Russian National Research Programs in the North Pacific Ocean

– how are they related to PICES FUTURE ?

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April 18, 2014

Kohala Coast, Hawaii

Russian National Existing and Planned Programs related to FUTURE

- Federal Research Programs
- Fishery Agency programs
- Academy of Sciences Programs
- Hydrometeorological Service Programs

Federal Program "World Ocean"

Physical, chemical and biological processes, geology, geodynamics and mineral resources of oceanic lithosphere and continental margins, the role of the ocean in Climate pattern of the Earth, up-to-date climate and anthropogenic changes in natural oceanic systems

- **Theme 4.** State and variability in oceanic features of the Russian Far Eastern Seas and northwestern Pacific Ocean in relation to climate change and anthropogenic impact.
- **Theme 6.** Relationships between hydrochemical and biological processes in marine ecosystems under human activity and changes in climate

Russian Academy of Sciences,
Russian Hydrometeorological Service,
Russian Fisheries Agency

Russian Academy of Sciences Fundamental Programs

Fundamental Research in accordance with the Program for Fundamental research of the state Academies of Sciences in 2013-2020

Scientific Basis for Development of Methods, Technologies and Means for Research of the Earth, Atmosphere (including ionosphere and magnetic sphere, hydrosphere and cryosphere), Modeling and Geoinformation

Development of new innovative technologies for multi-purpose oceanographic research

Period : 2013-2020
Leading institute: V.I.Il'ichev Pacific Oceanological Institute, Far Eastern Branch of the Russian Academy of Sciences

Major Study Areas of the Russian Academy of Sciences in the North Pacific

- **Russian Far Eastern Seas and North Pacific** – climate and teleconnections
- **Japan/East Sea** – basin scale and Northwestern Pacific coastal areas
- **Northwestern Okhotsk Sea**
  - ✓ Amur River Estuary and impact
  - ✓ tides and rivers impacts on the bays
- **Northwestern Okhotsk Sea and northeastern JES** – methane fluxes

Assessment of mechanisms for climate regimes and anomalies

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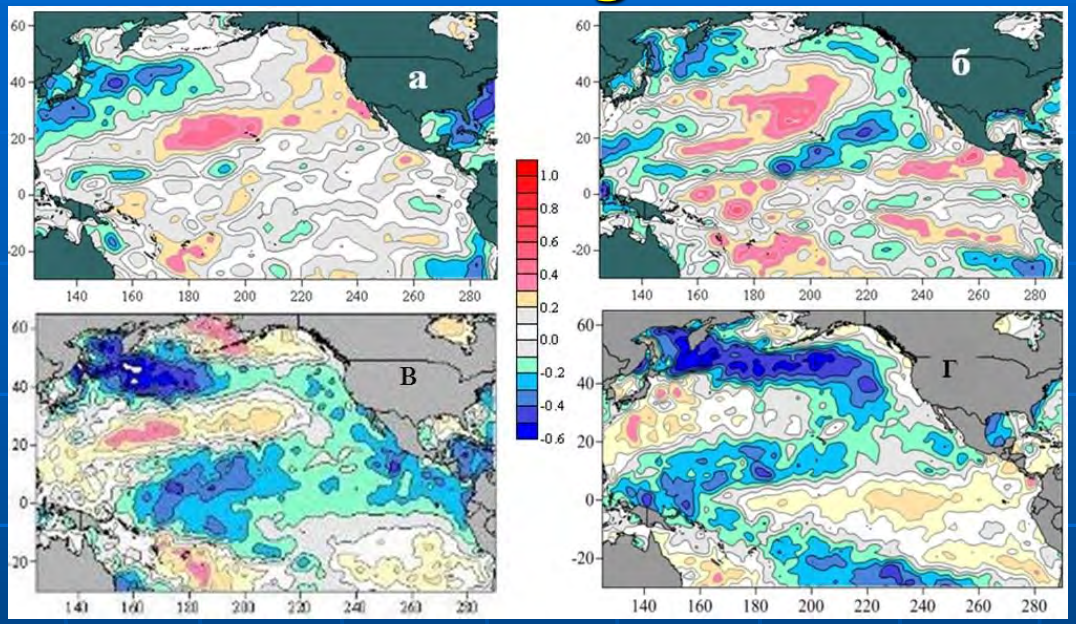


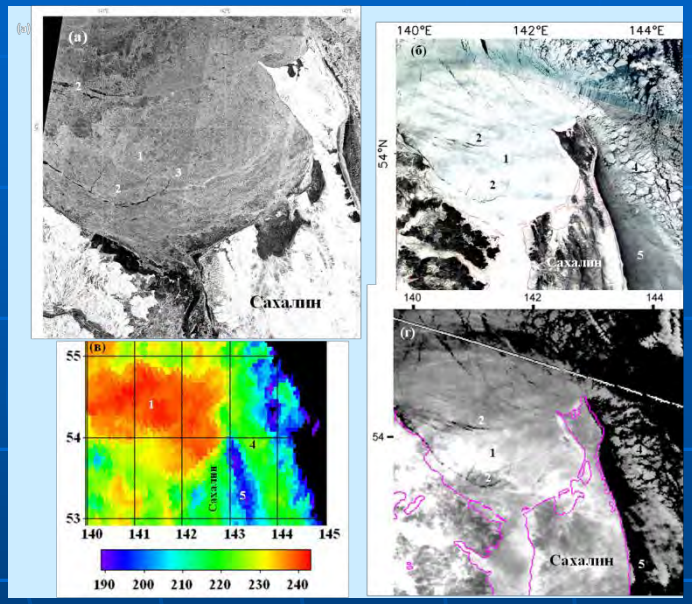
Large-scale processes of interaction between the ocean and the atmosphere in the NPO, and characteristic scenarios and signals for extreme climate anomalies were analyzed

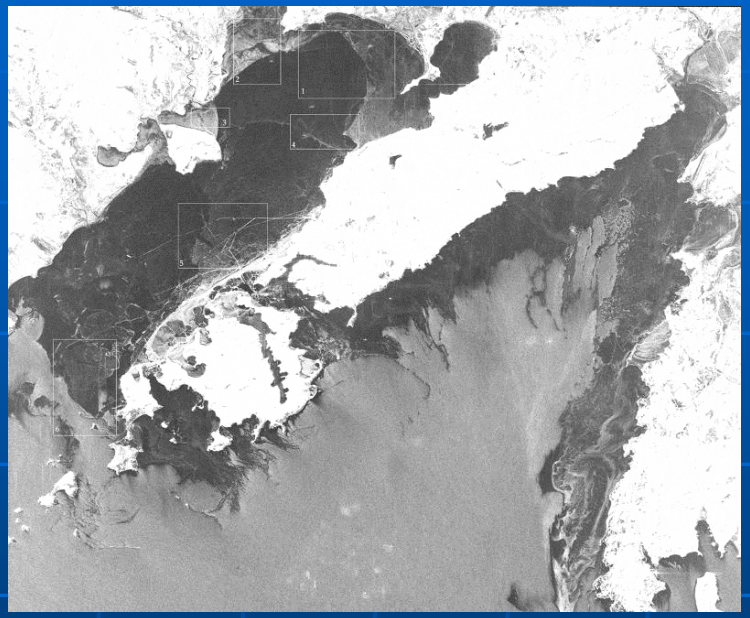
Data on heat balance between the ocean and the atmosphere were analyzed in different parts of the NPO

•**It was revealed that, in the last 60 years, there was an increase in a warm flow from the surface into the deep layers in the Pacific Ocean tropical latitudes (in the result of increased short-wave radiation and heat loss decrease due to evaporation). In the energetically active Kuroshio area and Subarctic frontal zone, there exists a heat loss due to evaporation, and as a result, an increase in a total amount of heat coming up to the atmosphere from the ocean. In the Gulf of Alaska, there is a heat loss from evaporation and turbulence. In the northeastern Pacific and California Current areas, significant increase in the annual heat flow from the atmosphere down to the ocean was observed.**

•**Climate trends and heat balance oscillations on the oceanic surface north of 30°S, and their relations to SST in the Pacific Ocean and sea ice cover in the Japan and Okhotsk seas were identified. It was shown that an increase in winter monsoon and ice cover on the short- and long-term scales are associated with increased heat flow into the atmosphere in Kuroshio area and western Subarctic (for JES) and western and eastern Subarctic (for OS), accompanied by SST decrease in Subarctic, east tropicxal and tropical Pacific Ocean.**

Archive for sea ice and forecasting of sea ice conditions in the Russian Far Eastern Seas





Archive includes data on age, form and thickness of sea ice in the Japan, Okhotsk and Bering seas in 1960-2012 with the main goal to forecast sea ice conditions on short- and long-term scales

Trends and cyclic variability in ice conditions are analyzed on a regular basis

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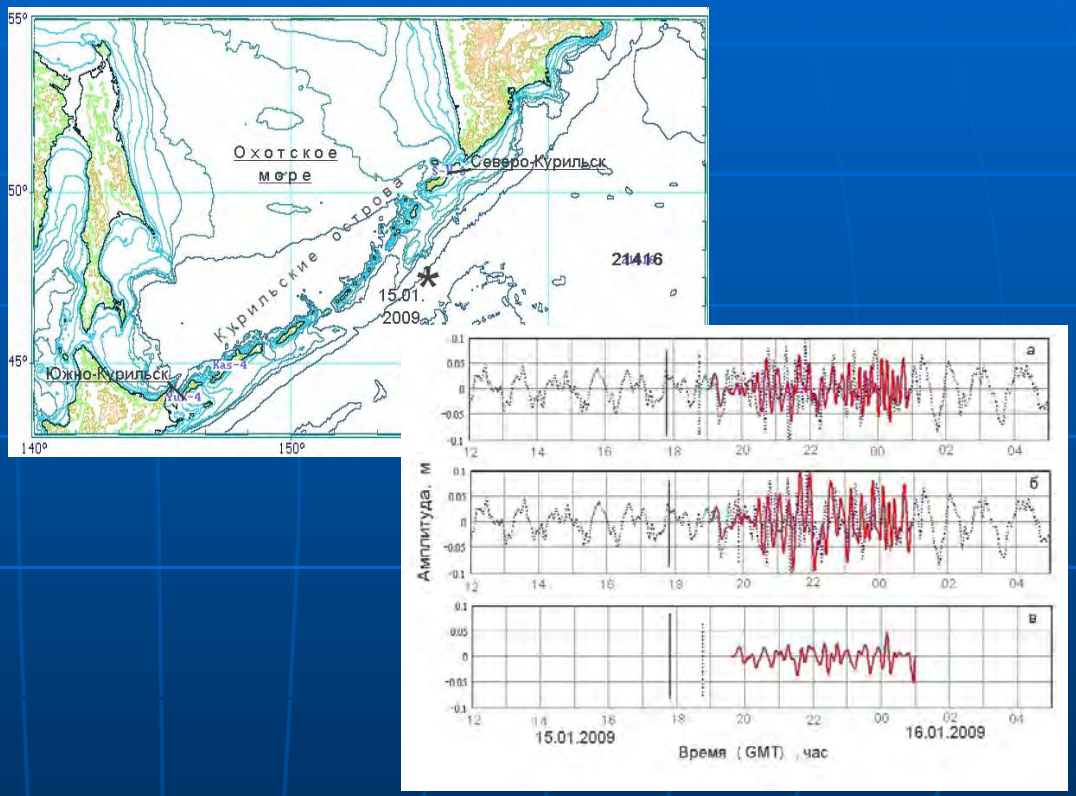
Dangerous oceanic impacts on human society

Atlas for Trouble-causing hydrometerological features



Detecting tsunami in the Far Eastern region

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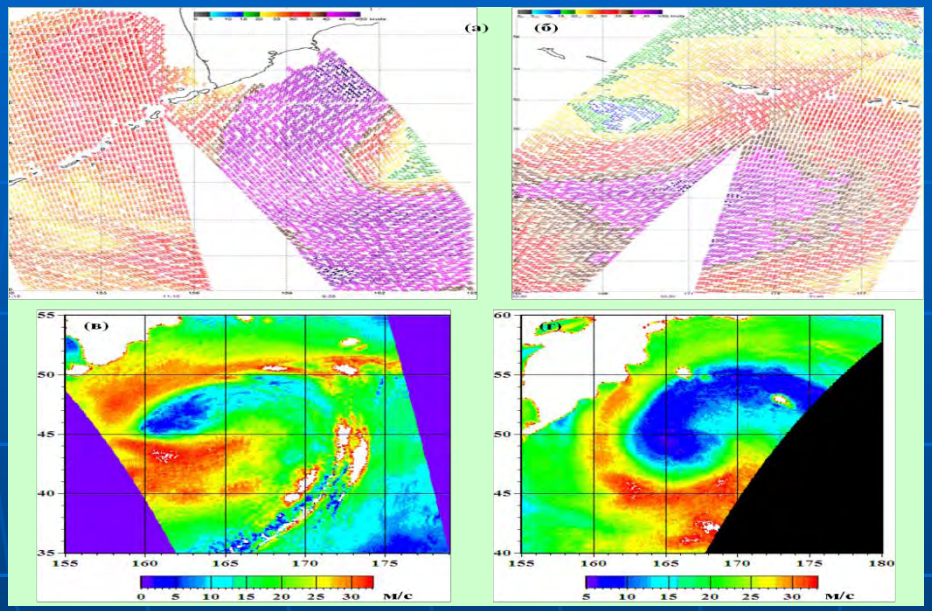
Satellite-based parameters to study the atmosphere and the ocean



Assessments of wind speed, amount of atmospheric vapour and water-content of clouds based on short-wave detection in order to study atmospheric features and forecast tropical and polar cyclones and cold intrusions

Image analyses in visual, infrared and short-wave spectra to fine-classify sea ice

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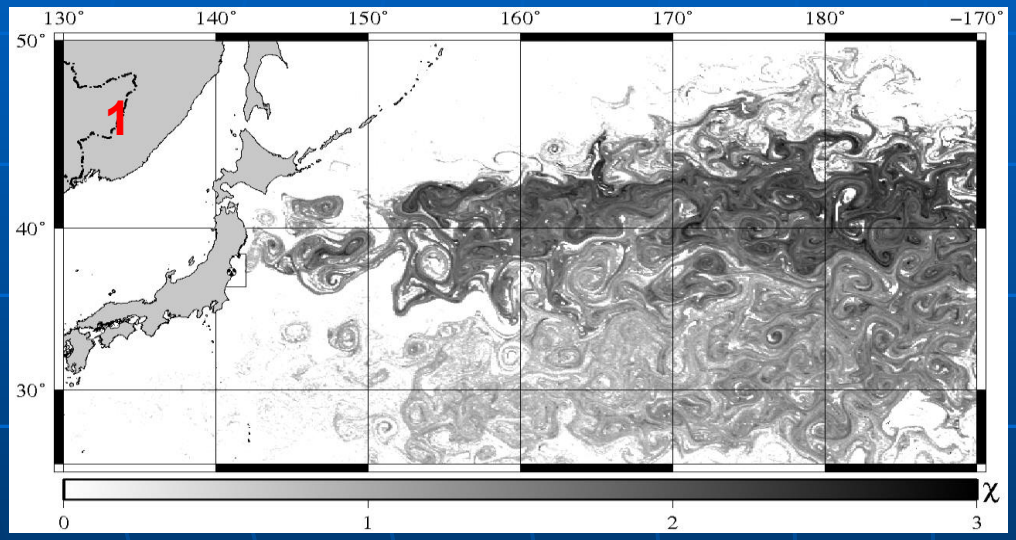
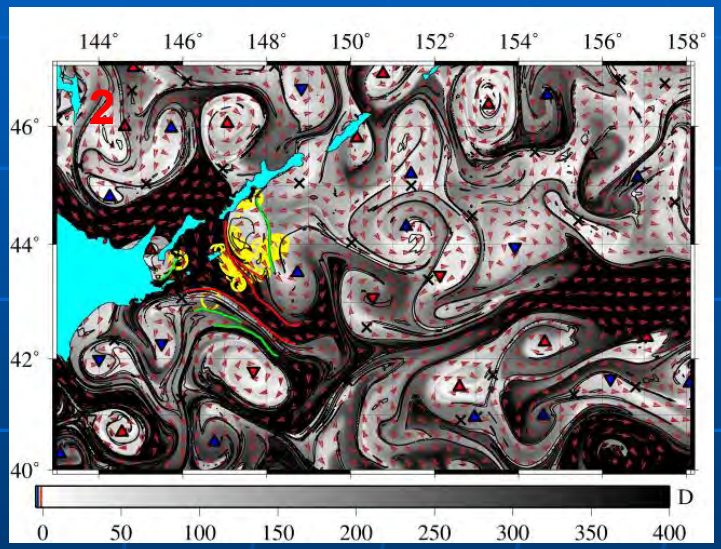
Modeling of non-linear processes in the ocean and the atmosphere

Lagrangian approach is used to produce models for various dynamic processes



Map showing drift of particles from Fukushima (September 14, 2012)



Lagrangian drift pattern for September 14, 2012 with a forecast of most favorable areas for saury fishing during following 3-5 days (red and green lines). Saury catch in these days is shown in yellow.

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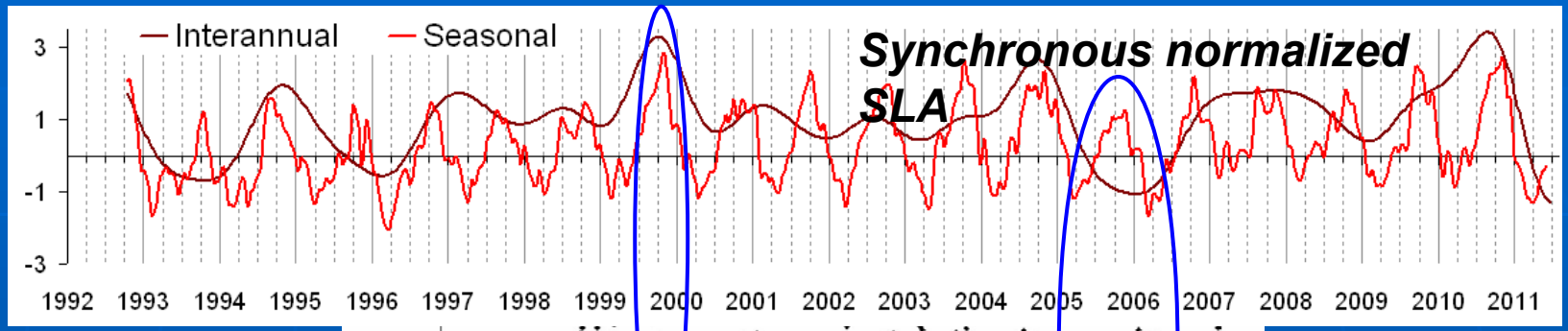
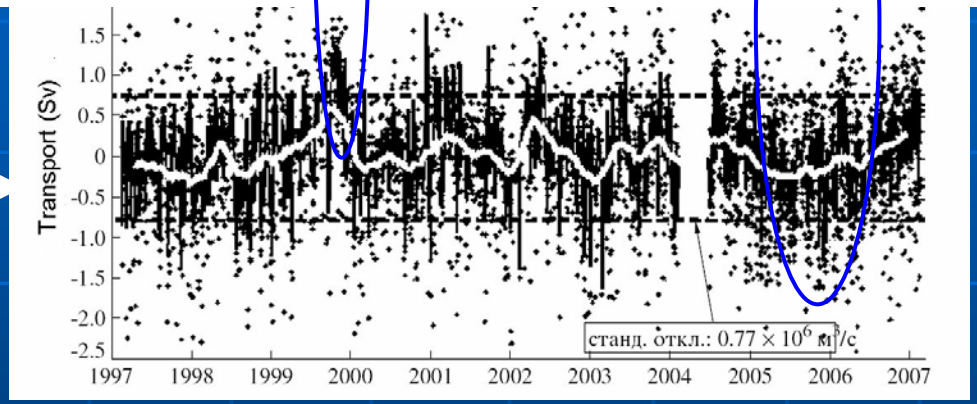
Studies of Sea Level Altimetry



Sea level rise in the North Pacific and East Asia marginal seas is mostly caused by steric effects (changes of sea water density) (Fukumori, Wang, 2013; Marcos et al., 2010).



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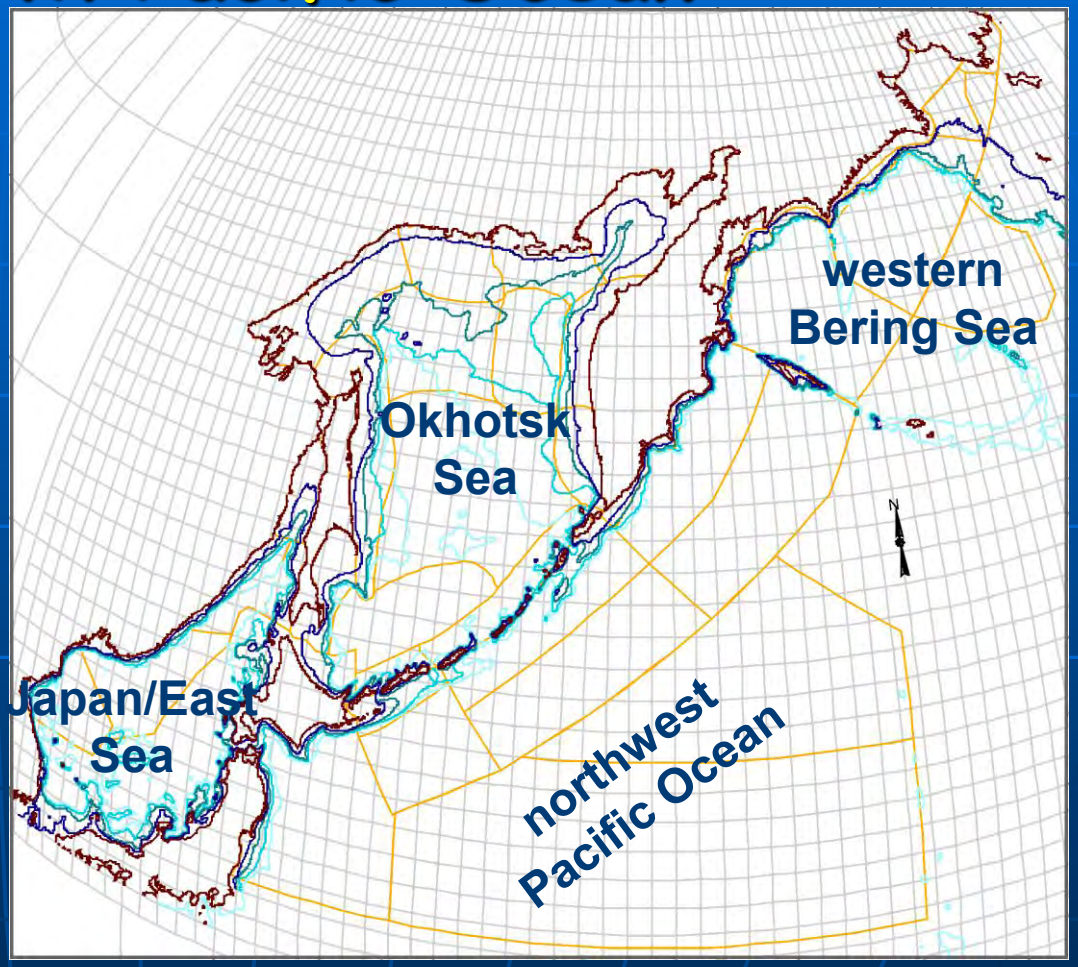
In the **JES**, synchronous oscillations, beyond the steric sea level rise and related to changes of water volume, suggest **quasi-biennial periodicity rather than a trend**.

In the **Bering Sea**, **positive trend** of 1.2 – 1.5 mm/yr persists for 70+ yrs (Saveliev, 1999, and AVISO altimetry), which can be related to the eustatic (post-Ice-Age) adjustment.

In the **Okhotsk Sea**, **opposite trends occur in the adjacent areas**, possibly due to the eustatic adjustment and tectonic movements (Poezhalova, Shevchenko, 1997; Sedaeva, Shevchenko, 1997).

Fishery Agency Research Programs in the North Pacific Ocean



Bering Sea
Okhotsk Sea
Japan Sea
Northwest Pacific Ocean
Pacific Salmon

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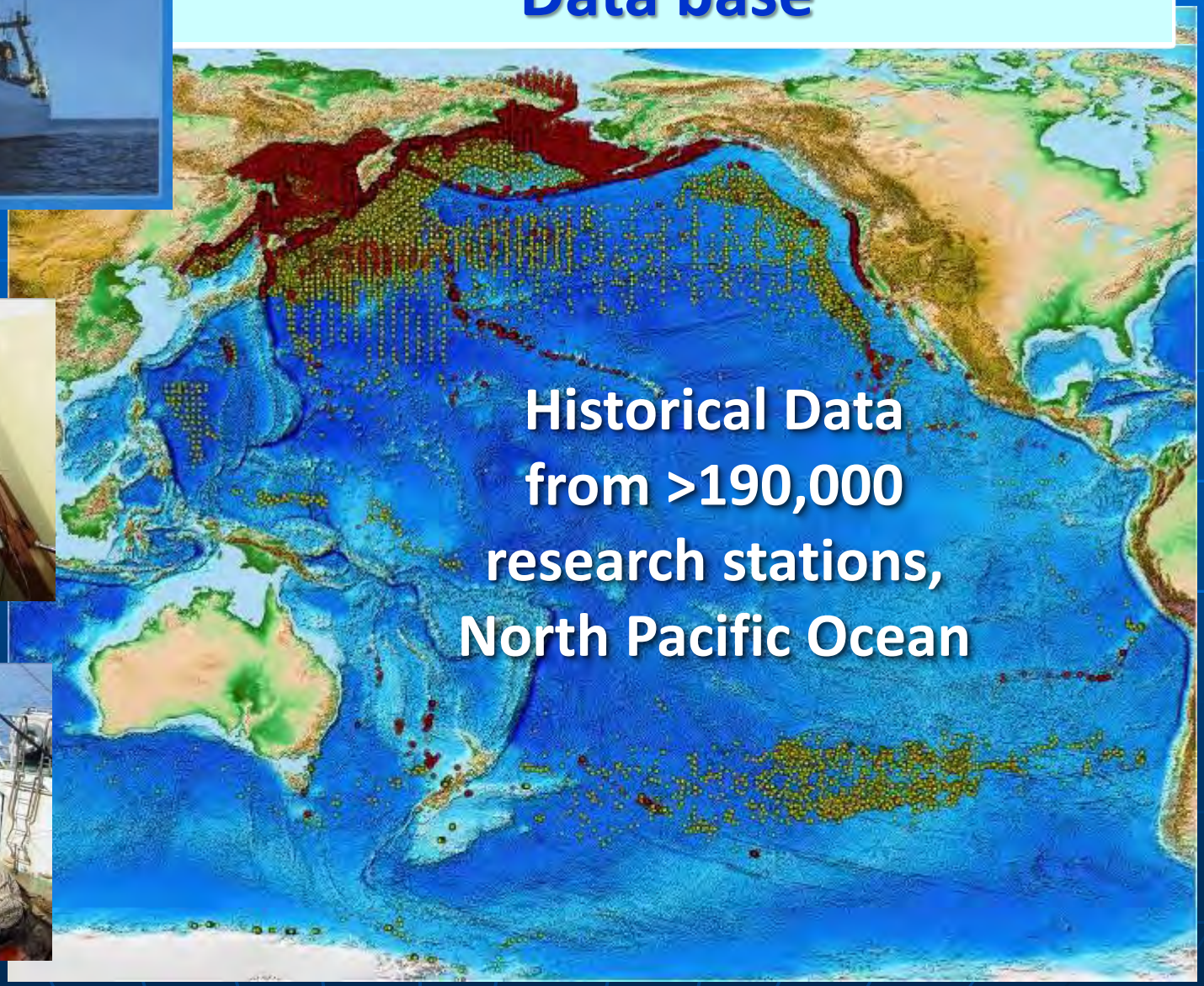
Research Objectives

- **Regular research on ecosystems**, including research in climate and oceanography, hydrobiology, trophic interactions, productivity, biocenology, and conservation measures
- **Regular research on major biological resources**, particularly, on commercially valuable species; detailed studies in their ecology and relations to the observed changes in climate and oceanography, including hydrobiological background; population and production biology, biocenology, rational fishery and management of natural resources
- **Regular research on potentially commercial marine biological resources** (capelin, some flatfishes, shrimps, clams and cephalopods, echinoderms, etc.)
- **Regular research in coastal areas**, improve monitoring activities, involve new resources into fishery, and develop balanced approach toward their stable utilization
- Coordinate studies on **unification and standardization** of methods of stock assessment, estimates of recruitment and TAC, research programs of various regional fishery institutions
- **Inter-calibration experiments** on the efficiency of various catching gears (plankton nets, trawl nets, crab pots, etc.); improve the existing methods of data collection and calculations of stock abundance of commercial species
- **Develop multi-species approach to fishery**
- **Develop coastal mariculture**, estimate capacity of farmed areas, work out technology for rearing species in artificial plans and in nature
- **Develop technology for processing and utilization** of biological resources that are subject to fishery and aquaculture

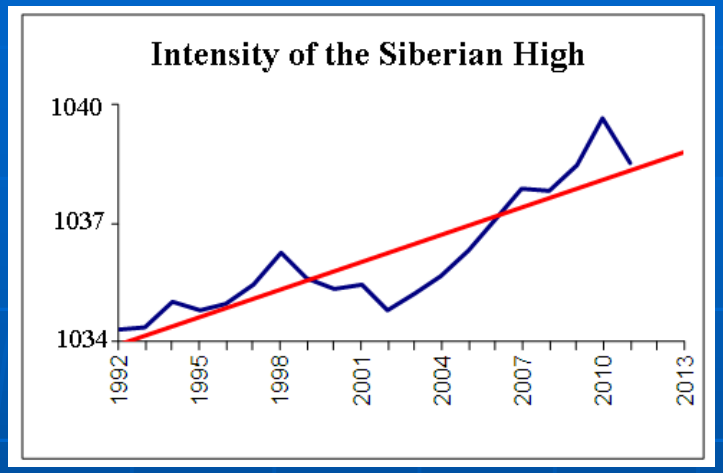
Research fields

- Climate (regional, local features)
- Oceanography (T, S, density, sea ice, currents, oxygen, nutrients, etc.)
- Lower and Upper trophics (plankton, nekton, benthos)
- Environmental Quality (pollutants, radioactivity, etc.)
- Engagement (TAC adoption, knowledge dissemination, etc.)

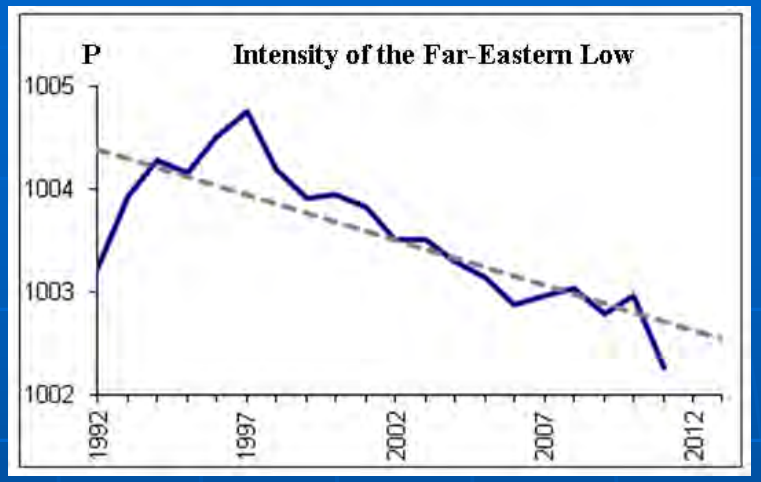
Biological and Oceanographic Data base



Atmospheric conditions in the Northeast Asia and Northwest Pacific

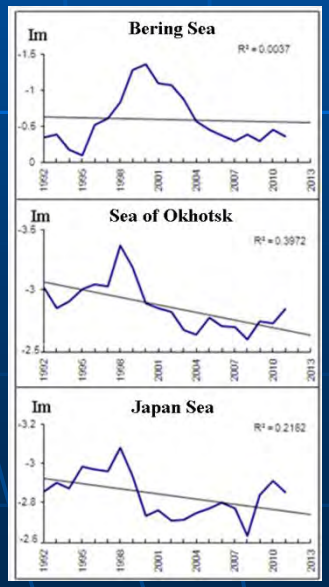


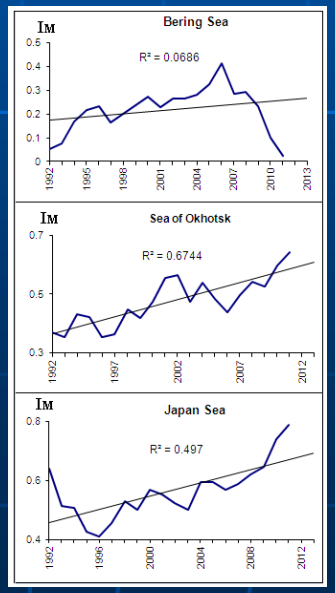
Increase in pressure in the SH



Decrease in pressure in the FEL

Weakening of winter monsoon (most notable in the Okhotsk and JES)





Increase in summer monsoon (most notable in the Okhotsk and JES)

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Cyclogenesis above the NWP marginal seas (winter pattern)

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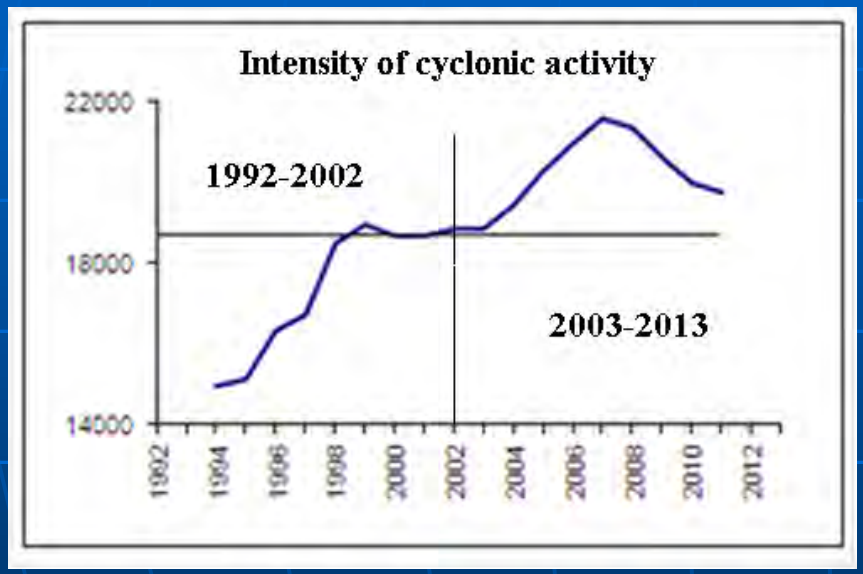
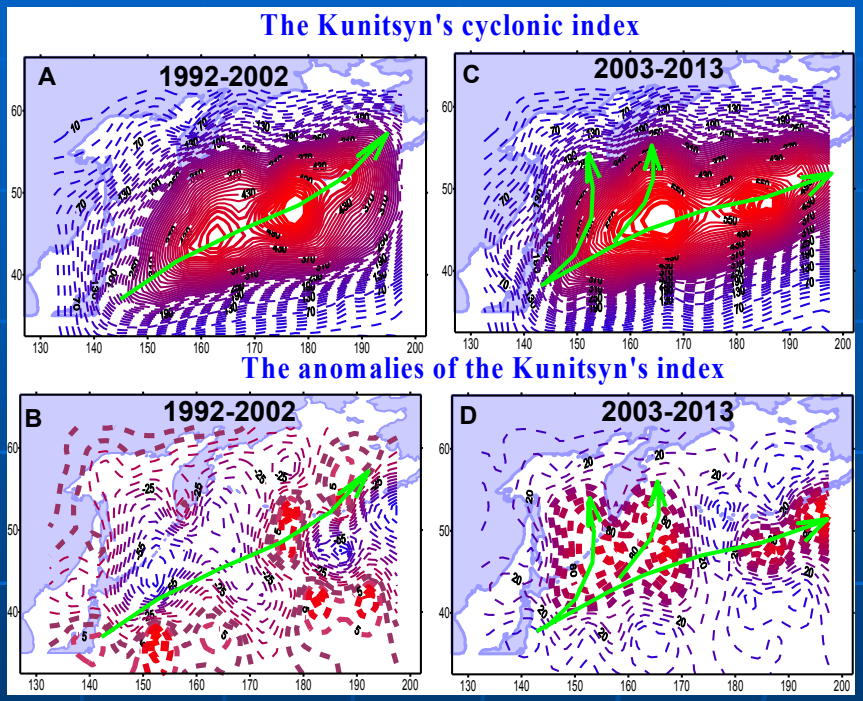
Increase in Siberian High





1992-2002: Low cyclonic activity and increased northern monsoon

2003-2013: Increased cyclonic activity and weaker northern transport

1992-2002: Oceanic pathways for major cyclones (and strong northern transport)

2003-2013: Three major directions for major cyclones (and easterly transport with weak winter monsoon)

Cyclogenesis above the NWP marginal seas (summer pattern)

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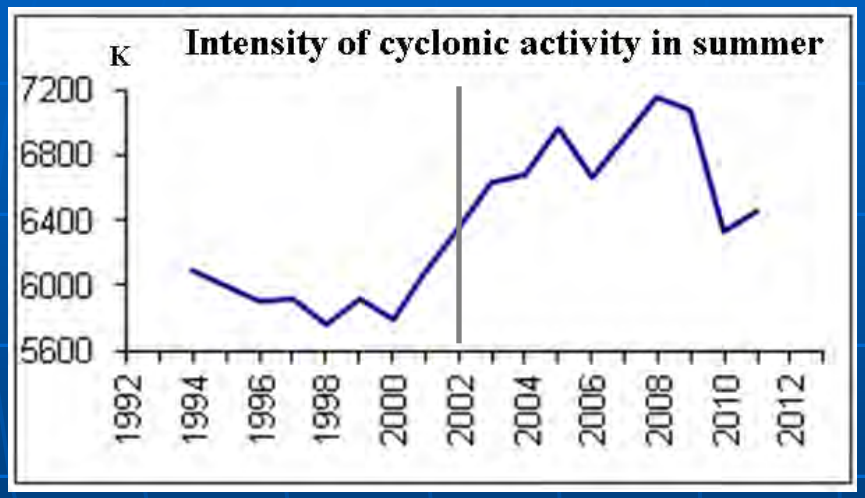
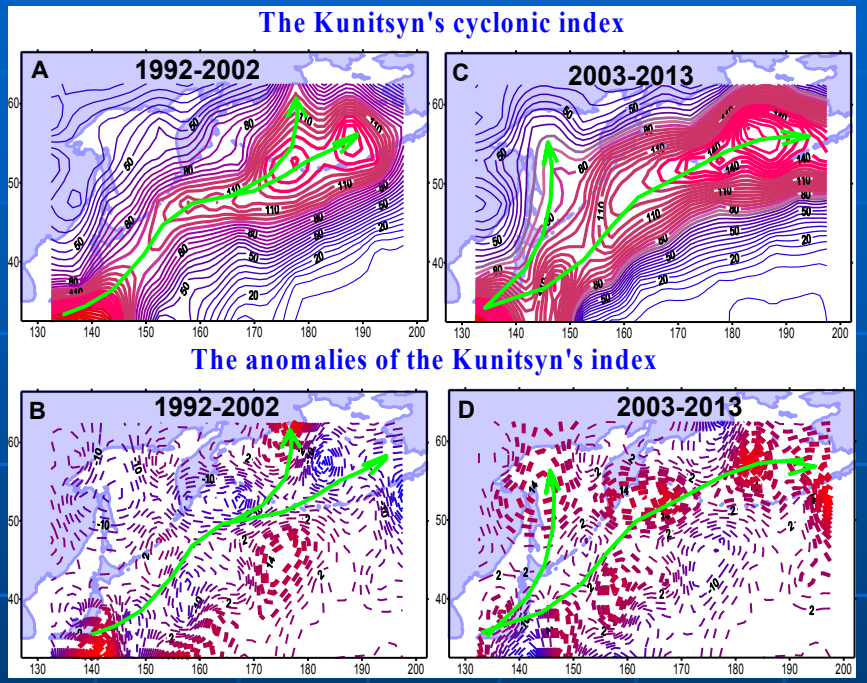
Decrease in Far Eastern Low





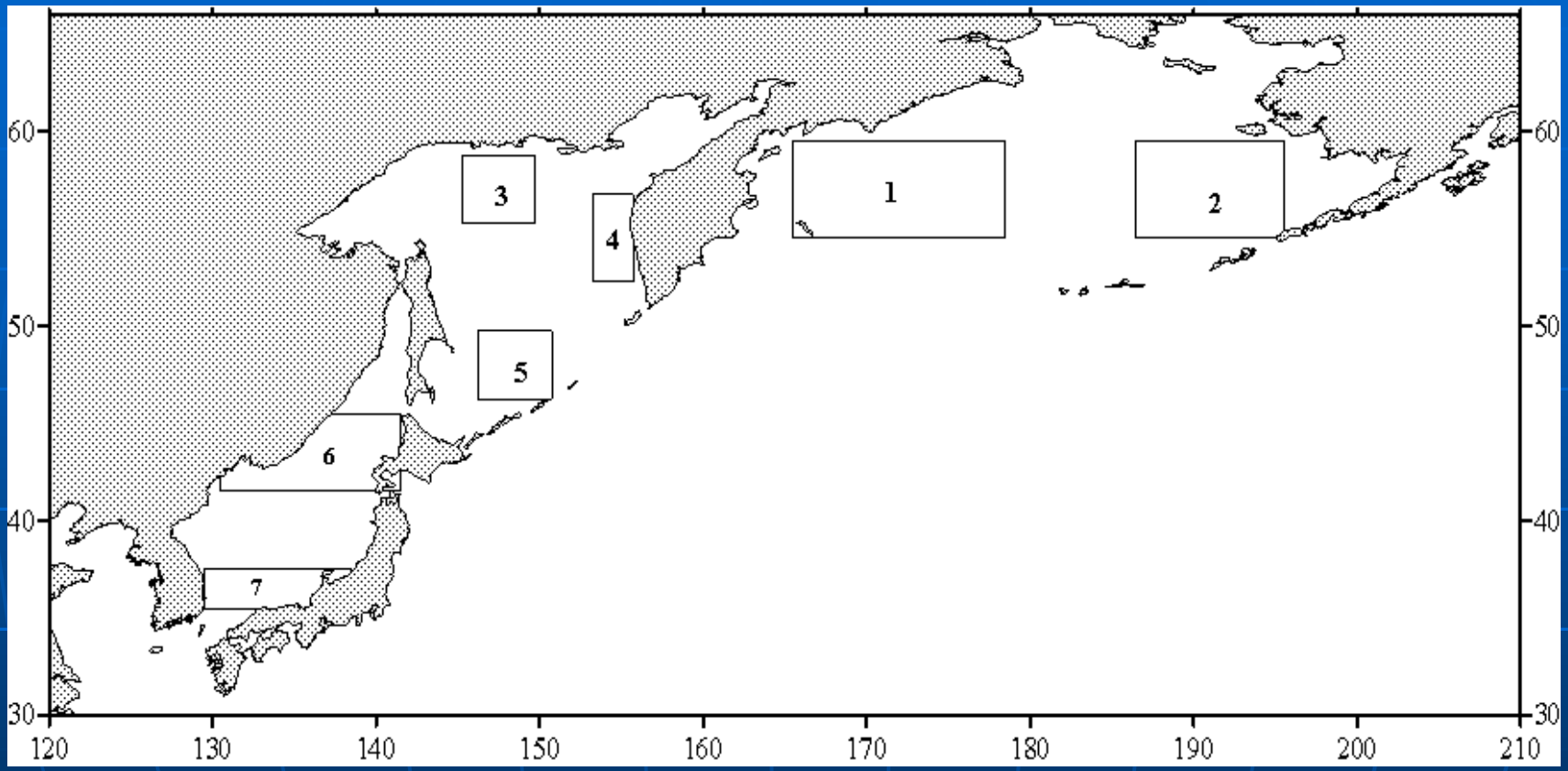
1992-2002: Low cyclonic activity and weak south monsoon

1992-2002: Oceanic pathways for major cyclones up to north Bering Sea

2003-2013: Higher cyclonic activity and stronger southern transport

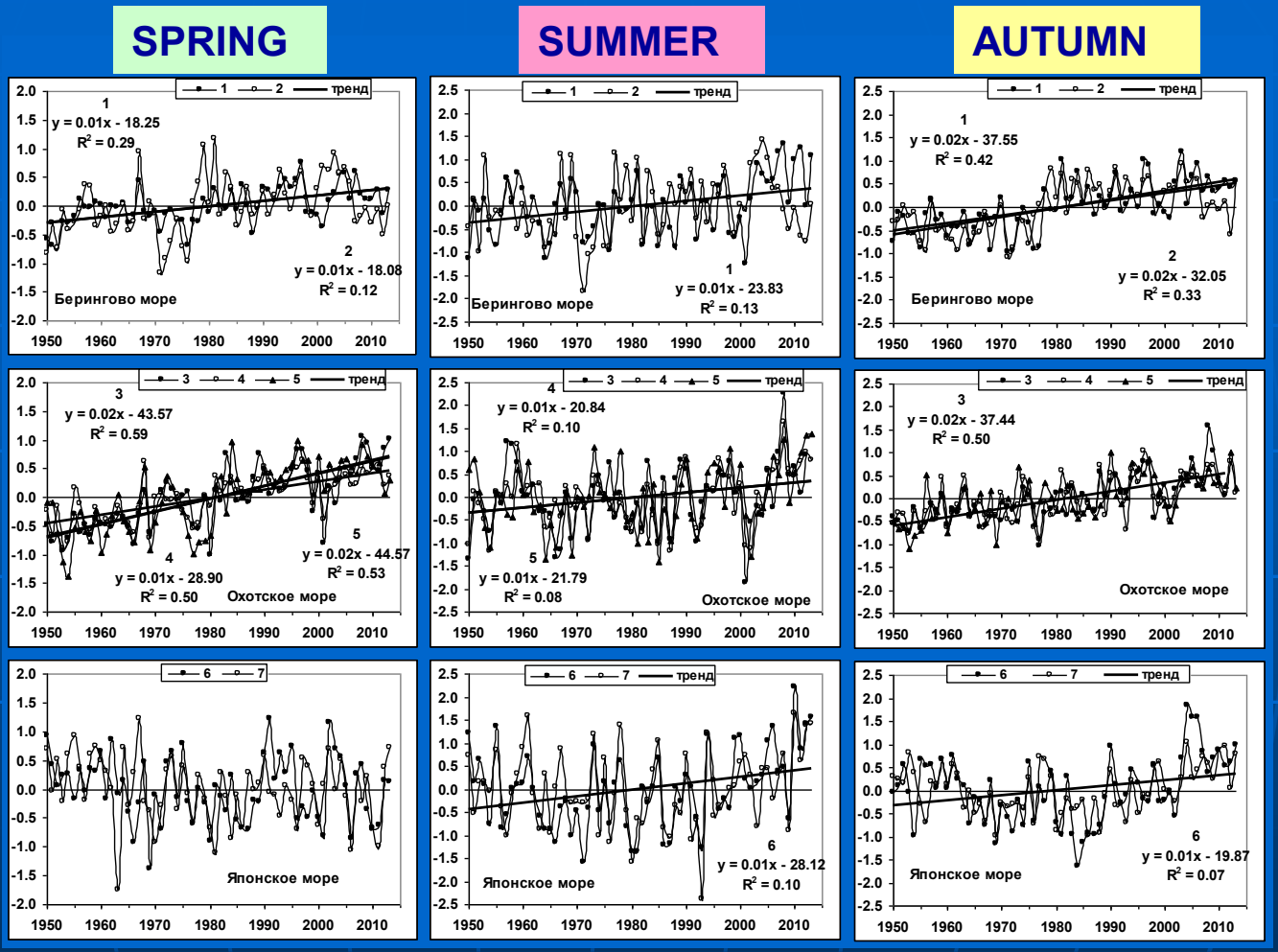
2003-2013: Two major directions for major cyclones up to north Okhotsk Sea and east Bering Sea

Data for the study of SST anomalies in the North Pacific Ocean marginal seas



Research areas:
1 – west, 2 – east Bering Sea;
3 – north, 4 – east, 5 – south Okhotsk Sea;
6 – north, 7 – south Japan Sea

SST anomalies and their seasonal trends (95%) in the North Pacific marginal seas



1) Similar trends within each sea;
2) Summer trends are generally stronger;
3) Notable positive trends in the Okhotsk Sea;
4) Variable changes in the Bering and Japan/East Sea

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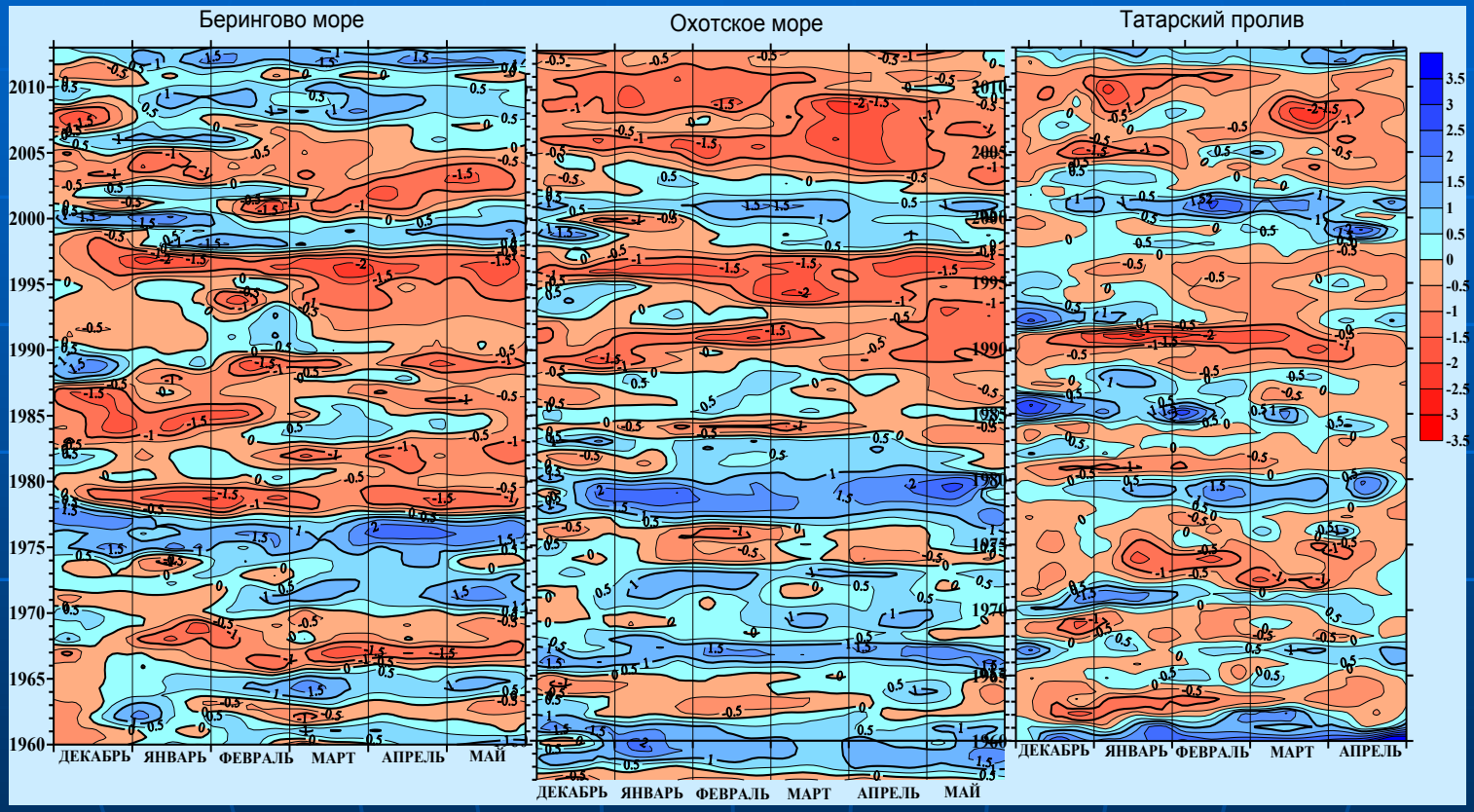
Annual and seasonal patterns in the ice cover in the East Asian seas

Positive (=red) anomalies correspond to warm conditions, negative (=blue) to cold

Bering Sea **Okhotsk Sea** **Tatar Strait**



Dec-May **Dec-May** **Dec-April**

1) Recent warm conditions in the Okhotsk Sea

2) Cooling in the Bering and north Japan seas

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Dissolved Oxygen (ml/l) the at different isopycnal surfaces in the Okhotsk Sea deep basin intermediate layer

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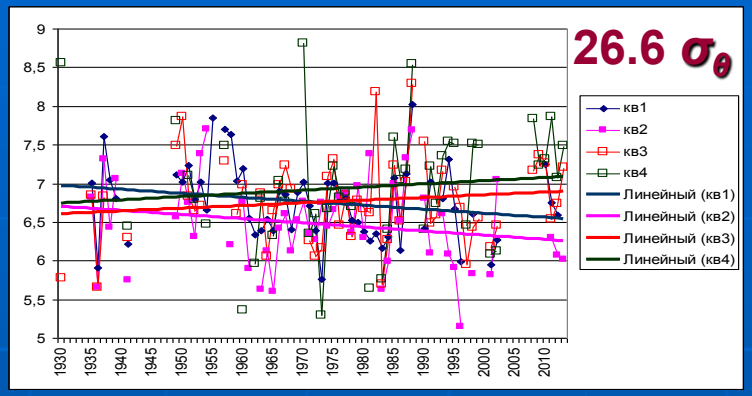

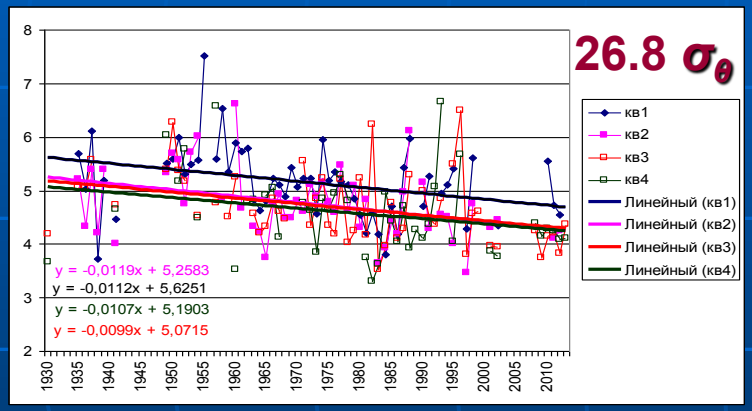

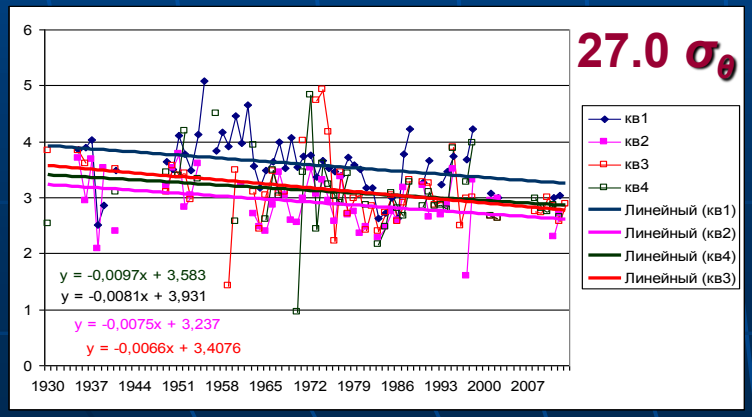

1) at isopycnal surface 26.6 σ_θ positive trends were observed in the northern areas and negative in the southern areas

2) at 26.8 and 27.0 σ_θ negative trends were present in the entire deep basin

Warming of the Intermediate Layer has been observed during the last 25 years

Decrease in the concentration of dissolved oxygen has been observed in the Intermediate Layer during the last 25 years; however, cooling of the Subsurface Layer was associated with a rise in dissolved oxygen in the northern areas

Dissolved oxygen in the Pacific Ocean Intermediate Layer (2013)

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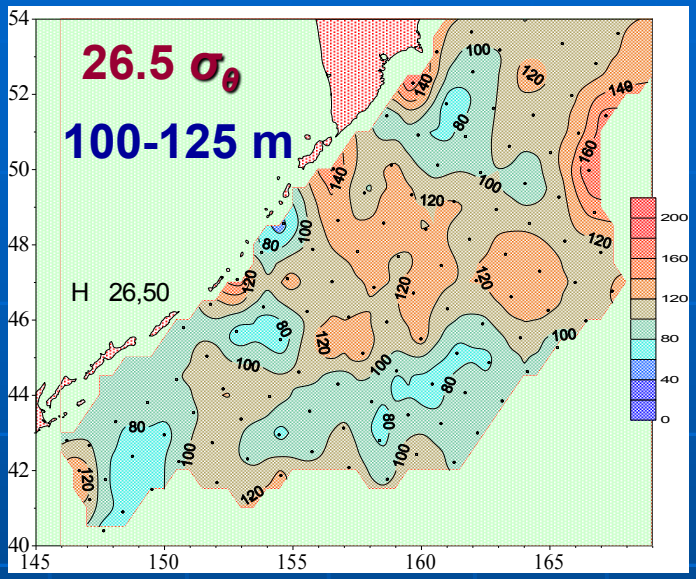
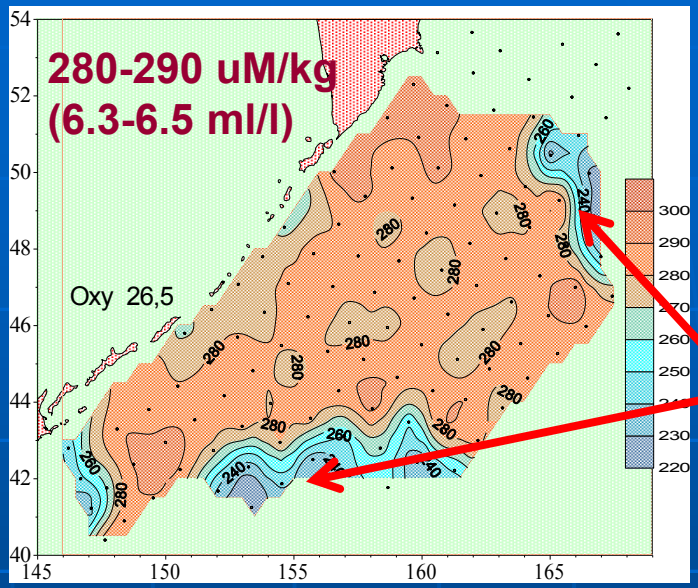
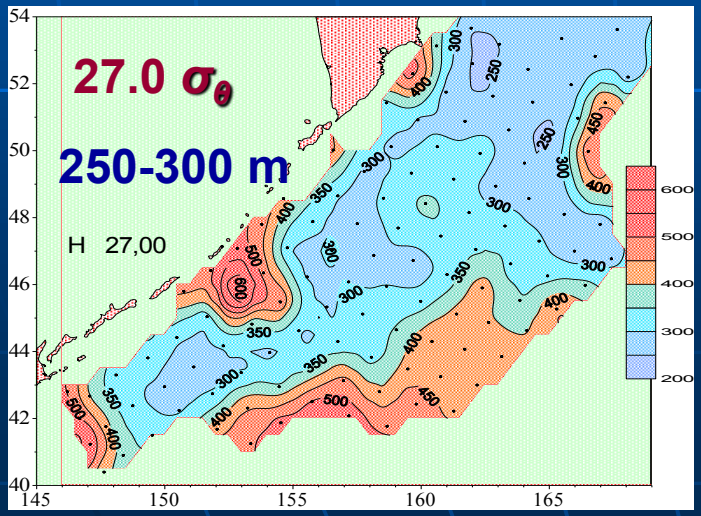
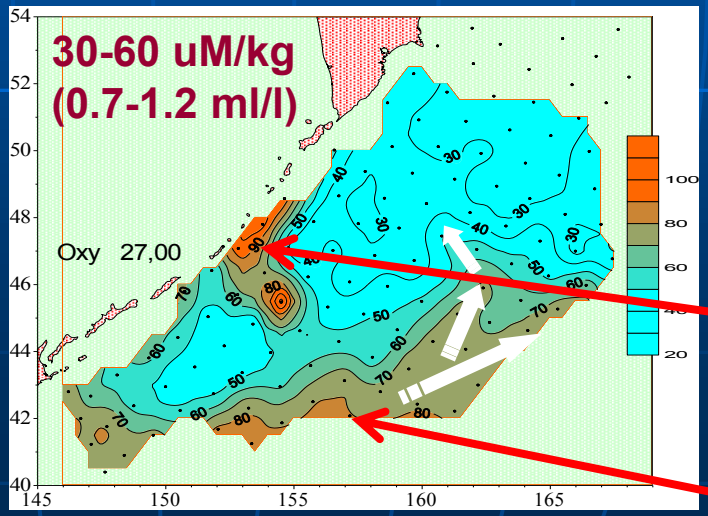




Uniform O_2 concentration over vast area

Low O_2 Concentration in the Transition zone and Alaskan Stream





2 areas with high O_2 concentration 70-100 uM (1.6-2.2 ml/l)

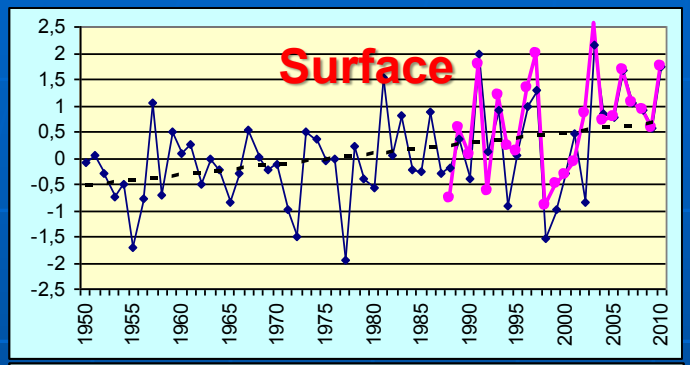
1) Off the Kuril Islands (due to tidal mixing)

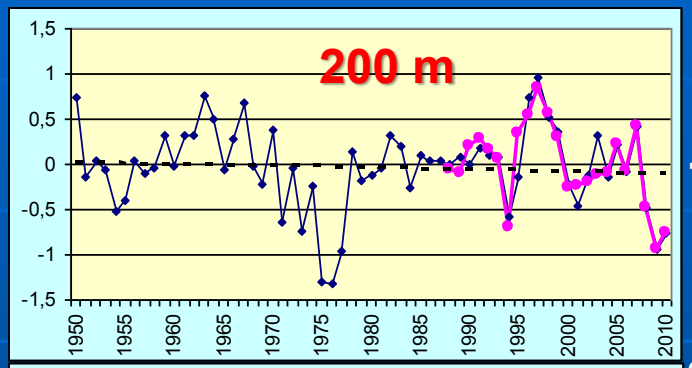
2) In the Transition Zone (due to Ekman pumping)

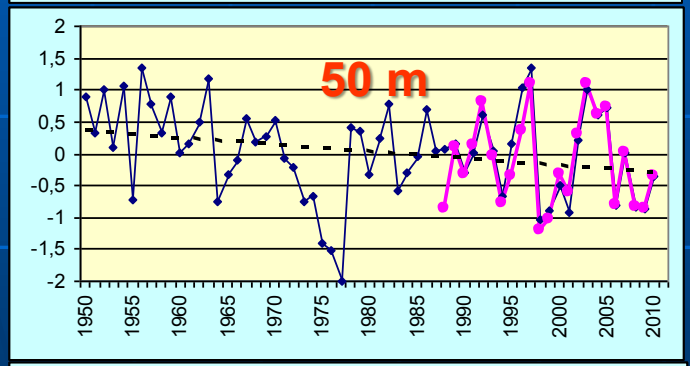
Vast area with low DO in the *IL* to the east of the Kuril Chain

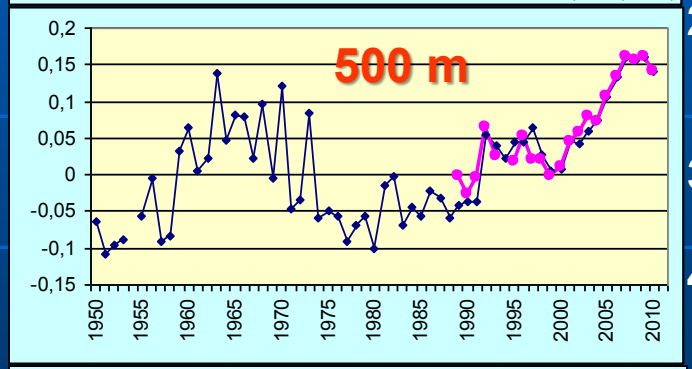
Water temperature anomalies (0-800 m) in the Bering Sea
Dark lines - 1950-2004 (Climatic Atlas of the North Pacific Seas…, 2009). Pink lines - 1986-2010 (TINRO-Centre data)

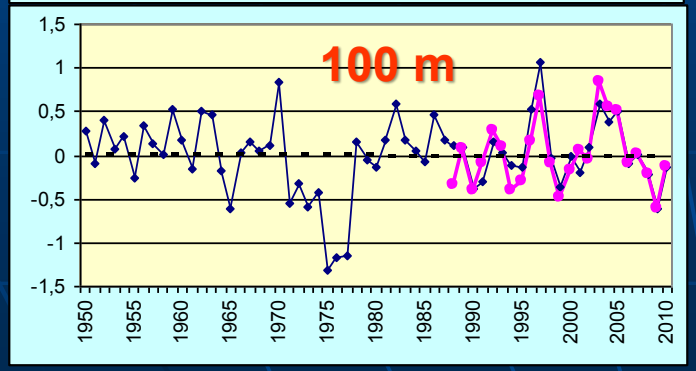
Khen et al., 2013; Deep-Sea Research II, 94, 106-120

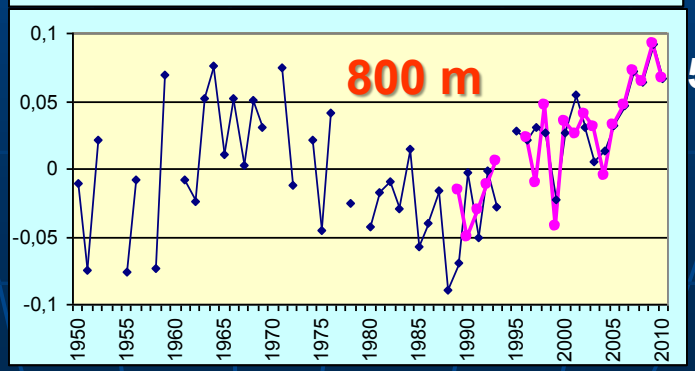












1. Data from Climatic Atlas… and TINRO-Centre observations are compatible
2. Different trends from surface down to deep-sea
3. Positive trend on the surface
4. Negative trend at 50 m (Cold Subsurface Layer)
5. Rapid growth of T° in the deep-sea layers (500-800 m)

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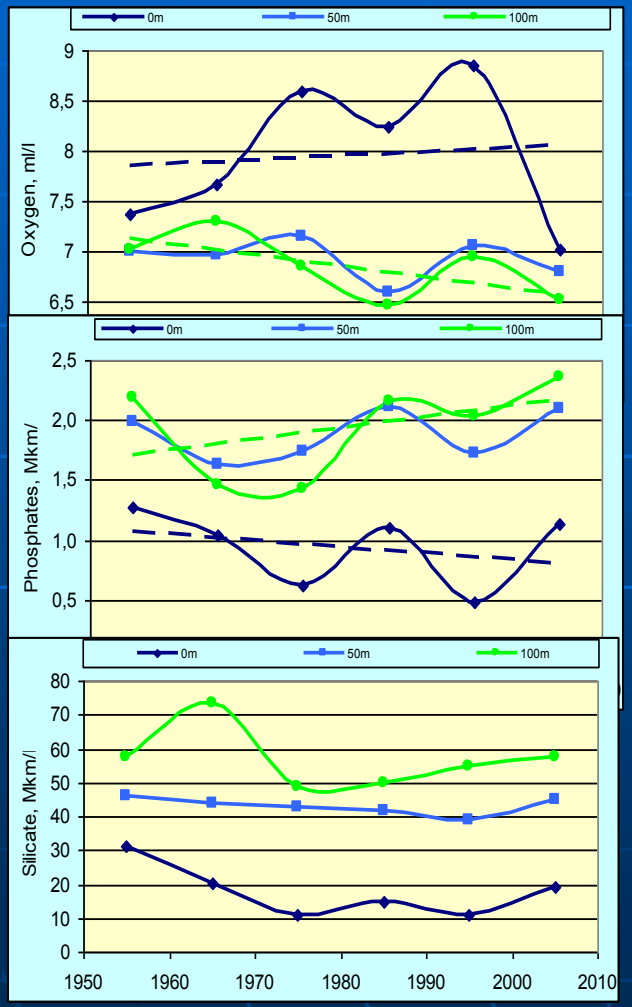
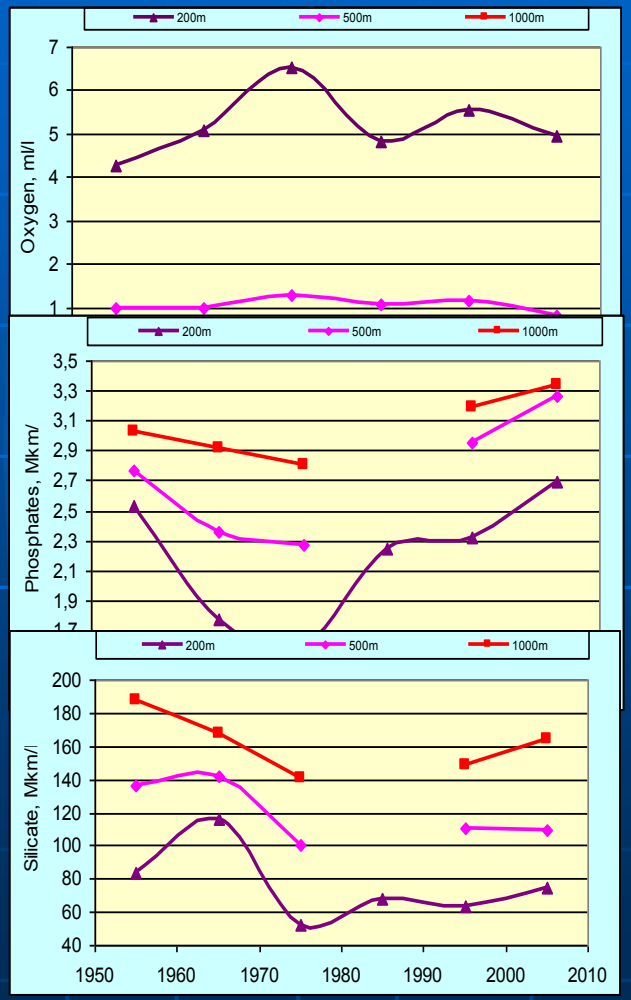
Dissolved Oxygen, Phosphates and Silicates in the Bering Sea (0-1000 m)

Khen et al., 2013; Deep-Sea Research II, 94, 106-120





Weakening of the water exchange between upper and intermediate layers

hampers the input of nutrients up into the euphotic zone, what results in decrease of new production there and reduces the convective transport of oxygenated (by photosynthesis) water to deeper horizons

General Observations on physical factors

- Large-scale geographic pattern (Northeast Asian marginal seas and Northwest Pacific Ocean)
- Long-term time-series of observations
- Multi-layer pattern (major atmospheric circulation systems, near-surface local features, from the sea surface down to bathyal zone)
- Large number of parameters
- Instrumental measurements for physical oceanographic characters (on board the RV) along with widely-accessible satellite-based data…

FUTURE relations:

Key Questions 1 and 2 (ecosystems: resilience, vulnerability, response…)

Objective 1 (increase understanding…)

Biological ecosystem components

Plankton Nekton Benthos

1) Extensive sampling using different catch gear

2) Wide geographic scale

3) Wide depth range (from epi- down to bathypelagic zone, from the shelf to the continental slope…)

4) Long time-series of observations

5) Building and analysis of the DataBase for various ecosystem components

6) Aiming at practical and societal needs

Database processing

Software, statistics

ГИС

DB

knowledge

DataBase

Statistical Tables

GIS

Data source for the study of biological resources in the Russian Far Eastern Seas:

- done
- to be accomplished

Nekton

Benthos

Plankton, etc

Okhotsk Sea

Japan Sea

Bering Sea

Pacific Ocean

Nekton

Benthos

PLankton, etc

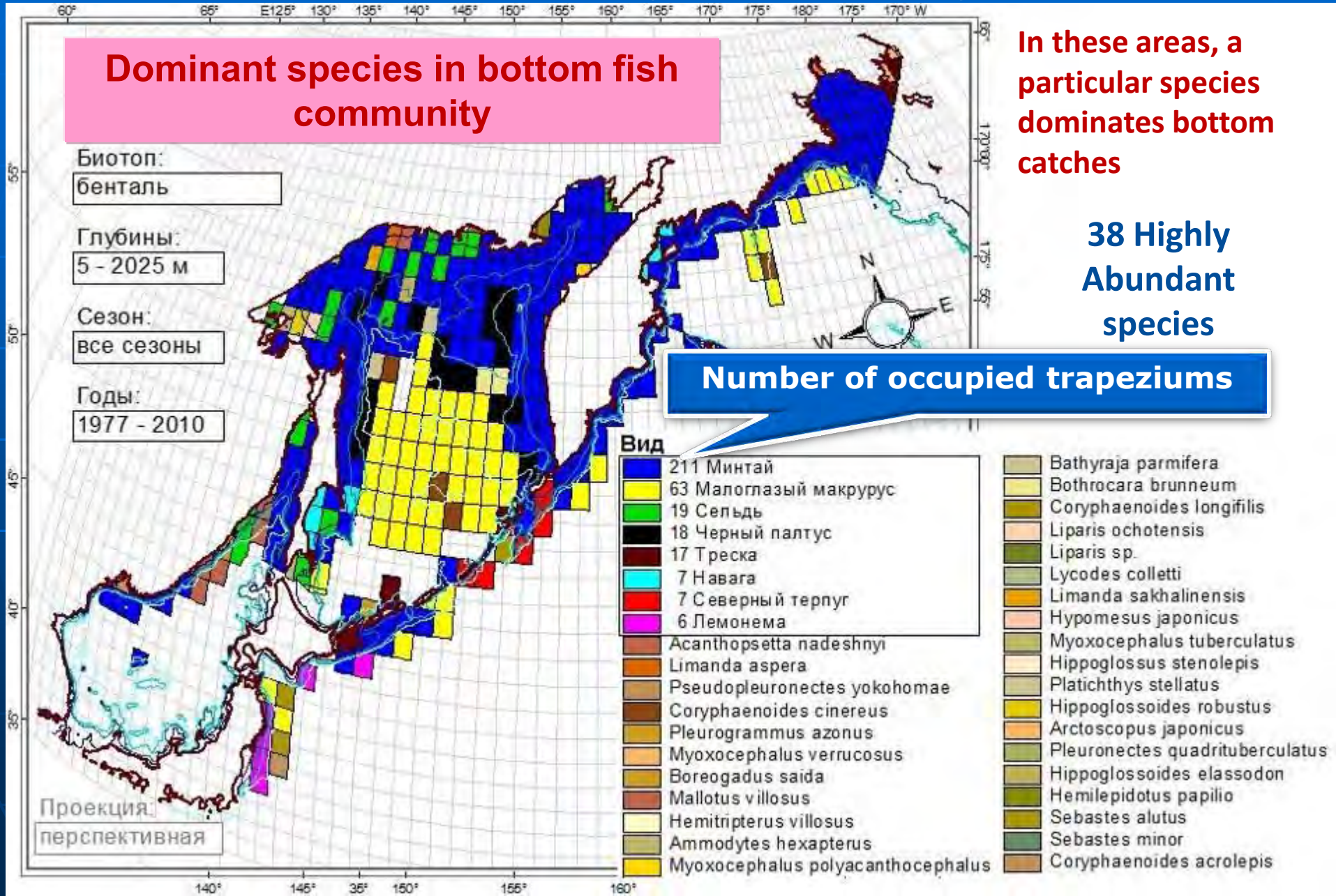
Okhotsk Sea

Japan Sea

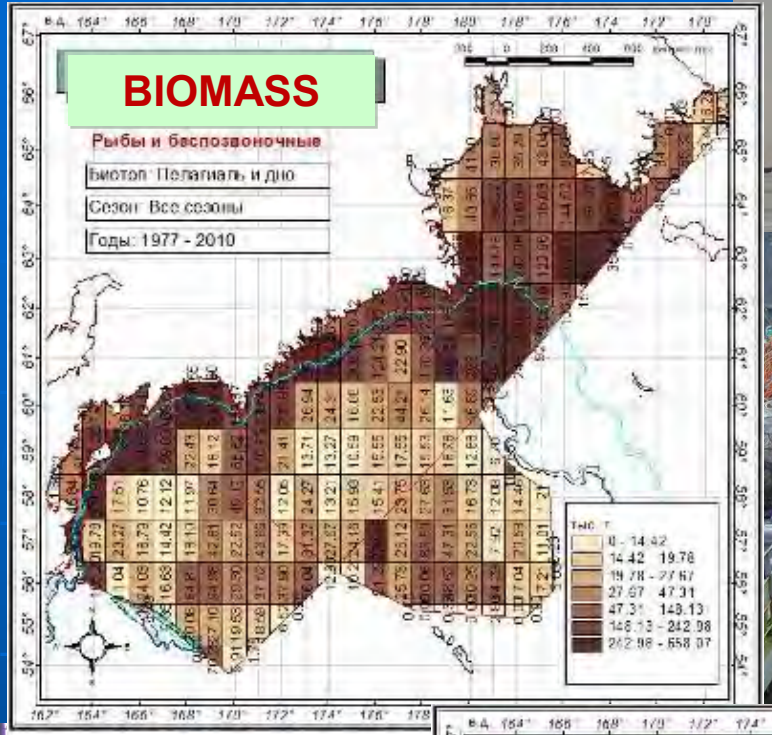
Bering Sea

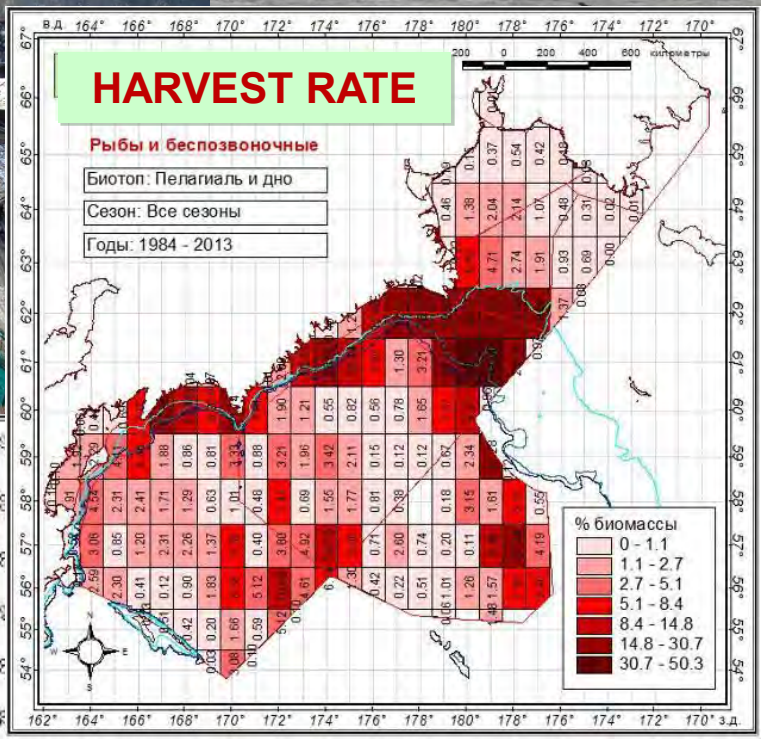
Species Adaptive Zone

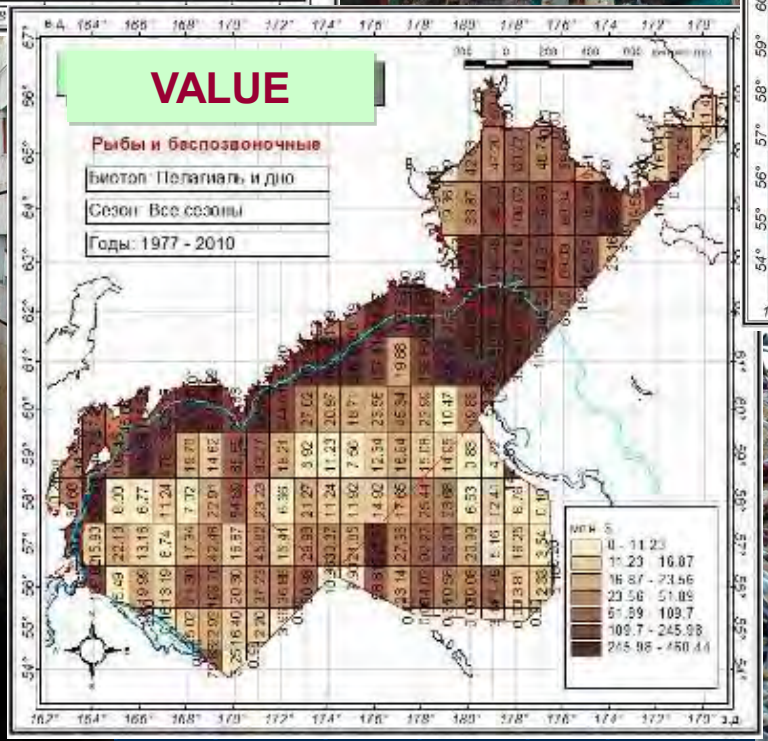
area where conditions favor species dominance by biomass



Biomass (thousand tons), value (million US $) and proportion (%) of harvested biomass for fish and invertebrates in the western Bering Sea in 1977-2010







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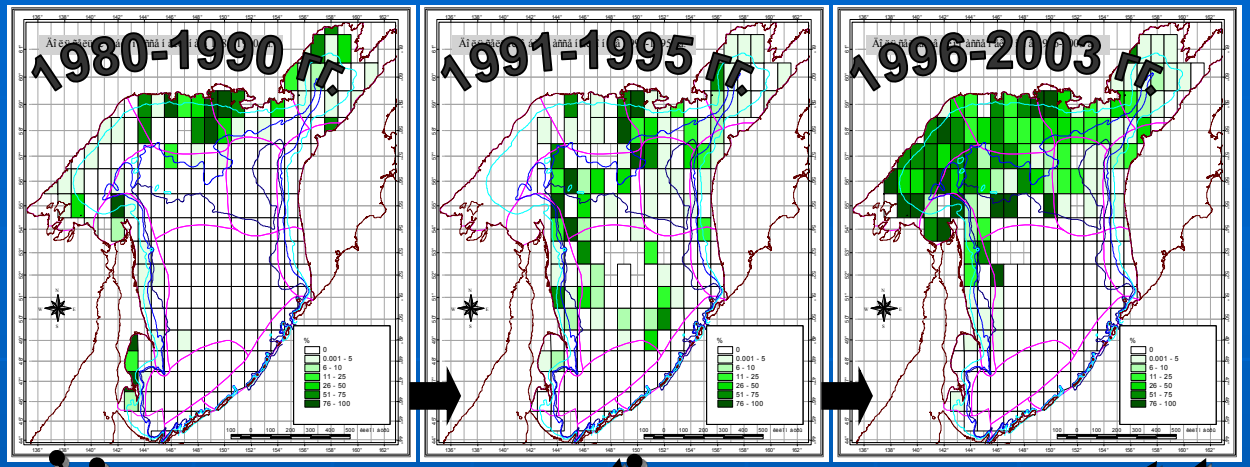
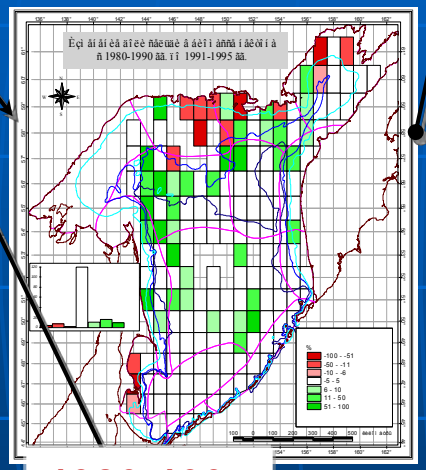
Studies on dynamics of species abundance

The share (%) of Pacific herring biomass in the Okhotsk Sea nekton during 1980-2003



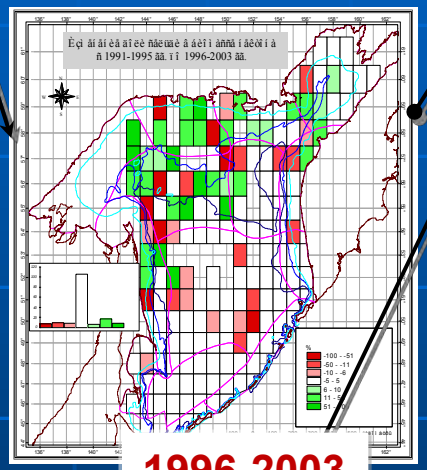
P_1

P_3



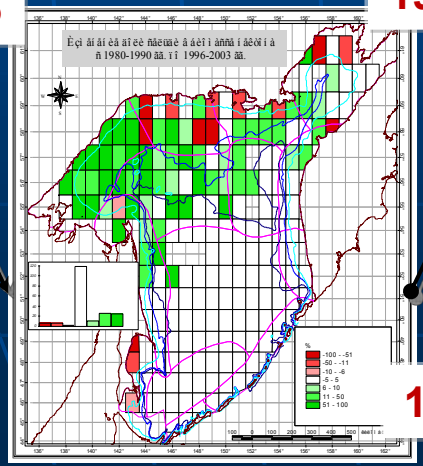
P_2-P_1

1980-1995



P_3-P_2

1996-2003



P_3-P_1

1980-2003

Central and Lower charts show annual trends in herring biomass:

red – decrease

green – increase

white – insignificant change

$$\Delta P=(P_2-P_1)+(P_3-P_2)=P_3-P_1$$

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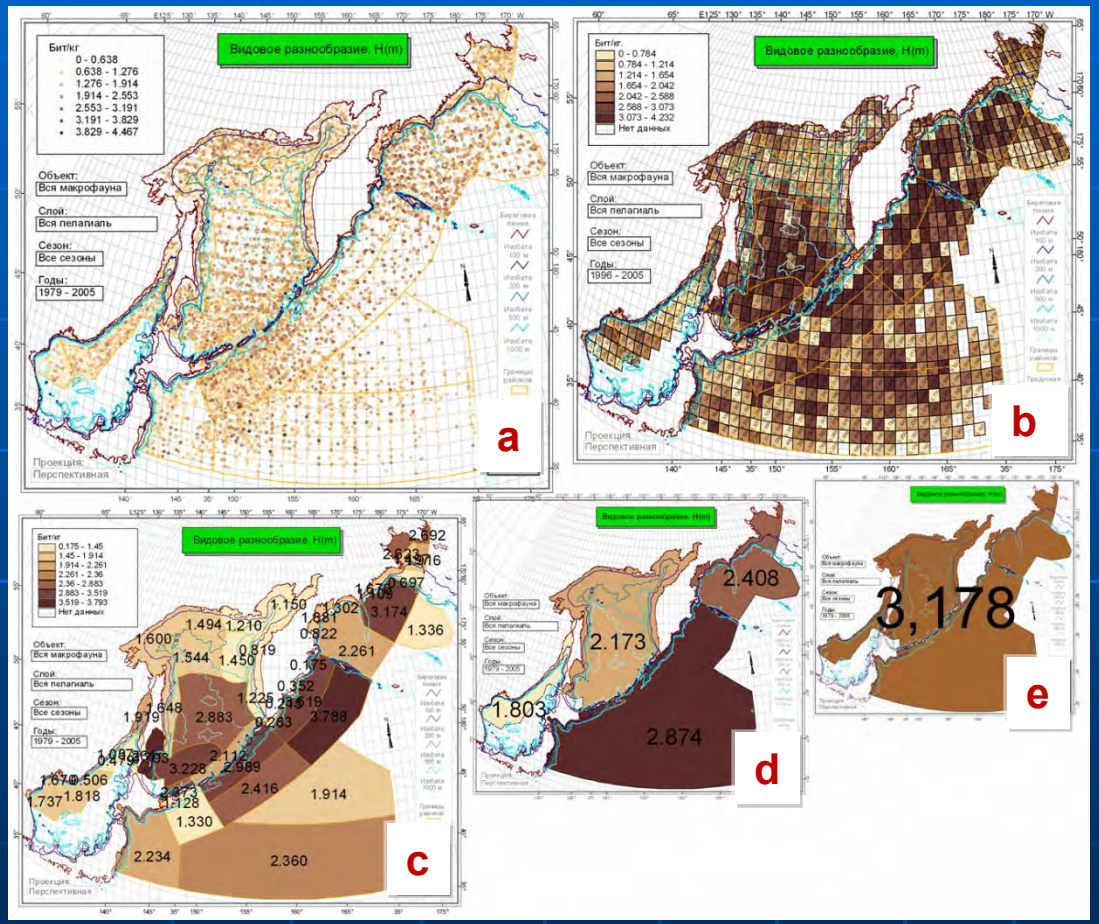
BIODIVERISTY ISSUES

Species Diversity (Sannon index) for pelagic macrofauna in the Northwest Pacific and marginal seas



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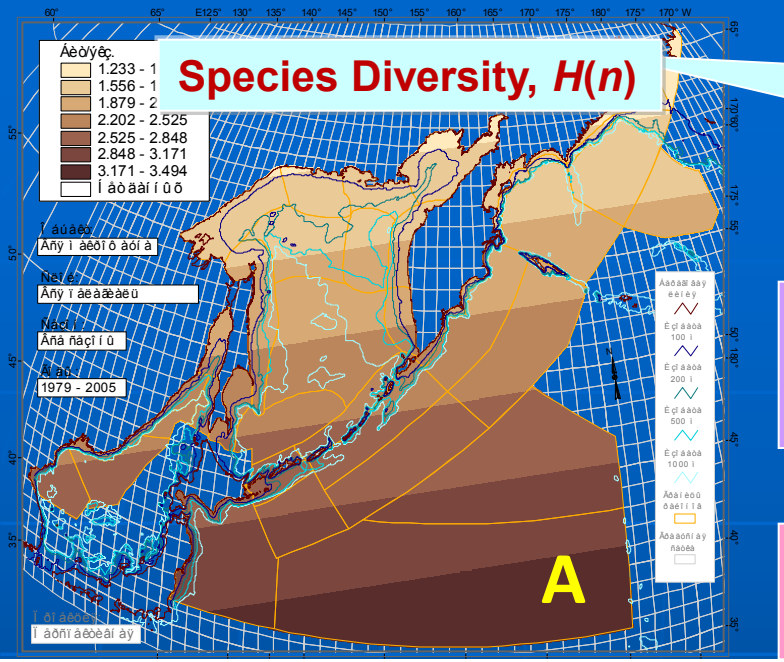
a – trawl stations,
b – one-degree trapeziums,
c – biostatistical areas,
d – regions,
e – total area

Study Group on Biodiversity Conservation (2013-2014)



Shannon Index

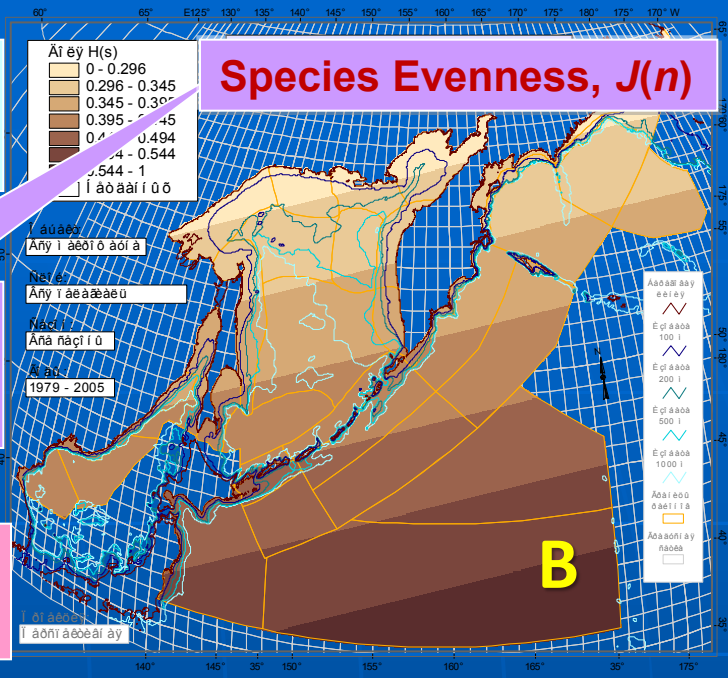
$H = -\Sigma p_i \cdot \log_2 p_i$

where $p_i = n_i/N$

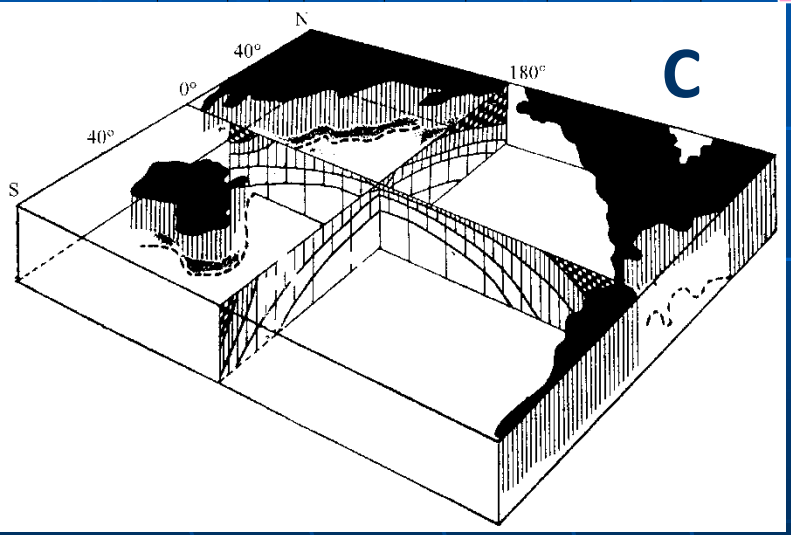
Pielou's Index

$J = H/Hmax$

where $H_{max} = \log_2 S$



THREE CHART TYPES:



A) – Diversity in pelagic macrofauna in the NWP

B) – Evenness in pelagic macrofauna species structure

C) – Biological structure of the Pacific Ocean (Bogorov, 1970); density of dashed lines corresponds to productivity

Diversity (D) and evenness (E) negatively correlate with productivity (P) in the NWP

(D and E decrease, while P increases from central to marginal areas)

Negative correlation between D and E on one hand and P on the other exists in both space and time. During the 1980s - early 1990s, there was a decline in fish productivity and a rise in diversity and evenness

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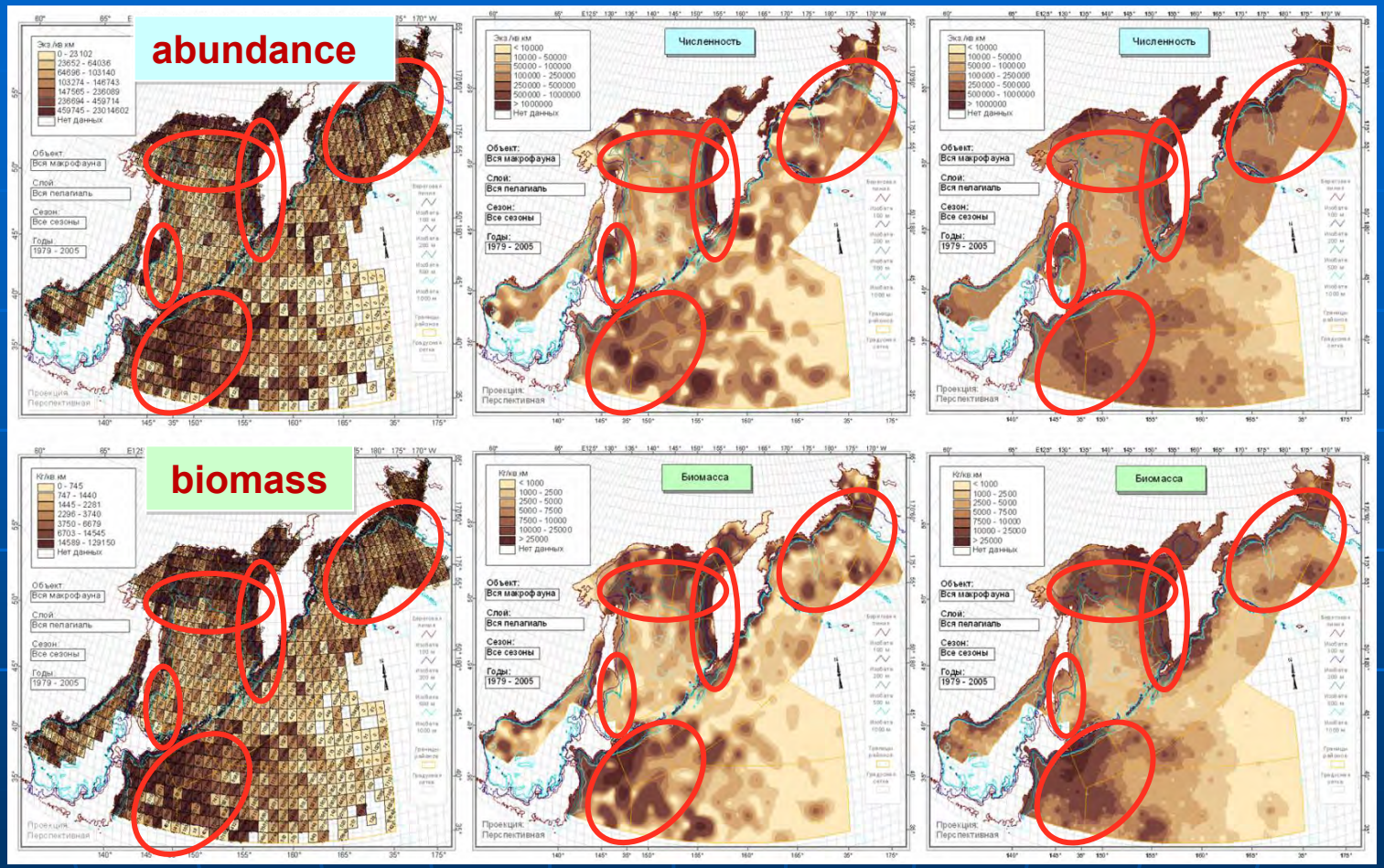
Spatial distribution of abundance and biomass for pelagic macrofauna

Different levels of data aggregation



Macrofauna is most abundant on the shelf close to big land areas and above the slope, and decreases from periphery towards the centre of the ocean

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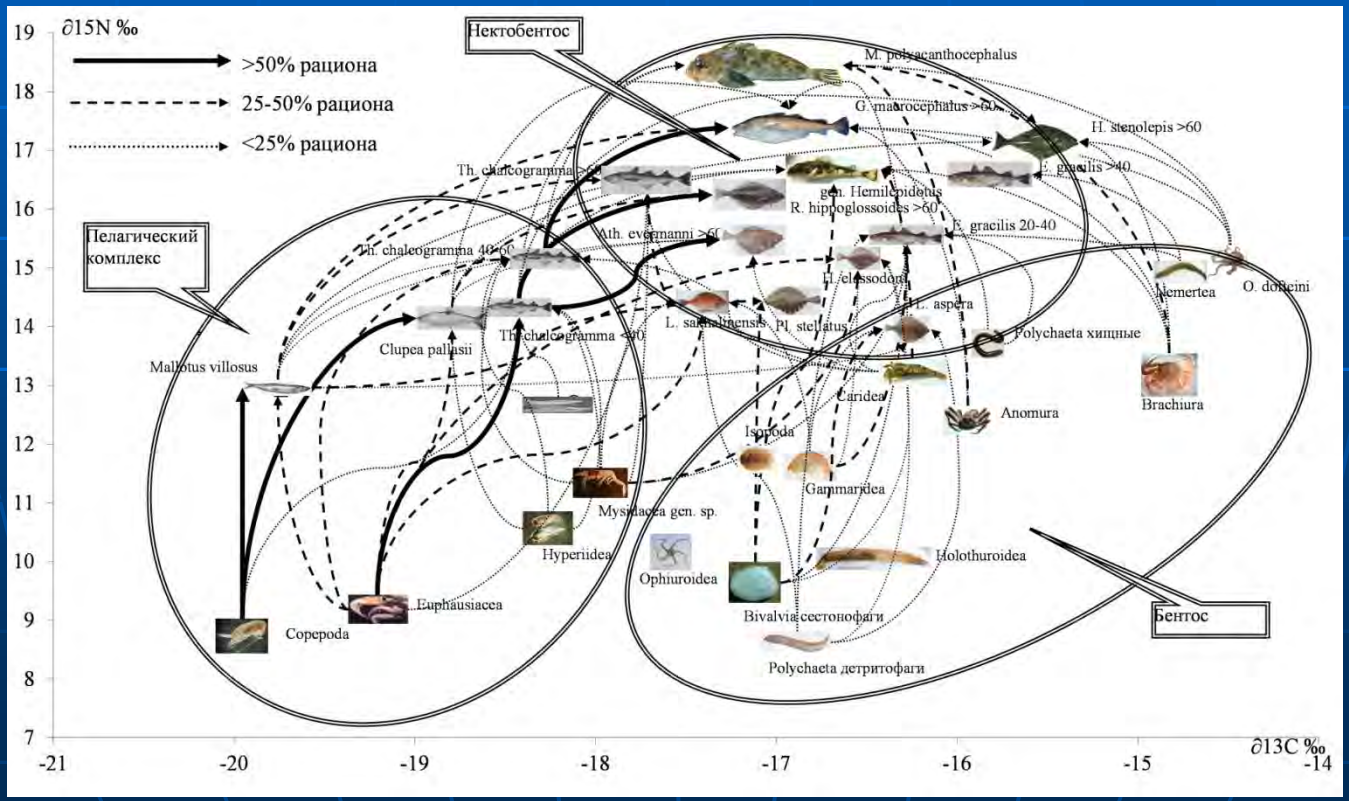
Studies of complex trophic interactions in pelagic and bottom communities

(the Okhotsk Sea example)

Data from stable isotopes proportions for nitrogen ($\delta^{15}N=^{15}N/^{14}N$) and carbon ($\delta^{13}C=^{13}C/^{12}C$)



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Climate (IPCC) projections downscaling to regional ecosystems

Section on Climate Change Effects on Marine Ecosystems (2011-2020)

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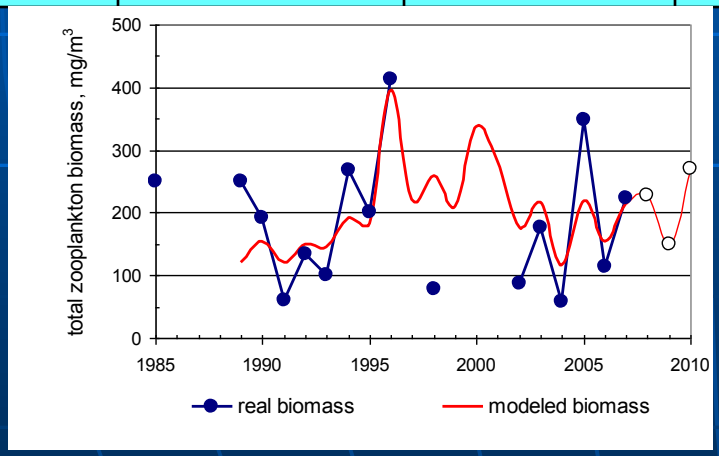
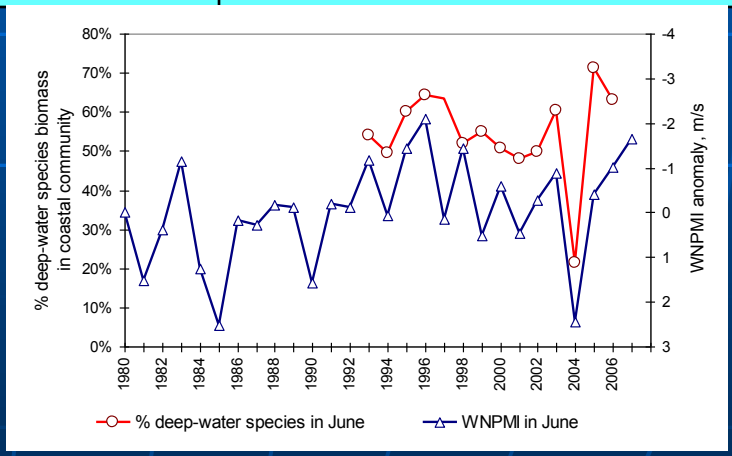
Scale	Possibility of projecting	Uncertainty	Trophic levels that can be projected	Examples
Basin-	Possible	Low	Primary Production Zooplankton Nekton	Potential PP model Zooplankton biomass model Saffron cod stock model
Meso-	Possible	High	Zooplankton	Zooplankton species composition in the coastal zone



Annual changes in SST and temperature in the Intermediate Layer can be used to predict the abundance of deep-water zooplankton in the NW JES



Deep-water zooplankton biomass variability is associated with the strength of summer monsoon (in the NW JES)

General Observations on biological characteristics

- Large-scale geographic pattern (Northeast Asian marginal seas and Northwest Pacific Ocean)
- Long-term time-series of observations on numerous ecosystem components
- Large number of ecosystem components (lower- to higher trophics, data from the sea surface down to bathyal zone, etc.)
- Multi-dimensional pattern (various biological parameters, including population features, complex trophic interactions, relationships to physical parameters, etc.)

FUTURE relations (similar to non-biological parameters):

Key Questions 1 and 2 (ecosystems: resilience, vulnerability, response…)

Objective 1 (increase understanding…)

The study of environmental and resource quality

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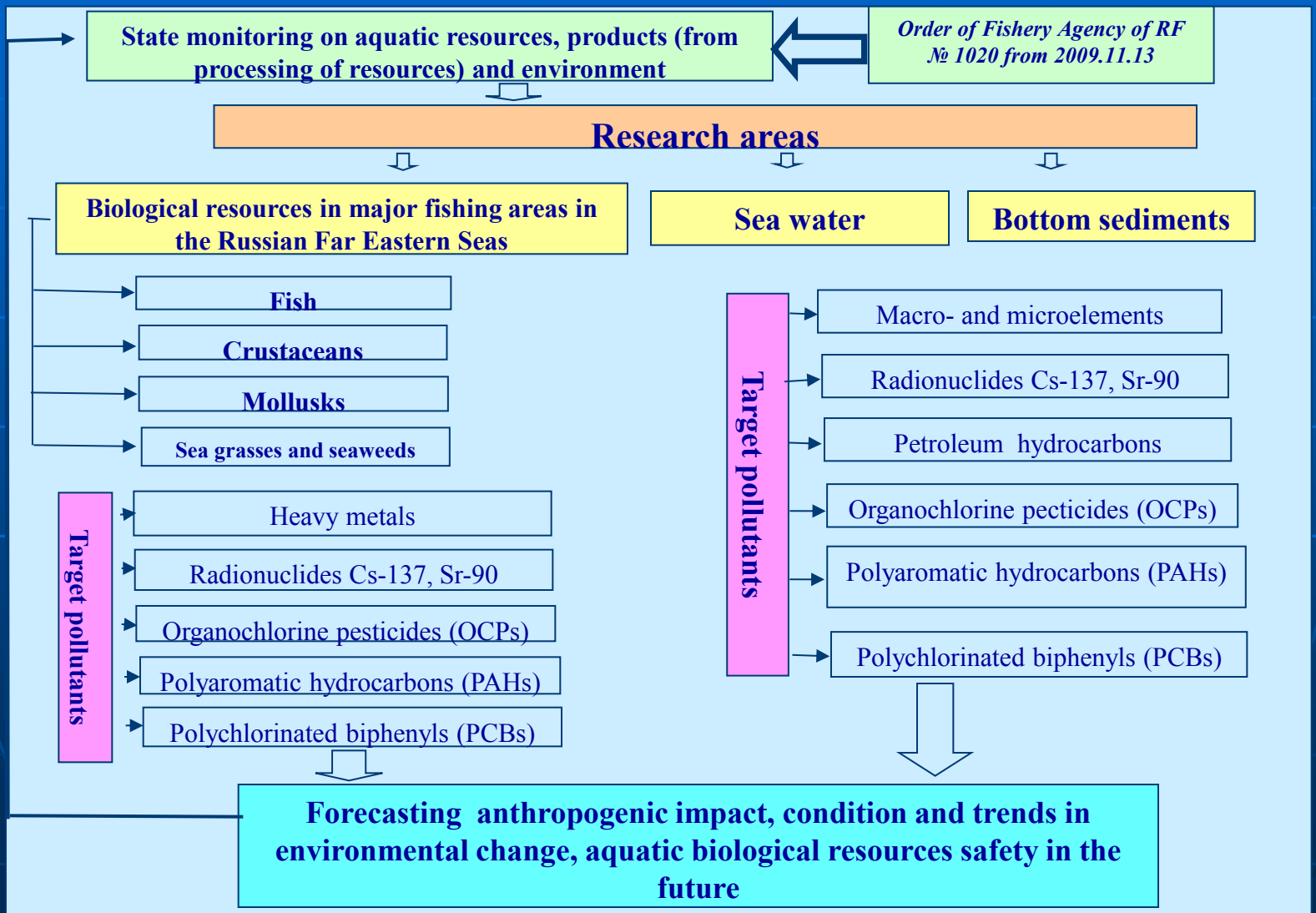
Study Group on Marine Pollutants (2011 - 2013)
Working Group on Emerging Topics in Marine Pollution (2014 - 2016)

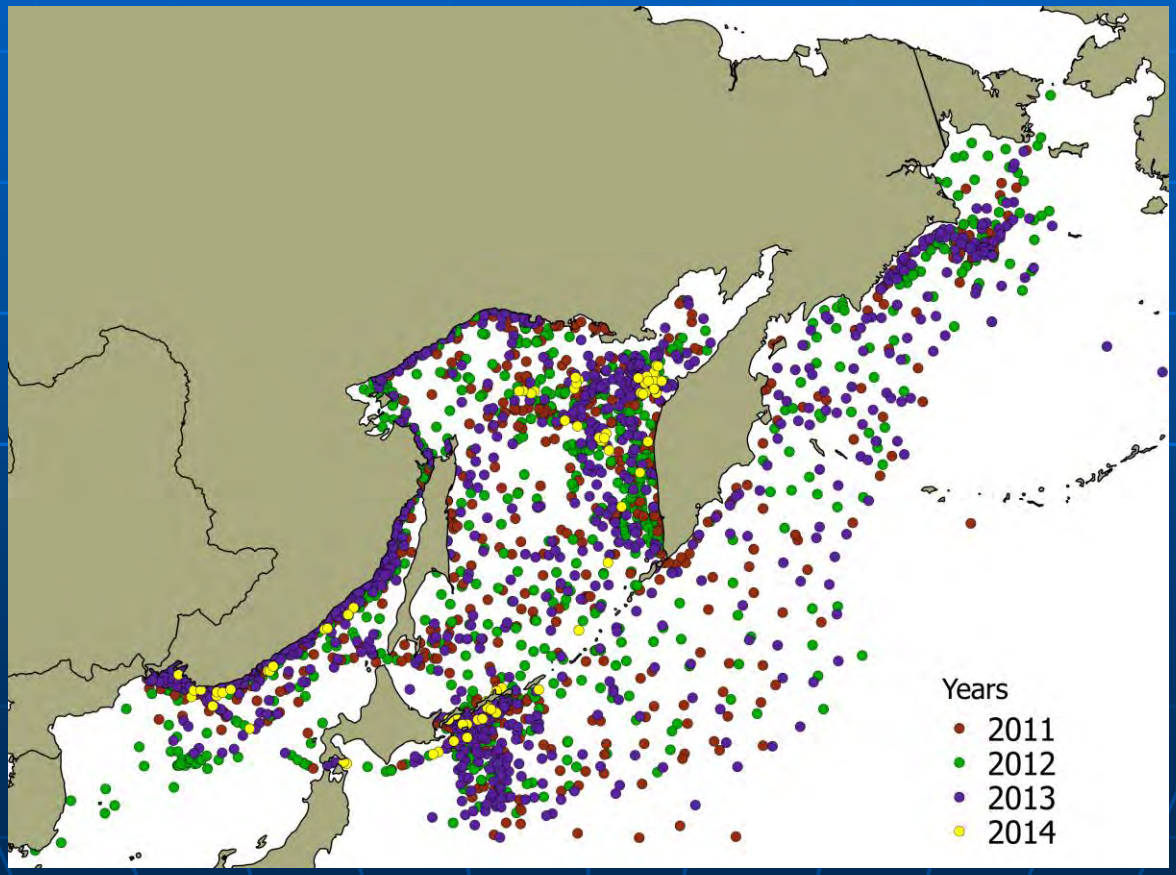


Radioactivity

Research area for regular measurements of radioactivity (μR/h) on board RVs

Air, Water, Catch

Study Group on Radionuclide Science in the North Pacific Ocean (2013 - …)



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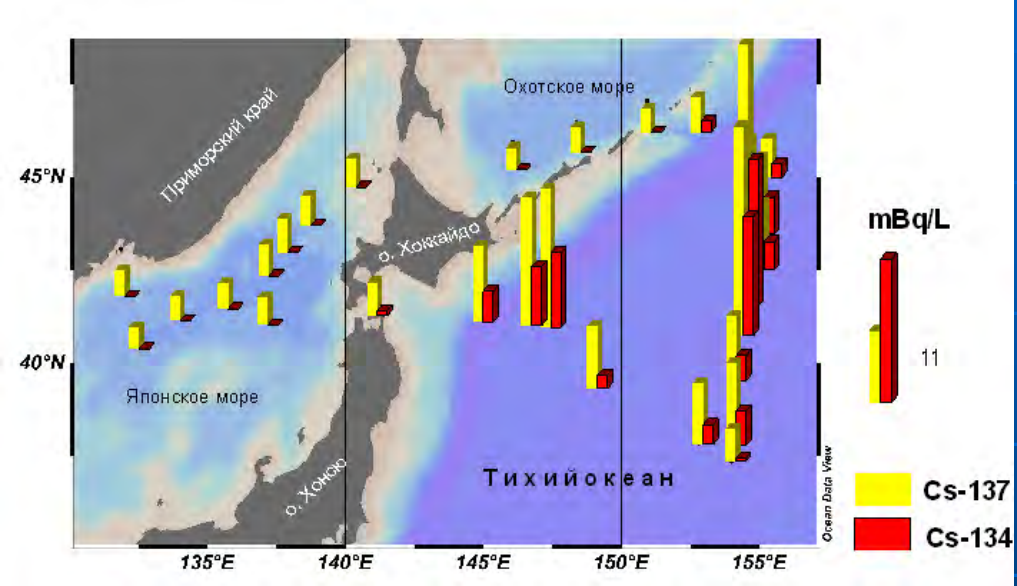
Radiation studies, RAS (deep into the ocean)



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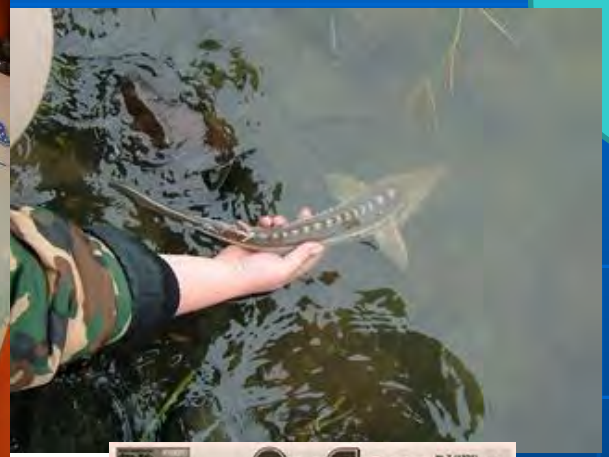
In the Pacific Ocean off Kuril Islands and Japan (in areas of convergence associated with synopyic-scale eddies in the Kuroshio-Oyashio transition zone), increased concentrations of Cs^{134} и Cs^{137} from Fukushima were observed. Radionuclides were distributed down into deep layers, and higher concentrations were observed down to 200-350 m, and increased values were detected even at 1000 m. However, these figures appeared several orders lower than those harmful for people's health.

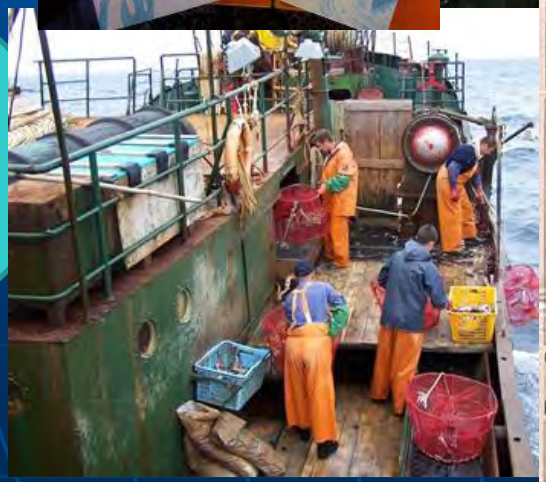
Issues in Human Dimension & Science Communication

Fishery forecasts



Tagging programs

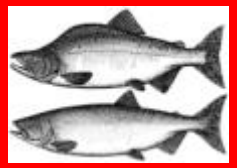
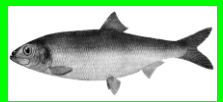
Joint research on commercial vessels



Scientific periodicals

Section on Human Dimensions of Marine Systems (2011-2020)

Development of Basin-Scale Forecasts for Fishery Management

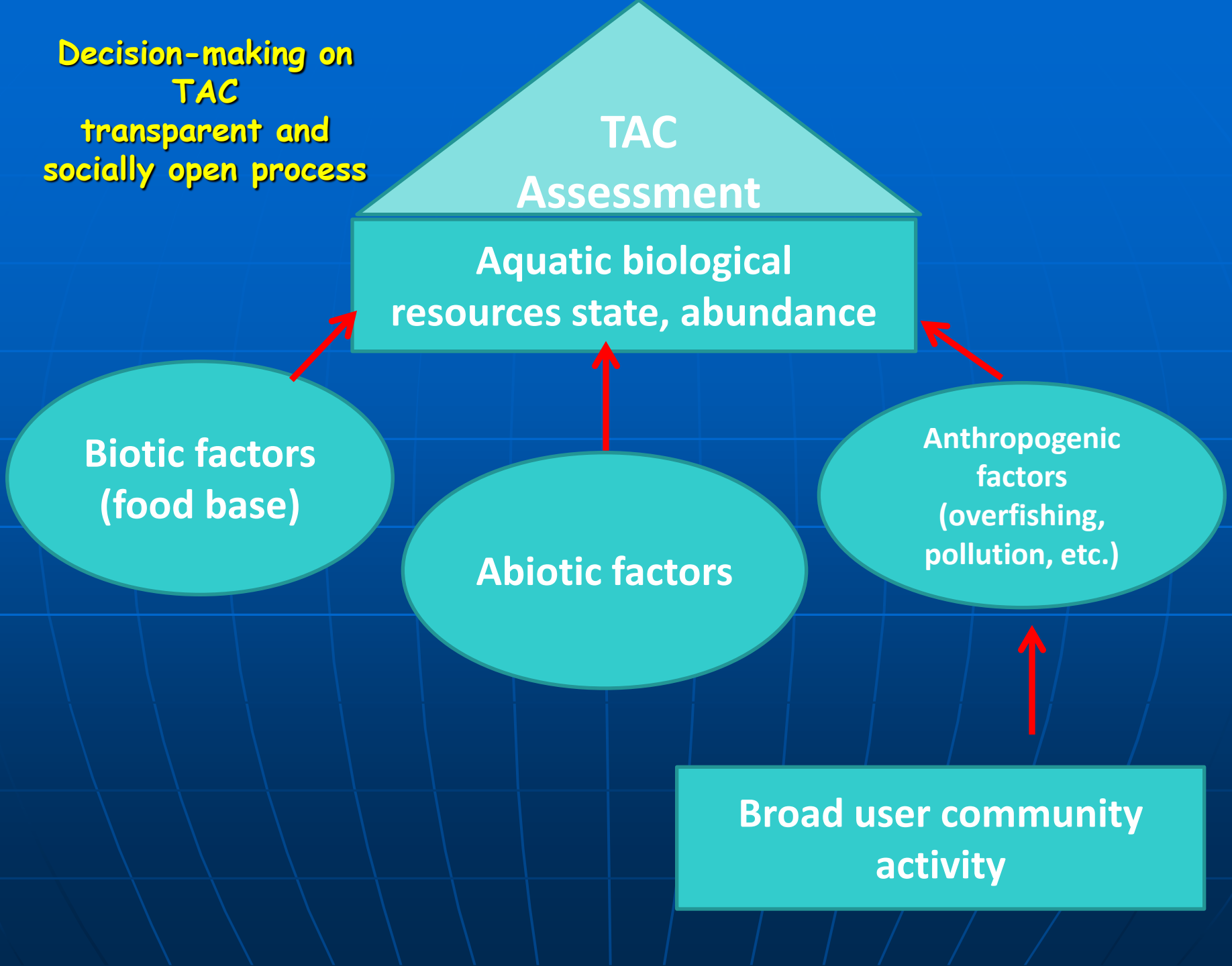
salmon	herring	pollock (Okhotsk Sea)	pollock (Bering Sea)	saury	king crab
					
ЛОСОСЬ (с 1999 г.) ПУТИННЫЙ ПРОГНОЗ	НАГУЛЬНАЯ СЕЛЬДЬ (с 1999 г.) ПУТИННЫЙ ПРОГНОЗ	ОХОТОМОРСКИЙ МИНТАЙ (с 2000 г.) ПУТИННЫЙ ПРОГНОЗ	БЕРИНГОВО-МОРСКАЯ МИНТАЕВАЯ ПУТИНА (с 2000 г.) ПУТИННЫЙ ПРОГНОЗ	САЙРА (с 2001 г.) ПУТИННЫЙ ПРОГНОЗ	КАМЧАТСКИЙ КРАБ (С 2002 Г.) ПУТИННЫЙ ПРОГНОЗ

Various forecasts for particular fisheries

1. Гидрометеорологических условий — oceanography
2. Состояние запасов объекта — stock assessment
3. Анализ промысла — analysis of fishing activities
4. Прогноз хода путины — fishing season forecast
5. Рекомендации по орудиям лова
6. Рекомендации по переработке сырья
7. Обзор рынков и цен
8. Правовые основы промысла

http://www.tinro-center.ru/uslugi-i-produkcia/podderzka-promysla/mesacnye-prognozy

Decision-making on TAC transparent and socially open process



General Observations on human-related activities

- Effective communication of science using a wide variety of means and across the whole societal structure from native communities up to decision-makers
- Mostly coastal-associated programs and activities related to assessment of environmental quality (with an expansion to off-shore area, e.g. radionuclide studies)…

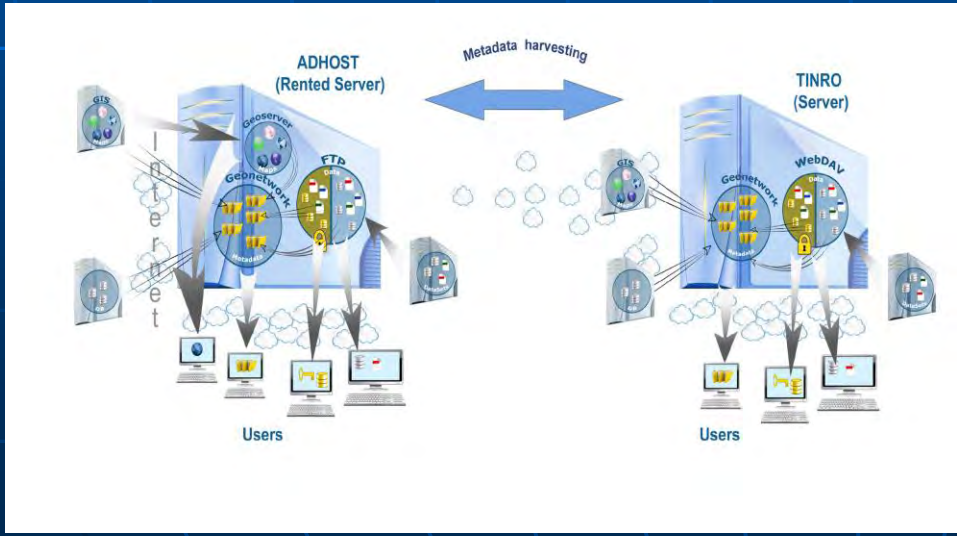
FUTURE relations:

Key Question 3 (societal issues associated with ecosystems…)

Objective 2 (activities for delivering science products to society…)

Metadata/data federation

- TINRO-Centre established and maintains a GeoNetwork-based server to **promote metadata/data exchange** among Russian academic and fishery scientists to support data management and enhance the timely availability of physical and biological data/information/services on marine ecosystems of the North Pacific
- The server provides **collection and synchronization of metadata** with the PICES TCODE geospatial server (which is administered by the TINRO-Centre team)
- The server should become a vital tool for individual scientists, expert groups, national and international projects including those of the PICES FUTURE



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Wrap-ups

- Russian National Programs are closely related to FUTURE Research themes and Objectives
- These Programs are COMPLEX (multi-disciplinary) and are aimed at describing the structure, state and function of oceanic and coastal communities, and climate and oceanography of the vast marine areas in the North Pacific
- These studies include collection of database on environmental and anthropogenic impacts on marine resources, and are aimed at utilizing that database to a maximum advantage
- Studies within these programs reveal changes and trends in communities, ecosystem components (including valuable marine resources), and environmental factors, apply to ecosystem services and broad uses of marine resources by human societies
- The results of the studies are used to produce outlooks and forecasts, and major achievements are delivered to the broad community, including public, managers, politicians, etc.

General conclusions from Russian potential investment to the FUTURE implementation

Key Questions – AICE and COVE business

- **Major effort is given to physical-chemical processes and ecosystem structure, state and function (COVE)**
- **More effort (compared to 2009) is given to coastal issues relating to anthropogenic influence (AICE)**

SOFE business

- **Major effort is given to STATUS and OUTLOOK**
- **More effort (compared to 2009) effort is given to FORECAST and ENGAGEMENT**

Future FUTURE

New Yorker Magazine…

What do we need for FUTURE?

1) Propagate open-minded understanding of natural processes (try not to be obsessed with "fashionable" ideas)…
2) Utilize the possibility for multi-national cooperative research to a maximum extent (better use the possibilities provided by PICES)…
3) Perceive Human Dimensions broadly (concentrate on societal and people's needs, not only on the needs of stakeholders)…