %.

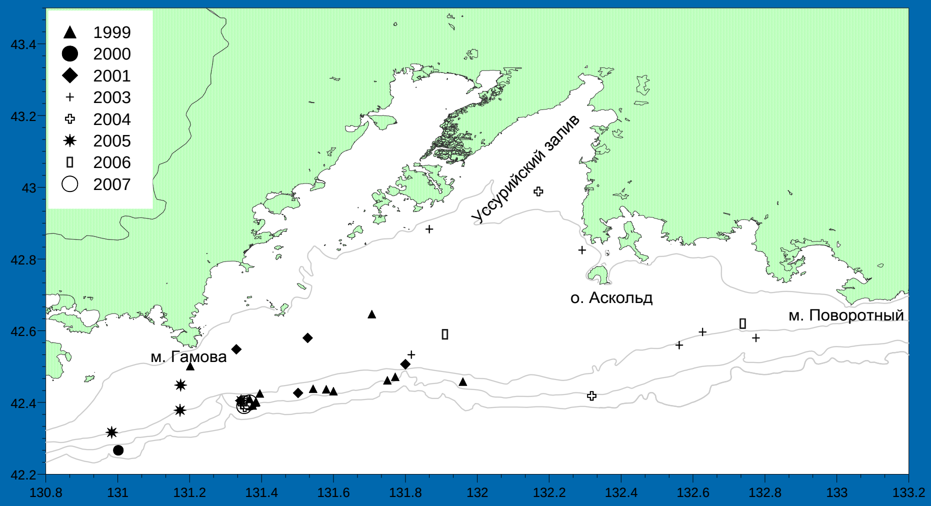
List of non-indigenous species of fish

Abbottina rivularis (Basilewsky, 1855)
Acanthorhodeus chankaensis (Dybowski, 1872)
Acanthorhodeus sp.
Aristichthys nobilis (Richardson, 1845)
Ctenopharyngodon idella (Valenciennes in Cuvier, Valenciennes, 1844)
Culter alburnus Basilewsky, 1855
Hemiculter leucisculus (Basilewsky, 1855)
Hypophthalmichthys molitrix (Valenciennes in Cuvier, Valenciennes, 1844)
Sarcocheilichthys czerskii (Berg, 1914)
Sarcocheilichthys sinensis
Silurus soldatovi Nikolsky et Soin, 1948
Sander lucioperca (Linnaeus, 1758)
Channa argus (Cantor, 1842)

List of non-indigenous copepod species of ships' ballast water in the port of Vladivostok

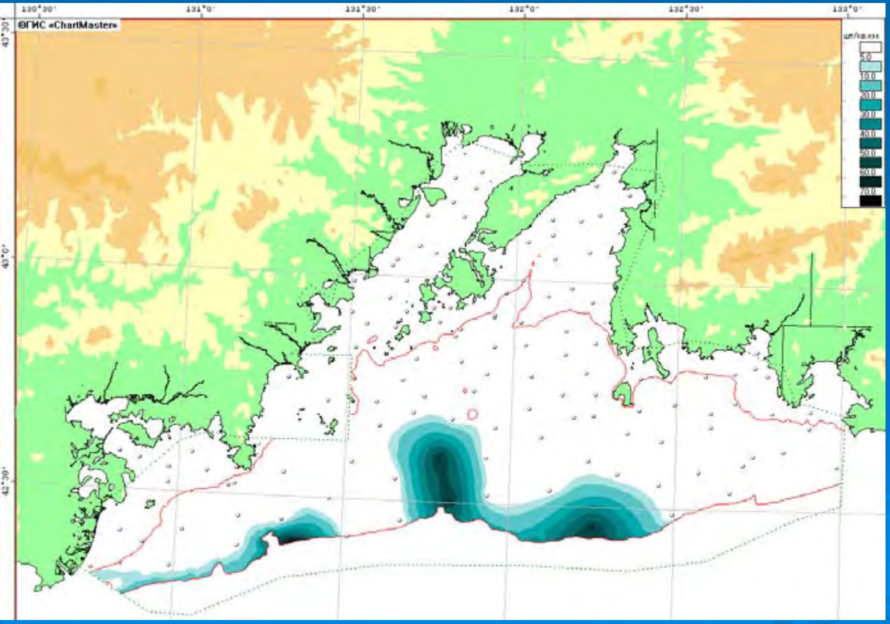
Pseudodiaptomus inopinus
Labidocera euchaeta
Calanus sinicus
Acartia bifilosa
Parvocalanus crassirostris
Oithona davisae
Dioithona rigida
Tortanus spinicaudatus (Kasyan, 2010)

Sites of blue king crab *Paralithodes platypus* detection in Peter the Great Bay

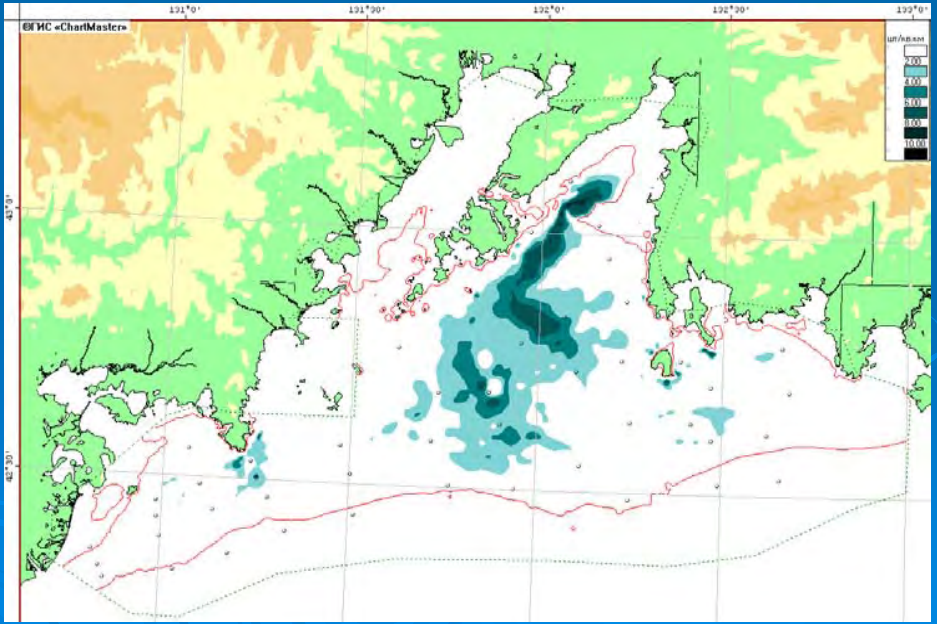


The distribution of crab in July-August 2008

Commercial males, March-May 2009



trawl survey



trap survey

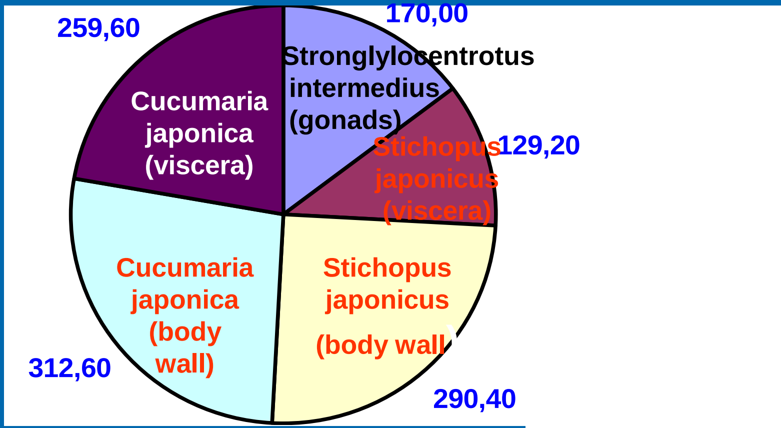
(Koblikov et al., 2010)

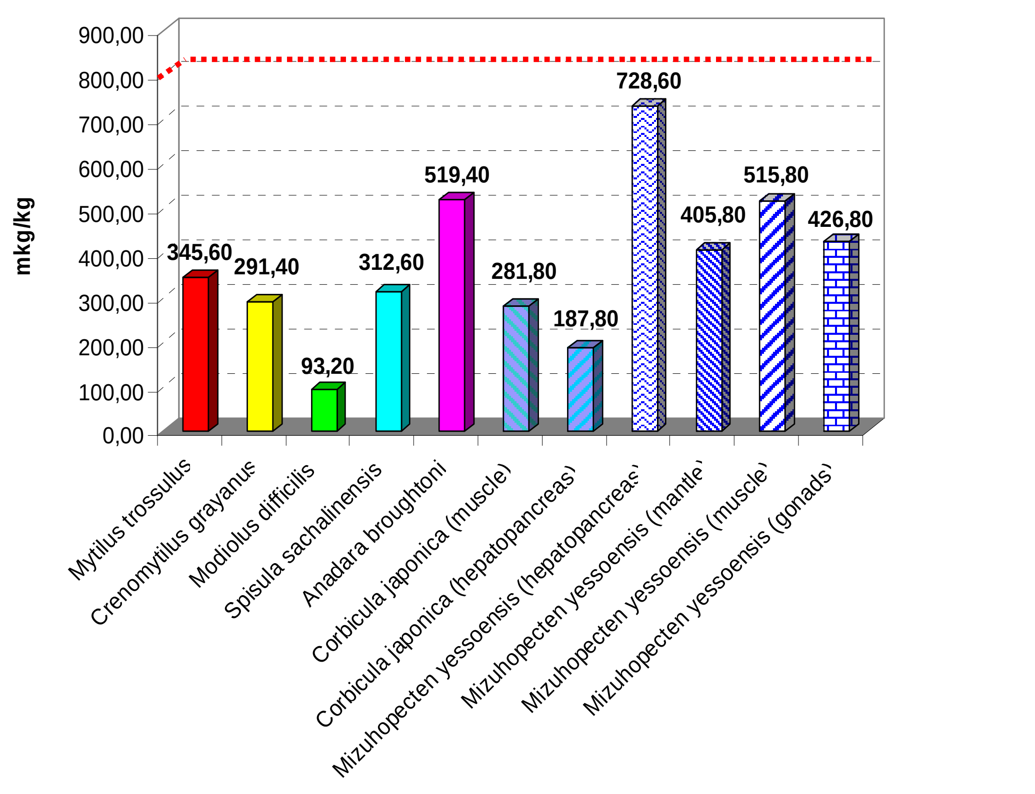
DOMOIC ACID CONCENTRATION IN SOFT TISSUES OF TESTED BIVALVES from Peter the Great Bay

Molluscs	Domoic acid, mkg/kg wet weight
Modiolus difficilis	0,054
Mytilus trossulus	0,111

(Pavel et al., 2007)

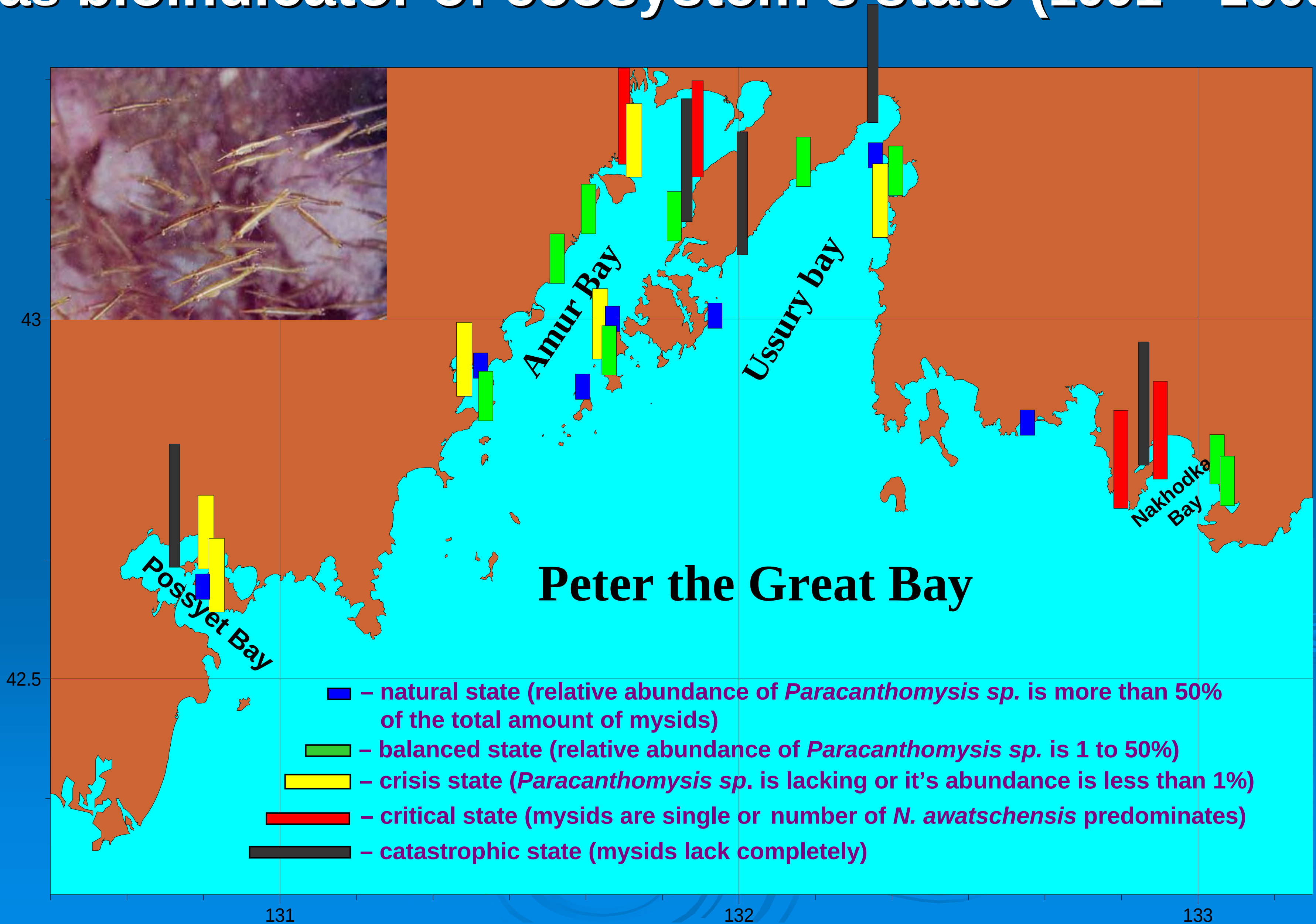
CONCENTRATION OF PSP-TOXINS IN ECHINODERMS AND MOLLUSCS from Peter the Great Bay (mkg/kg wet weight)



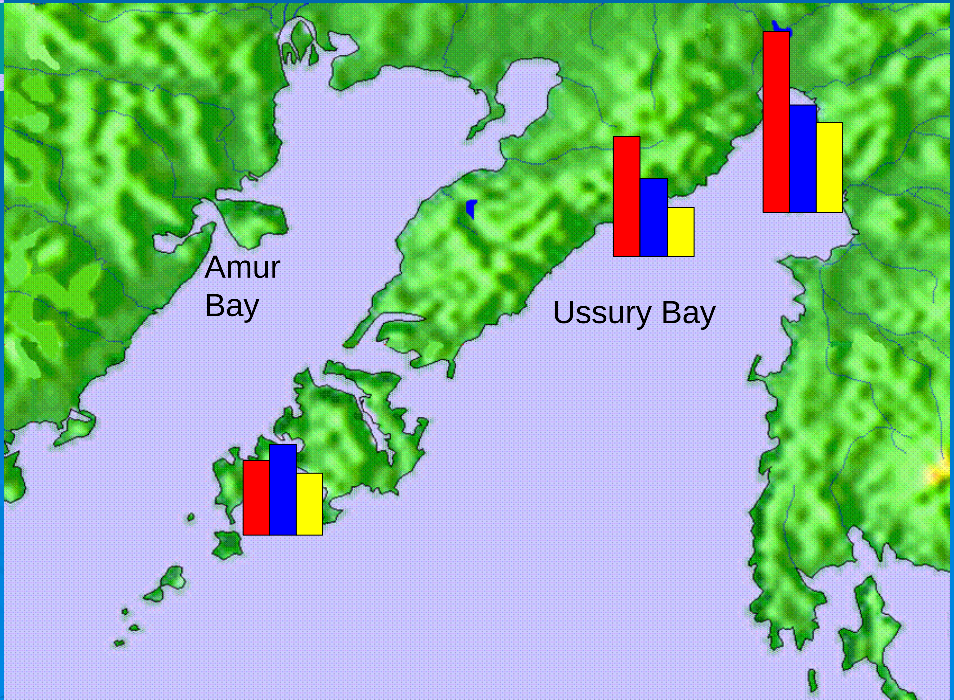


Pavel et al., 2007

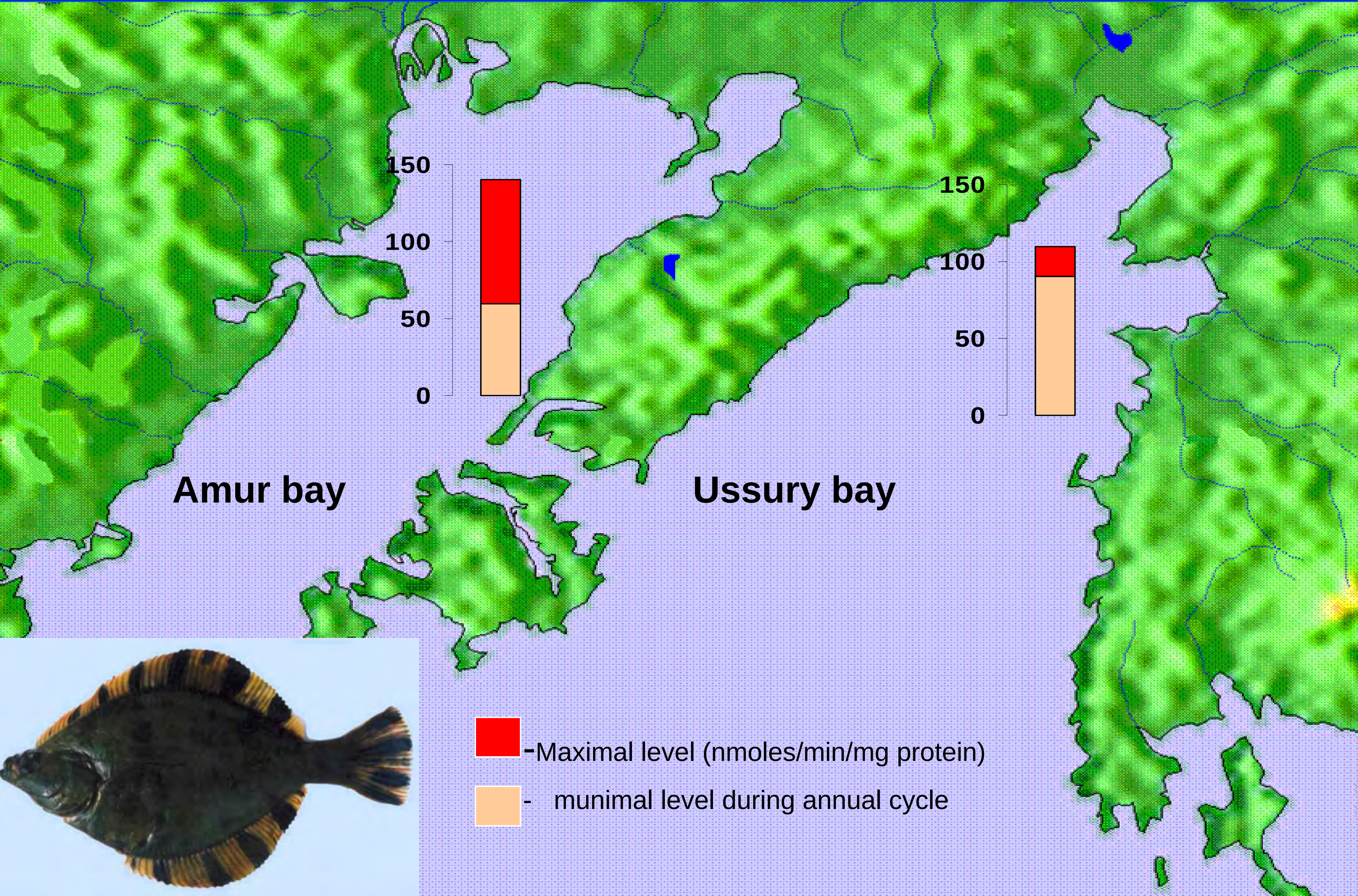
Relative abundance of mysids species as bioindicator of ecosystem's state (1991 – 2009)



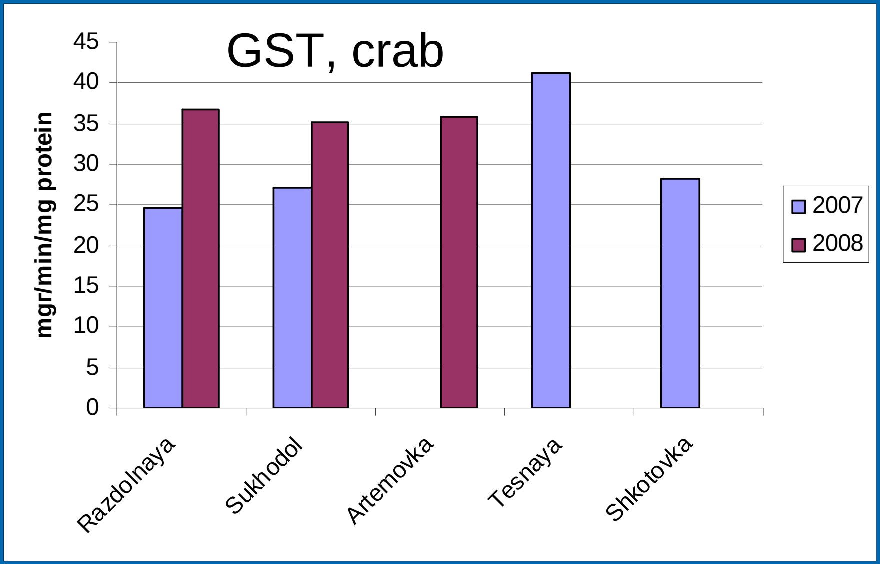
Glutathione-S-transpherase activity in organs of *Crenomytilus grayanus* from Peter the Great Bay



Glutathione-S-transpherase in the liver of flounder *Liopsetta pinnifasciata* from Amursky and Ussuriisky bays

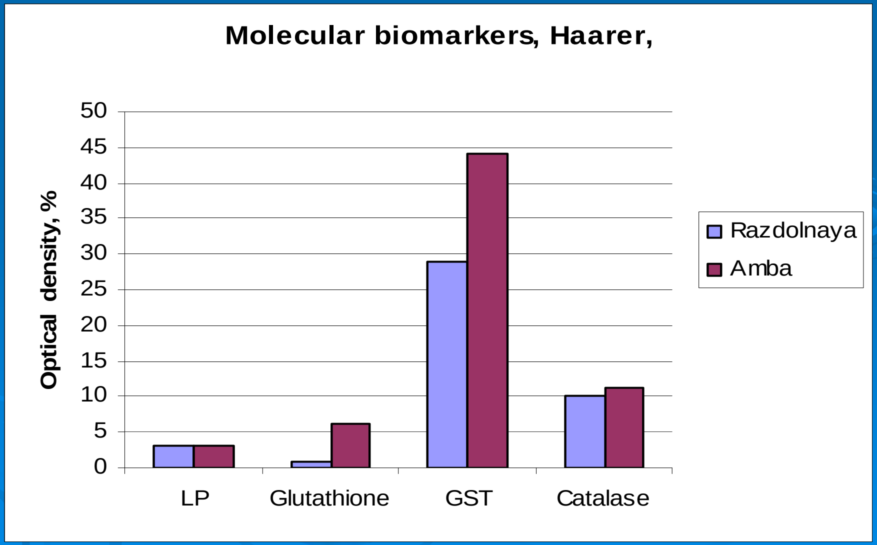


Molecular biomarkers of oxidative damage in the gills of Japanese mitten crab and liver of haarder from the estuarine zones of Peter the Great Bay

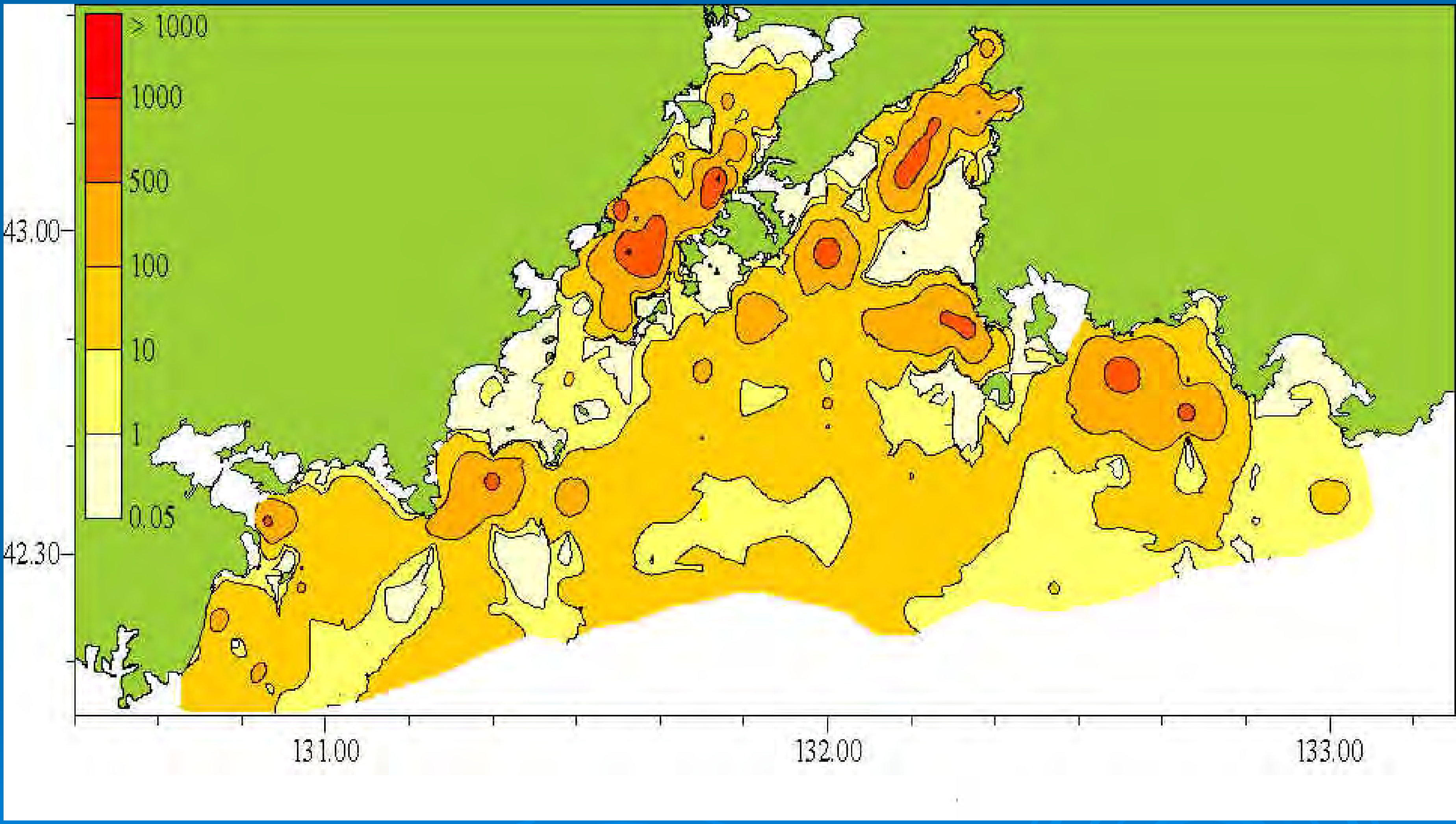


Crab *Eriocheir japonica*

Haarder *Liza haematocheila*



Macrozoobenthos total biomass (g/sq. m)) in Peter the Great Bay



(Nadtochiy et al., 2005)

Overall commercial stock and value of biological resources of Peter the Great Bay

	1999*		2001*		2009	
	Commercial stock, т	Value, Thous. $	Commercial stock, т	Value, Thous. $	Commercial stock, т	Value, Thous. $
Fish	95 130	162 027	87 700	167 435	108 668	216 358
Invertebrates	59 590	305 422	106 310	533 368	93 045	624 256
Seaweeds	89 750	127 625	63 293	90 820	77 500	28 880
Total	244 470	595 074	257 303	791 623	279 213	869 494

* - Ogorodnikova, 2001

The main ecosystem services of Peter the Great Bay :

Gas regulation

Nutrient cycling

Biological control

Food production

Raw materials

Cultural and recreation.

The total value of ecosystem services of the Bay is

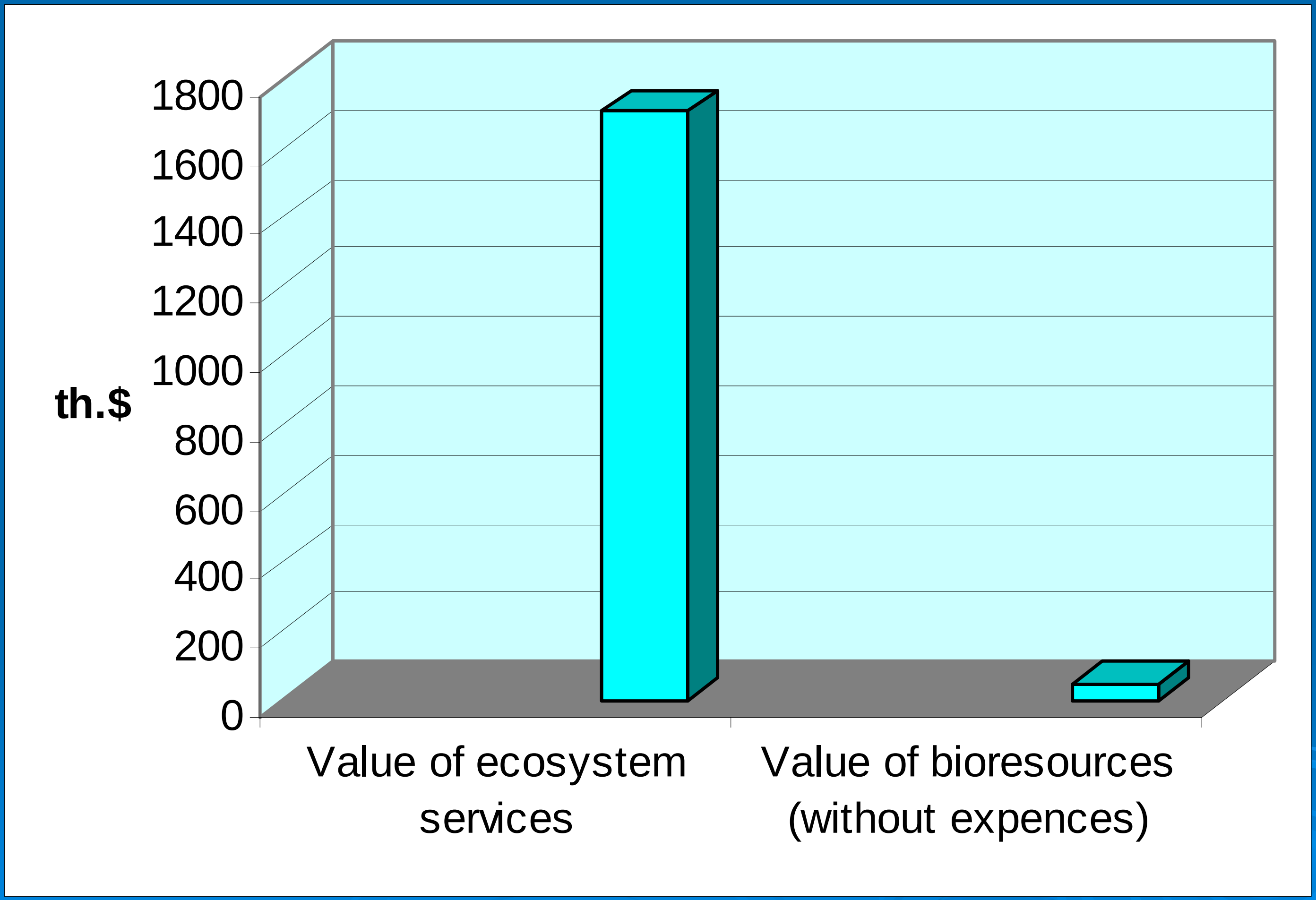
$ 1 706,6 x 10^6 yr^{-1} .

The value of biological resources of the Bay is

$ 870 x 10^6 yr^{-1} .

The value of biological resources of the Bay without the expences is $ 52,3 x 10^6.

The value of ecosystem services and biological resources of Peter the Great Bay



Conclusion

Impact of multiple stressors – chemical pollution and biological hazards - do not disturb chemical-biological balance and homeostasis of Peter the Great Bay at the end of 2010s.

Pollution of the Bay due to human activity is **moderate** for the Bay at whole and

significant for some internal bays - Amur Bay, Ussury Bay, Nakhodka Bay and Possyet Bay.

Chemical and biological monitoring of the Bay is a required step for sustainable development of local economy at whole and fisheries in particular and conservation of biodiversity.

Thank you for your attention