Assessment of eutrophication in potential eutrophic zones in Russia (Peter the Great Bay)

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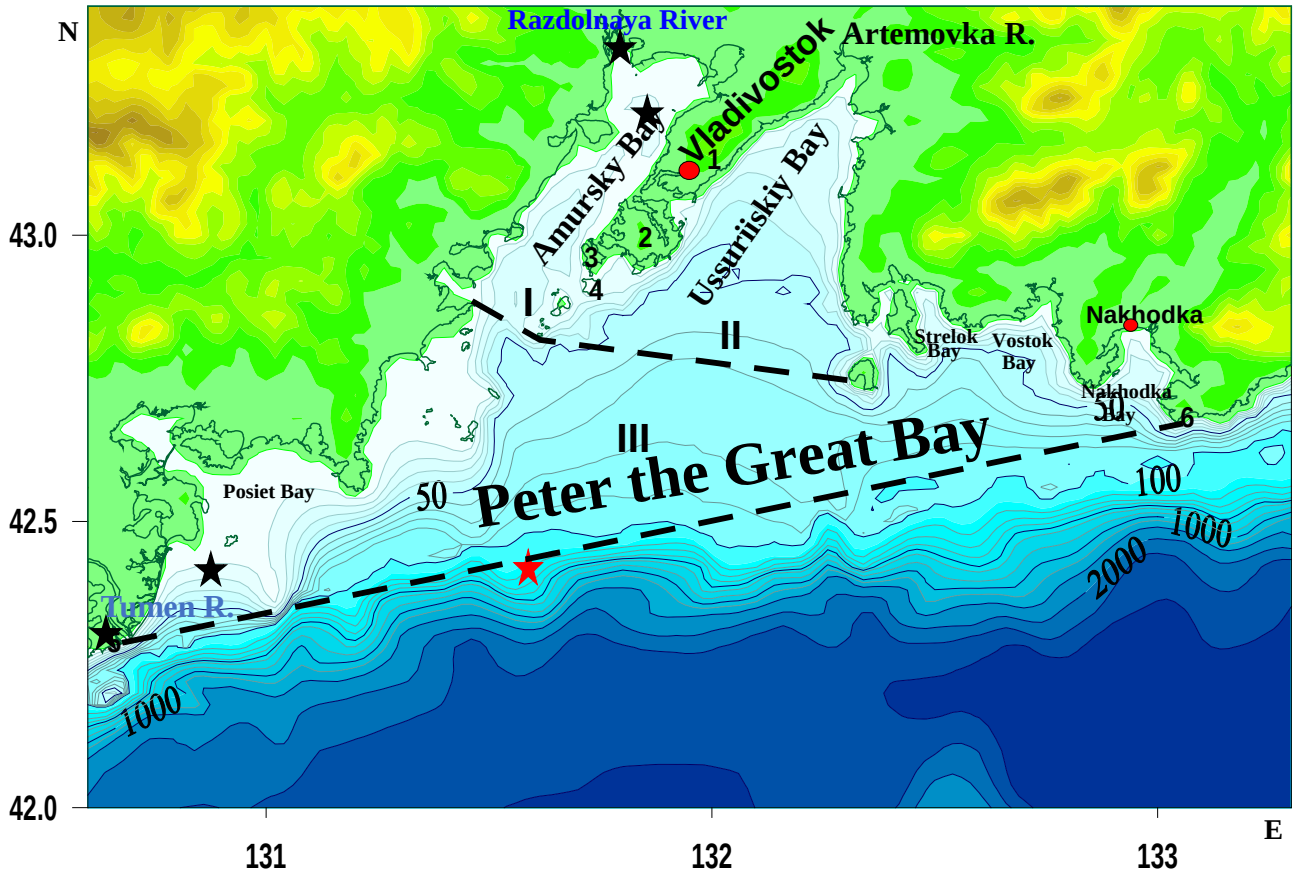
This presentation is based on the results provided by the studies of Tishchenko P.Ya. (POI FEBRAS, CEARAC expert), Zuenko Yu.I. (TINRO, POMRAC expert), Orlova T.Yu. (NSCMB, FEBRAS, CEARAC FP)

Background

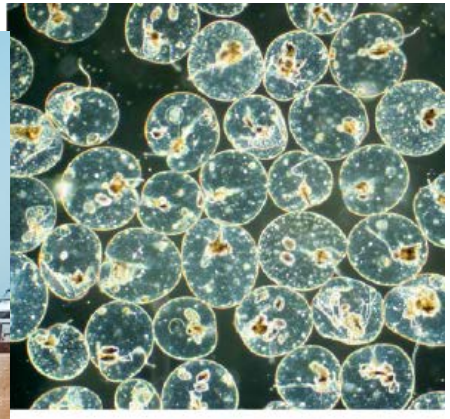
- Peter the Great Bay continues to be the most intensively used sea area within Russian part of the NOWPAP region, eutrophication with some negative consequences including hypoxia events is observed here



★ Hypoxia sites

★ Reference point

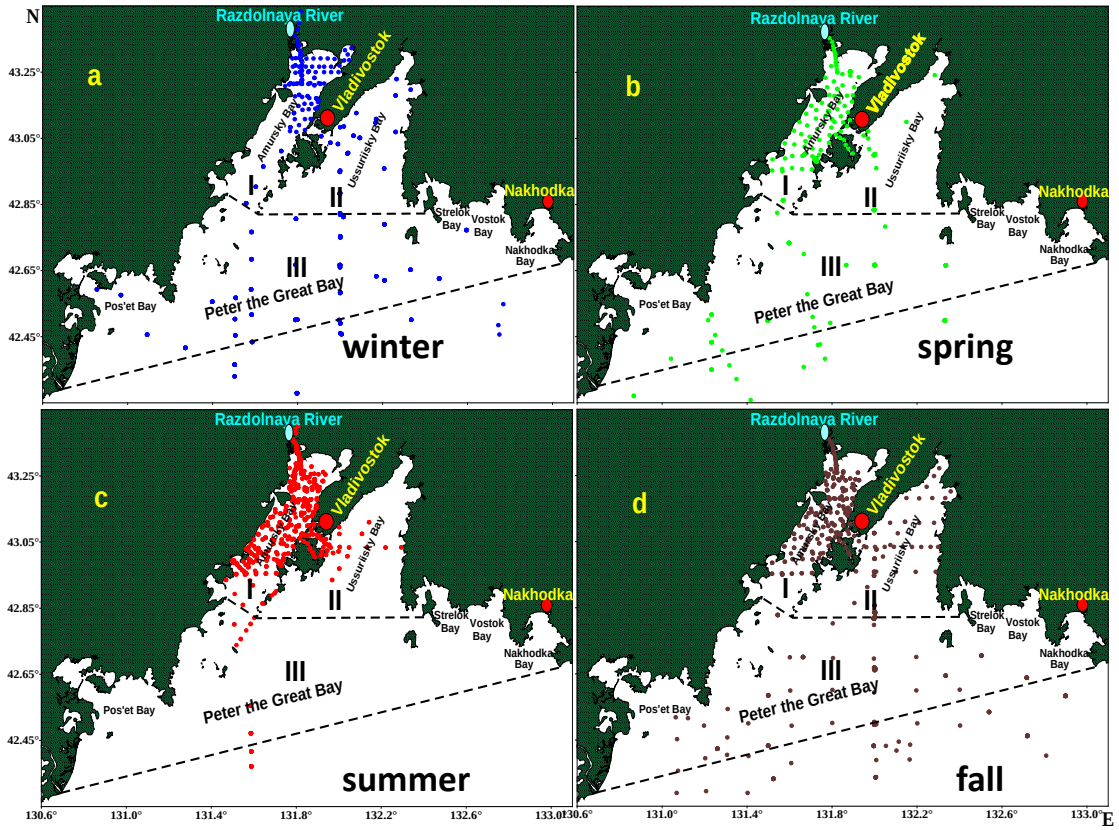
Plenty of nutrients delivered by land-based runoff provide eutrophic conditions in the inner parts of Peter the Great Bay and regular phytoplankton blooms usually during warm period (May-September)



- Vladivostok, 5 May 2017, *Noctiluca scintilis*

Agencies is studying Peter the Great Bay (PGB) in relation with eutrophication issues:

- State Hydrometeorological Service – regular observation on the state sampling network (39 stations within PGB)
- Pacific Oceanological Institute FEBRAS – thematic studies of biogeochemical processes in PGB
- TINRO-Center – regular studies on the own network covering all parts of PGB
- National Scientific Center on Marine Biology FEBRAS (former Institute of Marine Biology) – thematic studies on the composition of phytoplankton
- Pacific Geographical Institute FEBRAS – thematic studies in the key areas of PGB



State Hydrometeorological Service

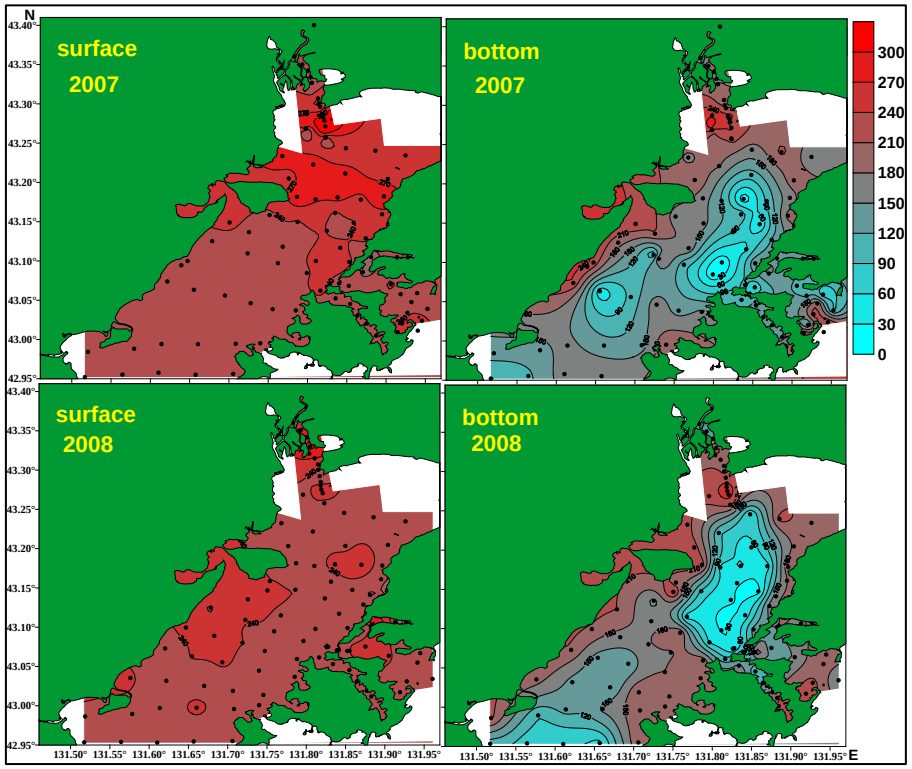
- Background information on the hydrochemical properties of the waters:

NO_3, NO_2, NH_4^+, DIP, TN, TP, some trace metals and POPs

- Major source of data for the assessment of inter-annual trend of environmental quality
- Absence of chlorophyll in the list of must parameters

Pacific Oceanological Institute – POI FEBRAS (Lab of Dr. P. Ya. Tishchenko)

- Provide a lot of reliable hydrochemical data on the different biogeochemical issues related to the eutrophication
- All set of nutrients, DO, DOC, humic substances, all components of carbonate system, ^{18}O, chlorophyll in-situ and by spectrophotometry



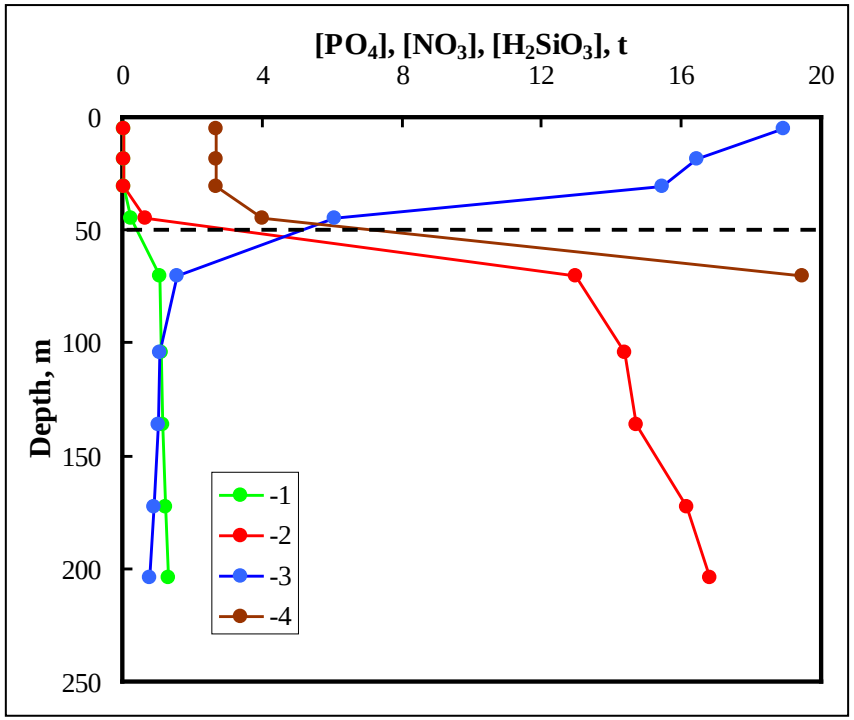
Summer hypoxia in bottom waters of central parts of Amursky Bay due to unbalanced destruction of phytoplankton biomass synthesized in the upper photic layer

Proliferation of phytoplankton due to impulse input of nutrients with river runoff seems first major factor controlling hypoxia

Stratification and geomorphological control (bottom depressions) are other master variables of hypoxia events

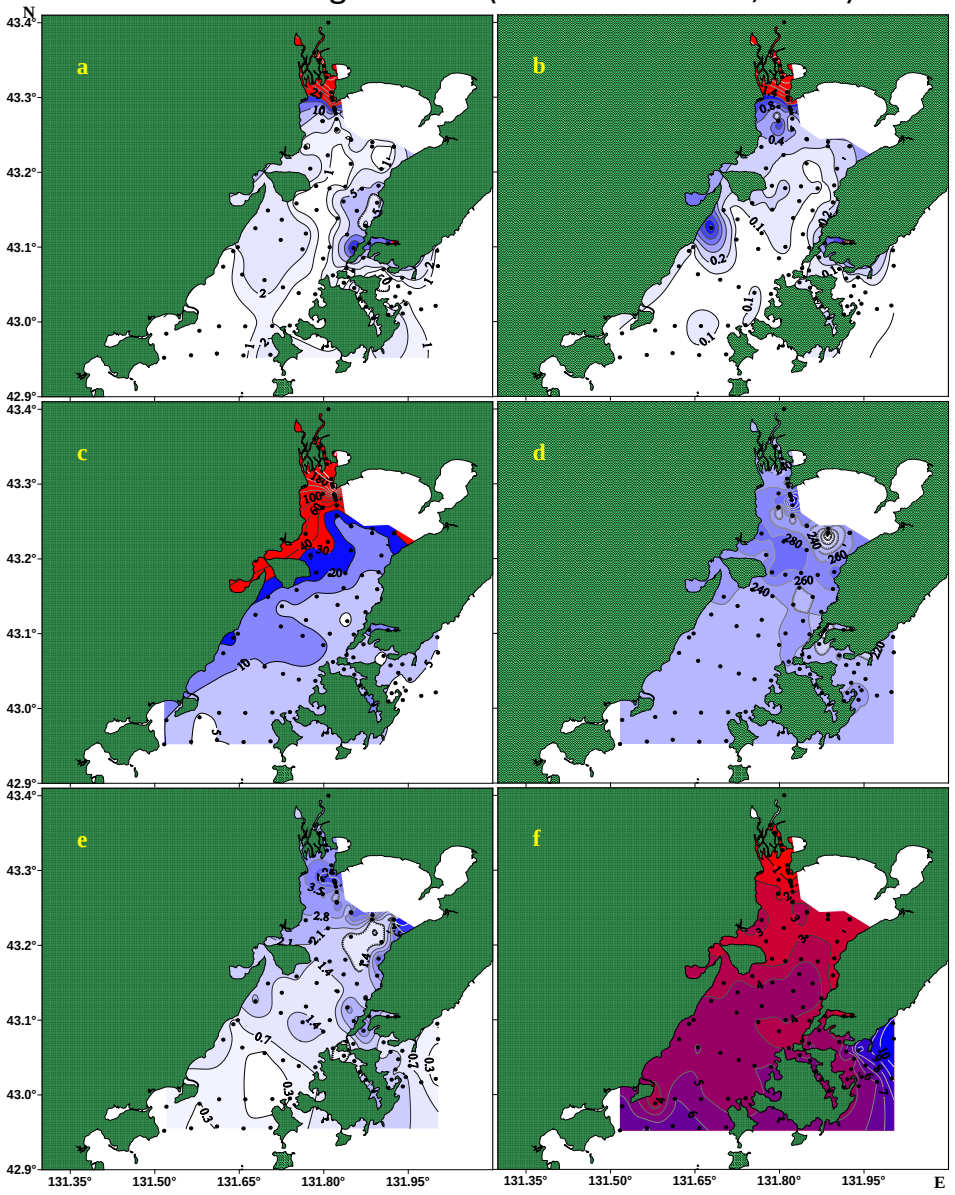
Autumn change of monsoon circulation with destroof y of stratification leads to the demolition of hypoxic condition in bottom waters

Pacific Oceanological Institute – POI FEBRAS (2)

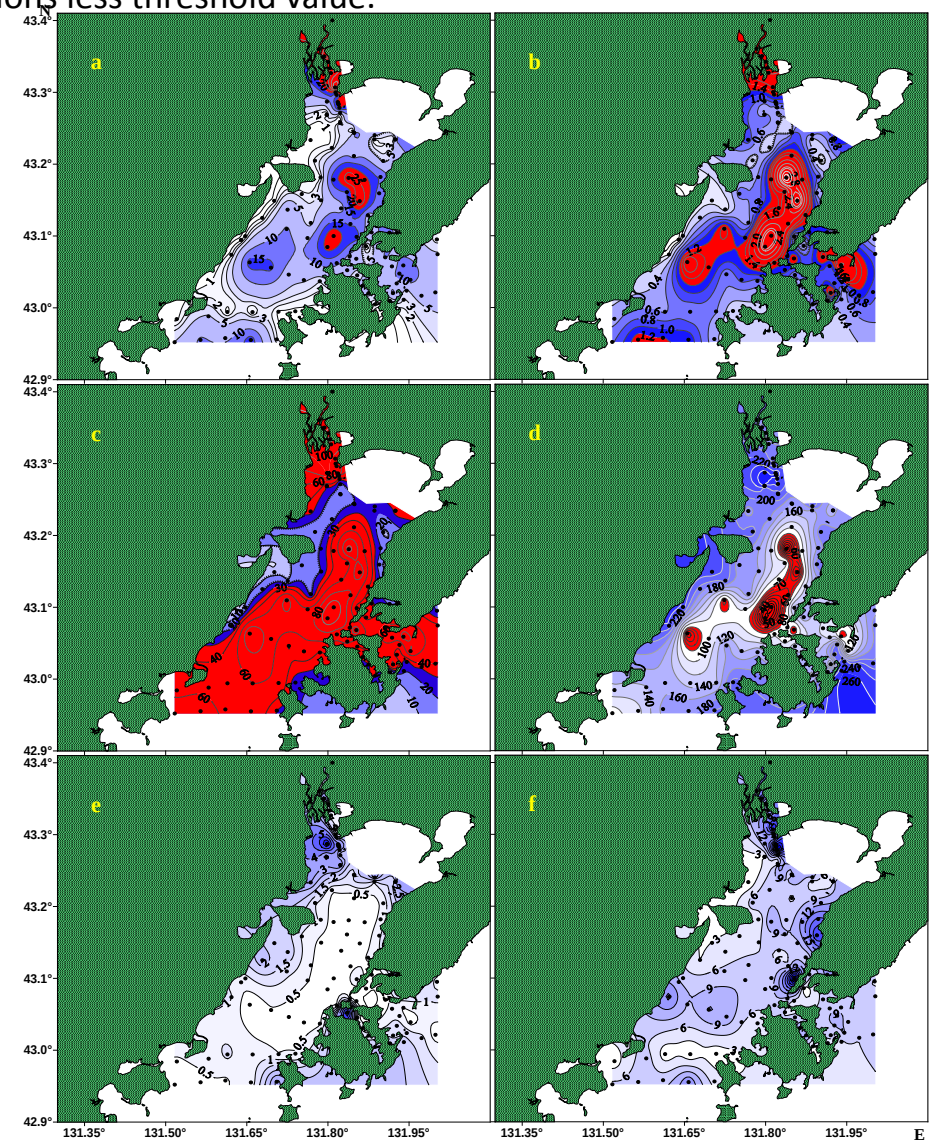


- Hypoxia and uneven vertical distribution of hydrochemical properties, including nutrients, in outer part of the Peter the Great Bay allow to suggest novel approach to assess (calculate) the threshold values of nutrients in coastal waters related to the potential eutrophication (Tishchenko et al., 2013)
- These values are corresponded to phytoplankton biomass which could be synthesized from these amount of nutrients, and could provide hypoxic conditions at the microbial consumption without advection
- Depending on season threshold values for DIN vary from 18.3 to 33.4 uM, and for DIP from 1.1 to 2.1 uM, and for Dsi from 19.4 to 35.5 uM, i.e. not far from the national standards for nutrients/ eutrophication in sea water of other NOWPAP countries

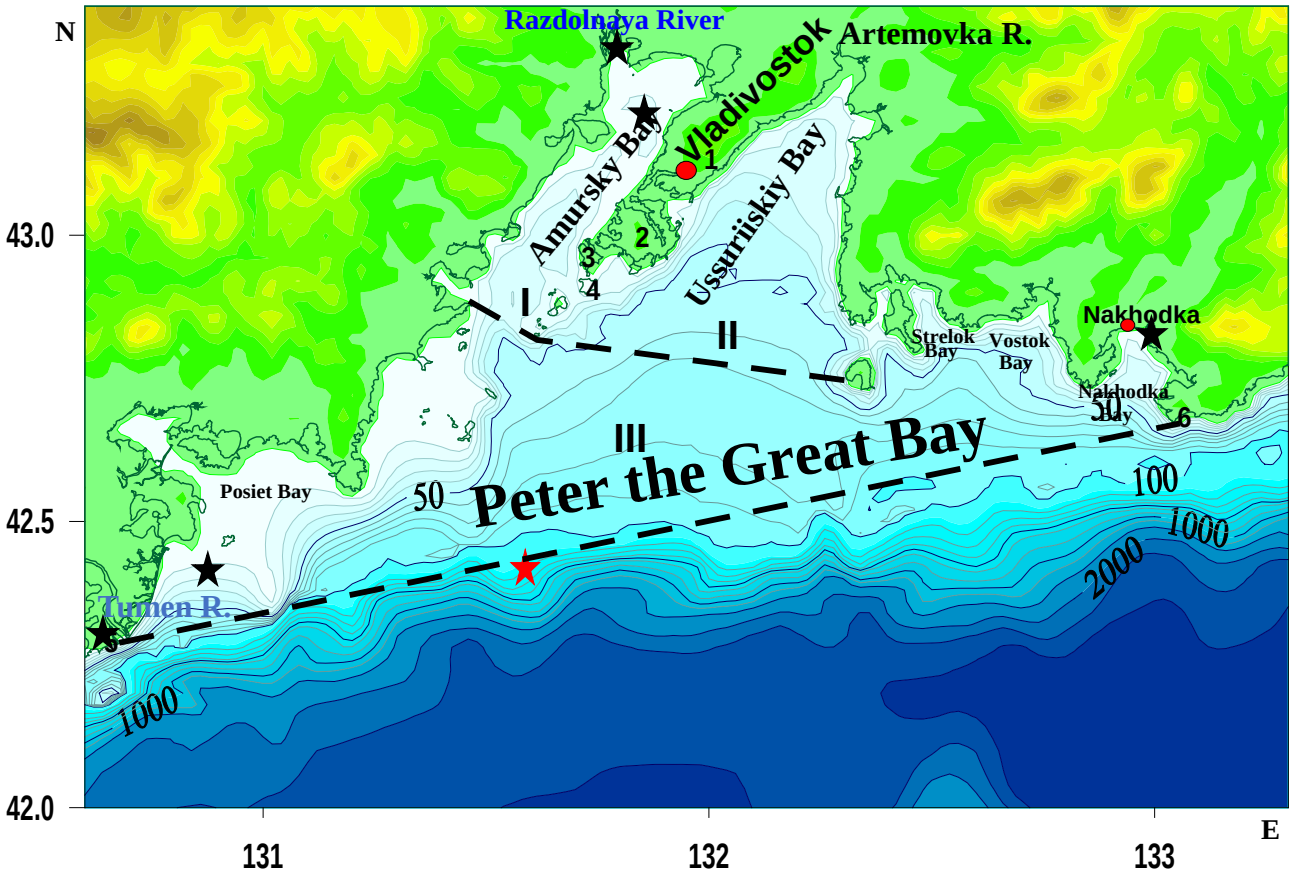
Distribution of **a** - DIN (µM), **b** – DIP (µM), **c** – DISi (µM), **d** – DO (µmol/kg), and **e** – chlorophyll a (µg/L) in surface layer of Amursky Bay. f – Depth of disk Secci (m). Red color means that nutrients concentrations exceed threshold values.
Data obtained at August 2007 (Tishchenko et al., 2013)



Distribution of **a** - DIN (µM), **b** – DIP (µM), **c** – DISi (µM), **d** – DO (µmol/kg), **e** – chlorophyll a (µg/L), f – atomic ratios of DIN/DIP in near bottom layer of Amursky Bay on the example of data obtained at August 2007 . Red color means that nutrients concentrations exceed threshold values and oxygen concentrations less threshold value.



- In depth investigation of hypoxia and analysis of causative relationships with environmental controlling factors continue to be one of the important activity of POI FEBRAS in Peter the Great Bay.



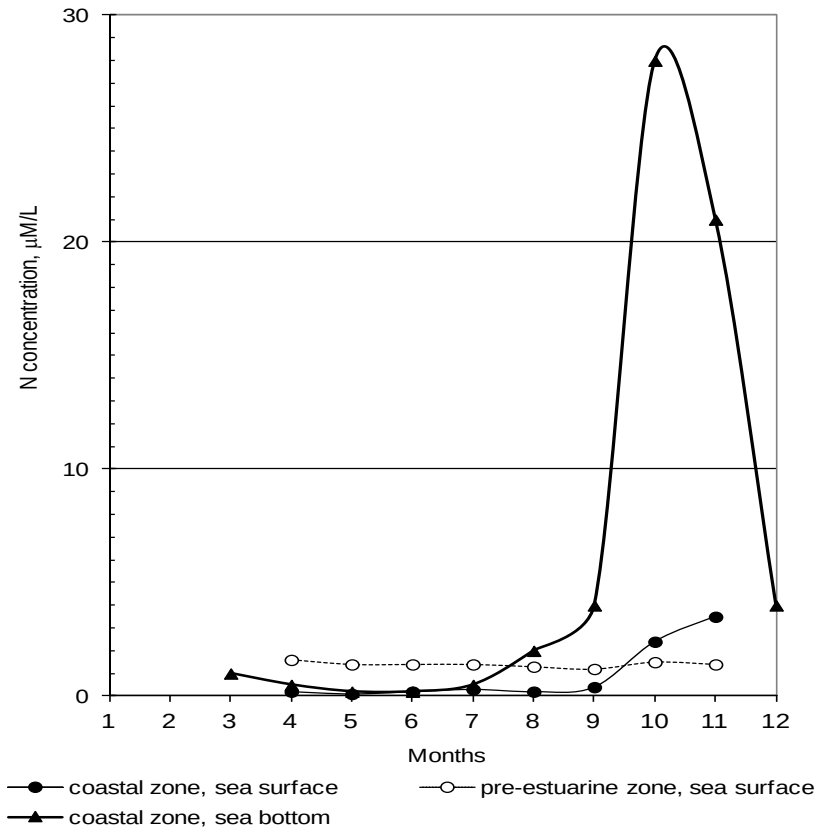
★ Hypoxia sites

★ Reference point

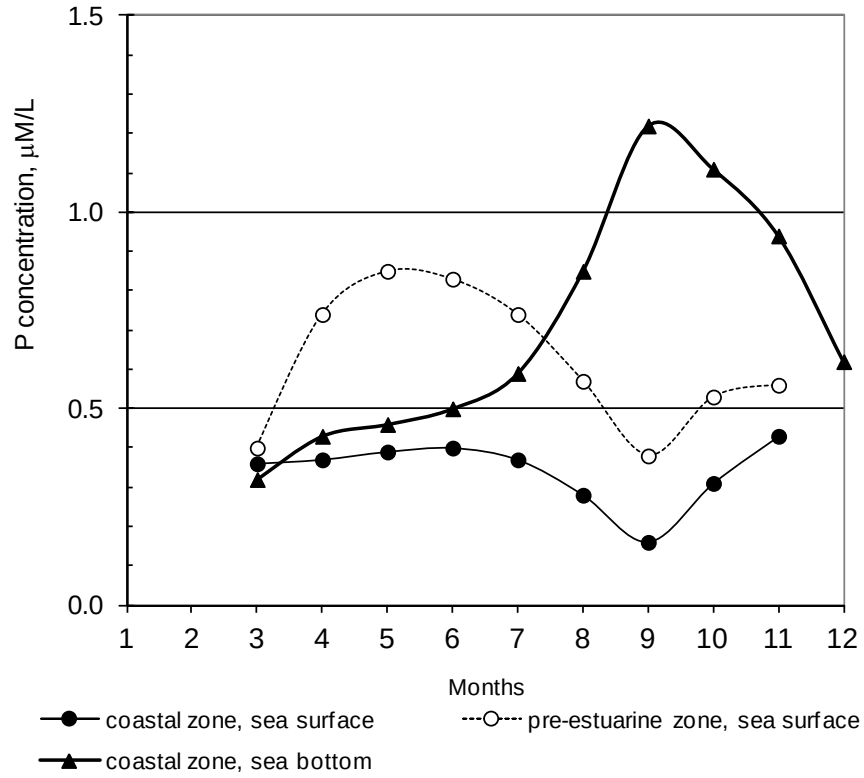
The different source of nutrients for the phytoplankton growth in coastal area (natural eutrophication) should be taken into account at the eutrophication assessment

- The use of nutrients concentration as indicator of anthropogenic eutrophication is possible if evidence of land-based source of nutrients is provided
- The concentration decrease trend offshore could be a proof
- In such case above mentioned threshold values of nutrients before the major phytoplankton growing periods could be an indicator of anthropogenic eutrophication
- It is necessary to distinguish clearly the seasonal changes of nutrients and chlorophyll due to natural reasons (phytoplankton cycles, seasonal oceanographic events) from the changes due to land-based sources variability

Seasonal changes of phytoplankton and nutrients in the different parts of Peter the Great Bay is one of the major topic of TINRO-center research

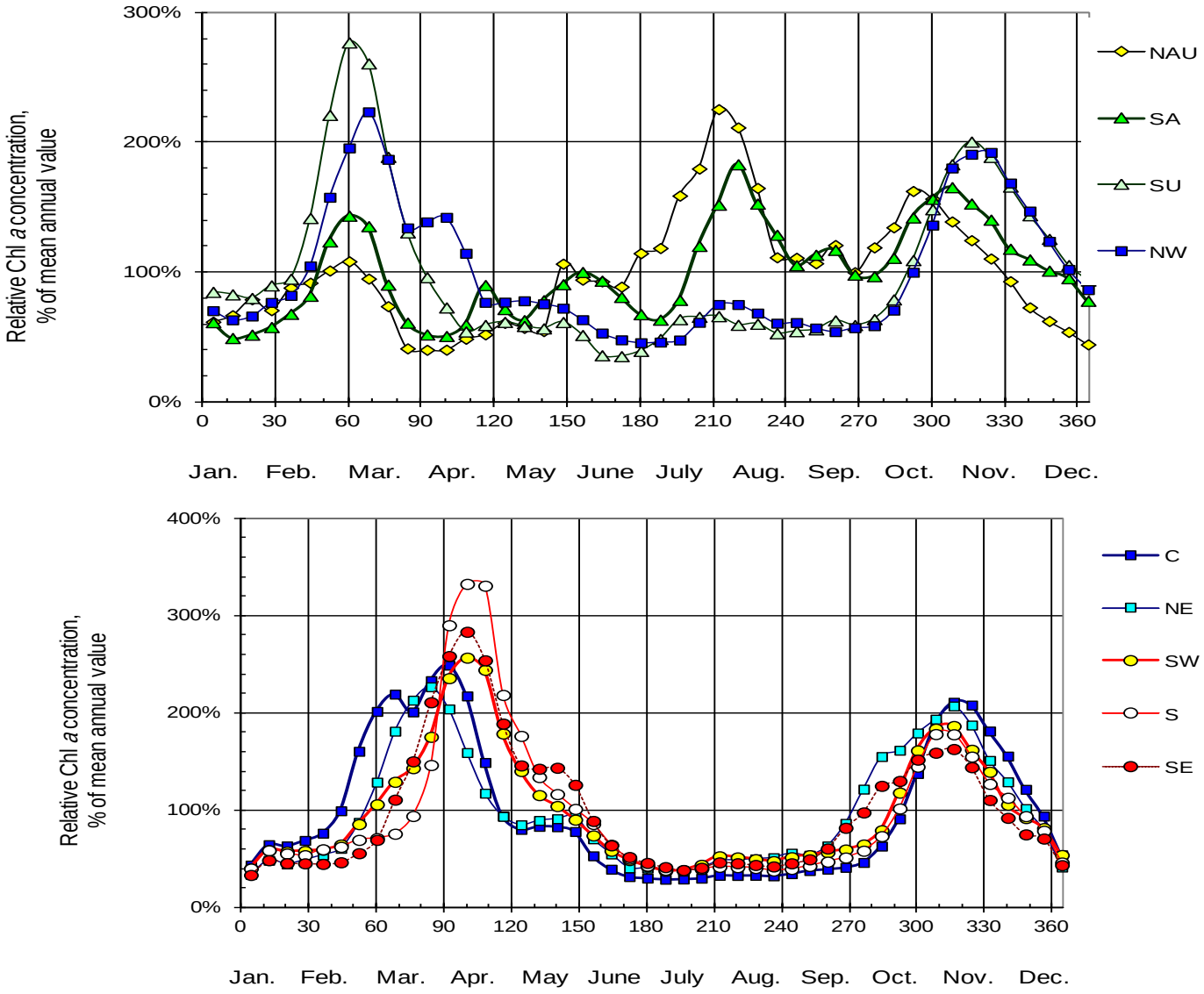


Seasonal variation of nitrate nitrogen concentration in the coastal waters of Peter the Great Bay, by results of long-term monitoring (Zuenko, 2008)



Seasonal variation of inorganic phosphorus concentration in the coastal waters of Peter the Great Bay, by results of long-term monitoring (Zuenko, 2008)

Seasonal variability of Chlorophyll *a* concentration (Zuenko, 2012)



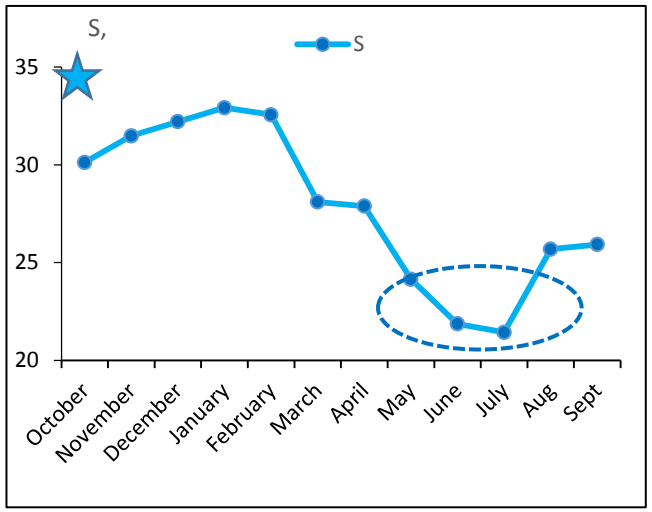
Mean for 1998-2008 seasonal changes of Chl a at the sea surface measured by satellite color scanners, by areas of Peter the Great Bay, relative to the mean annual values for each area (Zuenko, 2012)

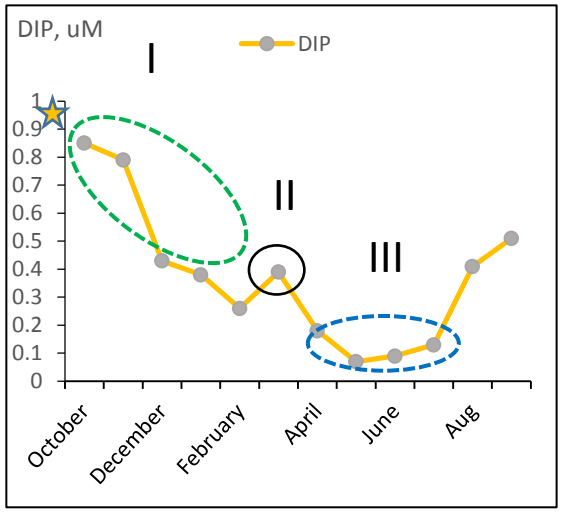
Pacific Geographic Institute and National Scientific Center on Marine Biology FEBRAS are concentrated on the complex study of the seasonal changes in phytoplankton community in relation to hydrochemical and oceanographical properties

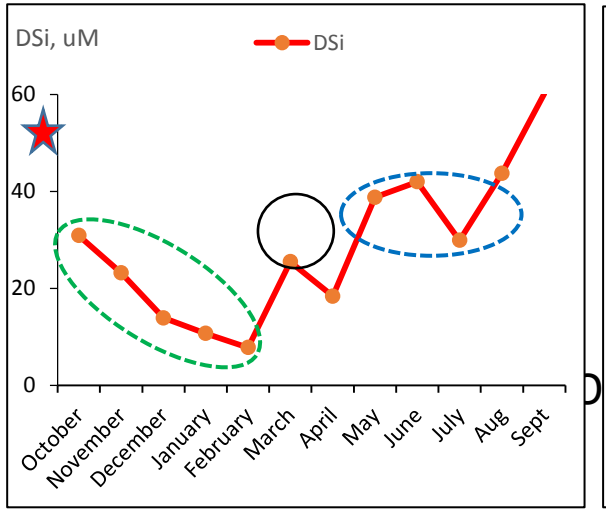
Are there links between seasonality of hydrochemical characteristics through the year and development of phytoplankton community?

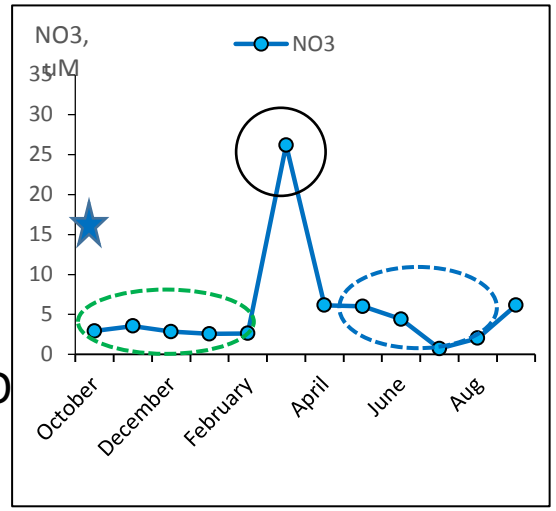
Seasonal changes of the monthly averaged salinity and nutrients concentrations at the long-lasting sampling station in the Amur Bay for 2009-2016 (n=12-17 for each month).

★ - parameters typical for the bottom waters of the Peter the Great Bay and Sea of Japan (Tishchenko et al., 2012)

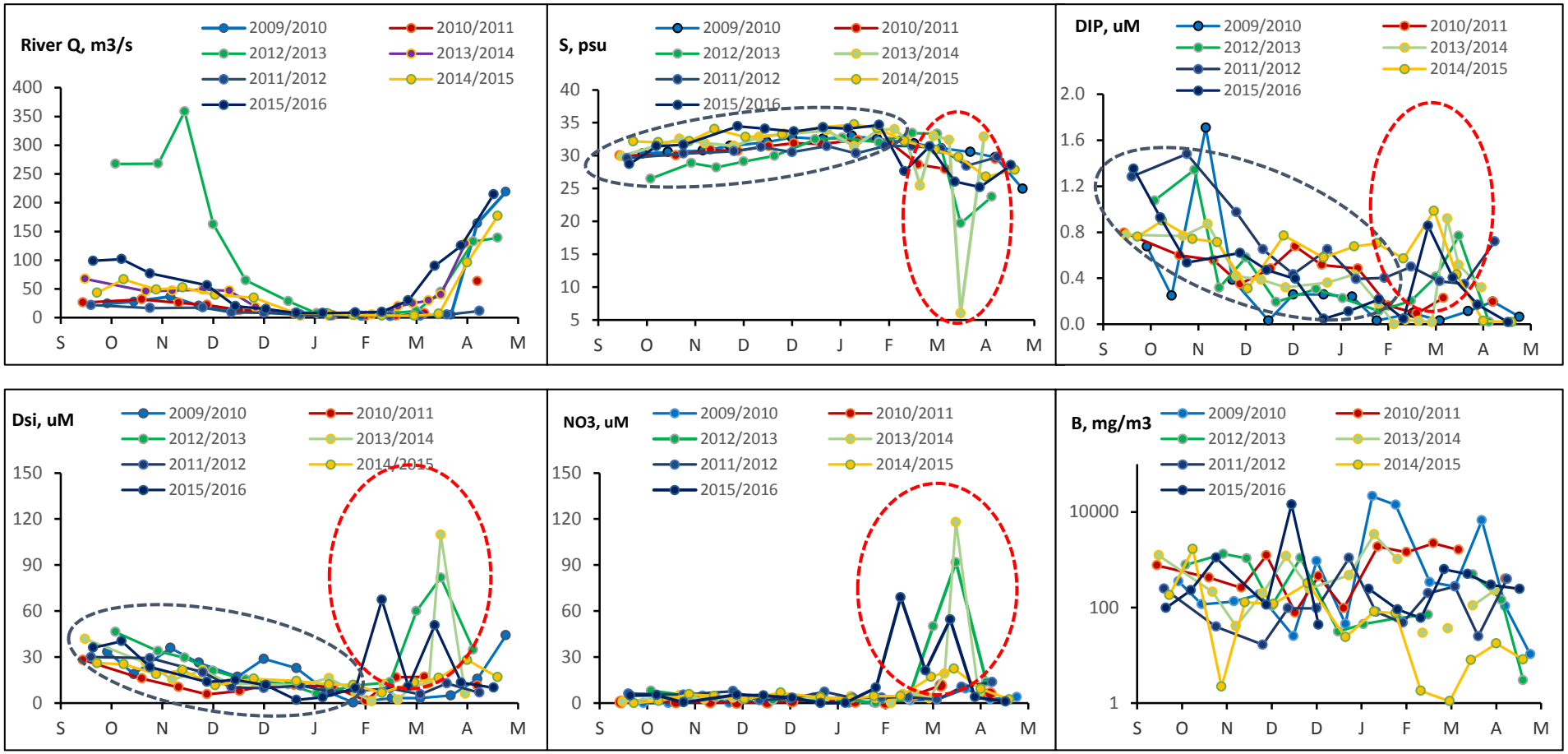








At the rather reasonable and explainable seasonal distribution of averaged values and data, the notable inter-annual variability of each parameters was observed



For hydrochemical parameters seasonal trends are reproduced despite the interannual variability, but phytoplankton characteristics are much more changeable

Stages of the hydrological features under ice of Amursky Bay

1

October-December

formation of homogeneous seawater

convection covers the entire column

Less favorable “active” conditions for “passively” moving diatoms

2

January-February

formation of warm brine bottom layer

layered convection

Most favorable “calm” conditions for “passively” moving diatoms

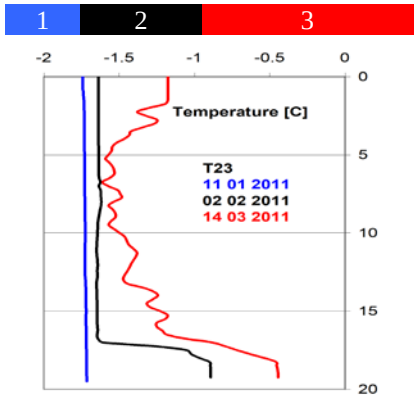
3

March

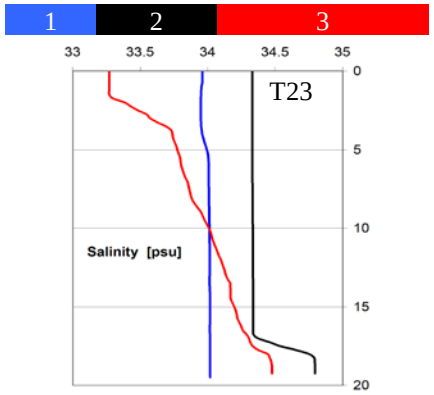
degradation of warm brine bottom layer and stratification of upper layer

layered convection

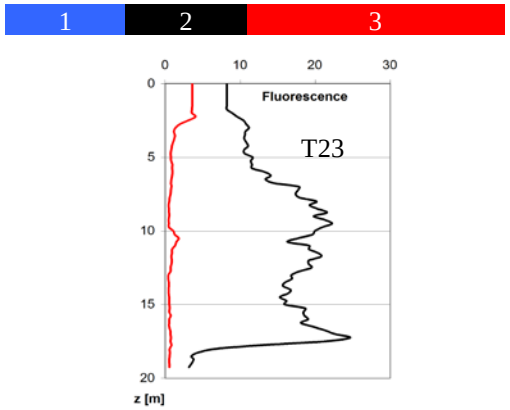
Stratified waters give preference to the active moving flagellates



Temperature



Salinity



Chl”a” (Fluor)

Brief summaries of potential eutrophic zones in Russian part of NOWPAP area

- **Existing data though are limited do not indicate significant worsening of the water status within Russian part of the NOWPAP region in general**
- **At the same time inner parts of Peter the Great Bay: 1) north parts of the Amursky and Ussurysky Bays, 2) areas close to the Tumen R. and 3) coastal areas adjoining to Vladivostok city show some signs of eutrophication**
- **(1) and (2) are the outer parts of estuaries of inputting rivers which provide nutrients of mixed anthropogenic and natural genesis**
- **In the nutrients runoff from Vladivostok city (3) anthropogenic component prevails**

Conclusions

- Peter the Great Bay continues to be the most intensively used sea area within Russian part of the NOWPAP region, and negative consequences of eutrophication including hypoxia events is observed here;
- The new potentially harmful microalgae blooms are registered in Peter the Great Bay as well;
- The use of remote sensing data to assess the chlorophyll “a” level in the different sea areas seems the most promising first step instrument to select potentially eutrophic zones taking into account the affinity of these areas to the estuarine zones where satellite data need to be checked;
- The comparison of situation between less controlled and exploited Russian coastal sea areas and more intensively used and studied sea areas of other NOWPAP states gives opportunity to distinguish the influence of different controlling factors and has mutual interest.