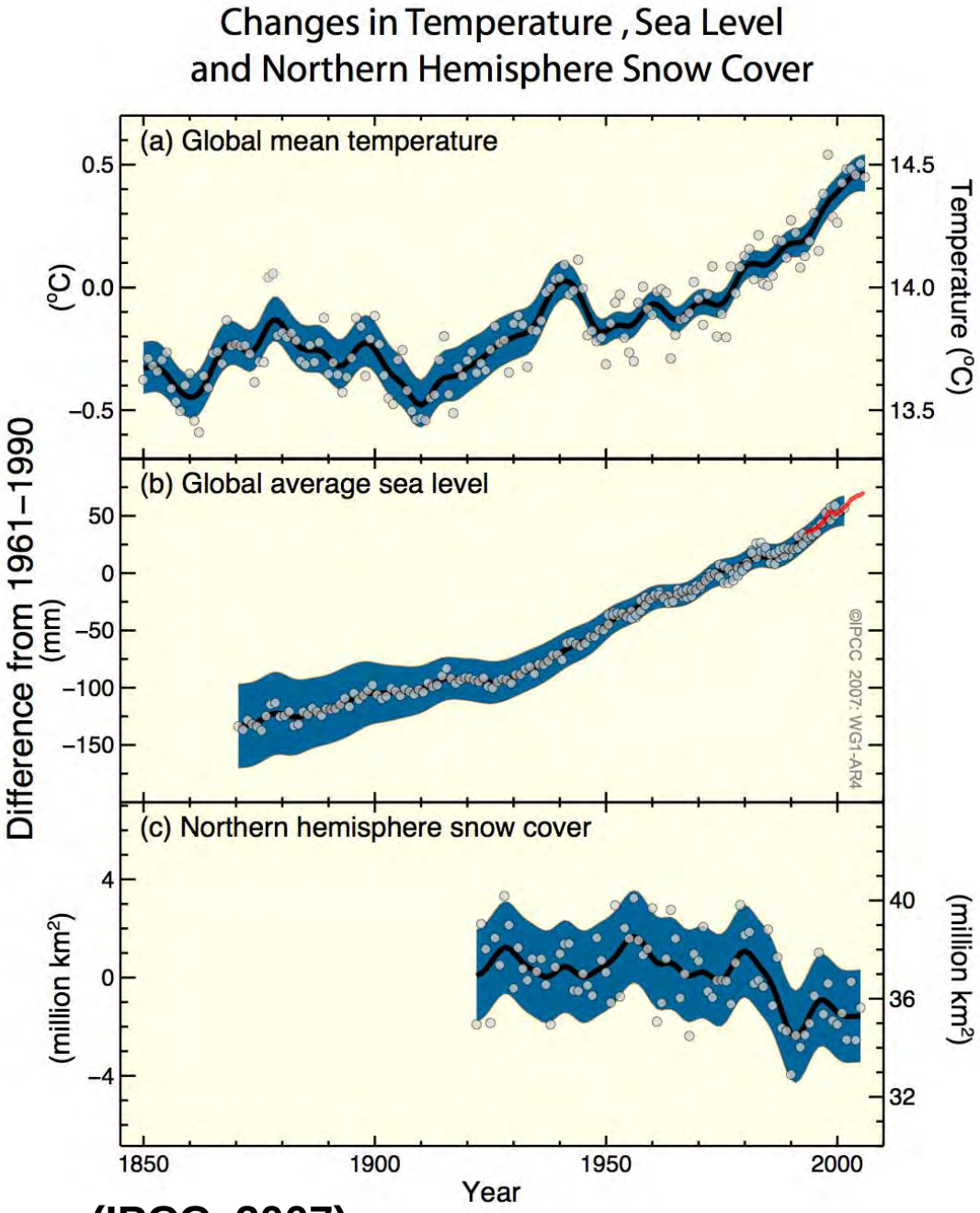
Pacific Scientific Research Fisheries Centre (TINRO-Center),
Vladivostok, Russia

Current reorganizations in marine ecosystem in relation to climate change: Global or regional forcing?

Vyacheslav Shuntov and Olga Temnykh

PICES 2011 Annual Meeting
Mechanisms of Marine Ecosystem Reorganization in the North Pacific Ocean



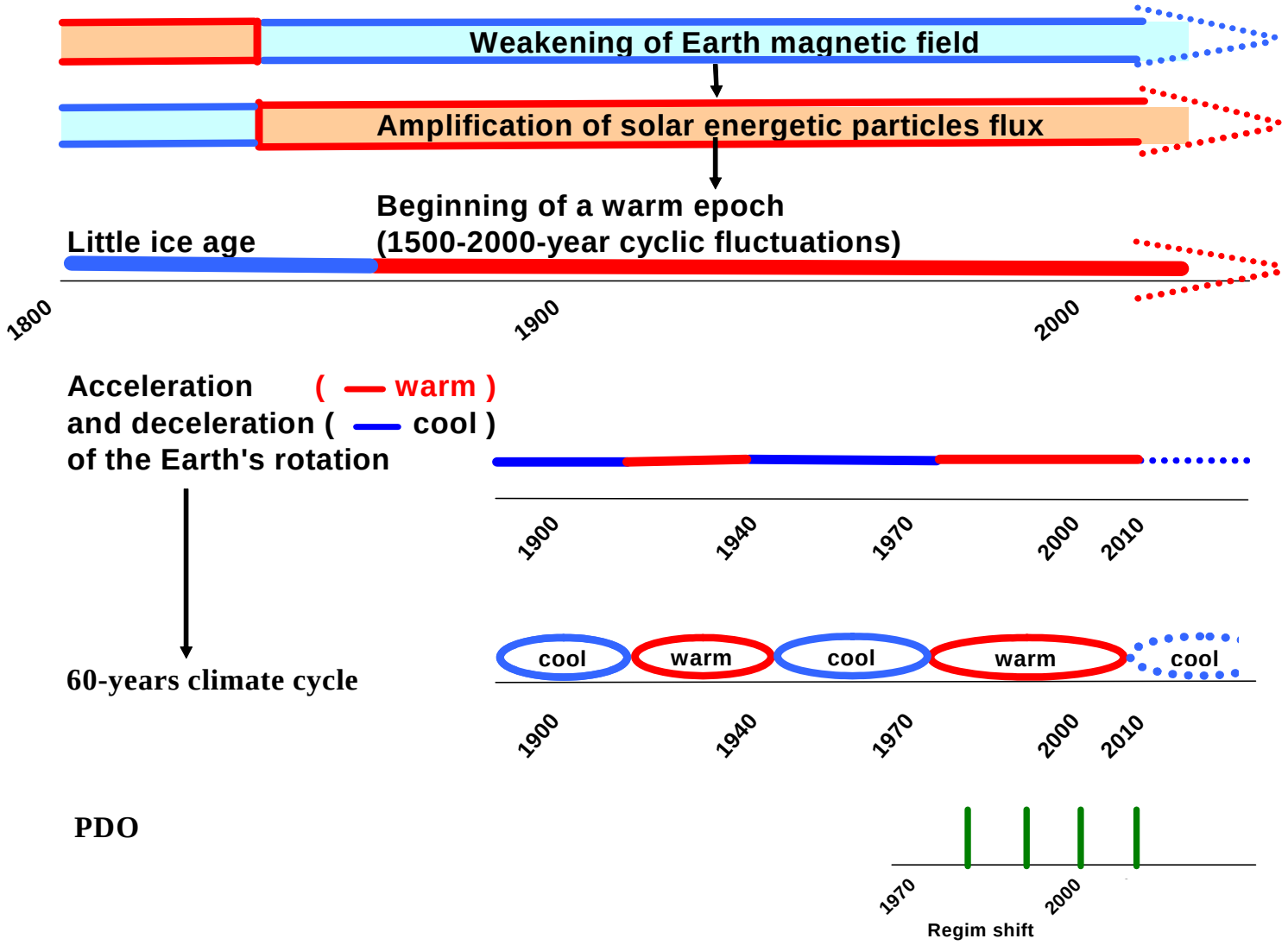
(IPCC, 2007)

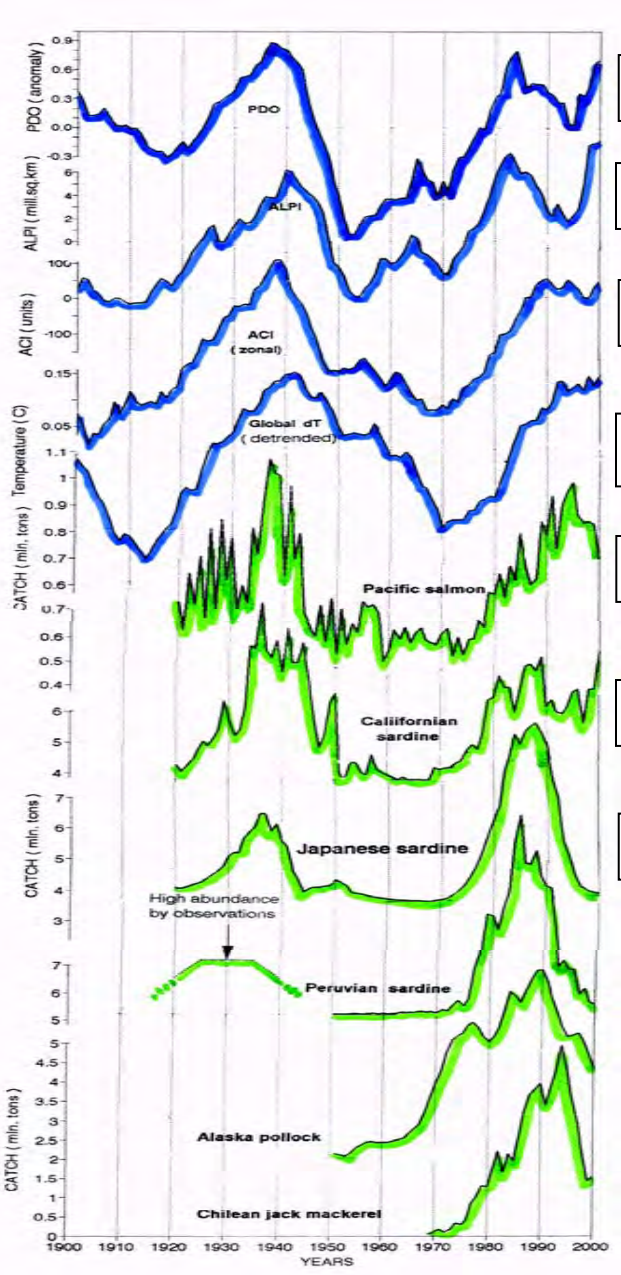
Global warming

- **Is global warming the result of greenhouse effect from human activity, or it reflects cyclic natural processes?**

Climate changes have a natural cyclic pattern. The modern climate state is a “common link” in the chain of the cycle of the planetary events, in which the nature epochs come to replace each other with a different periodicity in a wave-like manner

Long-term dynamics of some geophisical and climate factors in the last 1500-2000-years planetary cycle





PDO

ALPI

Zonal ACI

Global dT

Pacific salmon

Californian sardine

Japanese sardine

Peruvian sardine

Alaska pollock

Chilean Jack mackerel

Coherency of Climate and Commercial Catch Dynamics in the Pacific, 1900-2000

(after Klyashtorin and Lyubuschin, 2007)

Questions associated with assessment of state of knowledge on the dynamics of population abundance, biocenoses and ecosystems

- Why climate-oceanographic and ecological forecasts rarely prove to be true?
- Why only few species (mainly fluctuating) clearly respond to climate dynamics?
- Why ecologically similar species within a single area (and different populations of the same species in different areas) do not fluctuate synchronously?
- Why populations of ecologically similar species fluctuate synchronously in geographically distant areas?
- Why population waves (and species dominance in communities) may differ during analogous periods of two subsequent cycles?
- What are the causes for different duration of abundance cycles in different species?

? Why climate-oceanographic and ecological forecasts rarely prove to be true?

- Climate, geophysical, astronomic, and hydrological indices and their dynamics reflect the essence of climate variability only to a certain extent. Our quest for connections between ecosystem dynamics and climate-hydrological events is just an attempt to reveal outlines of relationships basing on simplified formal parameters of climate variability.

- impossible to find out an integral parameter of complex impact of numerous factors on separate biotic components

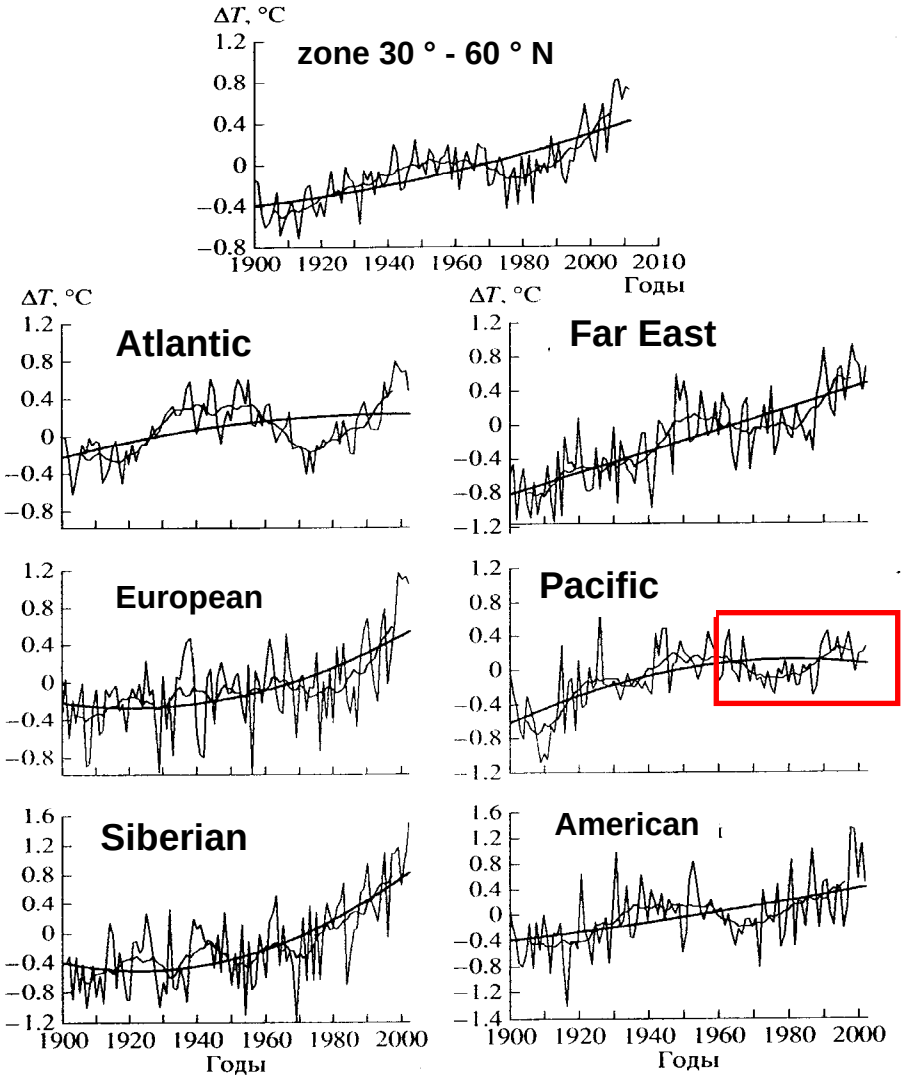
? Why ecologically similar species within a single area (and different populations of the same species in different areas) do not fluctuate synchronously?

? Why populations of ecologically similar species fluctuate synchronously in geographically distant areas?

- Regional patterns in dynamics of physical geography of landscape zones and associated biotas

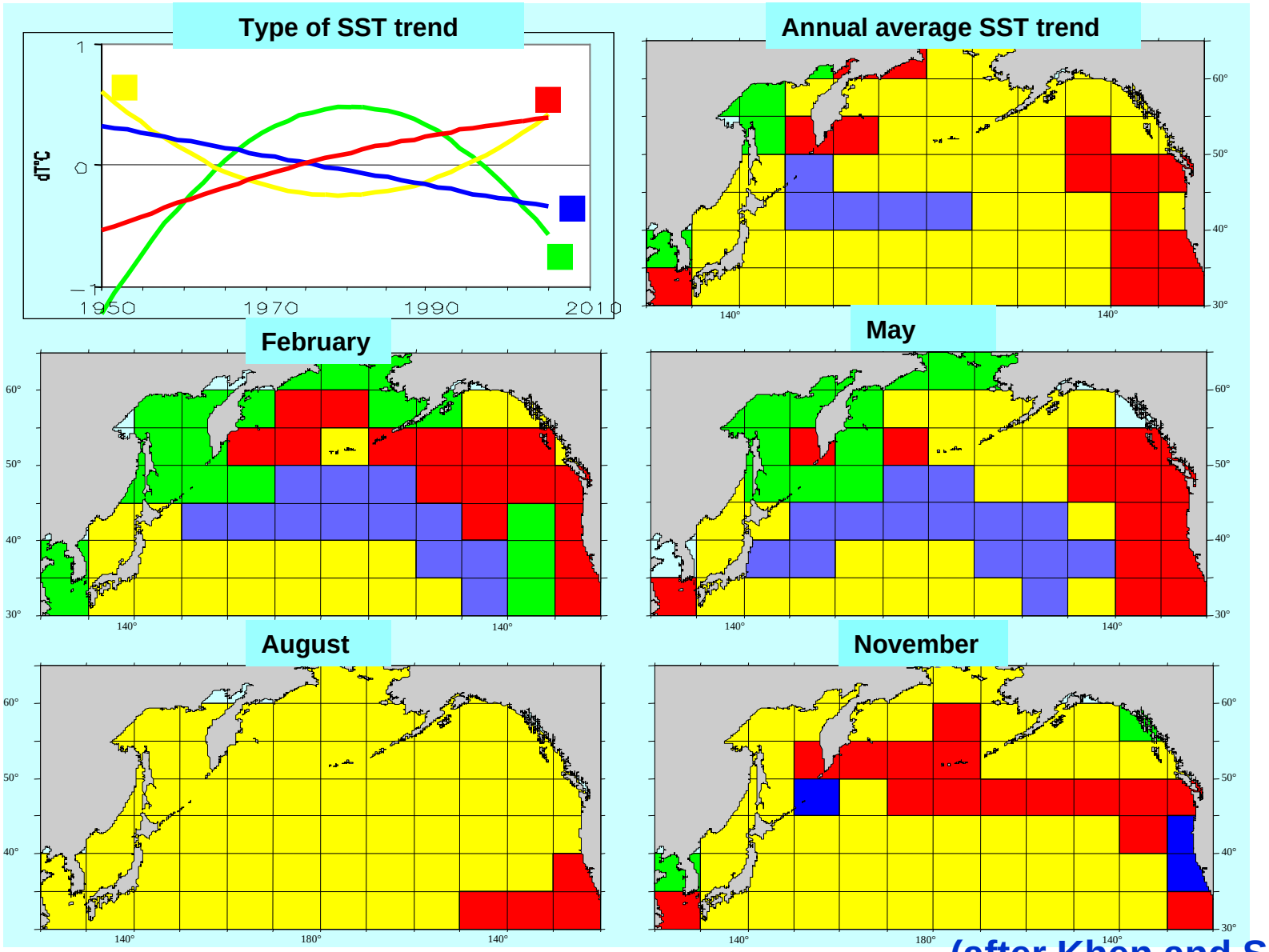
- Regional patterns in the dynamics of physical-geographic conditions of climate provinces and associated biotas

Changes in air temperature in the Northern Hemisphere (zone 30 ° - 60 ° N)



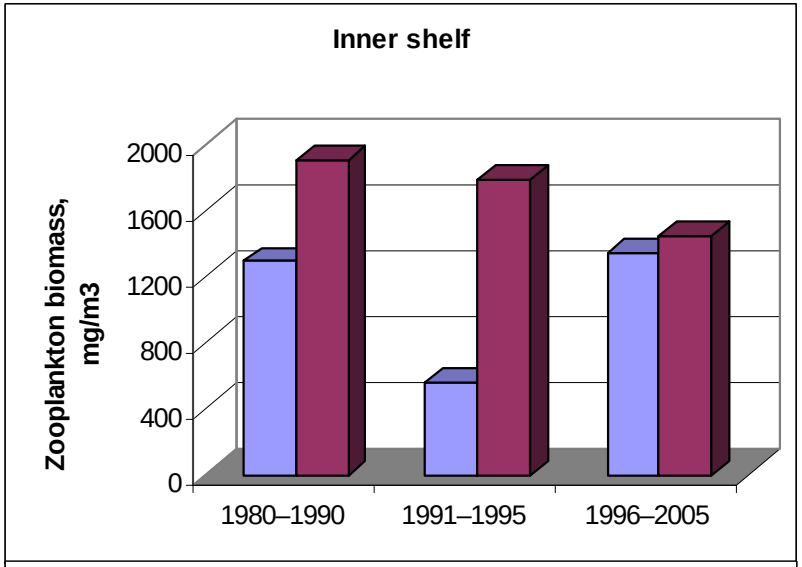
(after Byshev et al, 2006)

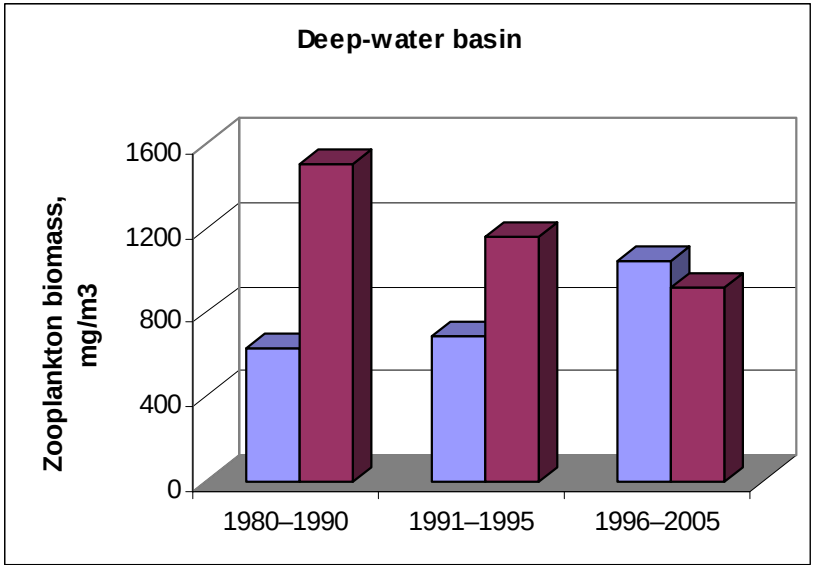
Types of low frequency SST variability in the North Pacific

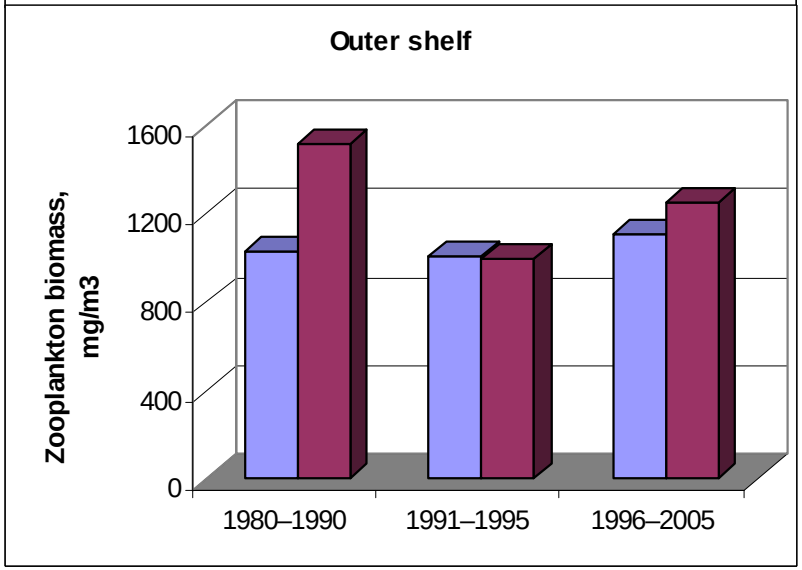


(after Khen and Sorokin 2009)

Average abundance of zooplankton (mg/m^3) in different landscape zones of the Far Eastern Seas



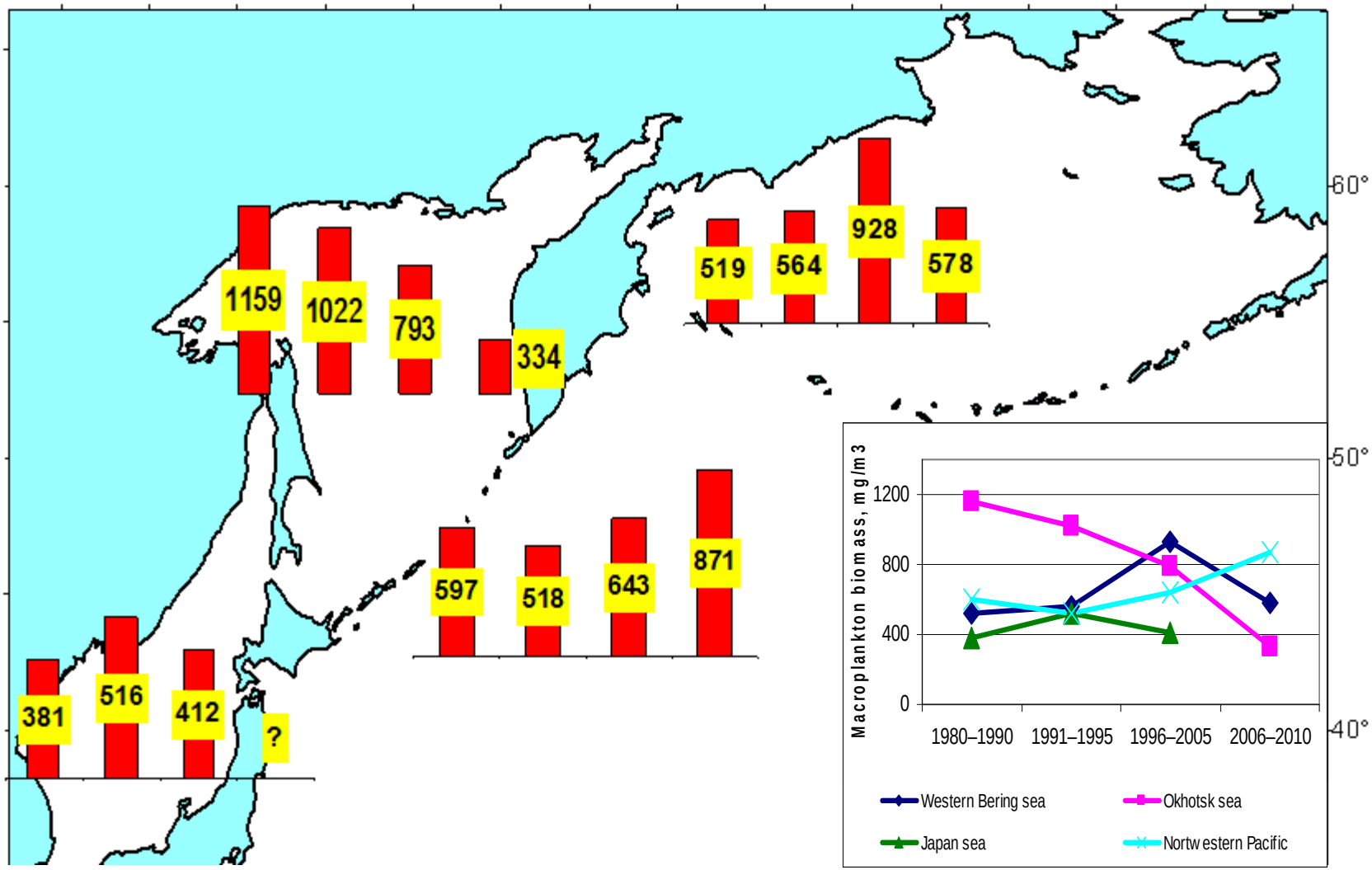




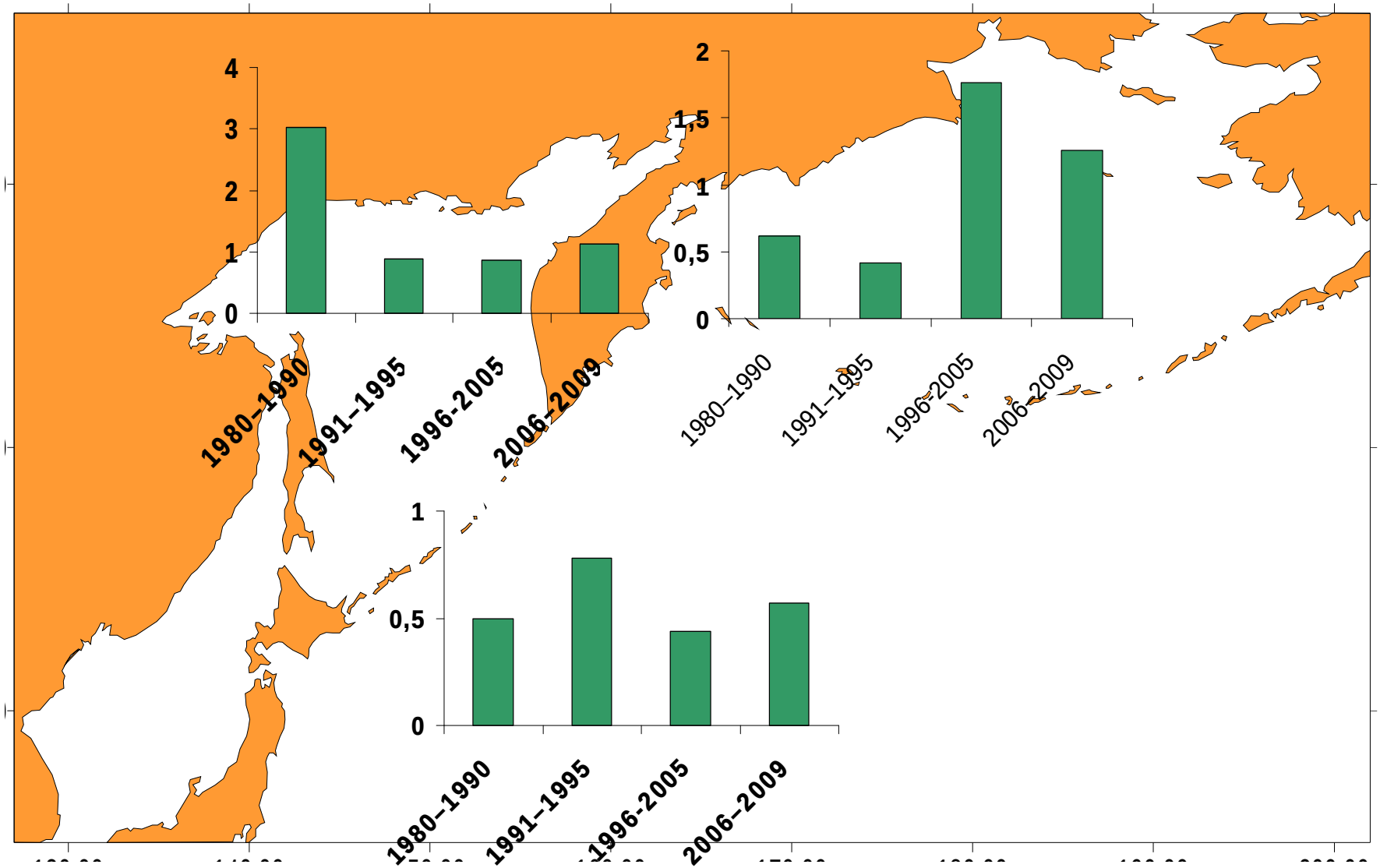
Bering sea

Okhotsk sea

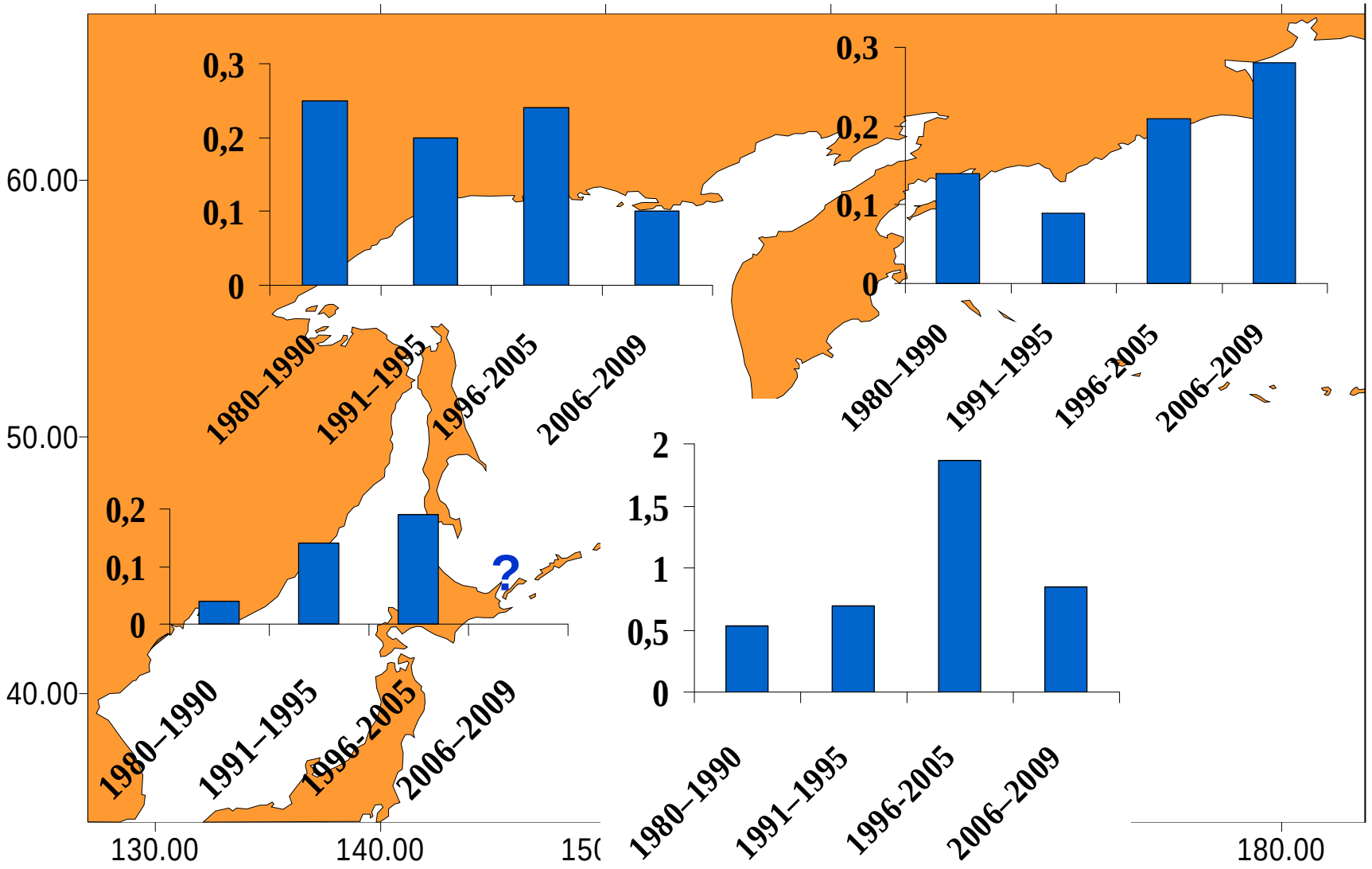
Dynamics of average zooplankton abundance of (mg/m^3) in different landscape zones of the Far Eastern Seas in the upper epipelagic zone of the Far Eastern seas and adjacent waters of northwest Pacific



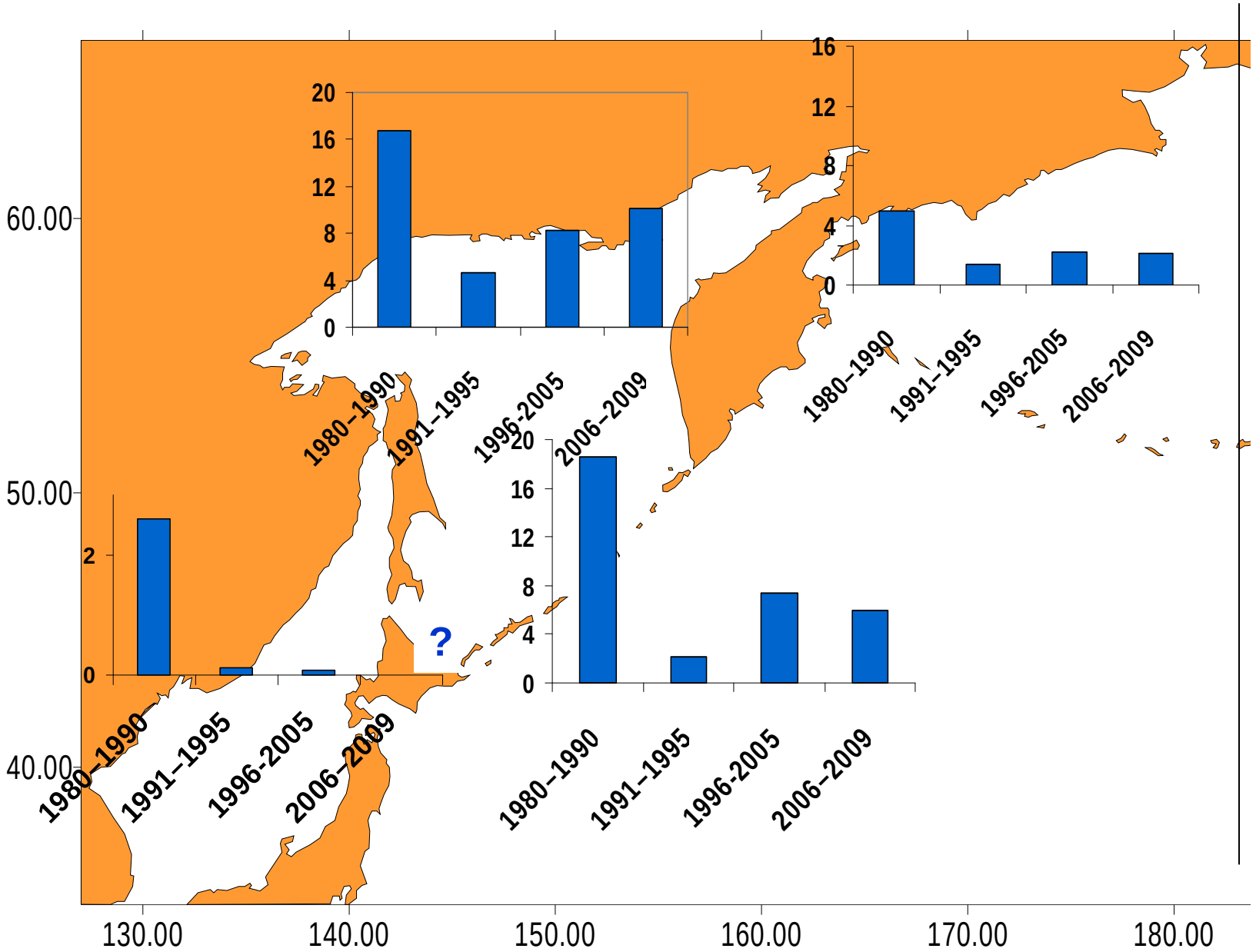
Dynamics of average annual biomass of large-size jellyfish in the upper epipelagic zone of the Far Eastern seas and adjacent waters of northwest Pacific in 1980-2000-s, mln t



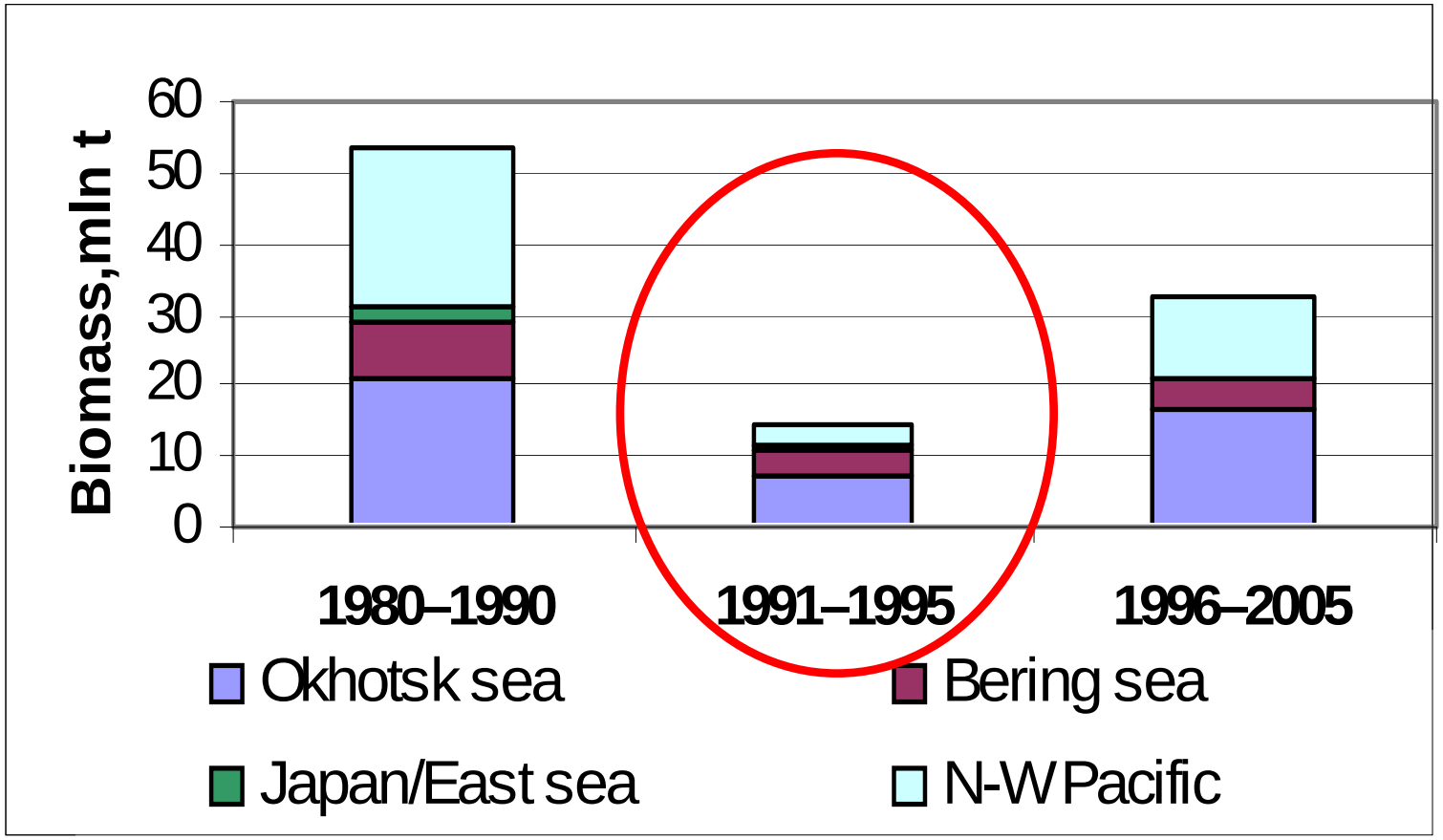
Dynamics of average annual biomass of squids in the upper epipelagic zone of the Far Eastern seas and adjacent waters of northwest Pacific in 1980-2000-s, mln t



Dynamics of average annual biomass of fishes in the upper epipelagic zone of the Far Eastern seas and adjacent waters of northwest Pacific in 1980-2000-s, mln t



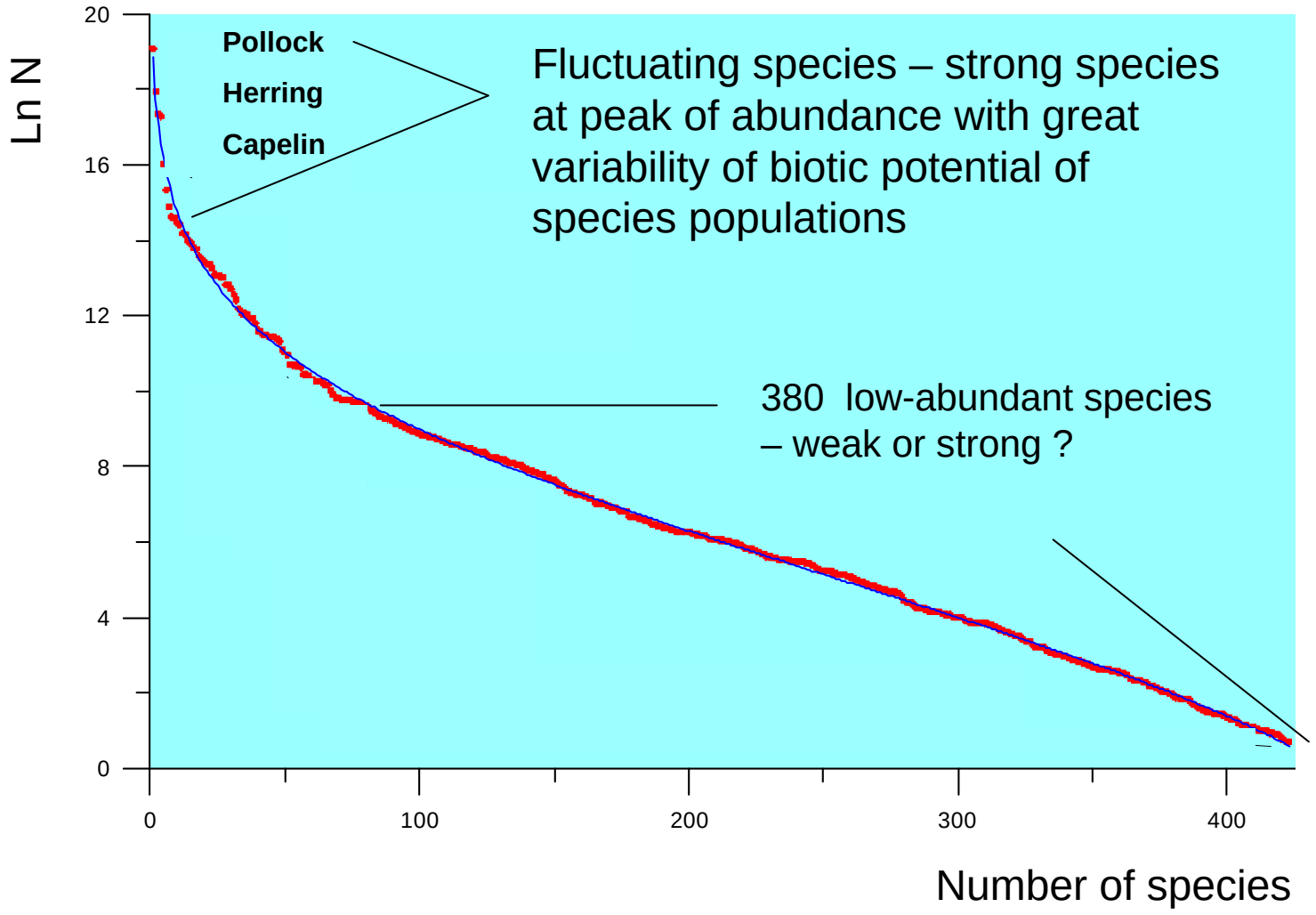
Dynamics of biomass of nekton in the upper epipelagic zone of the Far Eastern seas and adjacent waters of northwest Pacific in 1980-2000-s, mln t



? Why only few species (mainly fluctuating) clearly respond to climate dynamics?

Ranging of the Okhotsk Sea nekton species by abundance

(after Ivanov and Sukhanov 2009)



? Why only few species (mainly fluctuating) clearly respond to climate dynamics?

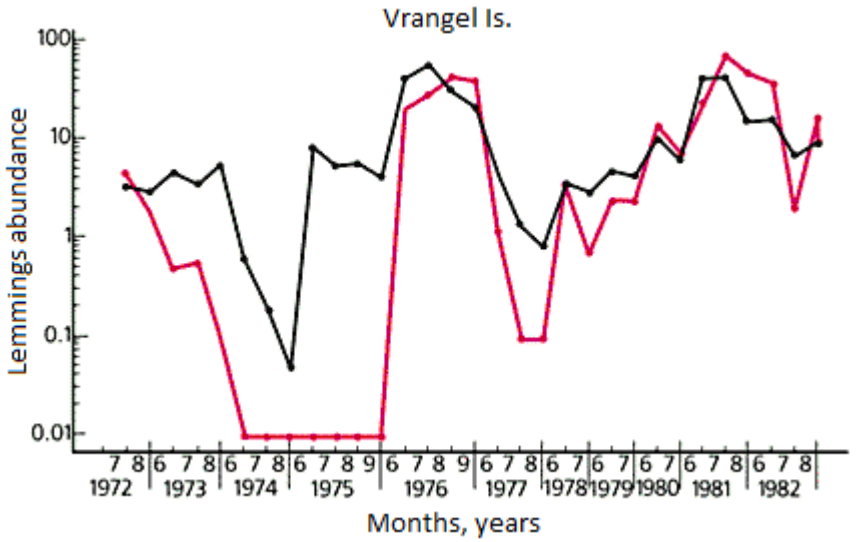
- The existence of strong and weak individuals, populations and species in communities. Instability of physical, physiological and genetic potentials of populations during various stages of waves in abundance

-

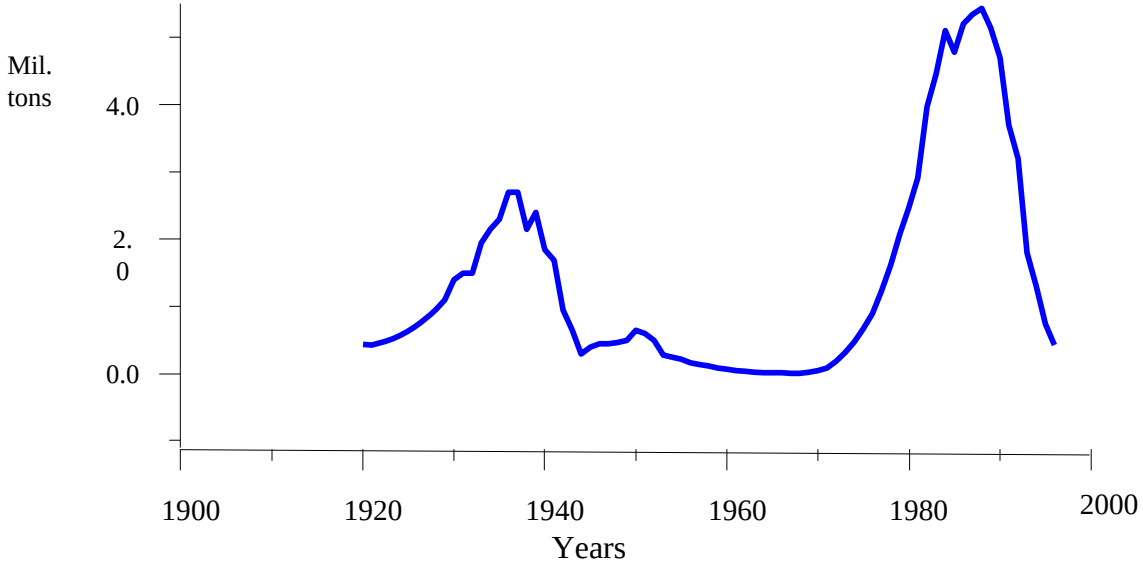
Abundance fluctuation of two species of lemmings (upper panel) and Japanise sardine (lower panel) under the influence of endogenic factors

Mechanisms of auto-regulation:

high population density → stress → decline in population quality and viability → increasing mortality

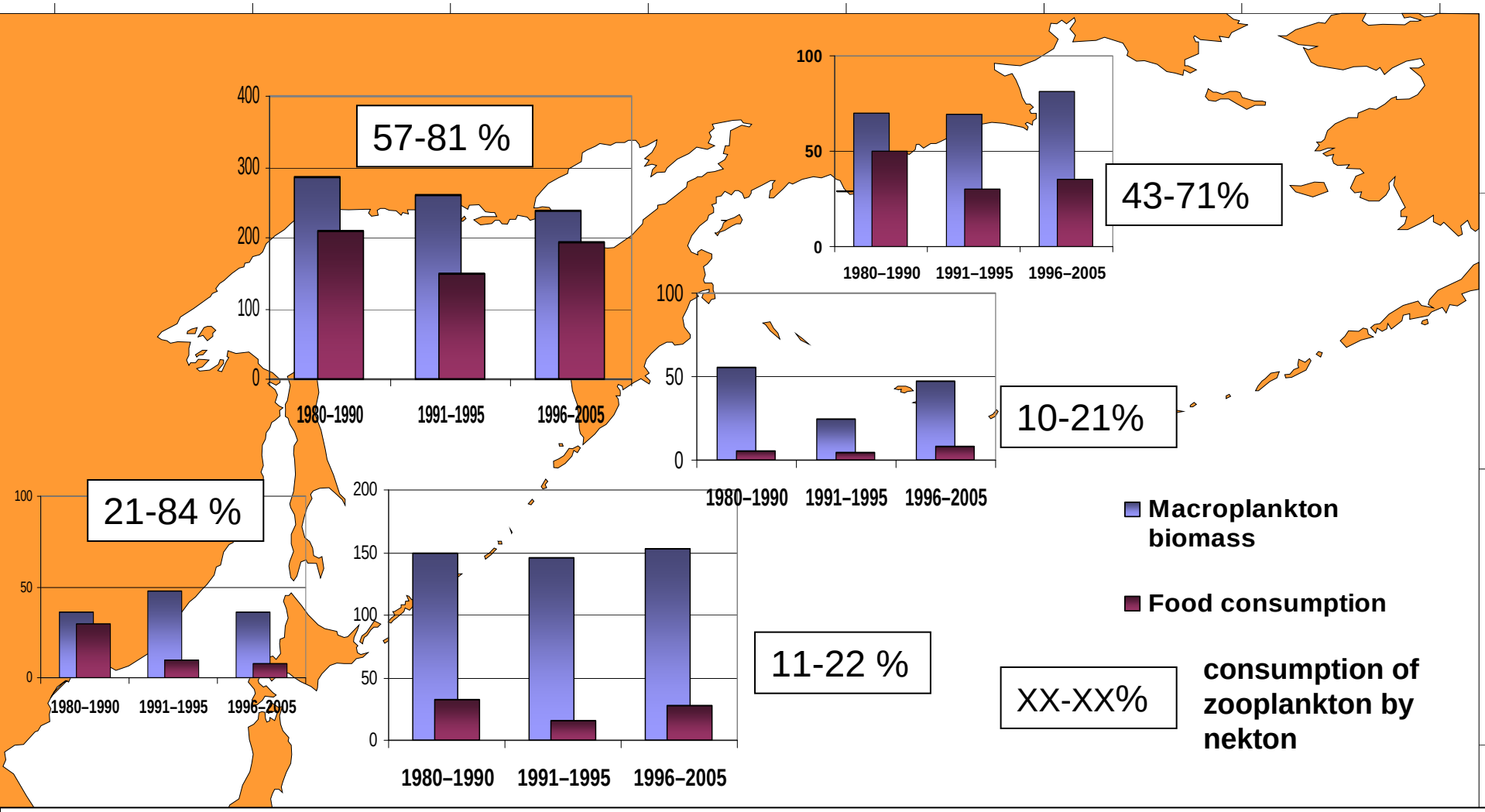


The same mechanism ?



? Effect of ecosystem interactions (bootom-up, top-down control) on dynamics of populations and species

Overall abundance and consumption of zooplankton by nekton (mln. t) in epipelagic layer (0-200 m) of the Far Eastern Seas

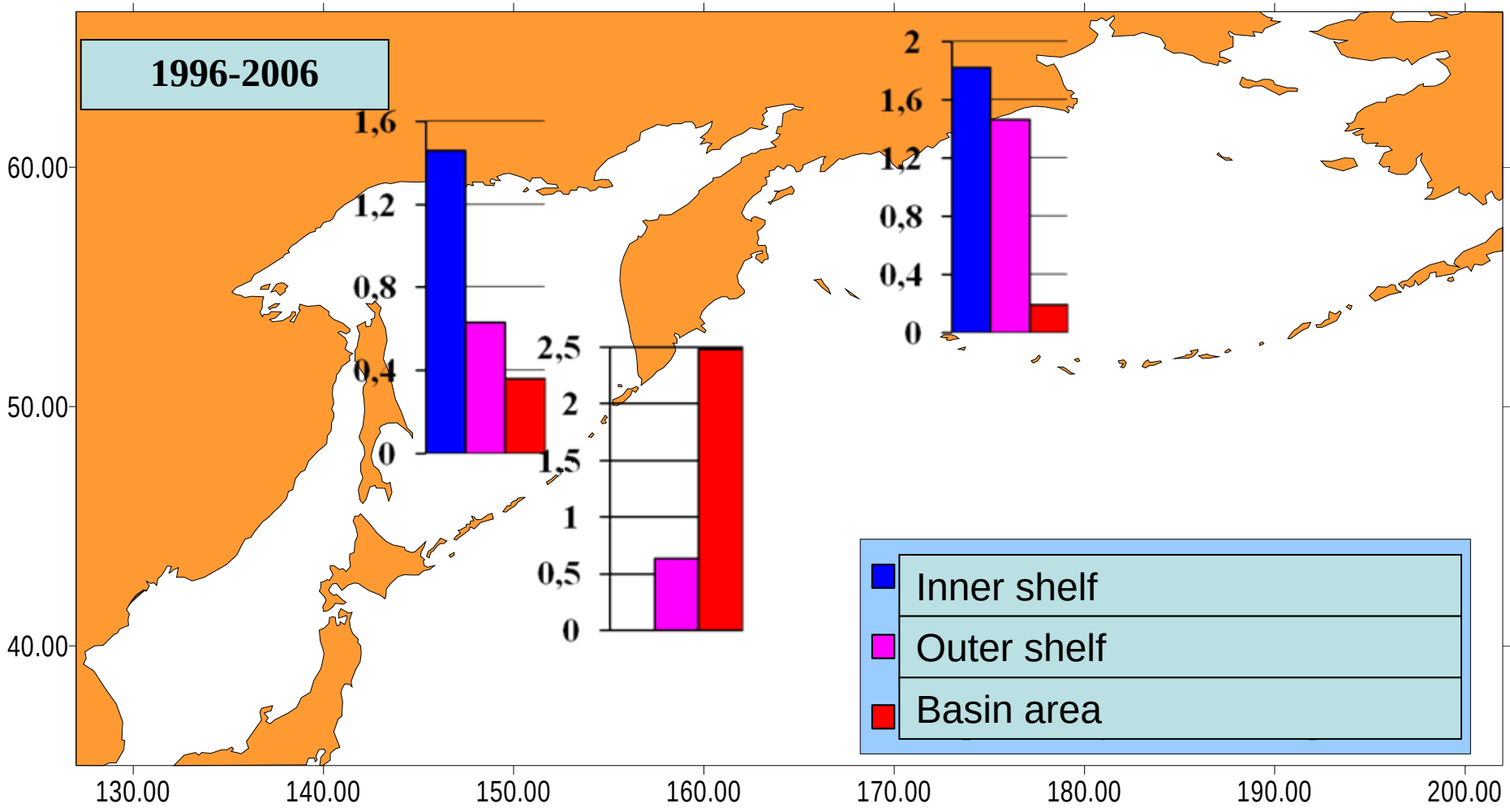


The portion of salmon in total zooplankton consumption by nekton is 2-5%

Consumption of zooplankton by nekton in the Far East seas (% of plankton production) in 1980-2000-s

Okhotsk sea	16-20 %
Bering sea	11-18%
Japan/East sea	5-21 %
North-west Pacific waters	3-5 %

Average abundance of micronekton (t/km^2) in epipelagic layer of different zones of Far Eastern Seas and northwestern Pacific waters



Relative abundance averages of small-size nekton species in the epipelagic layer are comparable to those of hyperiids

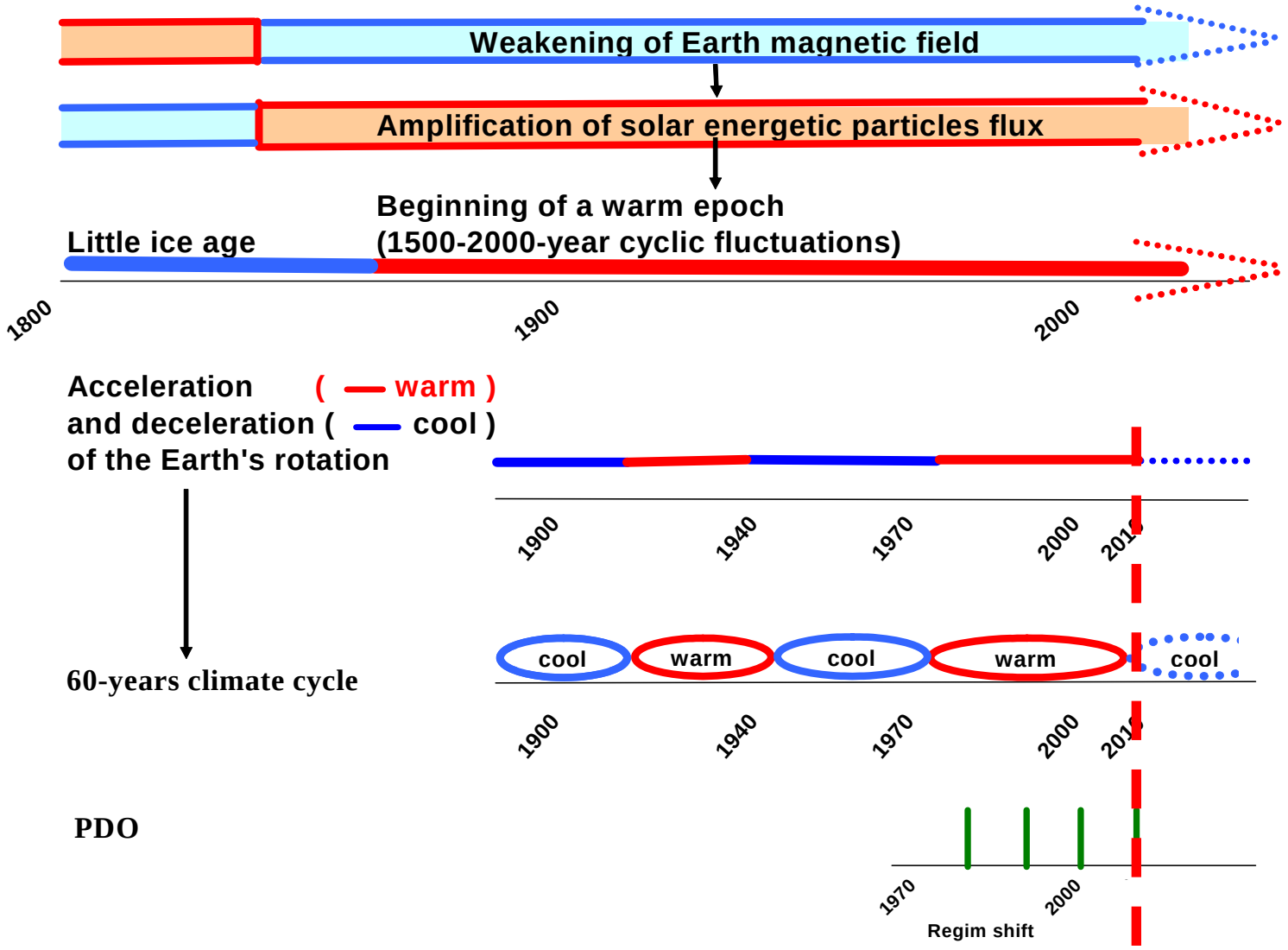
? Ecosystem interactions (bootom-up control)

- Forage resources of nekton and nektobenthic fishes are at a rather high level and do not limit species abundance

- Possibility of the limitation of the abundance of fish and invertebrates at the larval and fry stages

Both pelagic and the majority of the benthos species at the early stages of development are accumulated together in the pelagic growth zones and layers. In these growth zones, the early stages of such ergocenes are more dependent on each other, and their ability to maneuver vertically and especially horizontally is limited. Their sensitivity to the anomalous fluctuations in the environmental conditions and their dependence on the composition and size structure of the food base and the phenology of its development are well-known.

Long-term dynamics of some geophisical and climate factors in the last 1500-2000-years planetary cycle



Insufficient knowledge of issues related to understanding and forecasting rearrangements in populations, biocenoses and ecosystems – topics for future studies

- **The degree to which complex dynamics in climate and biological processes is reflected through the dynamics of climate and hydrological indices**
- **Methods of integral assessments of joint impact of numerous factors (including those that work in synergy) on the biota**
- **Underestimation of endogenic factors (in particular, neuro-endocrinal) in the formation of biotic potential (viability) and its variability in individuals and populations**
- **The existence of strong and weak individuals, populations and species in communities. Instability of physical, physiological and genetic potentials of populations during various stages of abundance waves**
- **Insufficiency of reliable quantitative assessments of parameters, which determine carrying capacity of biotopes, landscapes and ecosystems (hydrochemical and hydrodynamic basis for productivity formation, biomass and abundance of biotic components, biotic relationships)**
- **Regional patterns in dynamics of physical geography of landscape zones and associated biotas**
- **Regional patterns in the dynamics of physical-geographic conditions of climate provinces and associated biotas**