



North Pacific Marine Science Organization (PICES)

E i g h t h A n n u a l M e e t i n g

p r o g r a m

a b s t r a c t s

o c t o b e r 8 - 17, 1999

V l a d i v o s t o k , R u s s i a

# Schedule

Time			Events				
Fri.	8 <sup>th</sup>	09:00 - 17:30	REX Workshop	BASS Workshop	MONITOR Workshop	Working Group 13 Meeting	
Sat.	9 <sup>th</sup>	09:00 - 17:30	REX Workshop	BASS Workshop	MONITOR Workshop	TCODE Meeting	Working Group 13 Meeting
Sun.	10 <sup>th</sup>	09:00 - 12:30	REX Task Team Meeting	BASS Task Team Meeting	MONITOR Task Team Meeting	MODEL Task Team Meeting	Working Groups 8 Meeting
		13:30 - 17:30	CCCC IP/EC Meeting*				
		17:00 - 20:00	Registration				
Mon.	11 <sup>th</sup>	07:30 - 08:30	Registration				
		08:30 - 11:00	Opening Session				
		11:00 - 12:30	Governing Council*			Publication Committee Meeting*	
		13:30 - 17:30	FIS Topic		MEQ/BIO Topic		
		TBA	Welcoming Reception				
		Tues.	12 <sup>th</sup>	08:30 - 12:30	FIS Topic	MEQ/BIO Topic	Data Visualization Workshop Part I
		13:30 - 17:30	CCCC Implementation Panel Meeting		F & A Meeting*		
		TBA	Banquet				
Wed.	13 <sup>th</sup>	08:30 - 12:30	BIO Meeting	FIS Meeting	MEQ Meeting	POC Meeting	TCODE Meeting
		13:30 - 17:30	POC Topic		BIO/CCCC Topic	MEQ Topic	
		18:00 - 21:00	Science Board*				
		TBA	Extravaganza Dinner III				
Thurs.	14 <sup>th</sup>	08:30 - 12:30	POC Topic	BIO/CCCC Topic	MEQ Paper	F & A Meeting*	
		13:30 - 17:30	POC Paper	BIO Paper	FIS Paper	Iron Fertilization Experiment Panel Meeting	Data Visualization Workshop Part II
		18:00 - 21:00	Publication Committee Meeting*			Concert (exact time TBA)	
Fri.	15 <sup>th</sup>	08:30 - 17:30	Science Board Symposium				
		17:30 - 18:30	Closing Session				
Sat.	16 <sup>th</sup>	08:30 - 12:30	Science Board*				
		13:30 - 17:30	Governing Council*				
Sun.	17 <sup>th</sup>	08:30 - 12:30	Governing Council*				

\* Closed Session

## 8<sup>th</sup> October, 99 (Friday)

WORKSHOP ON HERRING AND EUPHAUSIIDS POPULATION DYNAMICS (09:00 - 17:30) - Day 1

(REX Workshop: Topic 7)

Co-Convenors: William T. Peterson (U.S.A.), Vladimir I. Radchenko (Russia), Tokio Wada (Japan) & Douglas E. Hay (Canada)

(Papers to be presented over 2 days. Check schedules on display for exact times and latest updates.)

### Introduction

Richard J. Beamish. Climate change: potential impacts in the North Pacific

William T. Peterson. Euphausiids and zooplankton of the North Pacific

Vladimir I. Radchenko and D.E. Hay. Herring populations of the North Pacific

### Herring Ecology

Douglas E. Hay. Herring and euphausiids spatial, temporal and life-stage variation in herring diets in British Columbia

Augustus J. Paul and J.M. Paul. Over winter energy changes in herring from Prince William Sound, Alaska

N.G. Chupisheva. Qualitative texture characteristic of herring (*Clupea pallasii pallasii*) prelarvae developed from the natural and artificial spawning-grounds in Severnaya Bay (Peter the Great Gulf)

### Long-Term Fluctuations in Abundance; Climate Influences

Richard J. Beamish, G.A. McFarlane and J. Schweigert. A comparison of ecosystem dynamics that affect Pacific herring abundance in the Strait of Georgia and off the west coast of Vancouver Island

Tokimasa Kobayashi, K. Yabuki and M. Sasaki. Long term fluctuation of the catch of Pacific herring around Japan

Jacqueline M. O'Connell. Holocene fossil fish remains from Saanich Inlet, British Columbia, Canada

Elza R. Ivshiana and I.Y. Bragina. About relation between euphausiids and Sakhalin-Hokkaido herring in the Sea of Japan, Tatar Strait

BASS and MONITOR Workshops (09:00 - 17:30)

Working Group 13 Meeting (09:00 - 17:30)

## 9<sup>th</sup> October, 99 (Saturday)

WORKSHOP ON HERRING AND EUPHAUSIIDS POPULATION DYNAMICS (08:30 - 17:30) - Day 2

(REX Workshop: Topic 7)

Co-Convenors: William T. Peterson (U.S.A.), Vladimir I. Radchenko (Russia), Tokio Wada (Japan) & Douglas E. Hay (Canada)

(Papers to be presented over 2 days. Check schedules on display for exact times and latest updates.)

### Predator-Prey Interactions and Trophodynamics

Stein Kaartvedt (invited). Fish predation on krill and krill antipredator behavior

N.I. Naumenko. Euphausiids in herring's feeding in the western Bering Sea

➤ Please check session schedules on display for exact presentation times and latest updates ◀

David M. Checkley, Jr. (invited). Interactions between fish and euphausiids and potential relations to climate and recruitment

Vladimir I. Radchenko and E.P. Dulepova. Shall we expect the Korf-Karaginsky herring migrations into the offshore western Bering Sea?

#### Distribution and Ecology of Euphausiids

Young Shil Kang. Euphausiids in the Korean waters and its relationship with major fish sources

Artur G. Pogodin. Euphausiid crustaceans of cold sector of the Japanese Sea as a fodder resource of a herring

William T. Peterson, L. Feinberg and J. Keister. Ecological zonation of euphausiids off central Oregon

Scott M. Rumsey. Environmentally forced variability in larval development and stage-structure: implications for the recruitment of *Euphausia pacifica* in the Southern California Bight

#### Trophodynamic Modelling of Herring & Euphausiid Interactions

Scott M. Rumsey (invited). Inverse modelling of developmental parameters in *Euphausia pacifica*: the relative importance of spawning history and environmental forcing in larval stage-frequency distributions

Michio J. Kishi, H. Motono and K. Asahi. An ecosystem model with zooplankton vertical migration focused on Oyashio region

**BASS and MONITOR Workshops (09:00 - 17:30)**

**TCODE Meeting (09:00 - 17:30)**

**Working Group 13 Meeting (09:00 - 17:30)**

### 10<sup>th</sup> October, 99 (Sunday)

**Task Team Meetings (09:00 - 12:30)**

BASS, REX, MODEL and MONITOR Task Teams

**Working Group 8 Meeting (09:00 - 12:30)**

**CCCC IP/EC Meeting\* (13:30 - 17:30)**

**Registration (17:00 - 20:00)**

### 11<sup>th</sup> October, 99 (Monday)

**Registration (07:30 - 08:30)**

**Opening Session (08:30 - 11:00)**

Opening / welcome address by representative from the Office of the Governor of Primorye

Welcome address by representative from the Russian State Committee of Fisheries

Remarks by Chairman

Remarks by representatives of contracting parties

Announcements

Overview of PICES scientific accomplishments by Science Board Chairman

Keynote lecture by Dr. Vyacheslav P. Shuntov: Review of research into macroecosystems of the

Far Eastern seas: results, objectives, doubts

**Governing Council Meeting\* (11:00 - 12:30)**

**Publication Committee Meeting\* (11:00 - 12:30)**

## GLOBEC AND GLOBEC-LIKE STUDIES AND APPLICATION TO FISHERY MANAGEMENT (13:30 - 17:30) - Day 1

(Fishery Science Committee: Topic 5)

Co-Convenors: Tokio Wada (Japan), Richard J. Beamish (Canada), James Ianelli (U.S.A.), Victor V. Lapko (Russia), Chang-Ik Zhang (Korea) & Qi-Sheng Tang (China)

(Papers to be presented over 2 days. Check schedules on display for exact times and latest updates.)

**Michael J. Fogarty** (keynote lecture). Environmental variability and population dynamics: utility of GLOBEC studies in a management context

**Victor V. Lapko** (invited). Application of results of TINRO-Center's ecosystem research in bioresources management

**Orio Yamamura**, S. Honda, O. Shida and K. Yabuki. Trophodynamic analysis of top-down control by walleye pollock: the importance of advection

**James N. Ianelli**. Modeling walleye pollock recruitment in the eastern Bering Sea: use of physical data integrated with stock assessment information

**Jacquelynn R. King**, G.A. McFarlane and R.J. Beamish. Dynamic marine systems: applications to the stock assessment and management of sablefish (*Anoplopoma fimbria*)

**Ling Tong**, Q.S. Tang and D. Pauly. Preliminary ecopath model in the Bohai Sea

**Patricia A. Livingston**. Ecosystem considerations in fisheries management: linking ecosystem management goals with ecosystem research

**V.V. Napazakov**, V.I. Radchenko, V.I. Chuchukalo, A.M. Slabinsky and V.A. Nadtochy. Trophic linkages of near-bottom nekton species in the western Bering Sea in terms of resource management

**Richard J. Beamish** and G.A. McFarlane. Let's get on with it - stabilizing our impacts on marine ecosystems

## COASTAL EUTROPHICATION, PHYTOPLANKTON DYNAMICS, AND HARMFUL ALGAL BLOOMS (13:30 - 17:30) - Day 1

(MEQ Committee/BIO Committee Joint Session: Topic 3)

Co-Convenors: David L. Garrison (U.S.A.) & Tatiana Orlova (Russia)

(Papers to be presented over 2 days. Check schedules on display for exact times and latest updates.)

**Mark L. Wells** (keynote lecture). The effect of bioactive metals on phytoplankton in nearshore waters

**Patricia A. Wheeler** and M. Naldi. Sequestering of iron in marine and estuarine ecosystems by marine microalgae

**Violeta N. Velikova** and T. Orlova. Phytoplankton blooms in coastal Black Sea and Japan Sea waters: similarities and differences

**David U. Hernandez-Becerril** and E. Bravo Sierra. High concentrations of coccolithophores to the phytoplankton abundances in Baja California, Mexico, during El Niño 1997-1998

**Bi-Juan Chen** and Y. Yuan. Study of the phytoplankton ecology characteristics in northern Jiaozhou Bay

**Chang Kyu Lee**, Y.C. Cho, H.G. Kim and C.S. Jeong. Phytoplankton succession before blooms of *Cochlodinium*, harmful algal blooms species off the southern coast of Korea

**Yi Cui**, B. Chen, Y. Yuan, and S. Ma. Study on correlation of phytoplankton and environmental factors in Rushan Bay

**Victoria V. Nadtochy** and Y.I. Zuenko. Sufficient conditions for phytoplankton blooms in certain areas of the northwestern Japan Sea

### Nutrients and Eutrophication

**Vladimir M. Shulkin**. Assessment of coastal ecosystems sustainability to the chemical contamination

**Tatyana V. Shaposhnikova** and N.V. Ivanova. Influence of pollution of coastal waters on morphology and reproduction of *Laminaria japonica* Aresch, *Phaeophyta*

I.I. Cherbagdy and L.I. Popova. Effects of environmental factors on the production indices of *Ahnfeltia tobuchiensis* population in Bay of Izmena, Kunashir Island

Welcoming Reception (time TBA)

## 12<sup>th</sup> October, 99 (Tuesday)

### GLOBEC AND GLOBEC-LIKE STUDIES AND APPLICATION TO FISHERY MANAGEMENT (13:30 - 17:30) - Day 2

(Fishery Science Committee: Topic 5)

Co-Convenors: Tokio Wada (Japan), Richard J. Beamish (Canada), James Ianelli (U.S.A.), Victor V. Lapko (Russia), Chang-Ik Zhang (Korea) & Qi-Sheng Tang (China)

Qi-Sheng Tang (invited). China GLOBEC studies and development

R. Ian Perry, D.L. Mackas and D.W. Welch (invited). Canadian GLOBEC studies and their contributions to management of marine living resources

Muneharu Tokimura, H. Horikawa, K. Yamamoto and M. Yoda. Long-term changes in distribution of groundfishes in the East China Sea

Yeong Gong, C.I. Zhang and J.B. Lee. Effect of ocean climate changes on Korean stock of Pacific saury, *Cololabis saira*

William W. Smoker, T.M. Sands and T.J. Quinn. Retrospective analysis of Yukon River chum salmon size 1965-1997

David W. Welch, F. Whitney, D. Bertram and A. Harfenist (invited). Ocean climate change and the growth and survival of Pacific salmon and seabirds

Vyacheslav Navrotsky. Regime shifts and sustainable fisheries

Atsushi Tsuda (invited). Comprehensive study of the Variation of the oceanic Environment and FISH populations in the North-western Pacific (VENFISH)

George W. Boehlert. Ecosystem approaches in fisheries research, conservation, and management: recommendations of the NMFS Ecosystem Principles Advisory Panel

Andrei S. Krovnin and A.M. Orlov. The role of climate in fluctuations of flatfishes in the Northwest Pacific

### COASTAL EUTROPHICATION, PHYTOPLANKTON DYNAMICS, AND HARMFUL ALGAL BLOOMS (13:30 - 17:30) - Day 2

(MEQ Committee/BIO Committee Joint Session: Topic 3)

Co-Convenors: David L. Garrison (U.S.A.) & Tatiana Orlova (Russia)

#### Harmful Algal Blooms

Vera L. Trainer, N.G. Adams, B.D. Bill, C.M. Stehr, K. Baugh and J.C. Wekell (keynote lecture). Distribution of *Pseudo-nitzschia* associated with 1998 toxification events

F.J.R. (Max) Taylor (invited). Paralytic shellfish poisoning in the North Pacific

William P. Cochlan and R.M. Kudela (invited). Nitrogen and carbon uptake kinetics and the influence of irradiance for a red tide bloom of the dinoflagellate *Lingulodinium polyedrum*

Yasuwo Fukuyo (keynote lecture). Harmful algal blooms in the Western Pacific

F.J.R. (Max) Taylor (invited). Reliable multi-year prediction of fish-killing heterosigma blooms in the Strait of Georgia, British Columbia

Hak Gyoon Kim, S.G. Lee, C.S. Jeong and W.A. Lim. Harmful algal blooms in Korean coastal waters

G. Konovalova, T. Orlova, M. Selina and I. Stonik. Events of harmful algal blooms in coastal waters of the Far Eastern Seas of Russia

Donald M. Anderson and E. Leinonen Du Fresne (invited). An expanded biogeography of the toxic dinoflagellate genus *Alexandrium*, with emphasis on the Western Pacific

**WORKSHOP ON THE APPLICATION OF SCIENTIFIC VISUALIZATION TO MARINE ECOSYSTEM ANALYSIS (08:30 - 12:30) - Day 1**

**(TCODE Workshop: Topic 8)**

*Co-Convenors: Bernard A. Megrey (U.S.A.), Thomas C. Royer (U.S.A.) & Igor I. Shevchenko (Russia)*  
(Papers to be presented over 2 days. Check schedules on display for exact times and latest updates.)

**Cathy M. Lascara** (invited). Visual analysis and knowledge discovery using collaborative virtual environments

**Elena V. Dmitrieva**, E.V. Boyko, N.I. Rudyh and I.D. Rostov. Development of integrated POI Oceanographic Database on the Northern Pacific

**Yutaka Nagata**, T. Suzuki, S. Oguma, H. Watanabe and S. Takasugi. Temperature and salinity distribution characteristics in the subarctic North Pacific, and statistical parameters which may be used in a visual quality-control software

**N.V. Bulatov**. The visual types of the Satellite IR Data and their use for oceanographical research

**A. Nikolaev**, I. Ubarchuk and M. Kuznetsov. System of registration, accumulation and secondary processing of acoustic measurements data

**Bernard A. Megrey**, E. Dobbins and S. Hinckley. Facilitating analysis of multi-dimensional data from a spatially-explicit, biophysical, individual-based model of marine fish early life history using scientific visualization tools

**G.S. Moiseenko**. Data presentation for analysis of catching vessels activity

**A.I. Alexanin**, M. Alexanina and I.I. Gorin. Thermal sea surface structures on NOAA IR-Imagery: time-scaling variability and association with sea surface flows

**Kohji Iida**, S. Saitoh, Y. Sakurai, T. Mukai, K. Miyashita, T. Hokimoto, Y. Fujimori, J. Yamamoto, and K. Yamauchi. Multimedia observation of fish resource and environment using satellite, acoustics and ROV remote sensing

**CCCC Implementation Panel Meeting (13:30 - 17:30)**

**Finance & Administration Committee Meeting\* (13:30 - 17:30)**

**Banquet (time TBA)**

## 13<sup>th</sup> October, 99 (Wednesday)

**Scientific Committee and TCODE Meetings (08:30 - 12:30)**

### **MODELLING AND PREDICTION OF PHYSICAL PROCESSES IN THE SUBARCTIC NORTH PACIFIC: PROGRESS SINCE 1994 (13:30 - 17:30) - Day 1**

**(Physical Oceanography & Climate Committee: Topic 2)**

*Co-Convenors: David L. Musgrave (U.S.A.), Nobuo Sugimoto (Japan) & Victor I. Kuzin (Russia)*

(Papers to be presented over 2 days. Check schedules on display for exact times and latest updates.)

#### **Modelling & Prediction; Local to Basin Scale**

**D. Eurin**, S.E. Allen and G. Holloway (invited). Mixing across the shelf-break in a stochastically-driven ocean

**Valentina D. Budaeva** and V.G. Makarov. Modeling of Sakhalin Bay currents

**George V. Shevchenko** and V. Putov. Empirical model of tidal regime on the northeastern shelf of Sakhalin Island

**Young Jae Ro**. Numerical modelling of the East (Japan) Sea circulation with data assimilation

**Christopher N.K. Mooers**, D.P. Snowden and H.S. Kang. Mesoscale variability over the Japan Basin: a comparison of numerical simulations and CREAMS I current meter time series

**F.F. Khrapchenkov** and V.V. Moroz. Analysis of seasonal variability of dynamics and water exchange in the Kuril Straits: Friz and Bussol

**David L. Musgrave**, T. Wakamatsu and T. Whitley. Assimilation of data into models of nutrient-

phytoplankton-zooplankton interactions

**Albert J. Hermann**, D.B. Haidvogel, P.J. Stabeno, S. Hinckley and D.L. Musgrave (invited).  
Interannual modeling of tidal and subtidal dynamics on the southeastern Bering Sea shelf

**Taiyo Kobayashi**. Study of the formation of North Pacific intermediate water by a general circulation model and the particle-tracking method, formation mechanisms of salinity minimum by the view of "critical gradient" of the Oyashio mixing ratio

**Leonid F. Muratov**. Water properties and instability over trenches in the subarctic North Pacific

### CLIMATE CHANGE AND CARRYING CAPACITY OF THE NORTH PACIFIC: RECENT FINDINGS OF GLOBEC AND GLOBEC-LIKE PROGRAMS IN THE NORTH PACIFIC (13:30 - 17:30) - Day 1

(BIO Committee/CCCC Program Joint Session: Topic 6)

Co-Convenors: *Mark D. Ohman (U.S.A.) & Vladimir I. Radchenko (Russia)*

(Papers to be presented over 2 days. Check schedules on display for exact times and latest updates.)

**Mark D. Ohman**, B.E. Lavaniegos, G. Rebstock and D.A. Checkley. Long term variability in zooplankton assemblages of the California Current System

**David L. Mackas**, R.E. Thomson, M. Galbraith and R.I. Perry. Changes in the N.E. Pacific continental margin zooplankton community 1985-1998

**Yasunori Sakurai**, S. Hotta, N. Shiga, H. Onishi, S. Takagi and T. Ikeda. Long-term monitoring of western North Pacific ecosystems during the summer of 1979-1997

**Suam Kim** and S. Kang. Ecological variations and El Niño effects off the southern coast of the Korean Peninsula during the last three decades

**Young Shil Kang**. Long-term changes and unusual high abundance in zooplankton biomass in the south Sea of Korea

**Sergei A. Gorbarenko**, I.G. Gvozdeva, A.V. Artyomova, J.R. Southon and M.V. Cherepanova. Millennial scale climate and hydrology oscillations in the west subarctic and Bering and Okhotsk Seas during late Pleistocene and Holocene

**Thomas C. Royer**. Seasonal, decadal and interdecadal forcing of temperature and salinity in the Northern Gulf of Alaska

**N.T. Dolganova** and K. Hirakawa. Seasonal variability of the copepod assemblage and its relationship with oceanographic structure at Yamato Tai (Japan Sea)

**Toru Kobari** and T. Ikeda. Interannual variabilities in abundance and body size of *Neocalanus* copepods.(Crustacea: Copepoda) in the central North Pacific

**Yasuo Matsukawa**. New hypothesis of Japanese sardine stock variation

### ECOLOGICAL IMPACTS OF OIL SPILLS AND EXPLORATION (13:30 - 17:30)

(Marine Environmental Quality Committee: Topic 4)

Co-Convenors: *Kwang-Woo Lee (Korea) & Alexander V. Tkalin (Russia)*

**Kazuichi Hayakawa** (invited). Oil spill from the tanker *Nakhodka*

**Bruce A. Wright** (invited). Ecological impacts of the *Exxon Valdez* oil spill

**Sonia D. Batten**, R.J.S. Allen and C.O.M. Wotton. The effects of *Sea Empress* oil spill on the plankton of the southern Irish Sea

**Douglas E. Hay**. Impact of *Nestucca* oil spill on herring in Barkley Sound, British Columbia

**Igor E. Kochergin**, A.A. Bogdanovsky, V.F. Mishukov, V.P. Putov and L.A. Reitsema. Characteristics of potential oil spill scenarios modeled for Sakhalin shelf

**Shang Chen**, M. Zhu, R. Li, R. Lu, B. Li and X. Mu. Effect of oil pollution on marine pelagic ecosystem: a mesocosm study

**Jeffrey W. Short**. Oil identification based on hydrocarbon analysis: a lesson from the *Exxon Valdez*

**Sergey M. Varlamov**, J.H. Yoon and H. Nagaishi. Simulation of oil spill spreading and fate for the tanker *Nakhodka* incident

Vasiliy F. Mishukov. Study of oil pollution transformation in the sea: some experimental and modeling results for Russian coastal waters

Thomas R. Loughlin. Marine mammal considerations during an oil spill

L.N. Luchseva and Yu.I. Konovalov. The mercury role in the increase of the water productivity and the sedimentation of organic matter in the sites of the oil and gas deposits of the eastern Sakhalin shelf

*Science Board Meeting\** (18:00 - 21:00)

*Extravaganza Dinner III (time TBA)* (pre-purchased tickets required)

## 14<sup>th</sup> October, 99 (Thursday)

### MODELLING AND PREDICTION OF PHYSICAL PROCESSES IN THE SUBARCTIC NORTH PACIFIC: PROGRESS SINCE 1994 (08:30 - 12:30) - Day 2

(Physical Oceanography & Climate Committee: Topic 2)

Co-Convenors: David L. Musgrave (U.S.A.), Nobuo Sugimoto (Japan) & Victor I. Kuzin (Russia)

#### Modelling & Prediction; Local to Basin Scale (cont'd)

Victor I. Kuzin and V.M. Moiseev. Sensitivity of the North Pacific circulation model to surface forcing

Hiroshi Ishizaki, G. Yamanaka and I. Ishikawa. North Pacific subarctic circulation simulated by a high-resolution primitive OGCM

Nobuo Sugimoto, H. Tsujino and H. Hasumi. Deep Pacific circulation controlled by vertical diffusivity at the lower thermocline depths

#### Modelling & Prediction; Ocean-Atmosphere Interaction

Kengo Miyamoto and K. Hanawa. Evaluation of sea surface wind stress in the northern hemisphere for the period of 100 years

Jing-Yi Wang. The effects of climate change on mid-range oscillation of monsoon circulation over Asia

Young-Seup Kim, J.D. Jang and H.S. Chung. Estimation of latent and sensible heat fluxes over the northwest Pacific using satellite data

Vladimir V. Plotnikov and S.A. Pokrashenko. The use of parameters of variability for the long-term and superlong-term ice sheet forecasts on the Far Eastern seas

### CLIMATE CHANGE AND CARRYING CAPACITY OF THE NORTH PACIFIC: RECENT FINDINGS OF GLOBEC AND GLOBEC-LIKE PROGRAMS IN THE NORTH PACIFIC (08:30 - 12:30) - Day 2

(BIO Committee/CCCC Program Joint Session: Topic 6)

Co-Convenors: Mark D. Ohman (U.S.A.) & Vladimir I. Radchenko (Russia)

Michio J. Kishi, H. Motono and K. Asahi. An ecosystem model with zooplankton vertical migration focused on Oyashio Region

Albert J. Hermann. Interannual modeling of circulation and salmon in the coastal Gulf of Alaska

Makoto Kashiwai, T. Azumaya, Y. Kawasaki and A. Tsuda. The effects of vertical migration and horizontal transport by subarctic circulation on zooplankton biomass dynamics

Yoshioki Oozeki. Japanese sardine recruitment project: studies on population structure and recruitment variability

D.C. Ianson, S.E. Allen and K.J. Orians. A 2-D carbon and nitrogen flux model of a North Pacific eastern boundary current

Patricia A. Wheeler, W.T. Peterson, A. Huyer, R.L. Smith, P.M. Kosro and J.A. Barth. U.S. GLOBEC northeast Pacific long-term observation program in the marine ecosystem of the northern California Current

Konstantin A. Rogachev and A.S. Salomatin. Tides, tidal currents and their effects on plankton community on Kashevarov Bank, Sea of Okhotsk

Kazuaki Tadokoro and T. Sugimoto. Geographic variability of Chl *a* seasonality in the subarctic North Pacific Ocean

Mikhail V. Flint and I.N. Sukhanova. Coccolithophorids in the Eastern Bering Sea phytoplankton: before and during anomalous 1997 bloom

Paul J. Harrison, D.E. Varela and S.L. Harris. Inshore offshore gradients in phytoplankton production and nutrient dynamics off the west coast of Canada

**PAPERS FOR THE MARINE ENVIRONMENTAL QUALITY COMMITTEE (08:30 - 12:30)**

Convenor: Alexander V. Tkalin (MEQ Chairman)

**Ecological Impacts of Oil Spills and Exploration (cont'd from Oct. 13)**

Bobby J. Presley. The environmental effects of off-shore oil production

Alexander V. Tkalin, D. Royle and O. Sergusheva. Ecological monitoring at the Piltun-Astokh area, NE Sakhalin Island shelf

**Papers for the MEQ Committee:**

V.A. Abramov, V.A. Abramova, B.V. Echov, V.P. Molev, I.U. Cherkrychov, V.G. Chernishov and V.V. Chernishova. Metal pollution of Pacific and technosphere APR

A. Obzhirov, E. Suess, N. Beibow, O Vereshchagina, A. Voronin, A. Salyuk, V. Sosnin, R. Shakirov and S. Lammers. Spring methane maximum in water of the northeastern Sakhalin shelf of the Sea of Okhotsk

Colin D. Levings, J. Grout, D. Marsden, K. Barry and B. Piercey. An ecosystem study of acid mine drainage effects in a British Columbia estuary

Vasilisy F. Mishukov, A. Medvedev and E. Slinko. Effects of atmospheric inputs on microelement contents in coastal zone of the Vladivostok

Gina M. Ylitalo, L. Hufnagle Jr., M. Goshio, P. Gearin, M.M. Krahn and J.E. Stein. Organochlorine and lipid levels in biopsy blubber samples of free-ranging gray whales (*Eschrichtius robustus*) sampled off the northwest Washington coast

Lev M. Gramm-Osipov, V.N. Gramm-Osipova, A.V. Savchenko and A.A. Marjash. Physico-chemical modeling of behavior of cobalt and mercury in the mixing zone of river and sea waters

Evgueni Shumilin, F. Paéz-Osuna, A.V. Alekseev, C. Green-Ruiz, D. Sapozhinikov and F. Koty Rodríguez-Meza D. New heavy metal data for the surface sediments of La Paz lagoon, southern Baja California, Mexico

A.V. Alekseev, A.P. Rodríguez-Casañeda, E.N. Shumilin and D.Yu. Sapozhnikov. As, Ba, Se and U enrichments in sediments of La Paz Bay, Baja California, Mexico

G.I. Mishukova and A.I. Obzhirov. Methane in the far-eastern transition zone

V.A. Goryachev, A.F. Sergeev and V.N. Soyfer. Tritium in the northwest part of the Japan Sea

***Finance & Administration Committee Meeting\* (08:30 - 12:30)***

**PAPERS FOR THE PHYSICAL OCEANOGRAPHY AND CLIMATE COMMITTEE (13:30 - 17:30)**

Convenor: Vyacheslav B. Lobanov (POC Chairman)

**Regional Observational Studies**

Ichiro Yasuda (invited). North Pacific intermediate water in the Kuroshio-Oyashio Interfrontal Zone  
Sergey V. Gladyshev, S.C. Riser and M. Wakatsuchi. Formation of the Okhotsk Sea intermediate water

Yasuhiro Kawasaki. On the tendency for fresher sea surface waters around the western subarctic circulation after 1994

Eugene V. Samko and Y.V. Novikov. Interannual variability of characteristics of Oyashio Current in summer of 1989-1998

- Kosei Komatsu**, Y. Hiroe, I. Yasuda, K. Kawasaki, T.M. Joyce and F. Bahr. Hydrographic structures of intermediate water and transports of the Kuroshio off the Boso Peninsula
- Josef Y. Cherniawsky**, W.R. Crawford and M.G.G. Foreman. Long-lived ocean eddies in Alaskan stream
- Yury I. Zuenko**. Heat and salt balance study in the coastal area of the Japan Sea
- Young-Sang Suh**, L.H. Jang and J.D. Hwang. Time and spatial variations of the upwelling cold water in the eastern coast of the Korean peninsula in the summer season
- Vyacheslav B. Lobanov**, V.I. Ponomarev, P.Y. Tishchenko, A.N. Salyuk, A.P. Nedashkovskiy, S. Sagalaev, Y.N. Volkov, L.D. Talley and S.C. Riser. Oceanographic conditions in the Northwestern Japan Sea in spring
- Lynne D. Talley**, V.A. Luchin, P.Y. Tischenko and V.I. Ponomarev. Preliminary results for hydrography and circulation of the Japan/East Sea in summer, 1999
- Vladimir I. Ponomarev**, A.N. Salyuk, V.B. Lobanov, S. Sagalaev, P.Y. Tishchenko and L.D. Talley. The Sea of Japan Proper Water inhomogeneity and warming in the 90s
- Larissa A. Gayko**. Variations of water and air temperature of Peter the Great Bay, the Sea of Japan over the century period
- A.A. Nikitin**, T.A. Shatilina, T.V. Dyomina and B.S. Dyakov. Some features of variability of water thermal conditions in the Tatar Strait (Sea of Japan) in the 80-90s
- Vladimir A. Luchin** and A.N. Man'ko. Seasonal variability of temperature and salinity in active layer of the Japan Sea

#### PAPERS FOR THE BIOLOGICAL OCEANOGRAPHY COMMITTEE (13:30 - 17:30)

Convenor: *Tsutomu Ikeda (BIO Chairman)*

- Patricia A. Wheeler** and J.K. Hill. Distribution and partitioning of organic carbon and nitrogen off the Oregon coast
- Jeong Hee Shim**, Y.C. Kang and M.W. Han. Chemical fluxes and mass balances in the sediment below a marine fish cage farm off Tong-young, south coast of the Korean Peninsula
- S.P. Zakharkov**, A.V. Alekseev, V.B. Lobanov, T.Yu. Orlova and E.A. Shtraiher. The distribution of phytoplankton and primary production in warm core eddies in the Sea of Japan (spring 1999)
- Jun Wang** and Y. Kang. Study of population dynamics of phytoplankton in the Bohai Sea
- Anatoly F. Volkov**. Decrease of quality of a zooplankton in the Sea of Okhotsk in 1997-98
- Artur G. Pogodin**. About the ctenophora fauna of the cold sector of the Sea of Japan
- Tsutomu Ikeda** and K. Hirakawa. Production, metabolism and production/biomass (P/B) ratio of *Metridia pacifica* (Crustacea; Copepoda) in Toyama Bay, southern Japan Sea
- Natali V. Kruk** and A.G. Pogodin. About Hyperiidia (Amphipoda, Crustacea) of the northern Japan Sea in the summer
- Artur G. Pogodin** and Yu.M. Yakovlev. The gelatinous plankton of cold sector of Sea of Japan
- Atsushi Tsuda**, H. Saito and H. Kasai. Life history of *Eucalanus bungii* in the western subarctic Pacific

#### PAPERS FOR THE FISHERY SCIENCE COMMITTEE (13:30 - 17:30)

Convenor: *Chang-Ik Zhang (FIS Chairman)*

- A.N. Vdovin** and D.V. Antonenko. New approach to estimation of fish stocks using the area method, as illustrated by the white spotted greenling (*Hexagrammos stelleri*) of Peter the Great Bay (Sea of Japan)
- S.K. Cho**, J.H. Lee and G.J. Pierce. A preliminary study on the squid fishery stock assessment in Korea waters
- V.V. Sukhanov** and I.V. Tiller. Spectral structure of oscillations in catches of Kamchatka salmon
- Aleksander N. Ivanov**. About the age structure of the northwestern Sakhalin chum salmon
- Andrei S. Krovnin**, N.V. Kovach and G.P. Moury. Impact of climatic changes on Chum salmon

abundance in the Northwest Pacific

**Jin-Yeong Kim**, Y.S. Kang, H.J. Oh, Y.S. Suh and J.D. Hwang. Geographical patterns of anchovy and hairtail early life stage and their relationship with water mass in the East China Sea

**V.P. Pavlychev**, A.B. Savin and E.O. Basyuk. Interannual changes in distribution of cod (*Gadus macrocephalus*), pollack (*Theragra chalcogramma*), rock sole (*Lepidopsetta bilineata*) and Alaska plaice (*Pleuronectes quadrituberculatus*) at the Anadyr Bay in foraging period

**Sergei Yu. Leontiev** and A.M. Orlov. Comparative characteristic of bottom ichthyocenoses of continental slope areas off the western Bering Sea, the northern Kuril Islands and southeastern Kamchatka

**Man Woo Lee**, S.I. Lee, C.I. Zhang and S.K. Yoon. Estimation of population ecological characteristics of sunset shell, *Nuttallia olivacea* in Dadaepo Shore, Korea

**Svetlana V. Davidova**. Spawning of the subtropical species in Peter the Great Bay in 1991-1998

**Alla V. Silina**. Determination of influence of environmental conditions on growth rates of the sea scallops using shell microrings

**Yao Sun**, B. Zhang, X.W. Guo, Y. Song, and Q.S. Tang. Effects of temperature on energy budget of two kinds of semi-demersal fishes in Bohai Sea

**Bo Zhang**, Y. Sun, X.W. Guo, J. Wang, and Q.S. Tang. Gastric evacuation rate of red sea bream (*Pagrosomus major*)

#### WORKSHOP ON THE APPLICATION OF SCIENTIFIC VISUALIZATION TO MARINE ECOSYSTEM ANALYSIS (13:30 - 17:30) - Day 2

(TCODE Workshop: Topic 8)

Co-Convenors: *Bernard A. Megrey (U.S.A.)*, *Thomas C. Royer (U.S.A.)* & *Igor I. Shevchenko (Russia)*

**Jerry Ault** (invited). Coastal bays to coral reefs: visualization of a spatial multistock production model

**Margarita V. Zhayvoronok**, F.F. Khrapchenkov and I.D. Rostov. Gypermedia information system "Ocean-Fareast On-Line"

**Toru Suzuki**, S. Akishima, T. Miyake and Y. Nagata. Quality control software which is easily applicable to oceanographic data processing in data originators

**Albert J. Hermann**, C. Moore and N.N. Soreide. Low-cost stereoscopic virtual reality for physical and biological model visualization

**Victor M. Bunin** and I.D. Rostov. Software for accessing and extracting oceanographic data from cd-roms "WOA94" and "WODod98" series

Discussion and software demonstrations

**Iron Fertilization Experiment Panel Meeting (13:30 - 17:30)**

**Publication Committee Meeting\* (18:00 - 21:00)**

**Concert (time TBA)**

### 15<sup>th</sup> October, 99 (Friday)

#### SCIENCE BOARD SYMPOSIUM: THE NATURE AND IMPACTS OF NORTH PACIFIC CLIMATE REGIME SHIFTS (08:30 - 17:30)

(Science Board: Topic 1)

Co-Convenors: *Steven R. Hare (U.S.A.)*, *Shoshiro Minobe (Japan)* & *Warren S. Wooster (U.S.A.)*

**Arthur J. Miller** (keynote lecture). Interdecadal climate regimes in the Pacific Ocean: theories, observations and impacts

**Shoshiro Minobe** (invited). Bidecadal and pentadecadal climatic oscillations over the North Pacific and North America

**Chang-Ik Zhang**, J.B. Lee, S. Kim and J.H. Oh. Climatic regime shifts and their impacts on marine

ecosystems and fisheries resources in Korean waters

**Konstantin A. Rogachev.** Recent variability in the Pacific western subarctic

**Larry D. Jacobson** (invited). Finding regime shifts in fisheries data

**Takashige Sugimoto** and **K. Tadokoro.** Delayed response of oceanic and biological conditions in the western Pacific to climate regime shifts

**Jai-Ho Oh** and **Y.H. Lee.** The nature and impacts of climate variables for the regime shift over East Asia in 1976-77

**Gordon A. McFarlane** and **R.J. Beamish.** Have there been recent changes in climate: ask the fish

**Nathan J. Mantua** and **S.R. Hare** (invited). On the assessment and identification of recent North Pacific climate regime shifts

**Gennady V. Khen** and **V.M. Petruk.** Interdecadal variations of the Bering Sea intermedial waters

**Suam Kim**, **S. Kang**, **S.W. Bae** and **D. Kang.** Changes in ecosystem components induced by climate variability off the eastern coast of the Korean Peninsula during 1960-1990

**Toshio Suga**, **A. Kato** and **K. Hanawa** (invited). North Pacific tropical water: its climatology and temporal changes associated with the regime shift in the 1970s

**Robert R. Bidigare**, **D.M. Karl** and **R.M. Letelier.** Long-term changes in plankton community structure and productivity in the subtropical North Pacific Ocean

**Ichiro Yasuda** (invited). Interdecadal SST variability of the Kuroshio Extension and Japanese sardine population in the 20<sup>th</sup> century

**James E. Overland**, **J.M. Adams** and **H. Mofjeld** (invited). Chaos in the North Pacific: Spatial modes and temporal irregularity

**Tatyana V. Smolyankina.** Peculiar semi-centennial variability of intensity and geographic position anomalies of atmospheric action centers in the Asian Pacific Region

*Closing Session (17:30 - 18:30)*

## 16<sup>th</sup> October, 99 (Saturday)

*Science Board Meeting\* (08:30 - 12:30)*

*Governing Council Meeting\* (13:30 - 17:30)*

## 17<sup>th</sup> October, 99 (Sunday)

*Governing Council Meeting\* (08:30 - 12:30)*

## Poster Session (throughout the duration of meeting)

### BIO Paper Session:

1. **Albert G. Ablav.** Additional data to biodiversity of the tertiary floras of Primorye and Priamurye, Southern Far East (Russia)
2. **Chul Park**, **J. Seo**, and **P.G. Lee.** Water masses and zooplankton distributions in the Northern East China Sea in summer of 1997 and winter of 1998

### BIO/CCCC Topic Session:

1. **Joong Ki Choi**, **J.H. Noh** and **G.S. Park.** Distribution of microbial organisms and primary productivity near the polar front in the East Sea
2. **Kaoru Nakata** and **Y. Matsukawa.** Effects of interannual variation of climatic factors on mesozooplankton community structure in the Kuroshio, early spring

3. Katsuyuki Sasaki, K. Kawasaki and K. Nakata. Comparison of nutrients, chlorophyll *a* and photosynthesis in April and June around Kuroshio Extension
4. Bruce A. Wright. The Gulf of Alaska Ecosystem Monitoring (GEM) Program: a permanent fund for the management and conservation of the Northern Gulf of Alaska marine ecosystem

#### FIS Paper Session:

1. Kenji Asano, S. Ohshimo, and K. Yokouchi. Spawning ground formation of horse mackerel in the East China Sea
2. Nadezhda L. Asseyeva. Infection of fish by myxosporidian parasites in dependence on hosts' ecology
3. Svetlana V. Davidova. Reproduction Japanese Gizzard Shad *Konosirus punctatus* (Clupeiformes, Clupeidae) in Peter the Great Bay (Japan Sea) in 1996-1998
4. N.T. Dolganova and N.M. Mokrin. Year-to-year variability of the Japanese flying squid feeding in the Japan Sea (on materials 1997-1998)
5. Vitaly A. Dudarev. Structure of bottom and demersal fish communities along the shelf and slope of northern Primorye
6. V.V. Evdokimov, I.V. Biryukova, and S.A. Khomyak. Reproduction of sea urchins nearshore of Northern Primorye
7. Isabella S. Gusarova, N.V. Ivanova, and T.V. Shaposhnikova. Adaptive reactions of *Laminaria japonica aresoh* in the Primorye region
8. Aleksander N. Ivanov. Chum and pink salmon downstream migration of the Langry River
9. Denis V. Izmyatinsky. Specific composition of fishes in Possjet Bay (Japan Sea)
10. Talgat R. Kilmatov and A.S. Sakun. Imitation model of fish resources export-import between two countries
11. Andrei S. Krovnin, N.V. Klovach, and G.P. Moury. Impact of climatic changes on chum salmon abundance in the northwest Pacific
12. T.N. Krupnova and V.A. Pavlyuchkov. Prospects of *Laminaria japonica* and sea urchins joint cultivation
13. C.W. Lee, I.J. Kim, B.J. Cha, and H.Y. Kim. Computer aided midwater trawl net design system
14. Sun-Kil Lee, C.I. Zhang, and M.W. Lee. Estimation of population ecological characteristics of clams in the Hadong intertidal area in Korea
15. V.A. Nuzhdin. Some peculiarities of growth rate of walleye pollock *Theragra chalcogramma* (pallas)
16. Seiji Ohshimo and K. Yokouchi. Distribution and year-class strength of Spanish mackerel (*Scomberomorus niphonius*) in the East China Sea
17. Alexei M. Orlov. Long-term changes in catch composition and rates of groundfishes on the Pacific upper continental slope off the northern Kuril Islands
18. Kwang Ki Park, C.I. Zhang, P.K. Kim, and S.H. Choi. Fish production and fisheries resources in the adjacent waters around Tokto Island, Korea
19. Hyeon Ok Shin, T.G. Park, and B.K. Hwang. Effect of dynamite explosion work noise on the behavior of Israeli carp in the cage of aquaculture
20. A.G. Slizkin, V.N. Koblikov, V.N. Dolzhenkov, and V.E. Rodin. The biology, dynamics long-term supplement of a trade stock and fishery for king crab from the western Kamchatka Shelf
21. T.G. Sokolovskaya and T.A. Shatilina. Long-term changes in the ichthyofauna of north-western part of the Pacific Ocean on the phone of dynamics of atmospheric and oceanological factors
22. Yong-Rhim Yang, S.K. Heo, Y.K. Kim, and C.I. Zhang. Selecting target species for tac-based management in Korean offshore fisheries
23. Akihiko Yatsu. Age estimation of four Oceanic Squids, *Ommastrephes bartramii*, *Dosidicus gigas*, *Sthenoteuthis oualaniensis*, and *Illex argentinus* (Cephalopoda, Ommastrephidae) based on statolith microstructure

#### FIS Topic Session:

1. **Chang -Ik Zhang**, J.B. Lee, and Y.I. Seo. Stock assessment and management implications of jack mackerel (*Trachurus japonicus*) in Korean waters, with respect to the environment-based recruitment

#### MEQ Paper Session:

1. **V.A. Abramov**, V.V. Chernishova, V.A. Abranoma, and V.G. Chernishov. Chromium syndrom in pollution area of water in the Japan and Okhotsk Seas, northwest Pacific
2. **Dmitry L. Aminin**, I.G. Agafonova, S.H. Kahng, J.R. Oh, and S.H. Lee. Fabrication of fiber optic chemical sensor for organotin detection
3. **Jae-Suk Choi**, J.Y. Cho, S.Y. Hong, and Y.K. Hong. Screening for antifouling agent from seaweed extracts
4. **H.J. Jin**, J.H. Jeong, L.G. Kim, J.Y. Park, C.H. Sohn, and Y.K. Hong. Algicidal activity and partial sequence of 18SrDNA from the seaweed *Corallina pilulifera*
5. **Myoung Sug Kim**, W.Y. Jung, L.J. Jun, J.Y. Jung, and H.D. Jeong. Development of 16S rRNA targeted PCR methods for the detection of *Vibrio vulnificus* in aquatic animals
6. **Eun-Hee Kwon**, S.-M. Park, J.S. Choi, and Y.K. Hong. Acid-resistant limit and protein expression of the seaweed *Porphyra yezoensis*
7. **L.N. Luchsheva** and Yu.I. Konovalov. Methane-mercury emanations and nitrogen recycling in Sakhalin Gulf
8. **Jae Ryoung Oh**, D.L. Aminin, I.G. Agafonova, S.K. Kim, Y.B. Shin, and S.H. Lee. Biomonitoring study with physiological biomarkers using fluorescent molecular probes in Oyster, *Crassostrea gigas*. Transplanting experiments.
9. **Hye Jing Park** and J.S. Choi. Antioxidant activity of *Symphyocladia latiuscula* and isolation of 2,3,6 - tribromo -4,5 - dihydroxy benzyl methyl ether as one of active principle
10. **Evgueni Shumilin**, J. Carriquiry, V. Camacho Ibar, D. Sapozhnikov, S. Kalmykov, S. Aguiniga and Y. Sapozhnikov. Geochemical assessment of environmental quality of sediments of the Colorado River Delta and adjacent upper Gulf of California
11. **V.N. Soyfer**, R.V. Gladkih, A.M. Kovalevskaya, V.A. Goryachev, A.F. Sergeev, N.P. Rubtsov, V.A. Ivanov, A.S. Astachov, O.V. Dudarev, B.A. Kotenko, I.S. Gorin, A.A. Isaeva, N.A. Vorontsova, and V.I. Fadeev. Evolution of radioactive contamination of bottom sediments in the ecosystem of the bight Chazma of the Japan Sea
12. **I.M. Yakovleva**. The role of a light spectral composition in the process of synthesis and accumulation of uv-protecting mycosporine-like amino acids
13. **Min Ho Yoo**, Y.J. Kim, J.B. Jeong, A.R. Kim, and H.D. Jeong. Distribution of different chloramphenicol resistance genes mediated by r plasmid in fish pathogen

#### MEQ Topic Session:

1. **V.A. Abramov**, V.A. Abramova, B.V. Ezhov, and I.U. Chekryzhov. Perspective oil and gas and protection of environment of Okhotsk - Japan Seas of geoblocks Pacific
2. **Alexander A. Bogdanovsky**. Technology of cutting and mud discharges modeling illustrated by well drilling operations on Sakhalin Shelf
3. **Alexander A. Gavrilovsky** and I.E. Kochergin. Characteristics of the impact produced by discharged drilling wastes on seawater in the area of Sakhalin Shelf
4. **Igor E. Kochergin** and O.O. Sergusheva. Methodological approach to environmental impact assessment for objects of Sakhalin Shelf oil-gas complex
5. **S.T. Kosenkova**, V.F. Mishukov, and A.S. Pavlov. Statistical analysis of effects of oil drilling faults on ecosystem shelf waters on Sakhalin Island
6. **Mikhail L. Krasny** and V.N. Khrumushin. Operative system constructing for a Sakhalin Shelf environmental monitoring

7. Alexander G. Pavilkov. Formation of ice covers on the sea rocks and seaport constructions
8. Valeryi A. Shustin and V.N. Khramushin. The prevention of oil spill on the Sakhalin offshore

#### MEQ/BIO Topic Session:

1. Tatyana A. Belan and A.V. Moschenko. Changes in diversity of polychaetes tozocene in coastal zone of the Japan Sea caused by eutrophication
2. Byung Cheol Cho, D.H. Choi, J.S. Park, C.Y. Hwang, and D.S. Lee. Microbial abundance structures and trophic relationships in hypoxic coastal waters in Mansan Bay, Korea
3. Ji-Young Cho, H.J. Jin, and Y.K. Hong. Procedure for axenic isolation and growth activation of the microalga *Isochrysis galbana*
4. Tatiana Orlova, M. Selina, and I. Stonik. Harmful algae monitoring in Peter the Great Bay, the Sea of Japan, Russia
5. Inna Stonik and T. Orlova. Spatial distribution patterns of phytoplankton of eutrophic coastal waters in Amurskii Bay (the Sea of Japan)
6. Natalia V. Zhukova. Changes in lipid composition of marine diatoms during the life cycle

#### POC Paper Session:

1. Andrew A. Bobkov. Tidal stirring in the Ekaterina Strait as ecological factor
2. A.M. Bogdanov. Interannual variability of ice formation in the Okhotsk and Bering Seas during 1995-1999
3. Pavel V. Boubnov. A light dynamic model to study particulate organic carbon variability in the eastern subarctic Pacific
4. Valentina D. Budaeva. Two types of hydrological regime in the sea around the northeastern shelf of Sakhalin
5. Mikhail A. Danchenkov and D. Aubrey. Scheme of surface water circulation of the northern Japan Sea
6. V.B. Darnitskiy, V.M. Petruk, Y.D. Sorokin, and S.M. Varlamov. The character of the long-term cyclic processes in the atmosphere above the Sea of Okhotsk near the earth's surface
7. V.B. Darnitskiy, V.M. Petruk, and S.M. Varlamov. The character of the polycyclic processes in the nearsurface atmosphere above the Japan Sea
8. S.Yu. Glebova. Types of synoptic situations and according weather conditions above the Okhotsk Sea
9. Darya Yu. Gushchina and B. Dewitte. ENSO simulation and prediction with intermediate coupled model
10. Akie Kato, A.V. Saveliev, and G.V. Shevchenko. Long term prognose of wind characteristics for Sakhalin Island
11. Igor E. Kochergin, S.I. Rybalko, V.P. Putov, and G.V. Shevchenko. Processing of instrumental datum series describing northeastern Sakhalin Shelf currents. Some Results
12. Ludmilla K. Kramareva. Eddies of the Okhotsk Sea south region in summer 1991
13. Ludmilla K. Kramareva and I.V. Tapinona. Investigation on dynamic of eddies structure in the frontal zone of Pacific Ocean
14. A.B. Loginov, T.R. Kilmатов, V.A. Petrova, and E.V. Dmitrieva. Thermohaline structure of the intermediate layers of the subarctical and subtropical parts of the Northern Pacific
15. V.V. Maslennikov, E.I. Ustinova, and V.M. Petruk. Water structure in the northwestern Bering Sea
16. Valentina V. Moroz and A.M. Polyakova. Monitoring of hydrometeorological fields variability in the northern part of the Pacific Ocean
17. Vadim V. Navrotsky and E.P. Pavlova. Characteristics of vertical fine structure in the far-eastern marginal seas and its effects on bioproductivity
18. Yury V. Novikov and E.V. Samko. Seasonal climatic thermohaline characteristics of waters of

active layers off the Kuril Islands

19. **V.P. Pavlychev.** On possibility of large-scale cyclonic meanderformation near the southern coast of Japan
20. **V.P. Pavlychev.** Atmospheric circulation over the Kuroshio Region in winter seasons of 1994-99
21. **V.P. Pavlychev and L.V. Muktepevel.** On influence of atmospheric processes on ice conditions of the Sea of Okhotsk
22. **Alexander G. Petrov.** Salinity change in the Tatarsky Strait in winter as a result of ice formation
23. **Alexander G. Petrov and N.A. Rykov.** Variability of cold intermediate layer in the Okhotsk Sea
24. **Irina I. Pipko and I.P. Semiletov.** On the role of the mesoscale CO<sub>2</sub> variability in the N. Pacific
25. **V.M. Pishchalnik and V.S. Arkhipkin.** Simulation of water circulation on the Okhotsk Sea shelf of Sakhalin Island
26. **Vladimir V. Plotnikov.** Formation of complete data base of the ice sheet for the analysis and subsequent use in the Far-Eastern seas
27. **Alexander V. Saveliev.** The signs of the El Niño phenomenon in the Japan Sea
28. **George V. Shevchenko and K.L. Puzankov.** Two models of seasonal changes of sea surface temperature in the area of south Kuril (on the base of satellite data)
29. **George V. Shevchenko, V.B. Krasavtsev, and K.L. Puzankov.** Wind-induced upwelling on the northeastern shelf of Sakhalin Island
30. **E.I. Ustinova, Yu. D. Sorokin, and G.V. Khen.** Long-term variability of the ice cover and air temperature in the Far-Eastern Seas
31. **G.V. Vlasova and A.M. Polyakova.** Correlation between the hydrodynamic systems and the types of the atmospheric processes in the South-Kuril region
32. **Lev P. Yakunin, M.G. Ogn'yova, and A.K. Skorupsky.** The reason of desalting of waters in the southern part of the Sea of Okhotsk in the spring
33. **Christopher N.K. Mooers, A. Ostrovski, and Y. Noh.** A proposed Japan (East) Sea model-data comparison study and analysis

#### Science Board Symposium:

1. **Leonid B. Klashtorin.** Climate-linked changes in main commercial stock fluctuations in the Atlantic and Pacific
2. **Shoshiro Minobe and N.J. Mantua.** Interdecadal modulation of interannual atmospheric and oceanic variability over the North Pacific
3. **Alexander D. Nelezin.** Large-scale variability of water thermodynamic structure in the northwestern Pacific Ocean
4. **Won Sun Park and Im Sang Oh.** Interannual and long-term variations of SST in the North Pacific and East Asian marginal seas
5. **Vladimir Ponomarev, O. Trusenkova, and S. Trousenkov.** On propagation of the low-frequency SST anomalies in the North Pacific
6. **Konstantin A. Rogachev and A.A. Larenteev.** The role of freshwater in the Sea of Okhotsk circulation and mixing
7. **N.I. Savelieva, I.P. Semiletov, L.N. Vasilevskaya, and S.P. Pugach.** Long-range variability and climate shift in seasonal values of meteorological and hydrological parameters in the Northern Asia
8. **G.V. Svinukhov and T.A. Shatilina.** Variability of atmospheric circulation over the northwestern part of the Pacific in the second half of the 20th century
9. **Yoshihiro Tachibana, M. Ogi, and M.A. Danchenkov.** Does the freshwater supply from the Amur River into the Sea of Okhotsk influence on decadal variability of the sea ice?
10. **Sergey M. Varlamov, N.A. Dashko, and C. Dorman.** Climatic variability of the Japan Sea area in relation to the deep water stagnation



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Session #3 MEQ/BIO Topic Session <i>Coastal eutrophication, phytoplankton dynamics, and harmful algal blooms</i>	oral presentations: 23 poster presentations: 33
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*Some of the abstracts in this collection have not been edited and have been printed in the condition that they were received.*

8AM1999-SBsymposium01 oral

## **LONG-TERM CHANGES IN PLANKTON COMMUNITY STRUCTURE AND PRODUCTIVITY IN THE SUBTROPICAL NORTH PACIFIC OCEAN**

Robert R. Bidigare, D.M. Karl and R.M. Letelier

*Dept. of Oceanography, University of Hawaii, 1000 Pope Road, Honolulu, HI 96822, U.S.A. e-mail: bidigare@inki.soest.hawaii.edu*

Oceanic productivity, fishery yields and the net marine sequestration of atmospheric greenhouse gases are all controlled by the structure and function of planktonic communities. Detailed paleoceanographic studies have documented abrupt changes in these processes over time scales ranging from centuries to millennia. Most of these major shifts in oceanic productivity and biodiversity are attributable to changes in Earth's climate, manifested through large scale ocean-atmosphere interactions. By comparison, contemporary biodiversity and plankton community dynamics are generally considered to be "static," in part due to the lack of a suitable time frame of reference, and the absence of oceanic data to document ecosystem change over relatively short time scales (decades to centuries). Here we show that the average concentrations of chlorophyll *a* (Chl *a*) and the estimated rates of primary production in the surface waters of the North Pacific subtropical gyre (NPSG) off Hawaii have more than doubled while the concentrations of silicate and phosphate have decreased during the past three decades. These changes are accompanied by an increase in the concentration of chl *b*, suggesting a shift in phytoplankton community structure. We hypothesize that these observed ecosystem trends and other related biogeochemical processes in the upper ocean are manifestations of plankton community succession in response to climate variations. The hypothesized photosynthetic population "domain shift" toward an ecosystem dominated by prokaryotes has altered nutrient flux pathways and affected food web structure, new and export production processes, and fishery yields.

8AM1999-SBsymposium02 invited

## **FINDING REGIME SHIFTS IN FISHERIES DATA**

Larry D. Jacobson

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Changes in catch and abundance of clupeoid fishes demonstrate environmental effects on ecosystems called "regime" shifts but there are problems due to biological and economic inertia in the response of catch and abundance. Alternative indices based on biological production and production rates are easy to calculate, more sensitive and respond quicker. Production rate calculations show regime shifts in several clupeoid stocks that would have been missed using either catch or abundance data. Furthermore, production rates show evidence of regime shifts up to ten year earlier than either catch or abundance data. It is important to consider time lags and insensitivity of catch and abundance data when comparing predictions from retrospective models to historical experience. Production rate indices are a better basis for comparison. Differences between species need also be considered. Production rates in consecutive years are positively correlated for long lived sardines and uncorrelated or negatively correlated for shorter lived (mostly anchovy) species. Thus, biological effects of favorable and unfavorable conditions last longer in sardines and effects of environmental variation appear to be mediated by longevity.

8AM1999-SBsymposium03 oral

### **INTERDECADAL VARIATIONS OF THE BERING SEA INTERMEDIAL WATERS**

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Interannual changes of temperature and salinity in the core of the warm intermediate layer in the northwest part of the Bering Sea are considered. In the beginning of the 1950s it was observed the low temperature and the high salinity (the first type), in the 1960s - the high values of temperature and salinity (the second type). The situation of 1950s was repeated in the beginning of 1970s and was continued by the middle of 1990s. From the 1995 the temperature was high, but the salinity was low (the third type).

The first and second types are connected with strengthening of the water exchange with the Pacific Ocean, the third type - with its weakening. The salinity of the intermediate waters in the Bering Sea has the strong dependence on the volume of the entering to the Bering Sea Pacific waters, while the temperature depends on the heat contents of the entering waters. The change of the typical situation in the intermediate layer happens not at once, but in the process of stable 2-3-year weakening or strengthening of the water exchange.

8AM1999-SBsymposium04 oral

### **CHANGES IN ECOSYSTEM COMPONENTS INDUCED BY CLIMATE VARIABILITY OFF THE EASTERN COAST OF THE KOREAN PENINSULA DURING 1960-1990**

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To understand the variation of ecosystem components in response to changing environment, we analyzed the time-series physical and biological data collected from the eastern part of the Korean peninsula during 1960-1990. The northeast pacific pressure index (NEPPI) in spring showed negative correlation ( $r=-0.516$ ,  $p<0.01$ ) with annual growth increment of red pine tree growing near the East Sea/Japan Sea coastal areas. The growth of tree, in turn, correlated highly with the spring zooplankton biomass as well as the catches of some major fish species in the east sea: sardine catch had a negative correlation with tree growth ( $r=-0.536$ ,  $p<0.01$ ) and spring zooplankton biomass ( $r=-0.503$ ,  $p<0.05$ ), while saury catch positive correlation with tree growth ( $r=0.462$ ,  $p<0.01$ ) and zooplankton ( $r=0.510$ ,  $p<0.01$ ), respectively. These phenomena can be understood that the same variation of physical environments resulted in good or bad condition to the abundance of specific fish species.

Generally, the NEPPI indicated the negative anomaly during 1961-1975, and the positive in 1976-1990. The mixed layer depth (MLD) was lower (18.2 m) and less fluctuated during 1961-1975 compared to that (26.1 m) during 1976-1996. The shallower MLD in spring during the earlier period had resulted in the higher Chl *a* concentration than that in the later. Consequently, zooplankton biomass in spring tended to decrease from the 1960s to late 1980s in accordance with the decrease of phytoplankton. However, the abundances of pelagic fish species (sardine and saury) had responded in different ways.

8AM1999-SBsymposium05 invited

## **ON THE ASSESSMENT AND IDENTIFICATION OF RECENT NORTH PACIFIC CLIMATE REGIME SHIFTS**

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The Pacific Decadal Oscillation (PDO) is a robust, recurring pattern of ocean-atmosphere variability with wide ranging influence on climate in and around the Pacific Basin. There is a wealth of evidence showing that the PDO abruptly switched phases in the winter of 1977. A number of Pacific Basin environmental and ecological parameters, including the winter PDO index, CalCofi zooplankton, Pacific salmon abundance, rockfish recruitment, and Bering Sea ice cover, suggest that a subsequent climate regime shift may have occurred in 1989. In this paper, we briefly review the PDO phenomenon, with special attention to the prospects for real-time assessments and predictability. We then compare and contrast evidence for climatic regime shifts in 1977 and 1989. This is done with data for 70 to 80 NE Pacific salmon and groundfish stocks, zooplankton biomass time series and fields of oceanic and atmospheric variables. We find evidence of a 1989 shift in some components of the North Pacific ecosystem, but the changes are neither as pervasive as the 1977 changes nor do they signal a simple return to pre-1977 conditions.

8AM1999SBsymposium06 oral

## **HAVE THERE BEEN RECENT CHANGES IN CLIMATE: ASK THE FISH**

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It is generally accepted that a climate shift occurred about 1977 that affected the dynamics of North Pacific marine ecosystems. Agreement on the possibility of climate shifts in 1989 and 1996 is not as widely accepted. However, there have been some changes in the dynamics of key commercial fishes that indicate changes in their environment occurred in the early 1990s, and possibly around 1996/97. One method of measuring climate change is to observe the dynamics of species that could be affected.

8AM1999-SBsymposium07 keynote

## **INTERDECADAL CLIMATE REGIMES IN THE PACIFIC OCEAN: THEORIES, OBSERVATIONS AND IMPACTS**

Arthur J. Miller

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Basin-scale regime changes in oceanic physical variables are thought to organize patterns of biological response across the Pacific Ocean over decadal and interannual time scales. Different physical mechanisms can be control the resulting basin-scale patterns of SST, thermocline depth and horizontal currents. Using oceanic and atmospheric data, ocean hindcasts and coupled model results as guides, feedback scenarios from various theories of Pacific climate regime changes will be summarized and examined for consistency. Processes by which these physical variations may drive ecosystem responses will be highlighted.

8AM1999-SBsymposium08 invited

## **BIDECADAL AND PENTADECADAL CLIMATIC OSCILLATIONS OVER THE NORTH PACIFIC AND NORTH AMERICA**

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Climatic variations on bidecadal (about 20 years) and pentadecadal (about 50 years) timescales are analyzed in terms of their seasonal and regional dependencies in the North Pacific and North American sector. The both bidecadal and pentadecadal variations are evident in SLP fields associated with the strength changes of the Aleutian low. The bidecadal variability is evident only in winter both in the SLP and air-temperature fields, whereas the pentadecadal signal exists from winter to spring seasons in the SLP field and only in spring in the air-temperature field. The SLP structure of the pentadecadal variability is approximately unchanged through the present century. The bidecadal variability exhibits frequency decrease (period increase) from 1930 to 1950, and simultaneously the center of the variability migrated southward. The century scale modulation of the bidecadal signal is also supported by the fact that an out-of-phase relationship between the Aleutian low strength and air-temperature holds throughout the present century for the Alaska but only after the 1930s for the West Coast of midlatitude North America.

8AM1999-SBsymposium09 oral

## **THE NATURE AND IMPACTS OF CLIMATE VARIABLES FOR THE REGIME SHIFT OVER EAST ASIA IN 1976-77**

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Climate variables such as precipitation and temperature are useful to detect climate changes. But these variables are interrelated each other, so it is difficult to understand their relationship and attributed processes.

We investigated on decadal scale climate variability in the time series of precipitation and temperature records over East Asia and analyzed the change of interrelationship between temperature and precipitation system associated with the climate regime shift over East Asia in 1977.

There was a positive regime shift in East Asia atmospheric systems around 1977 and all system was stronger than pre-1977 period. Most of the region above the 36 N of East Asia have a different probability distribution of temperature and precipitation between pre-1977s and post-1977s by the impacts of the East Asia circulation regime shift. The observed climate regime shift or climatic discontinuity from the temperature and precipitation over East Asia is not a local phenomena but a part of various global scale aspects.

8AM1999-SBsymposium10 invited

## **CHAOS IN THE NORTH PACIFIC: SPATIAL MODES AND TEMPORAL IRREGULARITY**

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The primary mode of organized variability of wintertime North Pacific SST is the Pacific Decadal Oscillation (PDO). The PDO is represented by the first EOF which captures about 21% of the interannual SST variance since 1900. Its maximum is located in the central North Pacific, which also corresponds to the region of

maximum SST variance outside of the tropics. The PDO is driven primarily by wind stress variations of the Aleutian Low. The second organized mode of variability is El Niño North, as represented by the second EOF with 13% of the interannual SST variance since 1950.

Wavelet analysis of the wintertime PDO, Aleutian Low intensity, and Sitka air temperatures (from 1832) suggest broad-banded time series with intermittent oscillatory behavior. As noted by Minobe, the different frequency bands do not appear to be independent, but line up to give major, 1920s, 1940s, 1970s and minor, 1958, 1989, shifts. The SST (PDO) tends to respond to the atmosphere at low frequencies (32 - 64 years) and when the atmosphere is operating at interdecadal (1950-1990s) rather than decadal scales, (1850-1950). The low variance of SST explained by the PDO, and the irregular nature of interannual variability of the PDO and its forcing, suggests a low order, nonlinear, chaotic system of atmospheric variability. As noted by others, such a system can be driven by short-term extreme events, such as ENSO or Siberian snow cover.

8AM1999-SBsymposium11 oral

### **RECENT VARIABILITY IN THE PACIFIC WESTERN SUBARCTIC**

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Warm and saline waters enter the northern part of the Pacific subarctic gyre from the south as part of the warm-to-cold water transformation process. Along this pathway the water column progressively cooled and freshened in marginal seas. Stratification in the Pacific western subarctic is maintained not only by the excess of precipitation, but also by the presence of this warm saline intermediate layer. This prominent mesothermal layer is associated with the halocline. The vertical profiles of salinity in the Kamchatka Current have a very sharp halocline at 100-200 m depth. The halocline off the southern Kuril Islands is much weaker and salinity decreases much more gradually.

I show the cooling and freshening of the western subarctic upper layer which occurred in the western subarctic during 1988-1998. The main consequences of this thermohaline transition were westward shift of the Oyashio path, significant changes in the mid layers (200-1000 dbar), and restratification in subarctic waters. The influx of warm subtropical waters far northward to the Oyashio area and weak coastal Oyashio observed before this transition. This influx appears to have retreated in the early 1990s. Now mesothermal waters from the north penetrated southward and created strong stratification in the Oyashio area. This transition is associated with the reinforcement of the coastal Oyashio.

These observations show that there was significant variability of the Oyashio and Kamchatka current structure and their fresh-core eddies. Lateral scale of these eddies, as well as their depth of penetration, decreased, while salinity and density increased at mid and deep levels.

8AM1999-SBsymposium12 oral

### **PECULIAR SEMI-CENTENNIAL VARIABILITY OF INTENSITY AND GEOGRAPHIC POSITION ANOMALIES OF ATMOSPHERIC ACTION CENTERS IN THE ASIAN PACIFIC REGION**

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Atmospheric action centers (AAC) are important for general atmospheric circulation. In Asian Pacific region four AACs are distinguished: North Pacific high, Aleutian low (permanent), winter Asian high, and summer Asian low

(seasonal). Mean yearly pressure, longitudinal and latitudinal anomalies of AACs registered in 1947-1994 are studied on the basis of World Hydrometeorological Data Center B.

In centers of North Pacific anticyclone until early 70s and Aleutian depression until late 70s pressure anomalies were mostly positive or actually normal, with center of the former tending to shift southward, of the latter northward. Gradual weakening and northward shift of North Pacific anticyclone's center is revealed for mid seventies-recent time, with longitudinal position of this center being characterized by great interyear variability.

Deepening of Aleutian depression characteristic of the 80s is shown to change for its intensity decrease in mid 80s. Western position of its center until early 80s and its consequent migration to the east is outlined.

Multiyear variability of pressure anomalies in center of Asian anticyclone is shown to be in antiphase with variable pressure anomalies of Aleutian depression. Variability anomalies of geographic position of Asian anticyclone's center reveal north and westward shifts of its center when anticyclone intensity decreases, and eastward migration when intensity increases.

Pressure anomalies and Asian depression latitude are shown to correlate. Migration of its center to the north forces depression to deepen, to the south to fill in.

Variability of characteristics inside the centers and between them is shown to agree. Recommendation is made to study climatic changes on basis of all four centers.

8AM1999-SBsymposium13 invited

## **NORTH PACIFIC TROPICAL WATER: ITS CLIMATOLOGY AND TEMPORAL CHANGES ASSOCIATED WITH THE REGIME SHIFT IN THE 1970S**

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North Pacific Tropical Water (NPTW) is characterized as a subsurface salinity maximum flowing in the North Equatorial Current and the main source of salt for the midlatitude North Pacific. We examine climatological features of its formation and circulation and temporal changes in its properties associated with the climatic regime shift in the 1970s, using variety of data: the repeat hydrographic sections along the 130E, 137E, 144E and 155E meridians, the hydrographic data from the Hawaii Ocean Time-Series, the World Ocean Atlas 1994, and available gridded data of wind stress, evaporation and SST. Classical ideas are confirmed that NPTW is originated from the zone of the highest sea surface salinity at 20-30N centered around the date line and spread along the isopycnal geostrophic flow patterns. The time scale of its advection from the central basin to the western boundary is estimated as 1-2.5 years. It is further shown that NPTW along a meridional section in the western basin is categorized into the northern, central, southern portions. The central portion has highest salinity and lowest potential vorticity among the three. This meridional structure of NPTW likely reflects the zonal differences in both the surface salinity and the mixed-layer thickness. NPTW in the western North Pacific increases its salinity significantly in the late 1970s. The more saline NPTW seems to be advected to the western basin because of increased Ekman pumping and spun-up circulation rather than changes in fresh water budget in its formation area.

8AM1999-SBsymposium14 oral

## **DELAYED RESPONSE OF OCEANIC AND BIOLOGICAL CONDITIONS IN THE WESTERN PACIFIC TO CLIMATE REGIME SHIFTS**

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In the Western Pacific region, regime shifts in the ocean circulations appear to be associated with multi-decadal scale climatic variations. In the western subtropical North Pacific, levels of chlorophyll *a* concentration in winter and summer noticeably decreased after 1980. This decadal change of zooplankton biomass was clear in the northern part of the subtropical gyre. Chlorophyll concentration in the central subarctic Pacific and zooplankton biomass in the Oyashio have been decreasing since the early 1980s, delayed from climatic regime shift by several years. These regime shift-like phenomena of the regional plankton biomass correspond to the variations in the density stratification or mixed layer depth in the upper ocean. Replacement of dominant species in the small pelagic fish, from mackerel to sardine, happened during later 1970s and the late 1980s-the early 1990s, from sardine to anchovy etc., in the water around Japan. In 1970s Far East sardine increased rapidly, and anchovy and mackerel decreased. Whereas, Far East sardine collapsed and anchovy, saury and common squid rapidly increased their population. Recruitment failure of Far East sardine happened during its juvenile stage in the Kuroshio-Oyashio Extension region, associated with northward retreatment of the Oyashio water. Necessity of studies on the change in prey zooplankton, especially in its species or size composition, will be stressed.

8AM1999-SBsymposium15 invited

## **INTERDECADAL SST VARIABILITY OF THE KUROSHIO EXTENSION AND JAPANESE SARDINE POPULATION IN THE 20<sup>TH</sup> CENTURY**

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Japanese sardine is known to greatly vary in inter-decadal time scales. In the 1900s, there were two peaks in the 1930s and 1980s. In 1988, the catch was over 4 million tons; it declined abruptly since 1989 and was below 1 million tons in 1995. We found the winter-SST in the Kuroshio Extension and its southern recirculation area (KESA: 30-35N, 145-180E) significantly correlates with the mortality coefficient of the Japanese sardine in 1979-1994. The warming in the KESA since 1988 possibly causes the collapse of the sardine. Larvae transport models using actual spawning and ocean current data revealed that most of sardine larvae and juvenile are possibly transported to the KESA by the Kuroshio and wind-induced currents, indicating that the Kuroshio environment represented by the SST affects on the sardine mortality. A simple empirical biomass model using the SST-mortality relation and SST successfully reproduced the sardine biomass fluctuation in the period of 1950-1994. We further tried to reproduce the sardine variations in the early 1900s, incorporated with the recent digitized Kobe-Collection and COADS dataset. With the correction algorithm by Folland et al. (1995), sardine fluctuation was not reproduced. Close analyses between the SST and night air temperature show that corrections should be applied to the data before 1946, which can reproduce the whole sardine variations in the 1900s and suggests the regime shift in the early 1940s.

8AM1999-SBsymposium16 oral

## CLIMATIC REGIME SHIFTS AND THEIR IMPACTS ON MARINE ECOSYSTEM AND FISHERIES RESOURCES IN KOREAN WATERS

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Climate change in 1976 affected the dynamics of the marine ecosystem and fisheries resources in Korean waters. Characterized as an abnormally warm year in Korea, the mean 1976 SST was higher than normal with a northward shift in the thermal front. After 1976, increased volume transport of the Kuroshio current, as well as higher seawater and air temperatures persisted. Also, sea level pressure and precipitation anomalies changed positive after 1976. Biological changes in Korean waters were exhibited as increases in chlorophyll concentration and zooplankton biomass in the early 1980s. The 1976 regime shift also affected the recruitment and production of some fish stocks in Korean waters. Based upon these results, the relationship between the climate-driven oceanic changes and changes in fisheries resources are discussed.

8AM1999-SBsymposium17 poster

## CLIMATE-LINKED CHANGES IN MAIN COMMERCIAL STOCK FLUCTUATIONS IN THE ATLANTIC AND PACIFIC

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Global impacts of fishing on marine ecosystems can be reliably evaluated against the background of natural long-term changes observed in these ecosystems. Main commercial species (Peruvian, Japanese and Californian sardine, anchovy, pacific salmon, walleye pollock, Chilean jack mackerel, Pacific and Atlantic herring, cod, and some others) producing about 50 percent of world marine fish harvest undergo long-term simultaneous oscillations. This phenomenon is believed to result from global climate change impacts. The dynamics of the global air temperature anomaly ( $\Delta t$ ) undergo high interannual variation and is poorly correlated with commercial stocks dynamics. In contrast, the atmospheric circulation index (ACI) characterizing the long-term periods (epochs) of predominant "meridional" or "latitudinal" directions of aerial mass transport is substantially less variable, and has been registered for more than 100 years. The ACI and commercial catches dynamics correlate closely. The main commercial species may be classified into two groups. The catch dynamics of Atlantic herring and cod, pacific herring, Peruvian and Japanese anchovy, and South African sardine closely correlate with "meridional" form of ACI. Peruvian, Japanese and Californian sardine, pacific salmon, Chilean mackerel, walleye pollock, and South African anchovy correlate with "latitudinal" ACI form. World production of main commercial species can be pictured over last century as regular alternating of "meridional" and "latitudinal" ACI epochs (each of 25-30 years long). ACI long-term dynamics are in phase with the dynamics of global geophysical characteristic - the length of day (LOD) that reflects a change in the earth rotation velocity and corresponds to general trend of global climate. Our recent studies suggest that close correlation takes place between ACI, LOD and commercial stock dynamics. This makes it possible to develop a predictive empirical "climate-regime model" to forecast general dynamics of main commercial stocks for 5-15 years.

8AM1999-SBsymposium18 poster

## **INTERDECADAL MODULATION OF INTERANNUAL ATMOSPHERIC AND OCEANIC VARIABILITY OVER THE NORTH PACIFIC**

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The interdecadal modulation of interannual variability of the atmosphere and ocean is examined over the North Pacific by using Wavelet Transform combined with EOF or SVD analysis. The interannual variability of the wintertime Aleutian Low, identified by either the North Pacific Index or the EOF-1 of North Pacific sea level pressure (SLP), exhibits an interdecadal modulation. Interannual variance in the strength of the Aleutian Low was relatively large from the mid-1920s to mid-1940s and in the mid-1980s, but relatively small in the periods from 1899 to the mid-1920s and from the mid-1940s to the mid-1970s. The periods of high (low) interannual variability roughly coincide with pentadecadal regimes having a time averaged relatively intense (weak) Aleutian Low. The SLP EOF-2, which is related to the North Pacific Oscillation, exhibited a strengthening trend from the beginning of this century to the mid-1960s, and significant weakening after that. Consistent changes are observed in the 500 hPa height and SST fields.

8AM1999-SBsymposium19 poster

## **LARGE-SCALE VARIABILITY OF WATER THERMODYNAMIC STRUCTURE IN THE NORTHWESTERN PACIFIC OCEAN**

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Thermodynamic water structure in the Northwestern Pacific is studied using deep sea observations. There are examined variability of the North Subtropic Gyre water transportation, heat storage of the baroclinic layer, and mean location of the Kuroshio front. Quantitative relation between water transport of the North Trade and Kuroshio currents and principal possibility for mean location of the Kuroshio front prediction are revealed.

The variability of the oceanic heat storage in the regions of the anticyclonic gyre and the southern meander of the Kuroshio is considered with the observation data for 1950-1991. Oscillation periods for the upper and baroclinic layers are identified.

The spatial and temporal variability of the Kuroshio front position to the East of the Honshu Island (140-150° E) in 1965-1991 has been considered. The mean front position and zone of its probable deviations have been defined by many average data. The extremal front position in 1977 and 1986 have been noted. Interyear variabilities of the mean front position have been studied, the prevailing period of 5-6 years has been defined.

Calculations of water transport by the North Equatorial and Kuroshio currents on a section along 137° E for the period between 1972 and 1991 have been performed. The prevailing trends in their multi-year variations were found. The trend components have been defined as well as the multi-year component on the basis of a filter-parameter. The calculated correlation coefficients showed a close relation of the multi-year variations of discharges in the North Equatorial and Kuroshio currents.

## **INTERANNUAL AND LONG TERM VARIATIONS OF SST IN THE NORTH PACIFIC AND EAST ASIAN MARGINAL SEAS**

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Using the SST data in  $1^{\circ} \times 1^{\circ}$  grids from COADS, EOF and coherency analysis are conducted.

EOF mode 1 (26%) of monthly SST Anomaly (SSTA) has interannual signals with the period of 3-4 years and interdecadal signal. The signal shows a very similar pattern to El Niño-Southern Oscillation (ENSO). The magnitude of eigenvectors in the equatorial region is about twice than those in the mid-latitude. Mode 3 (9%) also shows interannual and interdecadal variability like mode 1, but the magnitude of eigenvectors in the equatorial and mid-latitude of mode 3 are almost same. There are same signs of seesaw-like oscillation in the equatorial region in both mode 1 and 3, but the signs in the mid-latitude are different. Therefore, SST variability associated with ENSO is consistent for most El Niños in the equatorial region, but that is changeable in the mid-latitude.

Mode 1 (37%) of EOF using band pass filtered SSTA (2-8 years) has very similar patterns to the ENSO events, and the amplitudes of El Niños of 1972/73 and 1982/83 become almost same. Mode 1 (43%) of EOF using low pass filtered SSTA (>8 years) has both signals of decadal and bidecadal variability, and has minimum in about 1972 year, maximum in about 1983 year. From the amplitude difference of El Niño of 1972/73 and 1982/83, interannual variability related to the ENSO is similar pattern in both events, but the magnitude of anomaly is controlled by the longer time scale, such as decadal and interdecadal time scale.

Spectral energy of SSTA in equatorial region is high in the periods of 28, 42, and 56 months. There is strong energy in the period of longer than 5 years, and 18 years in the northwestern Pacific including the East Sea. SSTA in Niño 3.4 region leads about 6-9 months those in the Kuroshio region in interannual time scale, but SSTA in Kuroshio leads about few years in interdecadal time scale. SSTA in Niño 3.4 leads about 90 degrees those of East China Sea, Yellow Sea, and southern East Sea in about 2-3 years, and the coherency is higher in the East China Sea. Since the energy of 2-3 year period for the marginal seas does not show any significance in total SSTA variability, the portion of SSTA caused by El Niño in the EAMS to the total variation is low.

## **ON PROPAGATION OF THE LOW-FREQUENCY SST ANOMALIES IN THE NORTH PACIFIC**

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With the SST anomalies (seasonal deviations) decomposed into the Complex EOFs for 1950-1980, the anomaly waves are detected moving in the extratropical North Pacific as response patterns corresponding particularly to El Niño signal propagation in the northeast and central Pacific. The northwest Pacific mode points to the local Kuroshio/Oyashio frontal area characterized by the intensive ocean/atmosphere interaction. The moving wave patterns are emphasized for specific winter season as opposed to the "round-year" seasonal anomalies represented by both moving and standing waves.

The significant cross-correlation found for Principal Components (temporal amplitudes) in regard to El Niño Index (NINO 3) emphasizes the feedbacks in mid-latitude Pacific SST anomalies - ENSO system. Namely, in the "round-year" case, there is a positive cross-correlation for 1.5-2.5 year negative lags but negative one for 0.5-1.5 positive lags. Unlagged cross-correlation is found dominating for the low-frequency winter anomalies, as well as significant cross-correlations in the -1 to +2 year lag range. For this case, spectral maxima are obtained

coexisting in both decadal and El Niño time scales. The latter fact points out to the mutual feedbacks possible between the low frequency time scales considered for the mid-latitude Pacific.

The CEOF spatial amplitudes are demonstrated to correspond to the large-scale features of the North Pacific bottom topography.

8AM1999-SBsymposium22 poster

### **THE ROLE OF FRESHWATER IN THE SEA OF OKHOTSK CIRCULATION AND MIXING**

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Salinity stratification is critical to the vertical mixing and circulation of the high-latitude seas. The importance of fresh water to high-latitude mixing processes follows from the properties of the equation of state for sea water at low temperatures (thermal expansion coefficient for sea water at low temperature is small). Therefore, the introduction of small amounts of fresh water can prevent vertical mixing even in the case of substantial surface cooling. The export of fresh water from the Sea of Okhotsk and Bering Sea via Kamchatka and Oyashio current system is one of the major inputs to the North Pacific.

In this work we examine the fluxes of fresh water in the Sea of Okhotsk and its connections to the North Pacific and Sea of Japan. The individual terms are calculated as follows: runoff, precipitation less evaporation; saline water import through Soya Strait; saline and fresh water import through Kuril Straits; fresh water storage. Fresh water budget of the sea is considered with the main goal to describe recent dramatic changes in salinity which have occurred in the Pacific subarctic during the past decades. These changes are pronounced in variations of the Okhotsk Sea and Oyashio features. We have shown significant changes in precipitation and other fresh water terms, and found new regional indices which represent changes of salinity in the Pacific western subarctic: the time-lag of transitional seasons and north-south redistribution of precipitation. Mechanisms, responsible for these changes are explored.

8AM1999-SBsymposium23 poster

### **LONG-RANGE VARIABILITY AND CLIMATE SHIFT IN SEASONAL VALUES OF METEOROLOGICAL AND HYDROLOGICAL PARAMETERS IN THE NORTHERN ASIA**

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Hydrological cycle driving ocean thermohaline circulation and sea-ice formation is presently of increasing interest, especially during marked warming. As shown by recent investigations the troposphere warming is expected to be greater over continent than over the ocean, greater in winter than in summer.

Our investigations of a seasonal structure of riverine discharge and precipitation and air temperature in Siberian river's watersheds (the Ob, Enisey, Lena, Indigirka, Kolima) and comparison their long-range variability with characteristics of Asian High and Aleutian Low for the 1948-1993 period shown that in Asia continent climatic shift regime observed in the beginning 1970s. Average sea level pressure gradient between Asian High and Aleutian Low have been increased from 0.2 (before 1970) to 5.1 GPa (after 1970) at the moment when the Asia High intensity increased on 3.5 GPa, the Aleutian Low deepened on 1.6 GPa. The square of both atmospheric centers became higher, Asia High shifted to the west and Aleutian Low to the east removed each from other on 4° longitude. At the same time river runoff increased in cold period (especially the Enisey) on 13-45% relatively to normal winter values for investigated period. Summer discharge has slight negative trend. The averaged annual discharge of great Siberian rivers increased on 4.5% in comparison with before the 1970 period. The background

of these changes is increase of air temperature in winter and decrease in summer (17 stations in different parts of riverine watersheds). Changes in Asian High between before and after 1970s induced different tendency of winter precipitation according to geographical position of meteorological stations in study area. In the Lena watershed winter precipitation fallen, but in the Enisey watershed increased. Shift regime in winter precipitation took place in the end 60s - the beginning 70s, the unfreezing period (air temperature above zero) continued to increase after slight shortening in pointed out time span. Keeping in mind that tendency and amplitude of climatic change (warming) in Northern Hemisphere are propagating from west to east with time lag 5-10 years, the climatic shift regime in late 1970s in the North Pacific appeared more later than in neighboring Asian continent. So, perturbations in meteorological parameters and river runoff in the Northern Asia are good precursors in climate change in the North Pacific.

8AM1999-SBsymposium24 poster

## **VARIABILITY OF ATMOSPHERIC CIRCULATION OVER THE NORTHWESTERN PART OF THE PACIFIC IN THE SECOND HALF OF THE 20<sup>th</sup> CENTURY**

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500 - hPa field and H500 geopotential anomalies structural peculiarities are analyzed in January 1950-1998 over the northwestern part of the Pacific (NWP).

500-hPa typical fields of 1950s, 1960s, 1970s, 1980s and 1990s are determined. The main differences of 500-hPa field are in the position of Okhotsk low (area of low barometric pressure) and the ridge of the Pacific high (area of high barometric pressure) these years.

Years of large and extreme H500 geopotential anomalies are determined by cluster analyses. 500- hPa fields anomalous structures are formed in the result of Okhotsk low and the ridge of the Pacific high shifting from their climatic position.

Thus often invasions of the ridge of the Pacific high into Okhotsk limits and anomalous southern shift of Okhotsk low were observed in 1963, 1974, 1991 and 1997. Anomalous northern shift of Okhotsk low took place in 1972. The decrease of area of low pressure over the Japan Sea was observed in 1986-1987.

Sharp variability of the circulation processes over NWP noted to be accompanied by anomalous falls and rises in temperature at the surface of the earth.

In particularly intensive carrying-out of warm maritime air to the Okhotsk limits and the northern part of the Japan Sea was observed in 1963, 1974, 1991 and 1997.

El Niño Southern Oscillation (ENSO) phenomenon influence is supposed on H500 geopotential field disturbance over NWP. ENSO manifests in anomalous shifts of Okhotsk low, the ridge of the Pacific high and altitude frontal area (AFA) in Japan area.

8AM1999-SBsymposium25 poster

## **DOES THE FRESHWATER SUPPLY FROM THE AMUR RIVER INTO THE SEA OF OKHOTSK INFLUENCE ON THE DECADAL VARIABILITY OF THE SEA ICE?**

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The Sea of Okhotsk, which is located between Siberian continent and the North Pacific, is one of the southernmost ice-covered oceans in the Northern Hemisphere. It has been blindly believed that the inflow of much fresh water from the Amur River plays an important role in the formation of ice over the Sea of Okhotsk. Because low saline water due to the inflow of the fresh water from the Amur River brings about strong stratification in the surface layer of the ocean, this low saline layer suppresses the deep convections and makes it easy for water to freeze. To judge whether the sea ice is concerned with the discharge of the Amur River, we examined the relationship between the interannual variations of the Amur River discharge and the sea ice extent in the Sea of Okhotsk. Our result is completely opposite to the thought that has been believed. We could show that when the Amur River discharge was large, the sea ice extent was small in the following winter, whereas the sea ice coverage was larger than usual when the Amur River discharge was small. In addition, the ice and the amount of the river discharge have strong decadal signals with each other. The present results suggest reconsideration of the effect of the fresh water discharge on the ice formation over the Okhotsk Sea and linkage among grand hydrology in the Siberian continent, atmospheric circulation, and the Pacific Ocean.

8AM1999-SBsymposium26 poster

## **CLIMATIC VARIABILITY OF THE JAPAN SEA AREA IN RELATION TO THE DEEP WATER STAGNATION**

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The oceanographers showed the evidence for the stagnation of deep waters in the Sea of Japan during at least last 60 years (K. Kim, S. Riser, K.R. Kim, T. Gamo, etc.). It is mainly pronounced in decrease of dissolved oxygen concentration. As a main reason for this phenomena the change of winter climatic meteorological conditions are considered. Coastal station's temperature data surely show the regular warming for winter seasonal temperatures at the northern part of the Japan Sea. However, the air temperature is not only factor responsible for the intensity of winter ocean mixing processes, which depends from the net heat fluxes at the sea surface. The wind conditions as a number of other factors play an important role in the intensity of the surface sea-atmosphere interaction processes. Our results show that in winter time for the Sea of Japan the daily net heat flux at sea surface could be explained with accuracy approximately 80% by wind data only. In absence of long wind time series over the sea, the circumstantial coastal stations wind data and some winter monsoon indexes are used for the complex analysis of climatic variability in the Japan Sea area. The analysis performed for the Sea of Japan at all and for its northern parts shows the weak relation between coastal stations monthly temperature data and winter monthly monsoon indexes.

The historical analysis of climate variations in the Japan Sea area using available data related to the intensity of winter air-sea interaction processes (net heat flux at the sea surface) from the start of century will be discussed.

8AM1999-POCtopic01

oral

## MODELING OF SAKHALIN BAY CURRENTS

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Warm period circulation of water and fields of three-dimensional currents of Sakhalin Bay are assessed with the help of diagnostic model over the set density fields. Assessments are made with 5-minute horizontal resolution for 8 vertical levels. Density fields are calculated over historical temperature and salinity data collected by Far Eastern Regional Hydrometeorological Institute in 1951-1996. Numerical model is based on primitive motion equations written in the orthogonal coordinate system with traditional (in such models) approximations. Horizontal turbulent exchange is ignored. Geometry of the bay and real seafloor topography are accounted. The results of numerical experiments are illustrated by distribution of full current function, current velocity fields at different depths, and integral frontality indexes of water density structure in the area under study.

8AM1999-POCtopic02

invited

## MIXING ACROSS THE SHELF-BREAK IN A STOCHASTICALLY-DRIVEN OCEAN

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A barotropic primitive equation numerical model of a slope-shelf topography was forced with stochastic winds to generate a strong but realistic eddy field. The forcing causes stronger eddy kinetic energy in shallower water. Two mean alongshore jets are then observed. A poleward jet arises at the shelf-break as predicted by maximum entropy theory while an equatorward jet balances the momentum budget over the shelf. Evaluation of shelf-break mixing was made using a passive tracer which initially had a uniform gradient across the coastal region. The tracer advection in the model was evaluated with the Tremback-Bott transport scheme and a post-treatment of the transport fluxes to achieve monotonicity. The passive tracer eddy-diffusivity exhibits large spatial variability. It is found to be qualitatively related to the eddy kinetic energy and the cross-shelf gradient of potential vorticity. It is shown that scalar concentration fronts naturally tend to form at the shelf-edge.

8AM1999-POCtopic03

invited

## INTERANNUAL MODELING OF TIDAL AND SUBTIDAL DYNAMICS ON THE SOUTHEASTERN BERING SEA SHELF

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We describe interannual comparisons of the circulation field in the Bering Sea, as deduced from a regional circulation model which includes both tidal and subtidal dynamics. The model is forced locally by daily winds and heat flux; boundary forcing includes measured and modeled subtidal currents and five tidal components (M2, S2, N2, K1, O1). The phasing of the tides relative to one another can have important effects on the seasonal pattern of mixing, and should itself exhibit interannual variability. Two recent years (1995 versus 1997) are

compared, based on their radically different physical and biological character and the availability of field data. We explore the relative impact of winds, tides and heat flux for the simulated years, and investigate how these affect the fate of spawned walleye pollock spawned in different regions of the Southeastern Bering Sea.

8AM1999-POCtopic04

oral

## **NORTH PACIFIC SUBARCTIC CIRCULATION SIMULATED BY A HIGH-RESOLUTION PRIMITIVE OGCM**

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To study mean structure and variabilities of the subarctic circulation and its interaction with the subtropical circulation, a high-resolution North Pacific Ocean model was developed. The model domain is 100E - 75W and 15S - 65N with 1/4 deg (EW) x 1/6 deg (NS) horizontal resolution and 44 vertical levels. The model contains realistic coastal geometry and bottom topography. High-accuracy numerical schemes were adopted for advection of tracers (QUICK) and momentum (generalized Arakawa scheme). Starting with initial restoring body forcing toward the Levitus climatology, the model was integrated for 17 years with the use of climatological monthly-mean wind data. The final 3-year data were analyzed.

Intensive currents associated with the subarctic gyre are simulated well, such as the Kuroshio Extension, the East Kamchatka Current, the Oyashio, the Subarctic Current, and the Alaskan Stream. The Kuroshio separates from the east coast of Japan with the extension at 35 - 36N, consistent with observed feature. Confluence zone appears between the Kuroshio and the Oyashio, where many warm and cold core rings are formed.

The Alaskan Stream does not continue to flow westward west of 180E, but often forms detached rings around 170W and sometimes around 180E. Most of the rings are slowly migrated westward at 49-50N. Along the eastern coast of the Gulf of Alaska, annual variation is dominant in coastal current, with strongest northward flow appearing in winter. In other seasons many eddies are formed along the coast including the so-called Sitka Eddy, most of which are migrated west.

8AM1999-POCtopic05

oral

## **ANALYSIS OF SEASONAL VARIABILITY OF DYNAMICS AND WATER EXCHANGE IN THE KURIL STRAITS: FRIZ AND BUSSOL**

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Seasonal dynamics of the Kuril Straits, Friz and Bussol, were analyzed on the base of the data obtained in the POI expeditions in 1989-1991 and in the numerical experiments. The quasigeostrophic baroclinic model based on the principles of self-similarity of the second order was used. The numerical experiments have been carried out to calculate the seasonal variability of water circulation and water exchange of the Okhotsk Sea and the Pacific Ocean through the Kuril Straits: Friz and Bussol. The input data for calculations are real fields of the atmospheric pressure (they correspond to the two types of the atmospheric processes predominant for each month), water salinity and temperature on the sea surface. Bottom topography, coastline framework, and coefficients of vertical and horizontal turbulent exchange were taken into account. The fields of wind speed at the sea surface, depth of the homogenous layer, vertical and horizontal components of the current velocity were calculated. The fields of the stream functions are characterized by some permanent characteristics and specific

peculiarities. The estimation of the values and order of variability of water exchange through the straits according to seasons is presented.

8AM1999-POCtopic06

oral

### **ESTIMATION OF LATENT AND SENSIBLE HEAT FLUXES OVER THE NORTHWEST PACIFIC USING SATELLITE DATA**

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Latent and sensible heat fluxes over the oceans around the Korean Peninsula are estimated by the bulk formula with SSM/I wind speed and air humidity of DMSP satellite, MCSST of NOAA satellite, and sea level pressure and air temperature of NCEP/NCAR reanalysis product. The retrieved parameters from satellite data and estimated heat fluxes are validated using the JMA buoy data. The instantaneous bias of wind speed and humidity retrieved from SSM/I data is 0.25 m/s with 1.79 m/s RMSE and 0.53 g/kg with 1.84 g/kg RMSE, and the monthly bias is -0.16 m/s with 0.71 m/s RMSE and 0.41 g/kg with 1.31 g/kg RMSE, respectively. The instantaneous and monthly bias is -28 W/m<sup>2</sup> (RMSE 78 W/m<sup>2</sup>) and -25 W/m<sup>2</sup> (RMSE 49 W/m<sup>2</sup>) for latent flux, -7 W/m<sup>2</sup> (RMSE 26 W/m<sup>2</sup>) and -6 W/m<sup>2</sup> (RMSE 16 W/m<sup>2</sup>) for sensible flux, respectively, which is comparable with those of previous studies.

8AM1999-POCtopic07

oral

### **STUDY OF THE FORMATION OF NORTH PACIFIC INTERMEDIATE WATER BY A GENERAL CIRCULATION MODEL AND THE PARTICLE-TRACKING METHOD - FORMATION MECHANISMS OF SALINITY MINIMUM BY THE VIEW OF "CRITICAL GRADIENT" OF THE OYASHIO MIXING RATIO**

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To avoid "false North Pacific Intermediate Water (NPIW)" problem, a general circulation model is driven by the winter-like North Pacific wind that can separate the modeled Kuroshio from the coast around 36N. In the model a salinity minimum appears around the isopycnal of 26.8 sigma-theta, which does not outcrop in the North Pacific. Its formation processes are examined and compared with observations. It is clarified that NPIW salinity minimum is formed just above the less saline water influenced largely by the Oyashio water. The formation of NPIW is basically controlled by the rapid increase of the Oyashio layer thickness around 26.5--26.8 sigma-theta, whose structure is determined by Okhotsk Sea Mode Water pycnostad at 26.8--26.9 sigma-theta and the winter sea surface density of about 26.5 sigma-theta. For NPIW salinity minimum formation, it is the most important that the gradient of the Oyashio mixing ratio exceeds the "Critical Gradient" around 26.4--26.7 sigma-theta. For NPIW salinity minimum density, its value is almost determined by the heaviest density of this range (26.7 sigma-theta), which is about 0.1 sigma-theta less dense than that of the bottom of the rapid increase of the Oyashio layer thickness. Then cabbeling leads to increase of its density to 26.8 sigma-theta. The Sea of Okhotsk is very important for the formation of NPIW through the formation of the Oyashio thick layers, and it practically determines NPIW salinity minimum density.

8AM1999-POCtopic08

oral

### **SENSITIVITY OF THE NORTH PACIFIC CIRCULATION MODEL TO SURFACE FORCING**

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The 3-D finite element North Pacific Circulation Model developed in the Novosibirsk Institute of Computational Mathematics and Mathematical Geophysics (ICMMG) is used to study the sensitivity of the North Pacific circulation to the varying boundary conditions at the sea surface. The initial conditions were taken from the results of the tree-year spin-up numerical experiment of climatic circulation which were carried out on the basis of the climatic temperature and salinity data of Levitus, 1994 and the wind-stress of Hellerman, Rosenstein, 1982. The numerical experiment dealt with prognostic experiments for the study of variations of the North Pacific hydrophysical characteristics induced by real forcing at the surface. For this purpose the ten-days mean distribution of the surface forcing was adopted from the European Centre of Medium-Range Forecast Seasonal Ensemble Simulation, 1987. The simulation period was chosen as period of the pre-El Niño and El Niño events of 1982. Simulation experiment for several years period with the climatic initial state and varying boundary conditions at the sea surface was carried out. The results show the development of the positive temperature anomaly in the eastern part of the tropical Pacific induced by the Kelvin waves, propagating at some depth from the west to this region. The analysis of these processes and the comparison with the climatic state are done in the paper.

8AM1999-POCtopic09

oral

### **EVALUATION OF SEA SURFACE WIND STRESS IN THE NORTHERN HEMISPHERE FOR THE PERIOD OF 100 YEARS**

Kengo Miyamoto and Kimio Hanawa

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Using monthly mean sea surface pressure fields, monthly mean sea surface wind fields are reconstructed at 5 degrees x 5 degrees boxes over the sea in the Northern Hemisphere for the period of 100 years from 1899 to 1998. In addition, we try to estimate monthly mean wind stress fields using the above wind fields. Since the reconstructed winds are so-called velocity averaged ones, usual aerodynamic bulk formula cannot be applied. In the present study, we apply the empirical method proposed by Wright and Thompson (1983) to properly estimate monthly mean wind stresses. As a result of comparison to other independently obtained wind stress dataset, it is found wind stress fields are evaluated with enough accuracy. As well as this long-term change of wind stress fields, time series of calculated Sverdrup and Ekman transports are discussed.

8AM1999-POCtopic10 oral

## MESOSCALE VARIABILITY OVER THE JAPAN BASIN: A COMPARISON OF NUMERICAL SIMULATIONS AND CREAMS I CURRENT METER TIME SERIES

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It is well-known that the upper level mesoscale variability over the Japan Basin of the Japan (East) Sea (JES) is vigorous and rich in variety. Less well-known is the nature and intensity of the lower level mesoscale variability, and its connection to upper level mesoscale variability. However, the CREAMS I moored current meter array timeseries at several locations in the lower level of the Japan Basin (by Prof. Masaki Takematsu) provided dramatic evidence for vigorous mesoscale variability.

The Princeton Ocean Model (POM) has been implemented for the JES with mesoscale eddy - admitting resolution (ca. 10 km horizontal resolution and 26 sigma levels). A case with steady climatological wind and throughflow forcing, and a case with monthly climatological wind and steady throughflow forcing, are compared to 1,000 days of CREAMS I current meter data at several locations with spectrum analysis. Then the more comprehensive model output is analyzed in terms of dynamical and empirical modes to gain some insight into the coupling between the upper and lower levels. There is a dominance of 50-day timescale variability and most of the variance is accounted for by the first few dynamical and empirical modes.

This study helps to establish metrics for model-data comparisons, in particular, to determine if a more realistic simulation agrees better with observations than a less realistic simulation. It also serves to examine the upper level and lower level mesoscale coupling and provides guidance for future observations.

8AM1999-POCtopic11 oral

## WATER PROPERTIES AND INSTABILITY OVER TRENCHES IN THE SUBARCTIC NORTH PACIFIC

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The Pacific Ocean is ringed around much of its margins by deep trenches. Today long-term deep current measurements over trenches at the western and northern edges of the Pacific Ocean Central basin are available through Internet. Observations of water properties and deep currents over several trenches in the subarctic North Pacific give consistent evidence for recent ventilation of water below the trench sills and cyclonic sign of circulation over the trenches. The analysis of hydrographic data shows that the trenches are well ventilated by dense bottom water. Within the trenches this bottom water generally spreads away from its source, and a cyclonic sign of circulation is also suggested over the trenches. The mathematical model of Raleigh convection on the rotating earth in deep-water ocean depression is generalized for the case including the meridional temperature gradient. The stability of a steady-state thermal shear flow, caused by this gradient, has been studied with respect to the three-dimensional disturbances. Critical parameters determining the convection are calculated for the Kuril Kamchatka and Japan trenches. The velocity components of tidal flow have been calculated using the hypothesis of Prandtl mixing way for bottom layer of trenches.

8AM1999-POCtopic12

oral

## **ASSIMILATION OF DATA INTO MODELS OF NUTRIENT-PHYTOPLANKTON-ZOOPLANKTON INTERACTIONS**

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A one-dimensional (vertical) model of the interaction of nutrients, phytoplankton, and zooplankton has been developed for coastal regions in Alaska waters. We will present the results of the application of this model to Southeast Bering Sea and our initial attempts at assimilating observations of nitrate into the model.

8AM1999-POCtopic13

oral

## **THE USE OF PARAMETERS OF VARIABILITY FOR THE LONG-TERM AND SUPERLONG-TERM ICE SHEET FORECASTS ON THE FAR EASTERN SEAS**

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For the purposes of long-term planning the background long-term and superlong-term forecasts of expected ice conditions in the seas represents the undoubted interest. On their basis it is possible to arrive at certain conclusions about the possible character of ice processes development and to attempt to detail the forecast.

For every Far Eastern sea the long-term observation series of ice extent and coverage have been considered. The rows of latent periodicity have been revealed. Their optimum superposition has made it possible to carry out the extrapolation of these processes for the purposes of forecasting. It must be noted that the constant inflow of metocean data is necessary for the forecast elaboration.

Principally the scheme does not limit the term for the forecast. The attempt of the background ice conditions forecast for the Okhotsk, the Bering and the Japanese seas for the period of 1995-1996 up to 1998-1999 has been made. The estimation of precision of the prognosis recommendation (data for 1960-1995) mainly does not fall below 73% level. The average verification of the forecasts on the independent material (1995-1999) is a little lower and averages 70%. Therefore the efficiency of the method is obviously enough. The lower estimation falls for the initial period when the ice sheet is characterized by its extreme instability.

Basing on the estimation obtained it is possible to assume that on the whole the suggested circuit of the forecast reflects the long-term variability of ice extent of the Far East seas adequately enough and can be used to accomplish the applied tasks of the long-term planning of sea and offshore operations. For the purposes of long-term planning the background long-term and superlong-term forecasts of expected ice conditions in the seas represents the undoubted interest. On their basis it is possible to arrive at certain conclusions about the possible character of ice processes development and to attempt to detail the forecast.

For every Far Eastern sea the long-term observation series of ice extent and coverage have been considered. The rows of latent periodicity have been revealed. Their optimum superposition has made it possible to carry out the extrapolation of these processes for the purposes of forecasting. It must be noted that the constant inflow of metocean data is necessary for the forecast elaboration.

Principally the scheme does not limit the term for the forecast. The attempt of the background ice conditions forecast for the Okhotsk, the Bering and the Japanese seas for the period of 1995-1996 up to 1998-1999 has been made. The estimation of precision of the prognosis recommendation (data for 1960-1995) mainly does not fall below 73% level. The average verification of the forecasts on the independent material (1995-1999) is a little lower and averages 70%. Therefore the efficiency of the method is obviously enough. The lower estimation falls for the initial period when the ice sheet is characterized by its extreme instability.

Basing on the estimation obtained it is possible to assume that on the whole the suggested circuit of the forecast reflects the long-term variability of ice extent of the Far East seas adequately enough and can be used to accomplish the applied tasks of the long-term planning of sea and offshore operations.

8AM1999-POCtopic14

oral

## **NUMERICAL MODELLING OF THE EAST (JAPAN) SEA CIRCULATION WITH DATA ASSIMILATION**

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A numerical model, POM-ES is developed to understand the physics of the circulation of the East (Japan) Sea. The POM-ES is solving 3-D primitive equations with 1/10 degree horizontal resolution and realistic bottom topography. Climatological T-S forcing is done by use of Levitus monthly data sets as well as GDEM data sets. Optimal interpolated KODC and JODC hydrographic data would be assimilated into model. For surface wind stress, monthly Hellerman-Rosenstein data set is also used. For the inflow open boundary condition, 2-4 Sv. of volume transport is specified as seasonally varying with highest in August and lowest in February. Important features of circulation and mesoscale eddy dynamics will be presented through animated movies.

8AM1999-POCtopic15

oral

## **EMPIRICAL MODEL OF TIDAL REGIME ON THE NORTH-EASTERN SHELF OF SAKHALIN ISLAND**

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A correct prediction of tidal currents and sea levels is highly important for the northeastern shelf of Sakhalin Island because of development of the oil and natural gas industries in this area. The main problem of the tidal regime is determination of tidal harmonic constants (amplitudes and phases) from the available sea level and current observational series.

Environmental Company of Sakhalin carried out field observations on the northeastern shelf of Sakhalin Island during the last 15 years. We have analyzed the sea level series that were measured in about 30 spots (mareography station in the Nabil Bay, 8 temporal shore gauges and recorders on the floating bore pontoons) and more than 100 series of currents. The least square method was used to estimate the tidal harmonic constants. We have made maps of amplitudes and phases using the 2-dimensional spline interpolation for main semidiurnal (M2) and diurnal (O1, K1) constituents.

There are strong spatial variability of the sea level amplitudes and phases of diurnal harmonics and very strong diurnal currents in the nearshore zone. These effects are induced by O1 and K1 shelf waves that probably generated by diffraction of the main tidal waves on the northern end of Sakhalin Island. We estimated the phase speed of tidal shelf waves on the basis of data analyses.

In contrast to the diurnal tides, sea level harmonic constants of M2 constituent are relatively stable and semidiurnal currents are small on the northeastern shelf of Sakhalin Island.

The maps of harmonic constants of the main tidal constituents can be used to predict the sea level oscillation and currents for any point in the marine oil and gas-bearing areas.

8AM1999-POCtopic16 oral

## **DEEP PACIFIC CIRCULATION CONTROLLED BY VERTICAL DIFFUSIVITY AT THE LOWER THERMOCLINE DEPTHS**

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Deep Pacific circulation is investigated by using an idealized two-basin model. Depth-dependent vertical diffusivity is employed to control the circulation. Vertical diffusivity estimated from observations,  $0.1 \text{Å}^{-1} 10^{-4} \text{m}^2 \text{s}^{-1}$ , and  $3.0 \text{Å}^{-1} 10^{-4} \text{m}^2 \text{s}^{-1}$ , is adopted for the upper layer and for the deep layer, respectively. Comparison is made between two cases with a different value of vertical diffusivity at mid-depths. When vertical diffusivity is set to increase progressively with depth beginning at the lower thermocline depths, the deep circulation is significantly intensified. This is due to enhanced heat exchange between the thermocline water and the deep water through intense diffusion at the lower thermocline depths. The water below the thermocline is warmed and the water above the thermocline is cooled for the whole basin. The warmed deep water leads to large heat loss through the sea surface causing enhanced deep water formation in the deep water formation region. The cooled upper-layer water leads to large heat gain through the sea surface, balancing with large heat loss in the deep water formation region. In this way, the meridional overturning with large transport forms below the lower thermocline in the Pacific. This circulation yields tracer distributions that are well compared with the observation. Intensification of the deep Pacific circulation does not occur when vertical diffusivity is set to increase with depth beginning at the lower thermocline depths but not to increase below mid-depths.

It is confirmed in a world ocean model that depth-dependent vertical diffusivity which increases progressively with depth beginning at the lower thermocline depths well reproduces the intensity of meridional overturning circulation and tracer distributions.

8AM1999-POCtopic17 oral

## **THE EFFECTS OF CLIMATE CHANGE ON MID-RANGE OSCILLATION OF MONSOON CIRCULATION OVER THE ASIA**

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The mid-range oscillation with 30-45 days of the monsoon circulation during May-August was discussed. The data were obtained from synoptic and satellite cloud pictures. It is found that there are low and high pressure index patterns for the monsoon circulation in the Asia. In the period of low index, the group genesis and development of monsoon depressions, tropical cyclones over Arabian Sea and the Bengal Bay, typhoons over the western Pacific Ocean are always successfully observed from west to east. In this period, the rainfall over middle-India and eastern part of China usually increases. The results showed that the major characteristic of the mid-range oscillation are different between El Niño and La Niña years. We can use the oscillation of the pressure value over equatorial area to describe the mid-range oscillation of monsoon circulation and its related circulation system.

**A PROPOSED JAPAN (EAST) SEA MODEL-DATA COMPARISON STUDY AND ANALYSIS**Christopher N.K. **Moore**<sup>1</sup>, Alexander Ostrovski<sup>2</sup>, Yign Noh<sup>3</sup><sup>1</sup> *Ocean Prediction Experimental Laboratory, Rosenstiel School of Marine and Atmospheric Science, University of Miami, 4600 Rickenbacker Causeway, Miami, FL 33149-1098, U.S.A.*<sup>2</sup> *Institute for Global Research Change (IGCR), Seavans N. 7F, 1-2-1 Shibaura, Minato-ku, Tokyo 105-6794, Japan*<sup>3</sup> *Department of Atmospheric Science, Yoasei University, 134 Shinchon-dong, Seodanun-gu, Seoul 120-749 Republic of Korea*

Numerical simulations of the circulation of the Japan (East) Sea are being pursued with a variety of modeling strategies by ocean scientists in Russia, Japan, Korea, and USA. There is a serious need to compare these models with observations. There are some excellent observations available, especially during the CREAMS I years. However, not all of the germane observations are conveniently available to all of the modelers.

It is proposed to assemble a well-organized set of datasets which will be accessible to all of the modelers (or anyone else for that matter). High priority in situ datasets include current meter time series, CTD surveys, Lagrangian drifter tracks, and coastal sea level time series. And high priority remotely-sensed datasets include AVHRR imagery, MCSST, satellite altimetric surface heights, and satellite scatterometer surface winds. Maps of surface wind stress, heat flux, and moisture flux are very important, too. This archive of datasets will be used in multi-year simulations, model-data comparisons, and data assimilation efforts, which will lead to multi-year analyses.

An over-arching objective is to produce (model-observation-based) analyses through the CREAMS I years. These analyses would then be extended as the CREAMS II data becomes available. With these analyses completed for approximately a decade, process studies will be facilitated for physical, chemical, and biological oceanography. This activity is a logical follow-on to PICES Working Group 10 and needs to be coordinated with CREAMS I & II investigators and NEAR-GOOS.

8AM1999-MEQ/BIOtopic01 invited

## AN EXPANDED BIOGEOGRAPHY OF THE TOXIC DINOFLAGELLATE GENUS ALEXANDRIUM, WITH EMPHASIS ON THE WESTERN PACIFIC

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Prior work has shown that sequence analysis of large subunit ribosomal DNA (LSU rDNA) is an effective tool for investigating genetic diversity, phylogenetic relationships, and biogeography within the toxic dinoflagellate *Alexandrium*. Biogeographic relationships have been uncovered which do not fit with traditional taxonomy based on cell morphology. Previously, an LSU rDNA-based RFLP assay was used successfully to characterize isolates from North America, Western Europe, Japan, Thailand, and Australia. Here we describe an expansion of that study using a much broader set of isolates, which represent the coastal areas of South America, Africa, New Zealand and the Mediterranean in addition to new isolates from areas in the western Pacific. Several novel ribotypes were found within both the *tamarensis* and the *A. minutum/A. lusitanicum* group, in addition to previously known ribotypes. Isolates of *A. margalefii*, *A. pseudogonyaulax* and *A. ostenfeldii* all displayed unique ribotypes as well. In accordance with prior work, ribotypes do not reflect morphospecies. For the *tamarensis* complex, geographic origin is a better indicator of phylogeny than morphology. For all species, each ribotype contains either all toxic or non-toxic isolates, but not both.

With respect to the western Pacific strains, some interesting relationships emerged. Some (but not all) Japanese strains within the *tamarensis* complex had RFLP patterns equivalent to the North American ribotype, suggesting an introduction of the populations from North America either recently, as a result of human activity such as ballast water transport, or several million years ago via natural dispersal mechanisms. The time resolution of the rDNA analysis does not allow discrimination between these two possibilities. However, examination of the sequences and RFLP patterns of other isolates from the western Pacific, and in particular those from the Russian coast, indicate that natural dispersal in the distant past was the means of introduction to the region, rather than recent, human-assisted transport. These and other biogeographic issues related to this important dinoflagellate genus will be discussed.

8AM1999-MEQ/BIOtopic02 oral

## STUDY ON THE PHYTOPLANKTON ECOLOGY CHARACTERISTICS IN THE NORTHERN JIAOZHOU BAY

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Based on the investigation data of phytoplankton in the northern Jiaozhou Bay from mid-April to mid-October in 1998, the following results were conducted. There were 26 genus and 56 species phytoplankton in the northern Jiaozhou Bay. Among them, 22 genus 50 species were Bacillariophyta and 4 genus 6 species were Pyrophyta. The cell number and species of Bacillariophyta were absolutely predominant. The seasonal variation in phytoplankton abundance was significant. The peaks of phytoplankton appeared in mid-April and September, the mean values of phytoplankton were 1344.070104cell/m<sup>3</sup> and 12922.440104cell/m<sup>3</sup> respectively, its minimum appeared during the periods of June-July. The variation of phytoplankton number basically accord with the seasonal variation type which has two cycles in the temperate sea waters. Most of the phytoplankton belonged to temperate offshore species, but the species composition, dominant species and community structure vary obviously with season. In spring, the dominant species were *Asterionella kariana* and *Skeletonema costatum*, the biomass of them were 44-99.8% of total biomass. In summer, the dominant species was not obvious in June, the major species were *Chaetoceros Streptotheca thamesis*, *Ditylum brightwellii* and *Biddulphia sinensis*. The

dominant species was *Eucampia zoodiacus* in July and August. In autumn, the dominant species were *Eucampia zoodiacus*, *Skeletomema costatum* and *Bacteriastrum hyalinum*.

8AM1999-MEQ/BIOtopic03 oral

## EFFECT OF ENVIRONMENTAL FACTORS ON THE PRODUCTION INDICES OF *AHNFELTIA TOBUCHIENSIS* POPULATION IN THE BAY OF IZMENA, KUNASHIR ISLAND

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The population area of the agarophyte *Ahnfeltia tobuchiensis* (Kanno et Matsubara) Makienko in the Bay of Izmena is 23.3 km<sup>2</sup>. In this its biomass used for agar production in Russia is 125 000 tons. *A. tobuchiensis* forms an unattached stratum up to 1 m thick on the sandy and silty-sandy bottom. The influence of environmental factors on the production indices of *A. tobuchiensis* population was studied at 14 most characteristic stations during the summer period. The height of the stratum, algae biomass, penetration of photosynthetically active radiation (PAR) into the water column and into the stratum, water temperature near the bottom have been measured at each station. Algae samples were collected for the analysis of organic matter (Corg.), chlorophyll *a* (Chl *a*), nitrogen (N) and phosphorus (P) concentrations in the tissue of the algae. During the day, water samples were collected from the bottom stratum for the analysis of oxygen (O<sub>2</sub>), ammonium (NH<sub>4</sub><sup>+</sup>) and orthophosphate (M PO<sub>4</sub><sup>3-</sup>) concentrations. Oxygen (M O<sub>2</sub>), ammonium (M NH<sub>4</sub><sup>+</sup>) and orthophosphate (M PO<sub>4</sub><sup>2-</sup>) metabolism of *Ahnfeltia tobuchiensis* population were measured during the day in situ. Multiple regression analysis and correlation analysis were performed for the study of dependencies on several variables. An analysis of the correlation of "structural" (Corg, Chl *a*, N and P) and "functional" (M O<sub>2</sub>, M NH<sub>4</sub><sup>+</sup>, M PO<sub>4</sub><sup>3-</sup>) production indices of *Ahnfeltia* population to environmental factors (PAR, T(C, O<sub>2</sub>, NH<sub>4</sub><sup>+</sup>, PO<sub>4</sub><sup>3-</sup>) showed that M O<sub>2</sub> is closely connected with the PAR intensity and PO<sub>4</sub><sup>3-</sup> concentration in the water. Metabolism of M NH<sub>4</sub><sup>+</sup> and M PO<sub>4</sub><sup>3-</sup> depends on the concentration of ammonium in the water and on the content of phosphorus in the algae tissue. At PAR and NH<sub>4</sub><sup>+</sup>, PO<sub>4</sub><sup>3-</sup> concentrations corresponding to those algae habitats the study of light dependency of the photosynthesis rate in *A. tobuchiensis* stratum showed that light saturation occurred only at PAR levels exceeding 300 (mol m<sup>-2</sup> s<sup>-1</sup>) and at low concentrations of NH<sub>4</sub><sup>+</sup> and PO<sub>4</sub><sup>3-</sup>. The investigation of PAR effect on the velocity rate of M O<sub>2</sub> of population at different concentrations of nutrients showed that an increase in ammonium concentration from 0.01 to 3.0 (M in surrounding waters causes a 3-fold increase the M O<sub>2</sub> velocity. On the other hand, increase in PO<sub>4</sub><sup>3-</sup> concentration was more effective for the metabolism velocity of M O<sub>2</sub> at low PAR. Thus, on the basis of the represents and earlier found data have allowed us to conclude that the main factor that determines the metabolism of *A. tobuchiensis* population during the summer period is availability of PAR. It is likely that ammonium concentration in surrounding water limits the production processes of population at shallow depths.

8AM1999-MEQ/BIOtopic04 keynote/invited

## NITROGEN AND CARBON UPTAKE KINETICS AND THE INFLUENCE OF IRRADIANCE FOR A RED TIDE BLOOM OF THE DINOFLAGELLATE *Lingulodinium polyedrum*

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The kinetics of nitrogen (nitrate, ammonium, urea) and carbon uptake by a red tide bloom consisting almost exclusively of the dinoflagellate *Lingulodinium polyedrum* (Stein) Dodge were determined with <sup>15</sup>N- and <sup>13</sup>C-

tracer techniques, as a function of substrate concentration (for nitrogen) and irradiance (for both carbon and nitrogen). Samples were collected from Newport Bay, California during late March 1995, during a massive red tide bloom that occurred from the upper Baja peninsula in Mexico to Monterey Bay, California. At the collection site, surface concentrations of *L. polyedrum* reached  $1.1 \times 10^6$  cells/L, with chlorophyll *a* = 125  $\mu\text{g/L}$ . Maximal uptake rates of urea-N are approximately twice the maximal rates for either ammonium or nitrate during both the uptake vs. substrate and uptake vs. irradiance experiments, and the affinity for nitrate is much greater than previously demonstrated: half-saturation constant ( $K_s$ ) = 0.47  $\mu\text{M}$ . Carbon and nitrogen uptake rates as a function of irradiance are well described by a 3-parameter P vs. E relationship proposed by Platt and Gallegos (1980), although dark-uptake of nitrogen compounds accounts for ca. 50% of maximal specific uptake ( $V_{\text{max}}$ ). These results demonstrate that *L. polyedrum* is capable of utilizing a broad range of both nitrogen concentrations and light fluences, and that urea could potentially provide a large percentage of the nitrogen demand at ambient urea concentrations and across the entire spectrum of light fluences. These results represent a more complete quantification of the N uptake dynamics of this bloom-forming species, and contrast markedly compared to previous studies of *L. polyedrum*.

8AM1999-MEQ/BIOtopic05 oral

### **STUDY ON CORRELATION OF PHYTOPLANKTON AND ENVIRONMENTAL FACTORS IN RUSHAN BAY**

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Based on the investigation data of phytoplankton and environmental factors in the Rushan Bay from June to September in 1997, the relationship between cell number of phytoplankton and temperature, salinity, dissolved oxygen, chlorophyll and nutrient salts is discussed in this paper.

The analytical results show that nutrient salts, salinity and temperature are the main affecting factors on phytoplankton growth and breeding as well as species composition. By means of analyzing correlativity for phytoplankton and environmental factors showing, the temperature, dissolved oxygen and chlorophyll appear positive correlativity with phytoplankton, and salinity and nutrient salts appear negative correlativity with phytoplankton. The statistical results show that it has good a negative correlativity for the cell number of phytoplankton with the content of nutrient salts, and the correlative coefficients are -0.671, and -0.802 for inorganic nitrogen and phosphorus respectively, and the correlativity of inorganic phosphorus with phytoplankton is better than inorganic nitrogen. The contents of dissolved oxygen and chlorophyll appear closer positive correlativity with cell number of phytoplankton, the correlative coefficient are 0.922 and 0.850 for dissolved oxygen and chlorophyll respectively. Based on the analysis of N/P ratio, the N/P ratio in the Rushan Bay is less than the normal seawater N/P ratio (16:1) that phytoplankton take in nitrogen and phosphorus from seawater, except that of last-August is bigger than normal N/P ratio.

As remarked above, most of the phytoplankton belongs to temperate offshore species which adapt to the wider range of temperature and salinity. The change of nutrient salts, temperature, salinity and dissolved oxygen all affect the species composition, dominant species and community structure, especially the nutrient salts and temperature are main factors that affect the growth and breeding of phytoplankton, among those the nutrient salt is an important factor which influences the cell number and distribution of phytoplankton. The variance of temperature, salinity and dissolved oxygen is mainly controlled by climate and hydrology, and their obvious variance will result in the change of cell number, species composition and dominant species of phytoplankton. Once the water temperature is suited for the temperate range, the dense zone of phytoplankton often show up in the waters with higher temperature under the other adaptable environmental conditions. Because inshore waters is affected by land runoff, the contents of nutrient salt are normally more abundant than that of open sea, thus the growth and breeding is mainly controlled by salinity and temperature as well as nutrient salt.

8AM1999-MEQ/BIOtopic06 keynote/invited

## HARMFUL ALGAL BLOOMS IN WESTERN PACIFIC

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There are two types of harmful microorganisms in the western Pacific. One is the fish killing species such as *Chattonella antiqua*. The other one is the species responsible for shellfish toxins, which cause human food poisoning, such as *Alexandrium tamarense* and *Pyrodinium bahamense*.

The former often makes red tides followed by oxygen depletion and other noxious events. Usually red tide does not harm marine natural resources, but along with the development of aquaculture activity, mass mortality of fish in cages are increasing. Eutrophication of the coastal area often makes red tides bigger in term of case number, duration and suffering area.

Among five types of poisonings caused by microalgae, paralytic shellfish poisoning (PSP) is most harmful and has been giving damage to coastal societies in the western Pacific because of its acuteness of symptoms and high fatality. Marine products containing the toxin more than the permitted level cannot be sold in market, and therefore it causes economic loss. Moreover monitoring activity on toxin and causative microalgae needs much efforts and budget.

Scientific researches on the blooming mechanism of PSP causative microalgae and toxin contamination mechanism in shellfish have been conducted in these two decades. Ecological features of the causative organisms are area specific. *Alexandrium* in temperate and *Pyrodinium* in tropical water are meroplanktonic and complete their life cycles on the site, and therefore they recur in a certain area for longer time. Relationship between their blooming mechanism and environmental factors, especially oceanographic condition, is now the main subject to study.

8AM1999-MEQ/BIOtopic07 oral

## HIGH CONTRIBUTIONS OF COCCOLITHOPHORES TO THE PHYTOPLANKTON ABUNDANCES IN BAJA CALIFORNIA, MEXICO, DURING THE EL NIÑO 1997-1998

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The phytoplankton from waters of Baja California, Mexico, is relatively well-known: the best studied groups are diatoms and "armored" dinoflagellates. However, there have been few attempts to study the contributions of the different groups and/or fractions of phytoplankton to the biomass and productivity. During a cruise on March-April, 1998, considered the fall of the El Niño (1997-1998) event, samples were taken to collect the "preservable" fraction of the phytoplankton from three depths in six points in three different zones of Baja California: 4 l of water were filtered and preserved with a buffered (pH 7.5-8) solution. The analysis of the filters, by light and electron microscopy, revealed assemblages with low diversity, dominated by coccolithophores, mainly the species *Emiliania huxleyi*. Coccolithophores are a rather poorly-known group in Baja California. The abundances of phytoplankton ranged between  $5.4 \times 10^3$  and  $1.2 \times 10^5$ , with the coccolithophores counting up to 93 % of the total abundance, and reaching to a ratio of 21:1 with regard to diatoms, traditionally the most important group in the study area. Diatoms were dominated by small (less than 20  $\mu\text{m}$ ), solitary and lanceolate/centric species. The main thermocline was about 50-60 m, except in a shallow station. Discussion is made on the methodology used as well as on the effects of the oceanographic changes caused by the El Niño on the phytoplankton community.

8AM1999-MEQ/BIOTopic04 oral

## HARMFUL ALGAL BLOOMS IN KOREAN COASTAL WATERS

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The problem of harmful algal blooms (HABs) in Korea are now deeply concerned with frequency, intensity and scale. Therefore, HABs monitoring and research system have been reasonably well managed. However, causes and mechanisms of outbreak are not fully understood.

Totally 122 events of algal blooms were occurred in 1998, of which, phytoflagellates responsible for 85 times and diatoms 21 times respectively. The blooms of *Cochlodinium polykrikoides*, the most harmful fish killing species in Korea, have been persisted in the whole coast of the South Sea and as far as the East Sea every year from August to October since 1995.

National Fisheries Research and Development Institute (NFRDI) are monitoring at 70 stations around Korean coastal waters twice per month by research vessels from March to November. When the harmful algae are bloomed, NFRDI monitor everyday by research vessels and sometimes helicopter. Monitoring results are immediately disseminated to aquaculturists and local administration officers by fax, newspapers, automatic response system, and radio and TV broadcasting to mitigate the fisheries damages NFRDI forecast harmful algal blooms into two steps by alarm the appearance of harmful species such as *Cochlodinium polykrikoides*, *Gymnodinium mikimotoi*, *Chattonella marina* and by warning exceed it's the standard levels.

8AM1999-MEQ/BIOTopic09 oral

## EVENTS OF "BLOOMS" OF HARMFUL ALGAE IN COASTAL WATERS OF THE FAR-EASTERN SEAS IN RUSSIA

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The occurrence of 25 algae species known to be harmful has been established in the last 12 years in coastal waters of the Far-Eastern seas of Russia. A half of them cause water blooms in the seaport zones of Vladivostok (Amurskii Bay) and Petropavlovsk-Kamchatsky (Avachinskaya Guba Inlet), and also in the zone of Bering Sea shelf near the Korjak Mountain massive. The cases of water blooms caused by dangerous species were especially numerous in Amurskii Bay in summer and autumn 1987-1993. Red tides caused by dinoflagellates *Gymnodinium mikimotoi*, *Prorocentrum minimum* and raphidophytes *Heterosigma akashiwo* and *Chattonella* sp., were observed quite often. Blooms of potentially toxic diatoms *Pseudo-nitzschia multiseries*, *P. pseudodelicatissima* and *P. pungens* were recorded in the beach zone of Vladivostok in June and September 1991-1993. Widespread red tides caused by *Alexandrium tamarense* accompanied by marine animals mortality were observed in Bering Sea along north eastern coast of Kamchatka in 1988, 1990. Outbursts of *Dinophysis* were regularly observed in Avachinskaya Guba Inlet and Amurskii Bay in summer and autumn, mainly of *D. acuminata*. Cases of human poisoning were not recorded. A complex of factors favorable for the development of harmful algae exists in coastal waters of the far-eastern seas. The main cause of water blooms is obviously hypereutrophication of coastal waters due to the anthropogenic factors, but other factors and their combinations are also possible.

## **PHYTOPLANKTON SUCCESSION BEFORE BLOOMS OF *Cochlodinium*, HARMFUL ALGAL BLOOMS SPECIES IN THE SOUTHERN COASTS OF KOREA**

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Harmful algal blooms (HABs), *Cochlodinium polykrikoides* have damaged to fisheries animals in the southern coasts of Korean peninsula since 1995. We investigated phytoplankton composition and succession until outbreaks of *Cochlodinium* red tides for three successive years in the coastal area of Nardo and Namhedo where occurrence of red tides have been frequent in Korea.

In most cases, *Cochlodinium* has made a patch in two or three weeks at the coast of Nardo since one of two chains swimming cells were detected in August, initially. Approximately calculated specific growth rate of the species from the date of first incidence to that of making patch of the species ranged from 0.9 to 1.23.

Dominant species were *Ceratium furca*, *Prorocentrum micans* and *Gonyaulax* spp. for dinoflagellates, and were *Leptocylindrus danicus*, *Chaetoceros* spp., *Rhizosolenia* spp., *Nitzschia* spp. and *Guinardia flaccida* for diatoms before *Cochlodinium* blooms. Composition of phytoplankton varied depending on locations. The ratio of relative composition between dinoflagellates and diatoms was almost constant with the increase of *Cochlodinium* density suggesting that the growth of dinoflagellates and diatoms during the succession periods to *Cochlodinium* blooms be constrained simultaneously.

## **SUFFICIENT CONDITIONS FOR PHYTOPLANKTON BLOOMS IN CERTAIN AREAS OF THE NORTH-WESTERN JAPAN SEA**

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The conditions sufficient for phytoplankton blooms were determined for five domains with different water structure in the northwestern part of the Japan Sea: Polar Front, Subarctic, Primorye Current, Coastal, and small Pre-Estuarine one (near Suyfun River estuary). Irregular CTD data and the data of plankton net samples (net mouth 0.1 m<sup>2</sup>, mesh size 0.183 mm, towing 0-100 m) obtained in 1988-1998 were used for the analysis (about 700 samples). Note: phytoplankton cells are able to be collected by this net when blooming only.

Spring bloom of Diatom was observed everywhere. It began when water column had become stable: sigma-t difference between upper and subsurface layers (0/50 m horizons) was  $> 1.0$  that was caused by temperature difference  $> 1.0$  C in deep-water domains or by salinity difference in the Coastal and Pre-Estuarine domains. The bloom finished rapidly after water stability increasing in the Subarctic and Primorye Current zones, but was prolonged till SST increasing up to 10-11 C in the Polar Front and especially in the Coastal domains. We suppose that in the last case the end of the bloom wasn't controlled by upward nutrient influx because of other sources of nutrients and was stopped later by grazing by herbivorous zooplankton. In the Pre-Estuarine domain the spring bloom did not finish and continued till autumn with successive changes of phytoplankton species. During the spring bloom the main part of phytoplankton concentrated near sea surface.

In June a weak summer bloom of Diatom was observed in the Coastal domain caused by river discharge monsoon increasing, but it was rapidly crushed, possibly by grazing.

Autumn bloom did not observed in deep-water domains. Instead, warm-water Copepods were abundant in autumn, i.e. high grazing was supposed to be. In the Coastal domain the autumn bloom of Diatom began when SST had begun to fall (in early September); and continued till October when river run-off had weakened. The

bloom in the Pre-Estuarine domain finished simultaneously. During the autumn bloom, high concentrations of phytoplankton were observed near sea surface and in thermocline.

Year-to-year variations of terms, duration, and strength of the blooms were noticed. The spring bloom was earlier and stronger in relatively warm springs; the autumn bloom in the Coastal domain was later and stronger in warm autumns.

8AM1999-MEQ/BIOtopic12 oral

### **INFLUENCE OF POLLUTION OF COASTAL WATERS ON MORPHOLOGY AND REPRODUCTION OF *Laminaria japonica aresch*, PHAEOPHYTA**

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It is known, that macrophytes are capable to accumulate polluting substances, especially heavy metals. *Laminaria japonica*, as widely used in a food and pharmaceutical industry and forming kelp were over along coast northern Primorye, is chosen for an estimation of influence of pollution on morphology, anatomy and reproduction. The research was carried out along coast northern Primorye, including area of chronic pollution of waters by heavy metals (Rudnaya Bay, Japan Sea, Christophorova, 1989) during a number of years. Nine parameters of the fronds with anatomic structure and status of reproduction tissue of 700 two-year plants were analyzed with use of Statistica and Systat packages. The relationship between external and internal structure of the fronds and habitat condition was found. The decrease of weight and linear sizes of the plate and stipe was found in area of chronic pollution. The intense pigmentation formatives tissues and also reduction of the sizes of cells of all layers of tissue with increase of lanes is typical for all plants. The change of the sizes and forms zoospores and backlog in forming of reproduction tissue was observed. The reliability of criteria of reaction on pollution and use of *Laminaria japonica* as bioindicator is discussed.

8AM1999-MEQ/BIOtopic13 oral

### **ASSESSMENT OF COASTAL ECOSYSTEMS SUSTAINABILITY TO THE CHEMICAL CONTAMINATION**

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Coastal ecosystems (bays, inlets, lagoons, and estuaries) are the first barrier on the pathway of the different chemical contaminants arising due to human activities at the neighbour lands and coastal waters. The high value of the biological and recreational resources of coastal ecosystems demands assessment of the possible damage from the chemical contamination. The traditional manner for such investigations is based on the measurement of the contaminants concentration in the different ecosystem components (water, suspended matter, bottom sediments, organisms), and evaluation of the harmful effects of these concentrations by the toxicological tests. But huge variety of contaminants and complex sinergetic effects limit the scope of this approach. The expletive approach is based on the determination of the assimilative capacity of the concrete ecosystem for the different classes of contaminants. The assimilative capacity includes sum of contaminants fluxes due to water exchange, plankton assimilation, sedimentation, and destruction processes during settling. The background contaminants concentration is proposed as a base for the evaluation of these fluxes. The comparison of assimilative capacity for the different concrete ecosystems allows to assess their relative sustainability for the existing or possible chemical contamination. The comparison of the assimilative capacity with data of the contaminants input could forecast the concentration increase in the different parts of ecosystem. The limitations and advantages of these two approaches

will be demonstrated on the example of trace metals contamination of the Primorye coastal ecosystems (northwestern part Sea of Japan) with different contamination degree.

8AM1999-MEQ/BIOtopic14 invited

### **PARALYTIC SHELLFISH POISONING IN THE NORTH PACIFIC**

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PSP was first reliably documented in British Columbia in 1793 (the first undoubted record anywhere in the world). Since then its presence has been shown to be chronic and periodically severe along the North American west Coast from Alaska to California, also in Mexico and Guatemala (the highest number of fatalities occurring in the latter). In the North this phenomenon has been linked to blooms of several Alexandrium species whereas in the south it is caused mostly by Pyrodinium bahamense var. compressum. In the western Pacific the same pattern applies from eastern Russia, Japan and the Philippines (the most fatalities anywhere in the world).

The paper will summarize what is known of the ecology of the causative species including the lack of apparent links to eutrophication and the increasing severity during El Niño years, both in temperate and tropical regions.

8AM1999-MEQ/BIOtopic15 invited

### **RELIABLE MULTI-YEAR PREDICTION OF FISH-KILLING HETEROSIGMA BLOOMS IN THE STRAIT OF GEORGIA, BRITISH COLUMBIA**

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The chloromonad flagellate *Heterosigma carterae* (= *H. akashiwo*) has been known from British Columbia coastal waters since the late 1960s and has probably been indigenous long before. Farmed salmon are particularly vulnerable, wild fish being apparently unaffected due to avoidance of the blooms. In the Strait of Georgia blooms usually occur, beginning in June and often continuing for three or four months. Small, isolated blooms occur every year but in some years the blooms can cover almost the entire Strait and into northern Washington State waters.

In 1993 Taylor and Haigh published results from sampling at Jericho, Vancouver, that showed that in the severe years 1989 to 1991 extensive blooms occurred when a temperature on 15C coincided with a lessened salinity of at least 15ppt. The former is linked to excystment and the latter to stratification by Fraser River run-off, possibly with micronutrient enrichment. Subsequent study has confirmed this pattern, allowing forewarning based on snow-pack information as early as February.

8AM1999-MEQ/BIOtopic16 keynote/invited

## **DISTRIBUTION OF *Pseudo-nitzschia* ASSOCIATED WITH 1998 TOXIFICATION EVENTS**

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In May 1998, over 70 seizing sea lions stranded off the central California, U.S.A. coast. Their neurological signs were found to be due to domoic acid toxicity, caused by the ingestion of sardines and anchovies which had eaten the diatom *Pseudo-nitzschia australis*. The death of several of these sea lions motivated a series of research cruises and a focused coastal sampling effort in central Washington which resulted in the assessment of the spatial distribution of toxic *Pseudo-nitzschia* cells along the U.S. west coast. During the summer of 1998, these cells were found to be strongly associated with upwelling regions. Species distribution of toxic *Pseudo-nitzschia* shifted from *P. multiseriata* and *P. australis* in coastal regions off California and the southern parts of Oregon, to *P. pseudodelicatissima* in northern Oregon and Washington. This suggests that the fresh water flowing from the Columbia River may act as a barrier to northward mixing of cells via the California Current system. Several months after the sea lion deaths off central California, both Washington and Oregon razor clams were found to contain record levels of domoic acid. The toxification of Washington coastal razor clams in October 1998 was preceded in late September by the appearance of *P. pseudodelicatissima* cells in coastal waters. This observation, as well as the appearance of *P. australis* cells in Monterey Bay prior to the sea lions deaths, suggest that the presence of key species of toxic *Pseudo-nitzschia* can be used as a powerful early warning of domoic acid toxicity in coastal regions.

8AM1999-MEQ/BIOtopic17 oral

## **PHYTOPLANKTON BLOOMS IN COASTAL BLACK SEA AND JAPAN SEA WATERS: SIMILARITIES AND DIFFERENCES**

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Phytoplankton time-series data have been collected along the Bulgarian Black Sea coastline, including the 30-miles zone offshore, since 1954. Major shifts in phytoplankton variability have been well documented in bibliography for different periods of investigations. Since the early 1970s the major advances in knowledge have resulted from paying attention to algal communities of coastal waters, because of their more "obvious" sensitivity in relation to environmental changes (privately coastal eutrophication, nominated as a key ecological factor). Pollution and eutrophication problems have been reported increasingly also in a number of Russian Bays (the Japan Sea), subjected to industrial effluents, urban wastes from population largest centres and agricultural activities. An expansion of phytoplankton blooms in number, amplitude and species involved is reported in both the Black and the Japan Seas. The occurrence of harmful algal blooms appears to be most often in summer, though the coastal algal communities in these two basins manifest similar capacity to produce high biomass during all seasons.

The main aim of the present paper is a comparative study of the phytoplankton blooms in Varna Bay (the Black Sea), and Peter the Great and Amurskii Bay (the Sea of Japan). In order to reveal the similarities and differences the following aspects are discussed: inventory of species involved in bloom phenomena, abundance and biomass of predominating species, seasonal dynamics and frequency of blooms in the 1990s and in comparison to previous periods. The question is to what extent eutrophication could be considered to be the main influencing factor on phytoplankton in the Black and Japan Seas.

8AM1999-MEQ/BIOtopic18 invited

## **THE EFFECT OF BIOACTIVE METALS ON PHYTOPLANKTON IN NEARSHORE WATERS**

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It is now well recognized that bioactive metals, particularly iron, play a pivotal role in governing primary production in large regions of the open ocean. The potential impact bioactive metals exert in pristine nearshore waters is less well understood. Recent results demonstrate that while macronutrient concentrations in upwelling waters along the California coast are comparatively uniform, metal concentrations can vary dramatically. As a consequence, phytoplankton production in some nearshore waters becomes limited by iron, effectively generating coastal High Nitrate, Low Chlorophyll (HNLC) zones. Even under conditions where metals initially are replete, as these waters advect offshore the drawdown of iron is faster than that of nitrate, leading to offshore metal limiting conditions. Similar situations are expected to occur in other coastal regions and should have important impacts on fisheries production.

In addition to influencing bulk community production, changing metal conditions within coastal waters may dramatically affect algal species composition. Metals serve as active sites and co-factors for most redox enzymes and electron carriers and thus changing metal availabilities will influence the rate of metabolic processes. Laboratory culture experiments show that phytoplankton differ dramatically in their metal requirements and tolerances. Changing metal availability in coastal waters therefore should influence which species grow fastest, and thus might dominate the assemblage. Assessing metal: phytoplankton interactions may thus provide a rich framework for understanding the conditions that favour harmful algal bloom development and ascertaining whether man's activities are influencing the frequency and magnitude of these events.

8AM1999-MEQ/BIOtopic19 oral

## **SEQUESTERING OF IRON IN MARINE AND ESTUARINE ECOSYSTEMS BY MARINE MACROALGAE**

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Marine macroalgae dominate algal standing stocks and primary production in many coastal ecosystems. Fe is an essential trace element for all photosynthetic organisms and phytoplankton appear to be Fe-limited in oceanic and coastal upwelling regions. Here we use elemental cellular composition and growth rates to compare the N and Fe demands of phytoplankton and macroalgae globally and for coastal ecosystems. Globally, macroalgae account for 67% of algal organic C standing stocks. Compared to phytoplankton, marine macroalgae have a 3-fold higher Fe:C cellular composition and 8-fold higher Fe:N. As a result of high standing stocks and high Fe:C and Fe:N cell composition, marine macroalgae may contain 90% of algal-bound Fe in the global marine ecosystem. Our estimates of algal nutrient uptake rates for coastal shelves and estuaries indicate that the utilization of N and Fe by macroalgae exceeds that of coastal phytoplankton.

8AM1999-MEQ/BIOtopic20 poster

## **CHANGES IN DIVERSITY OF POLYCHAETES TAXOCENE IN COASTAL ZONE OF THE JAPAN SEA CAUSED BY EUTROPHICATION**

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Polychaetes taxocene has been investigated in three coastal areas of the Japan Sea affected by pollution and eutrophication. Golden Horn Bay (Vladivostok inner harbour) is the most polluted area, Amursky Bay is moderately polluted, and Ussurisky Bay is relatively clean (Table 1).

Table 1: Pollutant content in bottom sediments in 1986-1989.

Pollutants	Golden Horn Bay	Amursky Bay	Ussurisky Bay
PHC (ppm)	0.91	0.07	0.04
óu (ppb)	91.00	19.00	16.00
Pb (ppb)	124.00	21.00	20.00
Cd (ppb)	4.90	1.40	2.20
Hg (ppb)	0.72	0.06	0.04
DDT (ppt)	10.20	5.50	4.70

The following community data obtained seasonally in 1980-1989 have been analyzed: the number of species, total biomass and density, Shannon's, Pielou's and Simpson's indices. In 1980-1989, 14 families and 25 polychaete species have been found in Golden Horn Bay, 24 families and 61 species have been detected in Amursky Bay, 28 families and 81 species were observed in Ussurisky Bay. Ussurisky Bay had highest species diversity, while Golden Horn Bay showed the lowest diversity. Data obtained in heavy polluted site (Golden Horn Bay) showed:

1. There were negative temporal trends in changing of number of species, biomass, density, and ecological indices since 1980.
2. Disturbance of natural seasonal fluctuations of these parameters occurred.
3. "Dead area" has been detected periodically in the inner part of the Golden Horn Bay. Moderately polluted and relatively clean sites (Amursky and Ussurisky Bays) were characterized by the following:
  1. There were positive trends or no trends of changing of community characteristics during the same period (1980-1989).
  2. Seasonal fluctuations of these parameters were clearly observed.

8AM1999-MEQ/BIOtopic21 poster

## **MICROBIAL ABUNDANCE STRUCTURES AND TROPHIC RELATIONSHIPS IN HYPOXIC COASTAL WATERS IN MASAN BAY, KOREA**

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Eutrophication of coastal waters often create hypoxic or anoxic conditions causing environmental problems. However, we know little about microbiological processes and rates in such waters. Water samples were collected both in surface and bottom layers during May-August 1999. Abundances of bacteria, heterotrophic nanoflagellates (HNF), and viruses were measured. Bacterial production, virus production, and HNF grazing on

bacteria were also measured. We will present data on microbial abundance structures and trophic relationships in hypoxic coastal waters, and discuss their characteristics and controlling environmental factors.

8AM1999-MEQ/BIOtopic22 poster

### PROCEDURE FOR AXENIC ISOLATION AND GROWTH ACTIVATION OF THE MICROALGA *Isochrysis galbana*

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Axenic isolation of the marine microalga *Isochrysis galbana* was processed by the percoll-gradient centrifugation, antibiotics treatment, and growing on appropriate agar media. During the repeated culture for a long time, it has been heavily contaminated by many protozoa, microalgae and bacteria. To remove protozoa and other algae it was the most effective to centrifuge at 30-40% density of percoll layer. To remove bacteria it has been determined 5 antibiotics mixture by half of maximum non-lethal concentration of *I. galbana* against antibiotics. To pick up an axenic single colony it was a solid medium composed of 1% purified agar. Cell growth of the marine microalga *Isochrysis galbana* was regulated by the addition of seaweed extracts in the culture medium. Methanol-soluble extracts from 27 species of seaweed showed growth activation only from *Enteromorpha linza*, and growth inhibition from *Ishige foliacea* and *Sargassum sagamianum*. Water-soluble extracts from *Grateloupia turuturu* and *Monostroma nitidum* showed growth activation, while none of the seaweed showed growth inhibition. From results of growth activation of extracts on *I. galbana*, the water extract of *M. nitidum* was the most effective up to two-fold increase in cell density with the addition of 1 mg mL<sup>-1</sup> of extract to the medium. The cell growth rate was increased from 0.52 to 0.65 d<sup>-1</sup>. Cell size, gross biochemical compositions, fatty acid compositions, and digestion efficiency by shellfish differed marginally between cultures of *I. galbana* grown with and without the *M. nitidum* aqueous extract. This extract has also enhanced the growth of other feed microalgae tested, including *Dunaliella salina*.

8AM1999-MEQ/BIOtopic23 poster

### HARMFUL ALGAE MONITORING IN PETER THE GREAT BAY, THE SEA OF JAPAN, RUSSIA

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Harmful algal monitoring was carried out in the coastal waters of Primorye during summer-autumn period of 1995-1998. The species composition, abundance, spatial and temporal distribution of harmful microalgae were investigated in Peter the Great Bay at 58 stations in 5 study areas. Over the period of study 14 species that are known to be harmful were found. These microalgae were the diatoms *Pseudo-nitzschia multiseries*, *P. pungens*, *P. pseudodelicatissima* and *Chaetoceros concavicornis*; the dinoflagellates *Alexandrium tamarense*, *Prorocentrum minimum*, *Dinophysis acuminata*, *D. fortii*, *D. acuta*, *D. norvegica*, *Gymnodinium mikimotoi*, *Noctiluca scintillans* and raphidophycean flagellates *Heterosigma akashiwo* and *Chattonella* sp. The harmful algae occurred widely in all areas of study. Their concentrations ranged from a few cells to millions per liter. Lowest densities were obtained for seaward station in the open waters of all study area. The maximum concentration of harmful algae was observed in the innermost part of Amurskii and Nakhodka Bays subjected to the most powerful anthropogenic influence. *Pseudo-nitzschia* species, *Prorocentrum minimum* and *Heterosigma akashiwo* occurred in a large number.

A complex of factors favorable for the development of harmful algae exists in Peter the Great Bay in summer. In our opinion, the major factors are high levels of mineral and dissolved organic substances, as well as the vertical stability of water layers, associated with the substantial freshening and warming of the surface waters.

8AM1999-MEQ/BIOtopic24 poster

## SPATIAL DISTRIBUTION PATTERNS OF PHYTOPLANKTON OF EUTROPHIC COASTAL WATERS IN AMURSKII BAY (THE SEA OF JAPAN)

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Amurskii Bay, a highly productive area in the northern part of the Sea of Japan, is experiencing continuous anthropogenous influence. Individual parts of the Bay are exposed to the major factors of eutrophication. The northwestern Bay is exposed to the effect of the Razdolnaya River; in the northwestern Bay eutrophication is largely due to the industrial and communal sewage waters from Vladivostok.

A comparative study of phytoplankton was performed during 1991-1993 at stations located at different distances from a source of eutrophication. Densities of dominant and subdominant species of phytoplankton were irregularly distributed over the Bay. Outbreaks of the diatoms *Aulacosira ambigua*, *A. granulata*, *Asterionella formosa* and *Fragilaria crotonensis* occurred only in the innermost part of the Bay which is heavily impacted by the runoff the Razdolnaya River. The massive development of the euglenophyta *Eutreptia lanowii* was observed only near the site of sewage water discharge in Amurskii Bay. In eutrophicated areas of Amurskii Bay the phytoplankton is characterized by an increased overall density and abundance of microalgae; increased density of the diatom *Skeletonema costatum* and decreased values of the Shannon-Weaver index of species diversity during summer phytoplankton bloom periods; increased density of the nondiatom component of phytoplankton (dinoflagellates, chrysophytes, cryptophytes, chlorophytes, euglenophytes, raphidophytes and cyanobacteria).

8AM1999-MEQ/BIOtopic25 poster

## CHANGES IN LIPID COMPOSITION OF MARINE DIATOMS DURING THE LIFE CYCLE

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Research in mechanisms providing the successful existence of planktonic algae under fluctuating conditions of the marine environment has generally been restricted to the spore morphology and cell physiology. The biochemical processes, which may play an important role for the survival in natural environments and the onset of blooms; have been poorly investigated. Two diatoms, *Chaetoceros salsugineus* and *Thalassiosira* sp., isolated from Peter the Great Bay endure four weeks of nutrient exhaustion in the light by forming a physiological resting stage. The lipid and fatty acid composition is shown to vary during the life cycle. An increase in the relative proportion of polar lipids, structural components of the cell membranes and the photosynthetic apparatus, occurred at the stage of exponential growth and to a greater extent at the stage of resting cells and spore formation. The changes observed in the fatty acid composition of diatoms were due to the change in the proportion of the lipid classes and the increase in the content of polyunsaturated fatty acids. At resting stage, both species exhibited an increase in acids 20:5(n-3) and 16:3(n-4) associated with thylakoid membrane lipids. The accumulation of important structural components of the cell membranes during the resting stage ensures immediate germination as soon as suitable growth conditions occur and may be an essential means of maintaining population levels during environmental fluctuations.

## THE EFFECTS OF THE SEA EMPRESS OIL SPILL ON THE PLANKTON OF THE SOUTHERN IRISH SEA

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In February 1996 the *Sea Empress* ran aground just off the coast of south west Wales and released 72,000 tonnes of crude oil, making it the third largest spill to have occurred in UK waters. The oil affected 200 km of coastline and open waters up to 200 km from the spill site. We investigate the effects of the oil spill and clean-up operations on the local plankton communities since a significant proportion of the plankton in this area is made up of larval stages of benthic and littoral invertebrates so that a variety of habitats are represented in the plankton. The Continuous Plankton Recorder survey has monitored the plankton in this area on a monthly basis since 1970 giving an extensive time series for comparison with samples collected in 1996 after the spill. The most common taxa and the total community are examined for changes and although some unusual events are noted, no serious effects are evident.

The spring plankton community displays some differences from the previous year, however these cannot conclusively be attributed to the spill and in the autumn of 1996 significantly higher numbers of species are recorded. A long-term trend is also apparent in the community with a detectable shift in species composition. This 'natural' trend highlights the necessity of regular monitoring since if the opposite ends of the trend had been compared without the intermediate data it would have falsely appeared as though the spill had had a large impact.

## EFFECT OF OIL POLLUTION ON MARINE PELAGIC ECOSYSTEM: A MESOCOSM STUDY

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To study the effect of oil pollution on East China Sea pelagic ecosystem, the mesocosm experiment was conducted near the Changjiang River Estuary in May 1998. Dinoflagellate, *Prorocentrum dentatum*, was always the dominant species in the natural seawater and control mesocosm during the experiment. But in the mesocosm with oil, the diatom, *Skeletonema costatum*, became the first dominant species instead of the dinoflagellate, which shows dinoflagellate is more sensible than diatom to oil pollution. The oil pollution did not cause the obvious response of the phytoplankton stock, the Chl *a* and cell density did not change sharply, but the primary productivity decreased obviously. The primary productivity may be a good indicator to monitor the impact of oil pollution on marine ecosystem. The effect of adding oil to the different-size phytoplankton is diverse. To some extent, adding oil benefits the growth of macro-phytoplankton (>20µm), hinders the growth of meso-phytoplankton (2-20µm) and no harm to the micro-phytoplankton (GF/F-2 µm). Unlike the phytoplankton, the oil effect to zooplankton is simple. The zooplankton is more sensible than phytoplankton to oil pollution, and it began decreasing after adding oil. Bacteria is able to exploit the oil, so its productivity began increasing after adding oil. During experiment, particulate organic matter and carbon and nitrogen kept increasing, their increase was mainly attributed to the increase of phytoplankton. The sinking fluxes of phytoplankton, particulate organic matter and carbon and nitrogen kept increasing during experiment, which show the oil pollution strengthen the death of phytoplankton and zooplankton.

8AM1999-MEQtopic03 oral

## **IMPACT OF THE NESTUCCA OIL SPILL ON HERRING IN BARKLEY SOUND, BRITISH COLUMBIA**

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Oil from a spill in Oregon (the 'Nestucca' spill) reached Barkley Sound, on the west coast of Vancouver Island, in January 1989. The oil contaminated one of the largest herring spawning areas in the Province. Herring usually spawn in this area in March, so nearly 3 months lapsed between the time of the contamination and herring spawning. Records of the dates, exact locations and quantity of spawn have been made in this area for over 65 years. In the year of the spill (March 1989) herring showed a dramatic shift in spawning, by nearly 20 km, to a location previously unused for spawning. In the next year (1990) herring had returned to spawn in the original location, and have subsequently spawned in that spawned in that location in all subsequent years. Laboratory tests made at the time of the spill showed that eggs that had direct contact with oil-contaminated macrophytes died, but eggs that did not have direct contact with oil, survived. In general, the results indicate that there may be quite large impacts on herring spawning from relatively small spills, such as the 1989 Nestucca spill, but the apparent impact did not persist after one year.

8AM1999-MEQtopic04 invited

## **OIL SPILL FROM THE TANKER NAKHODKA**

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More than 6,200 kl of C-heavy oil, a type of fuel oil, was spilled from the Nakhodka into the Sea of Japan on January 2, 1997, and drifted to the sea coasts of eight prefectures in Japan. Heavy damages were observed on the sea coasts just after the accident and many of them have been recovered in two years. However, oil masses were still observed on several sea coasts covered with rocks or boulds/cobbles/pebbles/gravels in Noto peninsula. On the other hand, monocyclic aromatic hydrocarbons (AHs) and polycyclic aromatic hydrocarbons (PAHs) in the oil, beach sand, sea water, fish and air samples were determined. The concentration of naphthalene was the highest among AHs and PAHs in the Nakhodka oil suggesting that the concentration of naphthalene in the air might have been high just after the spill. The concentrations of PAHs having less than four rings decreased in the oil and sand, while PAHs having four or more rings first increased and then decreased. A decreasing tendency was observed for benzo[a]pyrene in sea water. However, the concentration was higher at the seashores where the oil was still present than at seashores where the oil had been quickly removed. In addition, the Nakhodka oil showed indirect-acting mutagenicity in the Ames test using the *S. typhimurium* strains as well as endocrine disrupting activity in the estrogen-dependent MCF-7 cells. As chemicals which showed these activities, PAHs and hydroxy-PAHs were considered.

## CHARACTERISTICS OF POTENTIAL OIL SPILL SCENARIOS MODELED FOR SAKHALIN SHELF

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Comparative characteristics of potential oil spill scenarios are considered for three-oil-gas fields of Sakhalin shelf and potentially dangerous sector of oil transportation route. For modeling wind regime was set over multiyear data series, current schemes were constructed over instrumental observations and model calculations of Drs. V.D. Budaeva and V.G. Makarov, trajectories of oil spill migration were calculated over S.N. Ovsienko's method.

1. Detailed calculations of potential accidental oil spill behavior in autumn and summer are made for Piltun-Astokhskoye oil field (northeastern shelf at Piltun Bay latitude). Characteristic meteosituations the circulation pattern has been calculated for are classified into types, with model 10-day hydrometeoscenarios being constructed to account real statistics of wind and current regimes.
2. For Astrakhanovskoye field (Sakhalin Bay) the hydrometeoscenarios are developed on the basis of real synchronous instrumental current and wind observations.
3. For Yuzhno-Kirinskoye field (Lunsky Bay latitude), most remote from a shoreline, statistical values of currents based on instrumental data series and real wind statistics collected for summer and autumn are used.
4. For potentially dangerous sector of oil transportation route (to the south of Terpeniye Cape) oil-spill modeling is made over the scheme analogous to those applied to Piltun-Astokhskoye field.

Percentage of oil spills reaching a shoreline assessed for different areas and distances from a shoreline, as well as different approaches to modeling resulted in:

Area #	Distance to a shoreline (km)	Percentage of oil reaching a shoreline (%)	
		summer	Autumn
1	20	15	30
	12	45	50
2	14	35	-
3	40-50	25	8
4	20	20	50

## MARINE MAMMAL CONSIDERATIONS DURING AN OIL SPILL

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During response to the Exxon Valdez oil spill in Prince William Sound, Alaska, and subsequent spills in the U.S. many lessons were learned on the scope and magnitude of actions and considerations needed in regard to effected marine mammals. Primary considerations were determination of the type and amount of spilled oil, availability of an action plan, inventory of species likely to be affected, vulnerable periods, collection, analysis, and storage of samples, and whether substrate cleaning or rehabilitation were options. Of special interest is the type and quantity of substance spilled and its potential for damage to the respiratory tract and nervous system of marine mammals. It is also important to have clear guidance through an action plan on a line of authority, use of available resources, and priorities for locations needing special attention for spill response activities. A more subtle, but vital component of spill response is the care and documentation of sample collection, storage, and analysis. Each of these considerations

will be discussed in detail and recommendations provided. The consensus of most experts is that shoreline cleaning must be conducted with extreme care. Also, most animal-care experts concur that rehabilitation of marine mammals is warranted in only a few special cases.

8AM1999-MEQtopic07 oral

### **THE MERCURY ROLE IN THE INCREASE OF THE WATER PRODUCTIVITY AND THE SEDIMENTATION OF ORGANIC MATTER IN THE SITES OF THE OIL AND GAS DEPOSITS OF THE EASTERN SAKHALIN SHELF**

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The concentrations of mercury in water, sediments and plankton were defined in 1992, 1993 and 1998. The maximal concentrations of mercury (to 1760 ng/l) were be found in the bottom layer of water on the shallow part of shelf. The appearance of mercury was attributed to, apparently, by the tectonic activating of region and was accompanied by the outcrops of methane.

Mercury-methane flows were parted on the shelf bench under the influence of joined eddy formations (Gruzevich et al., 1997). The methane flows ascended by cyclonic whirlwinds and were moved by tidal currents ashore. Mercury flows ascended more upright and deviated under the action of anticyclonic whirlwinds in offshore region.

The sharp decrease of particulate forms of mercury and increasing dissolved forms was observed during the passing of mercury in methane layer. The concentration of particulate mercury increased considerably over methane layer. Such conversions arise at microbiological processes, when amount dissolved mercury can enlarge at expense of the formation of high-toxic methylated forms of mercury, and particulate mercury - at expense of the formation of elemental mercury. Last can easily lift to surface and adhere to plankton and suspended matter. That is why in the places of the outcrops of elemental mercury on surface is observed the sharp increasing of the concentration of mercury in plankton, what contributes it heightened mortality rates.

Anticyclonic whirlwinds contribute the enrichment of the slope part of shelf by organic matter which serves substratum in the processes of oil and gas origin. The horizontal section of the thickness of water on depth 20 m on the shelf area with mercury-methane emanations showed, what maximal amounts of some organic substance, of especially organic phosphorus, were connected with local mercury-methane outcrops. The increasing of the concentrations of easily available organic matter may be attributed to the disintegration of the cells of bacterial plankton in toxic medium, what considerably increase the productivity of sea waters.

8AM1999-MEQtopic08 oral

### **STUDY OF OIL POLLUTION TRANSFORMATION IN THE SEA: SOME EXPERIMENTAL AND MODELING RESULTS FOR RUSSIAN COASTAL WATERS**

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At present the Government of Russia has given the sanction for industrial development of several marine deposits on Sakhalin shelf to a number of international industrial corporations. As shows international experience of development of marine deposits during a production of a petroleum and gas does not manage to avoid occurrence of emergencies, when on marine environment petroleum pollution arrives. The reality of petroleum pollution cause necessity of study of mechanisms and rates of petroleum pollution degradation.

The photooxidation rate of petroleum hydrocarbons was measured in the first case on change of concentration of

organic and inorganic peroxides by a iodine method and in the second case - on speed of absorption of a oxygen at constant volume of cell. Object of research was a oil of a marine deposit of Odoptu, which concerns to a class of easy, slight resin, slight serum content, and slight paraffin oil. Photooxidation of oil films and oil emaltions was conducted on a distilled water, on a artificial marine water, on a clean natural marine water from northeastern Sakhalin shelf, on a water, selected in the Amursky Bay of the Sea of Japan, which is polluted by waster waters of Vladivostok.

1) Study of a mechanism of initiation of photochemical reactions in a oil films demonstrated that formation of a singlet oxygen and its participation in oil photooxidation on a water surface was established.

2) Influence of temperature on oil film photooxidation accorded to Arrenius low and energy of activation ( $\dot{A}_n$ ) at photooxidation equal 46.6 kJ/mol.

3) The fall of initial photooxidation rate with reduction of thickness of a film is connected with suppression of singlet states of molecules and deactivation of radicals on surfaces of a film, though the specific absorbed energy per unit of volume of a film grows. Indirect confirmation of influence of surfaces on photooxidation rate is dependence of a peroxide output from a composition of underlying water.

4) Influence of intensity of light on oil photooxidation has shown, that the dependence has the kind  $W_{in} \approx I_{il}^2$ . Such kind of dependence testifies to a two-quantum mechanism of photooxidation at a initial stage.

5) The influence of temperature on photooxidation of "oil in a marine water" emulsion demonstrated that initial rates on a marine water were on 10-40 % below, than on distilled water and the energy of activation is equal (39.6 + 4.3) kJ/mol.

6) The fast transformation of chemical composition of oil was observed after its spilling on surfaces of water and ice under weathering processes at north-east coast of the Sakhalin. Evaporation and photochemical oxidation of oil hydrocarbons were the most intensive processes which change the oil composition.

8AM1999-MEQtopic09. oral

## **THE ENVIRONMENTAL EFFECTS OF OFF-SHORE OIL PRODUCTION**

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Off-shore oil production results in the discharge of a large variety of materials with the potential to adversely impact the marine environment. Typically, platforms must be constructed, manned and maintained and large amounts of material shipped to and from them. This can result in accidental and incidental losses of such things as shipping and construction materials, paint, welding rods, human wastes and petroleum products. The largest losses, however, are the deliberate discharge of muds used in drilling and water produced along with the oil.

The north-central Gulf of Mexico (GOM) is one of the most active oil producing areas in the world. More than 30,000 wells have been drilled in this area from about 3800 off-shore platforms. 500 to 1000 tons of drill mud is discharged for each well drilled and during the life of the well as much water as oil is produced. The typical GOM drill mud is 90% barium sulfate by weight but it contains many other metals in trace amounts, including highly toxic ones such as mercury, cadmium and lead. GOM drill muds also contain lignosulfonates, biocides and dozens of other ingredients. Petroleum from fuels and lubricants can be washed into the sea and well cuttings can be contaminated with oil. Contaminant metals and organics can affect organisms around off-shore platforms but there is little evidence for this in the GOM. Physical disturbance of the seafloor and the "reef effect" of the platform, however, have a measurable effect on marine organisms.

8AM1999-MEQtopic10 oral

## **OIL IDENTIFICATION BASED ON HYDROCARBON ANALYSIS: A LESSON FROM THE EXXON VALDEZ**

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Assessment of environmental damage following accidental oil spills requires reliable oil identification methods. Results from hydrocarbon analyses of environmental samples are often difficult to interpret, because of the changes in oil composition (or weathering) that follows release into the environment, and because of confounding by hydrocarbons from other sources. Weathering proceeded almost entirely according to simple first-order loss-rate (FOLR) kinetics for polycyclic aromatic hydrocarbons (PAH) based on molecular size within the extensive hydrocarbon data set collected for the Exxon Valdez oil spill. This relationship between relative weathering rate and molecular size can be exploited to infer the initial PAH composition of other spilled oils, and this information can be combined with results for weathering-invariant analytes to substantially increase the precision and accuracy of hydrocarbon source recognition methods. The approach presented here evaluates a goodness-of-fit metric between the measured hydrocarbon composition of an environmental sample and a suspected source, after correcting for PAH weathering losses based on FOLR kinetics. Variability from analytical and sampling error may thus be accounted for, and source identifications can be expressed as objective probability statements. This approach is illustrated by application to 4 petroleum and 2 coal sources, including one case where more traditional hydrocarbon source identification methods failed.

8AM1999-MEQtopic11 oral

## **ECOLOGICAL MONITORING AT THE PILTUN-ASTOKH AREA, NE SAKHALIN ISLAND SHELF**

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Oceanographic observations along the NE Sakhalin Island shelf have started in 1930s. Comprehensive ecological studies began in late 1980s. Since 1990, a few expeditions were implemented by FERHRI specialists at the Piltun-Astokh area (approximately 52-53°N, 143-144°E). Baseline characteristics of plankton and benthos communities as well as background concentrations of different classes of contaminants in seawater and bottom sediments were investigated.

SEIC organized a few baseline ecological surveys at the Piltun-Astokh field in 1989, 1995 and 1996. In July-September 1998, oil production platform, *Moliqpak*, has been installed (52°42'55N, 143°33'59E) and one appraisal well, *AW16*, was drilled in August-October (52°54'39N, 143°29'36E). In June and October, two ecological surveys were implemented to characterize marine environment conditions before and after *Moliqpak* installation as well as before and after *AW16* drilling.

Monitoring parameters included, among others, seawater temperature and salinity, pH, BOD, content of dissolved oxygen, nutrients, suspended solids, chlorophyll, petroleum hydrocarbons and dissolved trace metals. In bottom sediments, concentrations of petroleum hydrocarbons, polynuclear aromatic hydrocarbons and trace metals were measured. Characteristics of plankton and benthos communities and sediment grain size were also determined.

Statistically significant changes of grain size, benthos community parameters and concentrations of metals and hydrocarbons were registered only at the *AW16* drilling site and *Moliqpak* site. Outside the 125-m radius zone, no significant differences were observed between June and October data. Characteristics of plankton and benthos communities, concentrations of dissolved oxygen and nutrients demonstrated usual seasonal variability. Other measured parameters also did not differ significantly from baseline values observed previously. Ecological monitoring

at the Piltun-Astokh area will be continued in 1999 and beyond.

8AM1999-MEQtopic13

invited

### **ECOLOGICAL IMPACTS OF THE EXXON VALDEZ OIL SPILL**

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On March 24, 1989, the *Exxon Valdez* ran aground in the pristine waters of Prince William Sound, Alaska. Within hours 42,000,000 liters of North Slope crude oil spilled from the ruptured tanker's hull. The oil spread throughout western Prince William Sound, swept into the Gulf of Alaska and oiled thousands of kilometers of beaches, hundreds of kilometers away. The spill occurred just before the annual spawning of Pacific herring and the spring plankton bloom hitting the beaches about the time salmon fry were emerging from the gravel. Also thousands of sea ducks were staging in Prince William Sound readying for their migration north. Considerable ecological impacts were realized by intertidal biota, fish, birds, and mammals.

Several oil spill clean up techniques were employed, but none so devastating to the intertidal ecosystem as high pressure, hot water washing. Nearly all the epifauna and much of the infauna were killed, and fine grain sediments washed downslope, drastically altering the habitat. Salmon fisheries were closed resulting in overescapement to some systems, and an excessive number of salmon smolts were impacted as they overcropped their lake system invertebrate prey. Thousands of sea otters were killed removing an aggressive marine invertebrate predator and resulting in subtidal invertebrate species assemblage composition changes. It is estimated that 250,000 seabirds were killed by the spill, of which 74 percent were murre. Long-term effects on murre included population declines, reduced breeding success, and delayed breeding phenology.

8AM1999-MEQtopic14

poster

### **PERSPECTIVE OIL AND GAS AND PROTECTION OF ENVIRONMENT OF OKHOTSK - JAPAN SEAS OF GEOBLOCKS PACIFIC**

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The estimation of prospects oil and gas northwest Pacific is given on a shelf of the Far East seas and coastal sedimentary to pools. The absence here of developed deposits (except for Sakhalin) is explained in smallest volume reconnaissance oil and gas of works. The Far East region has vast oil and gas resources compared to stocks of next China. In view of a shelf outlying of the seas the resources hydrocarbon raise. For example, in the field of a shelf of Far East of Russia is allocated about 30 potentially oil and gas of deflections (Bering, Shantarsky, North-Sakhalin, North-Tatar, Isikari-West-Sakhalin). In addition it is supposed more than 20 oil and gas of areas in a continental part of region (Central Amur, Udoma-May, Amur-Ztay, Razdolneenskiy, Artemovskiy, Alhanskiy). Prognostication (shelf) stocks hydrocarbon are estimated now at a level of 5000 mln. t. On petroleum and more than 12000 mlrd.m<sup>3</sup> on gas. About 5 mlrd. T. petroleum and more than 50 mlrd. m<sup>3</sup> of gas is given by a tentative estimation on land. The real stocks hydrocarbon can be above.

The investigation and production hydrocarbon of raw material is carried out on about Sakhalin and in central Yakutia. In areas of development reconnaissance oil and gas and operational works the probability of failures and aggravation of ecological conditions is high, that negatively influences and environment. The development of system monitoring of a condition of water areas outlying of the seas of Far East region with reference to nature-climatic, geological and bioresources features is necessary. At operation of deposits at coast the control of pollution of superficial and earth waters, grounds, atmosphere is necessary. In this direction the flexible models of development of emergencies on

oil and gas objects of a land and shelf are perspective.

Result of ecology-technological modeling the strategy of prevention and liquidation of possible (probable) failures will be. Tactics of ecological protection provides the order of action of the personnel extractive oil and gas of objects at occurrence of any emergencies. "The Flexible modeling" stress will help to reduce expenses to liquidation of consequences of ecological accidents. Thus it are taken into account seismic danger and priority of protection of an environment Pacific and East of Asian. The global scales of an urgent problem assume close international cooperation of the scientists and experts geological, oil and ecological branches from the countries Zurkum-Pacific.

8AM1999-MEQtopic15 poster

### **TECHNOLOGY OF CUTTING AND MUD DISCHARGES MODELING ILLUSTRATED BY WELL DRILLING OPERATIONS ON SAKHALIN SHELF**

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Modeling of drilling cutting and mud discharges into the sea has been fulfilled within Environmental Impact Assessment and monitoring of the Sakhalin shelf oil-gas fields. Modeling technology, consisting of collecting and processing of initial information, determination of model parameters, modeling and analysis of results has been developed.

Initial information includes geographic position of the area, hydrometeorological model of the environment, fraction composition of discharged wastes, discharge regime, characteristics of pollutants, etc.

Three-dimensional diffusive-advective model based on "wondering particles" and using the generator of random numbers imitating nondeterminate processes is used for pollutants transport calculations. Besides transport characteristics it includes calculated turbulent parameters adapted to the conditions of Sakhalin shelf.

Modeling results represent: water thickness pollution and sedimentation zones, curves of pollution concentration in water thickness decreasing with distance from a source (toxicity curves), percentage of suspended matter precipitation in the vicinity of waste discharging outlets, etc.

The paper illustrates practical application of modeling for environmental impact assessments based on project data and monitoring results based on real data.

8AM1999-MEQtopic16 poster

### **METHODOLOGICAL APPROACH TO ENVIRONMENTAL IMPACT ASSESSMENT FOR OBJECTS OF SAKHALIN SHELF OIL-GAS COMPLEX**

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Technology of Environmental Impact Assessment (EIA) for objects of Sakhalin shelf oil-gas complex developed in 1995-1999 is based on EIA prepared for appraisal wells Yuzhno-Kirinskaya (1995), Arkutun-Daginskaya (1996), Piltun-Astokhsкая (1998), Astrakhanovskaya (1999), and Molikpaq Rig-based oil production complex "Vityaz" (1997-1998).

To work out EIA for any project one should know background information on environment, technical characteristics of project impact, its probability and intensity, and related laws/regulations. Background information includes

geography, geology, hydrometeorology, and biology of the area, pollution, social and economic characteristics, and natural disasters parameters. Background parameters impacted in course of drilling operations are described in all details with taking into account shelf drilling specifics and zones of direct and potential impact. Impact is assessed for each background parameter: geological and landscape-geomorphological conditions, air and seawater quality, bioresources, ornitofauna, social aspects, etc. EIA results are used to work out impact minimization and emergency plans, environmental monitoring projects, and research programs. The final stage of EIA is an over-all ecological-economic expertise and conclusions on whether project impact is acceptable or not.

EIA and follow-up monitoring proved local short-term impact of appraisal well drilling to be acceptable in general. Local air pollution observed during well tests was caused by diesel engine and burnt hydrocarbon wastes released into atmosphere in the area of sanitary protection. Seawater quality, sediments and biota suffered from local short-term impact of discharged drilling mud and cutting (if a project plans to discharge it into a sea). Significant impact may be produced by accidental oil spills, however probability of them is low, as during the period of Sakhalin shelf exploration accidents with heavy consequences never occurred.

Technology of EIA is described for different specific projects.

8AM1999-MEQtopic17 poster

### **STATISTICAL ANALYSIS OF EFFECTS OF OIL DRILLING FAULTS ON ECOSYSTEM OF SHELF WATERS OF THE SAKHALIN ISLAND**

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The authors investigated data of ecological monitoring of marine environment at Arkutun-Dagi region of the Sakhalin shelf where marine drilling platform was placed and faulted waste waters and waste materials in environment. Wide set of data such as bottom sediments (10 chemical elements, total quantity and total biomass of benthos animals, total organic content, granulation content) and water parameters (temperature, salinity, pH, oxygen, nutrients, total particulate matter, quantity and biomass of zooplankton etc.) was studied. Besides traditional statistics such as correlation analysis and estimates of difference of mean values by standard procedures the authors used original approximation method for classification and analysis of data (AMCAD). This method permitted to estimate the values of looking parameters as mixture of normal laws by multidimensional functions of distribution density. All computerizing results were graphically pictured together with experimental results and explained the variation in marine environment by oil drilling faults.

8AM1999-MEQtopic18 poster

### **OPERATIVE SYSTEM CONSTRUCTING FOR A SAKHALIN SHELF ENVIRONMENTAL MONITORING**

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Reconstitution on a modern technical level of environmental monitoring and observation system for a Russia Far East offshore is a most important problem on efficient and operative ensuring for the economy in Sakhalin region.

Like any complicated process, complex of technical facilities and aided systems for the expert decisions and regulations of acting operative observations and forecasting services can be formalized in the terms of the united process in the three dimensional logical space. Sakhalin realities of ocean monitoring (as a united object) possible define in the logical base, on coordinate axes, which are three independent directions and stages: designing, creation, and usage, of such system as generalized process. The approach to designing is account for achievement of modern

science and information-computing technologies, when new monitoring system, as well as for ensuring the possibility of unceasing improvement for a separates system elements, and the whole systems as a whole.

The important element of designed ocean monitoring system are computational experiments on fluid mechanics simulations and atmosphere-ocean interaction processes, which must continuously extrapolate given from telemetry observation on a greater sea water surfaces. If a direct simulation are requires the greater computing resources, is planned run for supercomputers of the Institute for High Performance Computing and Data Bases in Saint Petersburg, with use the access to him by internet communication.

Digital simulation of tides and currents, storm surges and other dangerous sea phenomena research with supporting of Russian Foundation for Basic Researches (97-05-6037). The special gratitude for the Far Eastern branch of the "Eurasia" foundation (V97-0696a), at support in use the rich resources of the Internet.

8AM1999MEQtopic19 poster

### **FORMATION OF ICE COVERS ON THE SEA ROCKS AND SEAPORT CONSTRUCTIONS**

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The blankets of ice formed on separately located sea rocks (kekury) in initial winters period of 1991-1994, before installation of an pack ice in a coastal strip on distance from 50 up to 1500 m from a coast on depth 5-10 m on the east coast of Sakhalin is (cape Delil- de- la- Kroyera), were investigated. The thickness of allocated in blanket of ice layers was coordinated to intensity of storm taking place in region on data of sea hydrologic stations. The same connection were studied on the basis of supervision of sedimentation of ice on construction in Alexandrovsk-on - Sakhalin seaport in 1975. The structure of layers, making the ice covers, their structure and capacity depending on height above a sea level and orientation of an accepting surface on the parties of light and in relation to influencing rough were investigated too. The regularities in formation of ice covers was investigated: reduction as a whole thickness of ice with height above a sea level, large thickness of ice covers on the side of prevalent roughness, and also change of density and salinity of formed ice. The weights of 1 m<sup>2</sup> of formed ice covers depending on height were designed. The given supervision will be important in connection with the beginning of assimilation of oil & gas fields on the Northern Sakhalin Offshore. The text is accompanied by characteristic photos and schemes.

8AM1999-MEQtopic20 poster

### **THE PREVENTION OF OIL SPILL ON THE SAKHALIN OFFSHORE**

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International experience of struggle with consequences of oil spill in the sea allowed to the scientists and experts to make a unequivocal conclusion that it is practically impossible not to bar a petroleum stain from a coast and to collect all petroleum spilled out in the sea, as well as to clear shallow water and bank shore out of petroleum and especially from its most toxic component - the polycyclic aromatic hydrocarbons, strong carcinogenic, transmitted on a food chain. The prediction of the dangerous hydrometeorological phenomena has important significant place in maintenance of safety on the sea. The questions of joint influence of roughness, rising tide, seysha and nagon (the lifting of the sea level from the wind pressure) on the Sakhalin offshore are strutinized not very good, just as combined action of drift and rising tide currents. The forecast of occurrence and development of these phenomena up to a dangerous level is possible only at using of correct hydrodynamic models, in development of which the Sakhalin scientists accumulate rich experience, but the progress in use of models in practice is impossible without organization of constant posts of ecological and hydrometeorological supervision and operative transfer of data from them. The

shipwrecks of some floating oil-rig platforms already took place in the Okhotsk Sea on the stages of their tugging in autumn and one floating oil-rig platform sinks in the Japanese sea. The several cases of entrancing of petroleum into the sea in result of impulses of the underwater pipeline, destruction of oil stores, from earthquakes and idle time criminal negligence had been registered officially. In April 1991 the petroleum has polluted coast on an extent of several kilometers in a gulf of Aniva and threatened to coast of Japan. The petroleum will penetrate into all gulfs of east coast of Sakhalin is in a case even of one oil spill similar the spill from the tanker "Exxon-Valdez " in 1989.

These gulfs are the place of fattening of Sakhalin salmon, the place of nesting of rare birds, brought in the Red Book, and location of tens patrimonial economies of the small peoples of the north. Here is located 8 especially protected territories. To remove petroleum from marshy coasts of gulfs it will be impossible in current at least 30 years.

8AM1999-FIStopic01

oral

## **LETS GET ON WITH IT - STABILIZING OUR IMPACTS ON MARINE ECOSYSTEMS**

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As humans occupy or intervene in more and more habitats, it is apparent that we must move from trying to preserve single species fisheries to protecting ecosystems. The understanding of the relationships in our marine ecosystems needs to be simplified and communicated beyond our community of scientists. We propose a method of doing this for the Strait of Georgia, which is one of the most important marine ecosystems off Canada's west coast. Our approach incorporates the current understanding of the key factors affecting the dynamics of single species into simplified management charts. The relationships among species are balanced using an EcoPath model. The intent is to stabilize human interventions within regimes that are defined by climate/ocean parameters. Management is forward looking and based on the understanding of the naturally evolved processes that regulate abundance. The difficulty is that we do not understand these processes well. The urgency is that climate is changing. The challenge is to focus our research and apply it to ensure that we balance our impacts on ecosystems with the needs of other species.

8AM1999-FIStopic02

oral

## **ECOSYSTEM APPROACHES IN FISHERIES RESEARCH, CONSERVATION, AND MANAGEMENT: RECOMMENDATIONS OF THE NMFS ECOSYSTEM PRINCIPLES ADVISORY PANEL**

George W. Boehlert

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Marine ecosystem management is not highly developed as an applied science but has the potential to improve upon single species management. The Sustainable Fisheries Act of 1996 required NMFS to convene a panel to i) examine how ecosystem principles are currently being applied in US fisheries research, management, and conservation, and ii) to recommend ways to better integrate these principles. A report was submitted to Congress early in 1999 describing the findings of the Ecosystem Principles Advisory Panel. Within the overall goal of maintaining ecosystem health and sustainability, the Panel identified eight ecosystem principles applicable to fisheries management and six policies for their implementation. Examination of the current fisheries management practices in the US suggests that there is only limited application of ecosystem principles; ecosystem research supporting fisheries management is also limited, although there exist excellent examples of both in different parts of the US.

The panel made several recommendations for steps to incorporate ecosystem principles in fisheries research and management in the US. The major recommendation is to develop Fishery Ecosystem Plans for each major ecosystem under jurisdiction of the Councils. These plans would supplement existing single species management plans and provide a context for improved, coordinated management options. Recommendations for research supporting ecosystem fisheries management included i) assessing the ecosystem effects of fishing, ii) improving monitoring of trends and dynamics of marine ecosystems, and iii) exploring ecosystem-based approaches to governance. In the context of this session, results of GLOBEC-type programs can contribute to meeting the second research need.

8AM1999-FIStopic03 invited

**ENVIRONMENTAL VARIABILITY AND POPULATION DYNAMICS: UTILITY OF GLOBEC STUDIES IN A MANAGEMENT CONTEXT**

Michael J. Fogarty

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The dynamics of exploited fish populations are strongly shaped by environmental forcing factors on a broad range of space and time scales.

8AM1999-FIStopic04 oral

**EFFECT OF OCEAN CLIMATE CHANGES ON KOREAN STOCK OF PACIFIC SAURY, *Cololabis saira***

Yeong Gong, Chang Ik Zhang, and Jae Bong Lee

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Atmospheric, hydrographic and fishery biological factors indicated that the abnormal northward shift in the distribution of Pacific saury might be the result of a strong flux of warm water in the East Sea in late 1970s. Recruitment failure of saury in late 1970s was attributed to the limitation of the productive area for primary production caused by oligotrophic warm water, and to mismatch of the time of spring outburst with the time of earlier than normal arrival of saury to the feeding ground. Comparison of monthly upper mixed layer depth (MLD) and critical depth supported the possibility of the mismatch phenomenon. A method to forecast the center of the main distribution and that of catch of saury using satellite SST images has been developed for the Korean saury gillnet fishery. However, an appropriate management scheme should be implemented to prevent recruitment overfishing for the stock when any sign of ocean climatic event is detected.

8AM1999-FIStopic05 oral

**MODELING WALLEYE POLLOCK RECRUITMENT IN THE EASTERN BERING SEA: USE OF PHYSICAL DATA INTEGRATED WITH STOCK ASSESSMENT INFORMATION**

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The assessments of Eastern Bering Sea (EBS) walleye pollock presented to managers has increasingly been sensitive to year-class abundance estimates prior to their availability to the fishery. The fishery from this region has annually produced an excess of 1 million tons of pollock for the past two decades. Data from two surveys proved to be crucial in developing a harvest strategy for 1997 and for projecting the expected fishery impacts in the short term (for 1998-2000). However, since considerable assessment uncertainty remains (even for age classes generally well-sampled by survey gear), we wish to explore how adding physical data based on working hypotheses of recruitment success might improve our ability to estimate year-class strengths. In this paper we present an integrated framework for evaluating stock condition of Eastern Bering Sea walleye pollock. This includes environmental information to help estimate the processes related to survival for pollock age-3 and younger. We model the spatial aspects of advection during the egg and larval phase of pollock to determine the extent that year-class strengths can be quantitatively analyzed. We use a Bayesian approach for the core model specification and develop alternative processes describing recruitment variability. A measure of surface current

movements following pollock spawning period explained a large fraction of the recruitment variability. This is consistent with the life-history strategy where juveniles are less susceptible to cannibalism by adult counterparts.

8AM1999-FIStopic06

oral

### **DYNAMIC MARINE SYSTEMS: APPLICATIONS TO THE STOCK ASSESSMENT AND MANAGEMENT OF SABLEFISH (*Anoplopoma fimbria*)**

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In the North Pacific, atmospheric and physical ocean systems have been shown to rapidly shift from one state to another. The application of the concept of climate and oceans as dynamic systems to fisheries science and management requires the identification of biotic responses. Like many groundfish species, sablefish is long-lived with a life history that enables populations to withstand prolonged periods of low productivity and poor year class success by maintaining a spawning biomass that can take advantage of shifts in their environment to a more productive state. Using several sources of estimates of year class success, an index of relative year class success (YCI) was developed for sablefish off the west coast of Canada. The YCI illustrates that recruitment patterns are relatively stable on decadal scales, but they abruptly switch with changes in climate-ocean states. Recognising that marine systems are dynamic and that biota respond to shifts in steady states, requires an enhancement of traditional stock assessment and management. The present age-structured stock assessment model for sablefish estimates initial biomass prior to fishing pressure. Calibrating the present model to segmented periods that correspond to environmental states and year class patterns would provide parameter estimates for different steady state scenarios. As another approach to stock assessment, we constructed a 'sablefish report card' which is a matrix of climate, ocean and biota parameters relevant to their recruitment. It is a step towards incorporating knowledge of dynamic marine systems of the North Pacific and ecosystem responses into sablefish stock assessment.

8AM1999-FIStopic07

oral

### **THE ROLE OF CLIMATE IN FLUCTUATIONS OF FLATFISHES IN THE NORTHWEST PACIFIC**

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In total Russian catch in the Far East Seas flatfishes constitutes only about 1.6%. However, many flatfish species are very expensive at fish market. In last years the intensity of flatfish fishery on the continental slope of the Northwest Pacific increased. Among the above fishes Greenland turbot, *Reinhardtius hippoglossoides*, Kamchatka flounder, *Atherestes evermanni*, Pacific halibut, *Hippoglossus stenolepis*, rock sole, *Pleuronectes bilineatus*, and flathead sole *Hippoglossoides elassodon*, are the most abundant and commercially important. Rational exploitation of flatfish stocks should be based on the knowledge of regularities of their abundance dynamics. In this paper we consider fluctuations in relative abundance of the above 5 species in the various regions of the Northwest Pacific from 1960 to 1997 in relation to climatic changes in the whole North Pacific area. For this purpose we analyzed spatial and temporal structure of seawater temperature variations, variability of geostrophic currents and atmospheric circulation. There is a good correspondence between changes in flatfish abundance and climate. Some mechanisms which may be responsible for fluctuations in abundance of the species are considered.

8AM1999-FIStopic08

invited

## **APPLICATION OF RESULTS OF TINRO-CENTER'S ECOSYSTEM RESEARCHES IN BIORESOURCES MANAGEMENT**

Victor V. Lapko

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Ecosystem researches have been started in TINRO-Center early in 1980s. Up to now composition and marine communities in the Far Eastern Russian economic zone have been determined, allowing to estimate a place and role in them of commercially valuable species and to assess a bioproductivity of Russian Pacific waters on the whole. Also by means of annual ecosystem monitoring, conducting by TINRO-Center, it become possible to trace of ecosystem dynamics during more than 15 years. As a sequence a direction of long-term trends was determined and some long-term prediction of communities' condition justified later have been made. For instance, Dr. V.P. Shuntov's predictions regarding decrease of pacific sardine and pollock abundance and increase of herring one from the end of 1980s are well known. However, ecosystem researches have additional so-called quick effect. From the early 1990s during some years with help of marine ecosystem surveys the prediction of abundance of pacific salmon run to the main spawning region have being corrected operationally. Resulted of ecosystem researches it was established, for example, that in the northern Okhotsk Sea fisheries resources including traditional "target species" are considerably higher than supposed before. This made possible to increase catch quotas noticeably for such species and groups as herring, some flatfishes, shrimps, crabs etc. Thus, the results of TINRO-Center's ecosystem researches are undoubtedly valuable for establishing of the durable strategy of the bioresources management in pacific region as well as for quick correcting of the catches limits.

8AM1999-FIStopic09

oral

## **ECOSYSTEM CONSIDERATIONS IN FISHERIES MANAGEMENT: LINKING ECOSYSTEM MANAGEMENT GOALS WITH ECOSYSTEM RESEARCH**

Patricia A. Livingston

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As fishery management organizations move towards ecosystem-oriented management, there is a need to more clearly define the ecosystem management goals of the organization and the tools available to managers to attain those goals. Parallel to this must be an expansion of the scientific advice provided to management beyond traditional single-species stock assessment advice. Although there have been advances in multispecies and ecosystem modeling approaches, these approaches have not yet been completely embraced by the fishery management community. In some cases this is so because of the difficulties in validating these models and in other cases because of the lack of sufficient data and knowledge of the critical processes to develop an appropriate model. Progress can be made, however, in providing ecosystem advice to managers while we wait for these approaches to mature. The burgeoning GLOBEC and GLOBEC-like research efforts going on throughout the world, increasing emphasis on habitat research, ongoing trophic interactions work, and long-term monitoring of non-commercial species all provide useful information on ecosystem status and trends. Some of this ecological information can be used to gauge the success of various management schemes that have been put in place to meet ecosystem management goals. The North Pacific Fishery Management Council (NPFMC) has started to include some of this ecosystem research information in an ecosystems considerations document that supplements the traditional single-species stock assessment reports. I outline here a proposed revision of the ecosystem considerations document of the NPFMC that will include ecosystem status and trend information and link management actions with ecosystem observations and discuss the benefits to scientists and management of such an approach.

## TROPHIC LINKAGES OF NEAR-BOTTOM NEKTON SPECIES IN THE WESTERN BERING SEA IN TERMS OF RESOURCE MANAGEMENT

V.V. Navpazakov, V.I. Radchenko, V.I. Chuchukalo, M. Slabinsky, and V.A. Nadtochy

Data was collected during bottom trawl survey in the western Bering Sea (86 hauls), 21 August - 4 October, 1998. Six nekton species groups were selected by food objects' predomination.

1. Planktivorous. Walleye pollock daily diet decreased from 5% BW (fish sized 10-20 cm) to 1,5% (60-70 cm). Pollock consumed euphausiids, copepods, shrimps, hyperiids, fishes, squid (Here and further, enumeration is ranked by portion value in descending order). Herring (2,2-3% BW) consumed euphausiids, hyperiids, copepods; schoolmaster squid (2,4-3,5%) - fish, own juveniles, euphausiids, shrimp.

2. Worm and shellfish eaters. Polychaete worms contributed up to 90% of Alaska plaice diet (3,5-3,8%BW). Sakhalin flounder (2-2,5%), rock sole (4,1-6,2%), long-snouted blenny (about 2,1%) consumed worms, bivalves, fish, young crabs and shrimps.

3. Shellfish and shrimp eaters. Flat-headed flounder (2,4-4,2%) consumed shrimp, bivalves, brittle stars.

4. Worm and shrimp eaters. Blackfin sculpin *M. zonurus* (3,2-4,3%) consumed worms, shrimp, fish (pollock fingerlings), squid.

5. Fish, crab, and shrimp eaters. Pacific cod (2,4-3,6%) and sea-scorpion *M. polyacanthocephalus* (2,5-3,9%) consumed pollock, snow crabs, other fishes, forage benthic animals, shrimp.

6. Fish, squid and shrimp eaters. Pacific halibut (1,9-2%), Greenland turbot (1,5-2,9%), arrowtooth flounders (1%), breasted grenadier (0,4-0,6%) consumed pollock, squid, shrimp.

Introduction of prey fishing mortality coefficient in TAC calculations for forage fish consumers would increase their harvesting and improve ecosystem balance. Calculations of additional harvest ( $\Delta Q^{predator}$ ) must achieve numerous linkages in trophic structure.

$$\Delta Q_i^{predator} = \frac{Q_i^{prey} \times p \times (B^{predator} + P^{predator})}{B_i^{prey} + P_i^{prey}};$$

$$\Delta Q^{predator} = \sum_i \Delta Q_i^{predator}$$

, where  $B^{prey}$ ,  $B^{predator}$  - biomass,  $P^{prey}$ ,  $P^{predator}$  - production,  $Q^{prey}$  - prey annual harvest,  $p$  - portion of prey consumption by predator in total its consumption in ecosystem.

## REGIME SHIFTS AND SUSTAINABLE FISHERIES

Vyacheslav Navrotsky

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Regime shifts may be considered as one of the most typical phenomena of dynamics of fish populations. This phenomenon apparently hamper the stable functioning of marine bioeconomic systems. The implementation of different fisheries strategies in fluctuating environment is considered. The effectiveness of these strategies is described by the variety of ecological and economic parameters. It is shown that discounted net benefit may be increased even under decreased average yield. The effects of migration on dynamics of exploited populations and of marine bioeconomic systems is considered.

8AM1999-FIStopic12

invited

## **CANADIAN GLOBEC STUDIES AND THEIR CONTRIBUTIONS TO MANAGEMENT OF MARINE LIVING RESOURCES**

R. Ian **Perry**<sup>1</sup>, David L. Mackas<sup>2</sup>, and David W. Welch<sup>1</sup>

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Marine ecosystem management has recently experienced a resurgence in popularity, in part driven by renewed interest in conservation and management of terrestrial ecosystems. But, are marine and terrestrial ecosystems sufficiently similar so that management principles determined for one system may be applied to the other? What are the critical concepts for marine and fisheries ecosystem management, and how can they be applied in practice? In this presentation, we explore these problems and provide insights derived from Canadian GLOBEC studies in the Northeast Pacific. We suggest that (1) there are important differences between marine and terrestrial ecosystems that mean they may respond differently to global forcings; (2) critical ecosystem concepts for management include developing indices of ecosystem state, recognising when the state has changed, and identifying appropriate management "control levers"; and (3) it is important to determine the appropriate time and space scales for the processes being managed.

8AM1999-FIStopic13

oral

## **RETROSPECTIVE ANALYSIS OF YUKON RIVER CHUM SALMON SIZE 1965-1997**

William W. **Smoker**, T.M. Sands, and T.J. Quinn

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Scales from Yukon River chum salmon (*Oncorhynchus keta*) have been collected by the Alaska Department of Fish and Game since the mid 1960s. This collection represents one of only a few long timeseries of chum salmon data. By measuring the distance between annuli on the scales we have obtained a proxy for annual growth. Size of chum salmon has decreased since 1965, and the widths of the second, third and fourth growth zones have decreased during the same period. These growth zones are believed to represent growth while the fish are in the Gulf of Alaska and North Pacific. The first and final growth zones showed no real trend during this time. Comparisons of our data with climatic data from the Gulf of Alaska and Bering Sea demonstrate correlations with different data sets at different life stages.

8AM1999-FIStopic14

invited

## **CHINA GLOBEC STUDIES AND DEVELOPMENT**

Qi-Sheng **Tang**

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The China-GLOBEC program, titled "Ecosystem Dynamics and Sustainable Utilization of Living Marine Resources in China Coastal Seas", has been identified as a high priority national science program. Supported by the National Natural Science Foundation of China, it is regarded as a contribution to providing an example of coastal ecosystem dynamics for IGBP/SCOR/IQC GLOBEC and are regional case for PICES/GLOBEC. The first project from the program is titled "Bohai Sea Ecosystem Dynamics and Sustainable Utilization of Living Resources", which focuses the scientific study in the Bohai Sea which is a semi-closed continental waters so of China with the area of 77,000km<sup>2</sup>. The project lasts to 2000 charged by Prof. Ji-lan Su and Prof. Qi-Sheng Tang.

The project is composed of four principle foci and they are early life history of the Bohai prawn and its key processes in the habitat, zooplankton population dynamics and its role in the productivity of the Bohai Sea ecosystem, trophodynamics of the food web and the shift mechanism of the dominant species, and Bohai Sea ecosystem dynamics modeling.

About 40 Chinese GLOBEC scientists attended a workshop on China-GLOBEC studies, March 4-6, 1999, which was organized by the China-GLOBEC SSC. The workshop made a summary of the first two years (1997-1998) studies of Bohai Sea project and discussed how to work for next two years (1999-2000). The scientists presented nearly 90 papers or abstracts and 15 people gave oral speech about their research at the meeting. The meeting also discussed how to apply for new national important basic research program for the second stage of China GLOBEC studies. The new Chinese GLOBEC project is planning to study the East China Sea and Yellow Sea ecosystem.

8AM1999-FIStopic15

oral

### **LONG-TERM CHANGES IN DISTRIBUTION OF GROUND FISHES IN THE EAST CHINA SEA**

Muneharu Tokimura, Hiroshi Horikawa, Keisuke Yamamoto, and Mari Yoda

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Long-term changes in distribution of groundfishes in the East China and adjacent seas were investigated with the catch at area data of Japanese pair trawlers, a series of trawl survey data, and The Nagasaki Marine Observatory's long-term water temperature data.

Dominant fishes, like hairtail (*Trichiurus japonicus*) and yellow croaker (*Larimichthys polyactis*), which had wide distribution ranges throughout the East China and Yellow Seas till 1970s showed clear shrinkage of the ranges especially at the Yellow sea, southern part of the East China Sea and outer part of continental shelf. Fishes which are distributed in outer part of the shelf in all the seasons, like yellow seabream (*Dentex tumifrons*) showed decrease of its density at shallower (less than 150m) zone especially in 1990s. These phenomena should be blamed to heavy exploitation of them by the fisheries of surrounding countries.

However, there showed northward expansions of the distribution range by a few fish species. Indian drift fish (*Ariomma indica*) which is mainly distributed in the South China Sea began to increase the range in 1970s and started to decrease in late 1980s. Yellow scraper (*Thamnaconus hypargyreus*) increased both biomass and range of it following the serious decrease of the black scraper (*Thamnacones modestus*). Causes of these phenomena will be related to changes of environmental factors like water temperature or changes of the stock level of related species. However, the problem still remains to be solved.

8AM1999-FIStopic16

oral

### **PRELIMINARY ECOPATH MODEL IN THE BOHAI SEA**

Ling Tong<sup>1</sup>, Qi-Sheng Tang<sup>1</sup> and Daniel Pauly<sup>2</sup>

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The Bohai Sea is an ocean space with distinct productivity, fishing activity and trophic relationship. An ECOPATH model of the sea is constructed on the basis of the data from fishery ecosystem survey conducted from April 1982 to May 1983. The living marine resource in the sea, especially the demersal and benthic fish species,

were over-exploited and most of living resources was utilized after 1962. Half of the landing was jellyfish, *Arca*, *Acetes* and other small shrimp in recent years.

The Bohai Sea mass-balance trophic model only consists of 13 function groups (boxes) for it is a preliminary Ecopath model in the sea. The P/B and Q/B parameters (P:production, B:biomass, Q:consumption) for most groups were estimated from similar function group in other models located in the around same latitude regions. The EE (Ecotrophic Efficiency) values are checked for the equilibration of the model and set high for most groups (>0.808) because the fishing pressure was very high and small living resources were being heavily preyed upon in the ecosystem. The model estimated the biomass density of the species commercially utilized is 12.33 ton/km<sup>2</sup>. Even though the value is low compared with the density in other ecosystem, such as Caribbean coral reef ecosystem and the Southern B.C. shelf model, it is higher than some data published by the paper used other method. Considering the lower value of bottom trawl survey than other stock assessment methods, the output here is reasonable. We conclude that the biomass of commercially fishing species in the sea is 950 thundred metric tons and 338 thundred tons are fish species in the value.

8AM1999-FIStopic17

invited

### **COMPREHENSIVE STUDY OF THE VARIATION OF THE OCEANIC ENVIRONMENT AND FISH POPULATIONS IN THE NORTH-WESTERN PACIFIC (VENFISH)**

Atshi **Tsuda**

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The field of this study is the northwestern Pacific where large fishery grounds of the important commercial fish are formed. Saury and walleye pollock are the representative species caught in this area. In recent studies, it has been suggested that the abundance of saury and walleye pollock greatly depends on the variation of the biomass of zooplankton and phytoplankton, and the biomass of plankton varies depending on the oceanic environment. Information of the prey organisms will increase the accuracy in forecasting stocks of those fish. The goal is to make clear the influence of the oceanic environment, phytoplankton and zooplankton to the resources variation, and develop the forecasting ecosystem models through food chain to contribute to the scientific fish management in EEZ.

Twenty-one subjects are running under this project, including from studies on primary production to those on the population dynamics of target fish. The target areas are the Kurōshio area for spawning and nursery ground for saury, transition area for feeding ground of saury, and the Oyashio area for feeding ground of both fish. The target prey organisms are *Oncaea* spp. in the Kuroshio area, *Calanus pacificus* and *Euphausia pacifica* in the transition area, and *Neocalanus* spp. and Euphausiids in Oyashio area. The distributions, phenology, and life-history characteristics of the prey organisms are studied for the modeling. Both population dynamics model and trophodynamics model are employed in this project for the understanding of the key processes in resources variations.

## OCEAN CLIMATE CHANGE AND THE GROWTH AND SURVIVAL OF PACIFIC SALMON AND SEABIRDS

David W. Welch<sup>1</sup>, Frank Whitney<sup>2</sup>, Doug Bertram<sup>3</sup>, and Anne Harfenist<sup>4</sup>

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Sharp declines in the ocean survival of young salmon entering the coastal ocean off south-central British Columbia have occurred since ca. 1989/90. These changes were not observed for populations entering the ocean from northern regions of B.C. Reduced ocean survival has been associated with a fundamental shift in the eastern North Pacific ecosystem during the 1990s to one where nitrate limitation has become a striking (and formerly absent) feature of the environment for most of the summer. Nitrate depression has become progressively more pronounced in recent years, and in early spring of 1998, nitrate was completely depleted from surface waters along Line P until far offshore.

Field surveys demonstrate that a north-south gradient in ocean productivity affecting growth and survival of key salmon species now exists. Growth of juvenile coho and chinook salmon off southern British Columbia was only half that found off northern British Columbia or south-east Alaska, and southern animals had smaller energy stores (fat). Cs<sup>137</sup>, a bioaccumulated radioactive isotope that is an indicator of lifetime feeding success, was found in similar concentrations (Bq/Kg) in salmon from different regions. Thus body size was directly proportional to Cs<sup>137</sup> levels; demonstrating that juvenile salmon in the south were smaller because they had consumed less food. The growth of seabird chicks in these two regions also showed a similar pattern of significantly improved growth and body condition to the north.

In sum, these differences appear to be the result of reduced oceanographic productivity limiting growth. The growth changes alone are sufficient to reduce ocean survival by a factor of 3-7 fold, which is sufficient to wipe out the productivity needed to support a fishery. The ultimate cause of reduced growth and survival appears to be the result of increased freshwater input to the surface mixed layer and increased temperature. Both processes increase the density gradient across the pycnocline, reducing the amount of nutrients injected into the surface mixed layer from the deep ocean reservoir. These changes then carry through the food chain, and are large enough to eliminate the surplus productivity on which commercial and sports fisheries depend. Both the increased temperature and decreased salinity observed in the 1990s are consistent with predictions from models of global warming. Thus, the markedly reduced ocean survival of salmon may either be the result of the early stages of global warming or a good analogue of what is likely to occur in the near future.

## TROPHODYNAMIC ANALYSIS OF TOP-DOWN CONTROL BY WALLEYE POLLOCK: THE IMPORTANCE OF ADVECTION

Orio Yamamura<sup>1</sup>, Satoshi Honda<sup>1</sup>, Osamu Shida<sup>2</sup>, and Keizou Yabuki<sup>1</sup>

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The continental shelf off southeastern coast of Hokkaido Island (Doto area) is an important feeding ground for walleye pollock distributed along the Pacific coast of Japan. A strong year class (YC) of walleye pollock reaching an average density at 0.5 inds m<sup>-2</sup> occurred in 1995. Its high density suggested that the YC affect considerably the dynamics of its zooplankton prey, *Neocalanus cristatus* and euphausiids. We therefore analyzed the top-down control on the dynamics of the prey in the Doto area using a trophodynamic model.

The annual cycles of the zooplankton were simulated based on a series of BONGO net samplings made over the shelf during 1996-1998. Daily predation pressure of the YC was then calculated by dividing its daily increase in biomass by conversion efficiency (CE). Other processes included in the model were pollock recruitment, growth, mortality, condition, emigration and immigration, and temperature dependence of CE.

Forced with the predation pressure, *N. cristatus* and euphausiids were depleted two-year and one-year after the recruitment of the YC, respectively. Since this improbable dynamics was ascribed to the lack of advective supply of zooplankton over the shelf, we added an advective term, in which a fraction of shelf plankton is replaced daily with intact offshore plankton, and then simulated under different replacement rates. Results of the simulations showed that a replacement rate of 3% was sufficient to compensate the predation pressure. It is therefore concluded that the shelf ecosystem is maintained through advective supply of prey from offshore waters.

8AM1999-FIStopic20

poster

**STOCK ASSESSMENT AND MANAGEMENT IMPLICATIONS OF JACK MACKEREL (*Trachurus japonicus*) IN KOREAN WATERS, WITH RESPECT TO THE ENVIRONMENT-BASED RECRUITMENT**

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This paper presents a case study to show the importance of environmental parameters in fish stock assessment as an example of jack mackerel (*Trachurus japonicus*) in Korea waters. The recruitment of jack mackerel was not dependent on the spawning stock size but correlated with environmental conditions during the early life history. Drastic ocean regime shifts, occurred in 1976/77 and 1987/88, affected the recruitment and production of jack mackerel stock in Korean waters. The relationship between the recruitment of jack mackerel and environmental factors was examined, and the environmental factors which were strongly correlated with the recruitment was incorporated into spawner-recruitment models. Considering these features, the management strategy of the jack mackerel stock was discussed.

8AM1999-BIO/CCCCtopic01 oral

## **COCCOLITHOPHORIDS IN THE EASTERN BERING SEA PHYTOPLANKTON: BEFORE AND DURING ANOMALOUS 1997 BLOOM**

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Unusual conditions occurred in the Eastern Bering Sea in spring - summer 1997. Ice retreating was very rapid, numbers of storms were reduced, amount of cloud free days were extraordinary high, upper mixed layer was anomalously shallow, sea surface temperature in summer was  $>4^{\circ}$  C above normal and water column stratification was extremely sharp. The conditions caused anomalous bloom of coccolithophorid *Emiliania huxleyi* in the eastern Bering Sea. The bloom was first observed in early July and lasted until late fall. Over the middle shelf ( ) in early October *E.huxleyi* numbers were  $2.1-2.8 \times 10^6$  cells/l and biomass 1.1-1.5 mg/l. Coccolithophorids formed  $>99.8\%$  of total phytoplankton numbers and  $>99.2\%$  of total biomass. The rest of phytoplankton was composed of diatoms. Typical phytoplankton numbers and biomass in the middle domain observed in late summer - early fall of 1992-1994 in the very time when coccolithophorid bloom occurred in 1997 were  $0.35-1 \times 10^6$  cells/l and 0.7-2.6 mg/l, respectively. Phytoplankton was dominated by diatoms which formed 93.3-98.7% of total numbers and 95.5-99.6% of total biomass. *E.huxleyi* numbers over the middle shelf were  $<500$  cell/l and biomass -  $<0.0002$  mg/l, over the outer shelf the numbers varied from  $<500$  to 2 000 cells/l and the biomass from  $<0.0002$  to 0.0005 mg/l. The highest *E.huxleyi* abundance was found in the oceanic domain: up to 2 600 cells/l and up to 0.001 mg/l but even here the species share in total phytoplankton numbers and biomass did not exceed 1%. Another coccolithophorid *Caliptosphaera sp.* in 1992-1994 was found to have highest numbers (1 300-147 500 cells/l) and biomass (0.003-0.215 mg/l) in the outer domain. The share of the species in total phytoplankton numbers and biomass reached 7.5% and 13%, respectively. In the middle and oceanic domains *Caliptosphaera sp.* numbers varied within  $1-15 \times 10^3$  cells/l and biomass - within 0.002- 0.05 mg/l. During 1997 *E.huxleyi* bloom *Caliptosphaera sp.* was not present in phytoplankton over the middle shelf.

8AM1999-BIO/CCCCtopic02 oral

## **MILLENNIAL SCALE CLIMATE AND HYDROLOGY OSCILLATIONS IN THE WEST SUBARCTIC AND BERING AND OKHOTSK SEAS DURING LATE PLEISTOCENE AND HOLOCENE**

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Detailed analysis of the sediment cores from the Bering, Okhotsk Seas and west subarctic was carried out. Oxygen and carbon isotope, carbonate and organic carbon content, lithology and ice rafted debris, pollen and diatom analyses were used for reconstruction changes in hydrology and productivity, sedimentology and marine ice cover and surrounded air and surface water climate respectively. Time scale model was based on oxygen isotope stratigraphy and AMS radiocarbon dating.

Besides long-term Milankovitch scale variability forced by orbital factors, all parameters had clear demonstrated the suborbital millennial scale oscillations similar to changes observed in Greenland ice core and North Atlantic.

Regional climate variability have led to remarkable oscillations in the surface water conditions, forming of the Okhotsk Sea Shelf Derived Water, Intermediate North Pacific Water and productivity. The sedimentation regime variability was forced by climate influenced marine ice cover extension and atmospheric transportation of the terrigenous material.

## INSHORE OFFSHORE GRADIENTS IN PHYTOPLANKTON PRODUCTION AND NUTRIENT DYNAMICS OFF THE WEST COAST OF CANADA

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Primary production and nutrient dynamics were studied throughout the upwelling season of 1997 and 1998 along inshore-offshore transects on the west coast of Vancouver Island. At inshore stations, larger phytoplankton ( $> 5 \mu\text{m}$ ) were responsible for most of the production and they utilized mainly nitrate. At offshore stations, smaller cells were responsible for most of the production which was based on regenerated nitrogen sources. When nitrate was available, it was the dominant nitrogen source for phytoplankton production throughout the entire region, and f-ratios were  $> 0.5$ . When nitrate was low, mainly at offshore stations, regenerated nitrogen became relatively more important as nitrogen sources for phytoplankton, and f-ratios decreased. Thus, cruise-to-cruise variations on the nitrate uptake by phytoplankton were the result of the availability of nitrate supplied by upwelling or mixing into surface waters. In comparison, studies done along a transect in the oceanic NE subarctic Pacific, extending from the continental slope off the southwest coast of Vancouver Island to Station Papa, showed that phytoplankton utilized mainly regenerated nitrogen forms year round despite the availability of nitrate and f-ratios were on average 0.2. Therefore, there is a transition from a continental shelf system which relies primarily on new nitrogen ( $\text{NO}_3$ ), to an oceanic system relying on regenerated nitrogen. The seasonal cycle in chl and primary productivity also decreases as one progresses offshore.

## INTERANNUAL MODELING OF CIRCULATION AND SALMON IN THE COASTAL GULF OF ALASKA

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As part of the U.S. GLOBEC Northeast Pacific program we are simulating currents and salmon life histories in the Coastal Gulf of Alaska, to explore sources of interannual and interdecadal variability. Forcing for the eddy resolving circulation model includes daily wind and heat fluxes from NCEP reanalyses, five tidal components from a global model, and estimates of monthly coastal freshwater runoff including major rivers (point) and distributed (line) sources. Results from the circulation model thus far indicate meanders and eddies at scales similar to those observed in satellite imagery, with preferred sites of formation. Surface currents and SST from the model, coupled with observed zooplankton densities, are used to simulate spatial and growth trajectories of juvenile salmon during a six month period (July-December) using an individual-based, bioenergetic model. Here we focus on years with contrasting wind patterns to assess how changes in climate forcing can effect migration and growth processes on the juvenile salmon life history.

8AM1999-BIO/CCCCtopic05 oral

## **A 2-D CARBON AND NITROGEN FLUX MODEL OF A NORTH PACIFIC EASTERN BOUNDARY CURRENT**

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A box model has been designed to study carbon and nitrogen cycling in the upwelling region off the west coast of Vancouver Island, British Columbia. The model is as simple as possible while representing all of the major pathways of both nutrients within and below the euphotic zone. All living organic carbon has been included in a surface particulate organic pool which takes up inorganic nutrients via Michaelis-Menton kinetics and decays in to either a particulate or a dissolved (semi-labile) non-living organic pool. These pools then remineralize into their respective inorganic pools at their characteristic decay rates. While particles are assumed only to sink or be laterally advected, dissolved pools may be mixed or advected between boxes. Air-sea gas exchange of carbon is estimated using differences between model determined surface CO<sub>2</sub> partial pressure (pCO<sub>2</sub>) and measured atmospheric pCO<sub>2</sub> with a seasonally varying gas transfer velocity and solubility. The basic seasonal cycle will be presented and the sensitivity of the cycle to model parameters discussed. The differences between ENSO and non-ENSO years and between pre- and post-1976 conditions on productivity, CO<sub>2</sub> exchange and surface export offshore will be explored.

8AM1999-BIO/CCCCtopic06 oral

## **LONG-TERM CHANGES AND UNUSUAL HIGH ABUNDANCE IN ZOOPLANKTON BIOMASS IN THE SOUTH SEA OF KOREA**

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The long-term changes in zooplankton biomass in response to climatic changes was studied in the South Sea of Korea. Additionally, this study was focused on the unusual high abundance of zooplankton biomass in 1997 and local variation.

The zooplankton samples were vertically towed with Norpac net from bottom to surface. Zooplankton biomass was calculated based on wet weight with taking off the organism larger than 3 cm in size. Data on zooplankton biomass and surface water temperature during 1965-1998 were used and analyzed according to subareas, offshore and inshore, divided based on the physical characteristics.

Zooplankton biomass showed a tendency to increase since 1990 with an annual mean, 117.3 mg/m<sup>3</sup>. In 1997 the zooplankton biomass was dramatically increased to be ca. 7 times than the other years. The zooplankton biomass of inshore area was higher than that of offshore area except 1993 and 1997. The anomaly of surface water temperature in February showed the positive value in the offshore area since 1990. Especially in April and June, 1997 surface water temperature is 2.5 °C higher than the mean over 1965-1998 in the all survey areas.

Considering that the zooplankton biomass and the surface water temperature in February are increasing since 1990, it is good reasons to believe that there are the regime shift in the early 1990s in zooplankton biomass in the South Sea of Korea. There can be no doubt that the increase of surface water temperature respond to the warm climate change and the Tsushima Warm Current in the South Sea of Korea. Thus it is assumed that the high zooplankton biomass in 1997 was mainly due to increase an allochthonous plankton transported by the Tsushima Warm Current.

8AM1999-BIO/CCCCtopic07 oral;

## **THE EFFECTS OF VERTICAL MIGRATION AND HORIZONTAL TRANSPORT BY SUBARCTIC CIRCULATION ON ZOOPLANKTON BIOMASS DYNAMICS**

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The combined effect of seasonal vertical migration and transport by the western subarctic circulation on zooplankton biomass dynamics was examined by a simple model and oceanographic data. The results show that the zooplankton biomass in the Oyashio Region is influenced by biomass dynamics of parent generation in the water east off Kamchatka.

8AM1999-BIO/CCCCtopic08 oral

## **ECOLOGICAL VARIATIONS AND EL NIÑO EFFECTS OFF THE SOUTHERN COAST OF THE KOREAN PENINSULA DURING THE LAST THREE DECADES**

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To provide the ecosystem response to the environmental changes we investigated the interannual and decadal changes in marine ecosystem with the data collected from the southern coast of the Korean Peninsula during the 1960s-1990s. Water property such as sea surface temperature (SST) and salinity in April did not show large variation during the 1970s, but a relatively cool water mass appeared from the early through mid 1980s and warm water mass replaced it after 1989. Chl *a* concentration in April which were converted from Secchi disk information was low during the period of 1968-1980 (1.34 mg/m<sup>3</sup>), but turned out to be a productive period for 7 years since 1981 (2.78 mg/m<sup>3</sup>). A negative correlation ( $r=-0.387$ ,  $p<0.05$ ) between SST and Chl *a* in April matched with high Chl *a* during the low SST period in the early and mid 1980s. Annual zooplankton biomass ranged from 37 to 132 mg/m<sup>3</sup>, but high abundance was frequently shown after 1984 and the low during the period of 1972-1982. The most representative pelagic fish species in the South Sea seemed to respond to the increase in planktonic organisms. Anchovy, mackerel and sardine increased since mid 1970s. High catches of anchovy and mackerel have lasted until 1990s, while sardine decreased after early 1990s. From the results of multiple correlation, Southern Oscillation Index (SOI) indicated a high correlation with SST in December in study area ( $p<0.05$ ). Catches of anchovy and mackerel had a positive correlation with Chl *a* and zooplankton during their early life periods as well as SST in December.

8AM1999-BIO/CCCCtopic09 oral

\* *This paper was also presented in the REX Workshop.*

## **AN ECOSYSTEM MODEL WITH ZOOPLANKTON VERTICAL MIGRATION FOCUSED ON OYASHIO REGION**

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A lower trophic model of Northern Pacific was proposed by PICES-CCCC MODEL Task Team at PICES VII. It was our duty to make its prototype and to apply it to Oyashio region. This model has ten compartments and large zooplankton (Copepods) migrates vertically. In early April they come up to euphotic zone and in late August they go down deeper than three hundred meters. When we embed it in one dimensional physical model with mixed layer, the inter annual variability of primary production and nitrate could be well reproduced.

8AM1999-BIO/CCCCtopic10 oral

## INTERANNUAL VARIABILITIES IN ABUNDANCE AND BODY SIZE OF NEOCALANUS COPEPODS (CRUSTACEA: COPEPODA) IN THE CENTRAL NORTH PACIFIC

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The interannual variations in abundance and body size of the C5 specimens of Neocalanus species (*Neocalanus cristatus*, *N. plumchrus* and *N. flemingeri*) were investigated on a series of samples (0-150 m vertical hauls with NORPAC nets) collected at stations on the longitudinal transect in the central North Pacific during summers of 1979-1997 (19 years). The stations extended to 5 subareas including; Alaska Current System (AS), Subarctic Current System (SA), Northern Transition Domain (TN), Southern Transition Domain (TS) and Subtropical Current System (ST). The Transition Domain expanded to the south in late 1980s and 1990s due to southward shift of the Transitional Front and Subarctic Boundary while the position of the boundary between the SA and TN was relatively stable. Patterns of year-to-year variations in the abundance of the Neocalanus copepods differed between subareas, but were very similar each other within each subarea. A pattern of a biennial cycle (high in even-year, low in odd-year) was evident in the SA, but was apparently at random in the TN and TS. Within subareas, interannual variations in the prosome length of the three species were closely matched in pattern (larger in odd-year, smaller in even-year). Possible effects of environmental parameters, including temperature, phytoplankton abundance and predators (chaetognaths, salmon) on these interannual variations were examined. Correlation analyses revealed that the most important parameter relating to the abundance of these copepods was phytoplankton abundance in the northern subareas, but was water temperature in southern subareas. No significant relation with these environmental parameters on the prosome length was found, however.

8AM1999-BIO/CCCCtopic11 oral

## CHANGES IN THE N.E. PACIFIC CONTINENTAL MARGIN ZOOPLANKTON COMMUNITY 1985-1998

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Samples of upper ocean zooplankton abundance and species composition have been collected from continental shelf and slope waters off southern Vancouver Island since 1979, and at standardized locations since 1985. Average seasonal cycles were described by Mackas (1992), and 1985-1992 zooplankton annual anomalies by Mackas (1995). In this paper we extend the zooplankton anomaly time series through 1998. During the past 15 years, there have been major (3-10 fold) changes in abundance of most of the dominant zooplankton taxa, as well as in atmospheric forcing (e.g. Overland et al. 1998, Schwing et al. 1996), upper ocean water properties (Whitney et al 1997) and harvested fish stocks (e.g. Beamish et al. 1997, Welch et al, submitted).

The dominant time scale for the zooplankton anomalies is decadal (or perhaps longer), rather than year-to-year. Although there are very strong time series correlations within groups of ecologically similar species, and between nearby but distinct oceanographic sub-regions (inner shelf vs. continental slope) the pattern of change is more complex than a simple high biomass-low biomass dichotomy. Two modes of variation are particularly striking and interesting:

Strongly negatively correlated trends of "southern" vs. "northern" continental margin copepods. Since about 1990, there have been marked declines in abundance of e.g. *Calanus marshallae*, *Acartia longiremis* and *Pseudocalanus* spp., and marked increases in e.g. *Paracalanus parvus*, *Ctenocalanus vanus* and *Clausocalanus* spp. Peterson (1999) has reported very similar trends off central Oregon.

Moderately negatively correlated fluctuations of euphausiids vs. subarctic oceanic copepods. *Euphausia pacifica* and *Thysanoessa spinifera* abundance increased for several years starting in the late 1980s, and appears to have decreased in the mid-late 1990s. *Neocalanus plumchrus* and *cristatus* abundance varied as an approximate mirror-image: high in the mid-late 1980s and late 1990s, low in the early-mid 1990s.

8AM1999-BIO/CCCCtopic12 oral

### **NEW HYPOTHESIS OF JAPANESE SARDINE STOCK VARIATION**

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The hypothesis is based on an idea of gradual but irreversible shift of the main spawning ground from the coastal (cold) region to the subtropical water (warm) region across Kuroshio. The idea is induced from two facts, "the more the population increased, the thinner the individuals became" and "the thinner the individuals became, the warmer water they selected as their spawning ground", and one probability, "their spawning temperature was fixed at their first spawning regardless of their nutritive recovery". The gradual but irreversible shift alone can explain not only the burst of population, which results from favorable dispersion of the larva by Kuroshio into the transient zone between Kuroshio and Oyashio, but also the catastrophe of population, which results from unfavorable dispersion of the larva by Kuroshio Countercurrent into the subtropical water region. The hypothesis is also based on another probability, "Japanese sardine is strongest among its competitors because of its filter feeding", which is induced from the fact that the competitors were destroyed or decreased during the period of the burst. The expansion and occupation of habitat after the favorable dispersion, along with the filter feeding on phytoplankton, explain why the sardine can have such a super stock as more than 10 million ton. Thus, the internal mechanisms promote and amplify the stock variation generated externally by atmospheric cooling or internally by overcoming the competitors.

8AM1999-BIO/CCCCtopic13 oral

### **LONG TERM VARIABILITY IN ZOOPLANKTON ASSEMBLAGES OF THE CALIFORNIA CURRENT SYSTEM**

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Historical studies have established the presence of interannual and interdecadal scale variations in the total biomass of macrozooplankton of the California Current System. Here we go beyond aggregate measures of zooplankton biomass, and examine shifts in zooplankton assemblages as determined by the analysis of individual zooplankton taxa over the period 1951 - 1999. Results will illustrate the changing relative importance of gelatinous and crustacean zooplankton in the CalCOFI time series, and the linkages between changes in zooplankton communities and the long-term variability of the hydrography of the California Current System.

8AM1999-BIO/CCCCtopic14 oral

## **JAPANESE SARDINE RECRUITMENT PROJECT: STUDIES ON POPULATION STRUCTURE AND RECRUITMENT VARIABILITY**

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A ten-year research project on the population dynamics of the Japanese sardine was started in 1989, with the aim of understanding the recruitment processes in the Japanese sardine. Two types of population dynamics models were developed for explaining the population fluctuation of Japanese sardine. A population dynamics model was tested to explain annual variation of recruitment based on the information of growth, survival, transport, and interspecific relationships. This model requires SST, estimated egg production, the food density, biomass of other fish species, and the position of the Kuroshio Axis as input data. After the adjustment using the data from 1966 to 1993, recruitment success or failure was well explained. As a mechanism of the interdecadal fluctuation, a positive feed back loop was assumed and the loop was driven by density-dependent changes in the range of distribution and food availability. This hypothesis was tested by a simple population dynamics model. With the fluctuation of population, various ecological changes have been observed such as shift of spawning ground, expansion or reduction of the geographical area of nursery ground, and changes in the fecundity per unit of biomass. Significant relationship has also been pointed out between the survival rate up to one-year-old fish and the SST of the Kuroshio Extension in winter. Model outputs showed the relationship between egg production and number of recruits, which was well corresponding to the stock and recruitment relationship actually observed. These results suggest that the changes in food availability cause the recruitment success or failure, and the positive feed back loop sustain the population abundance in high or low level.

8AM1999-BIO/CCCCtopic15 oral

## **TIDES, TIDAL CURRENTS AND THEIR EFFECTS ON PLANKTON COMMUNITY ON KASHEVAROV BANK, SEA OF OKHOTSK**

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This is process-oriented research with emphasis on the role of strong tidal mixing on plankton community in the Sea of Okhotsk. Tidal mixing on the Kashevarov Bank, have been investigated using the observations of bottom pressure variations and tidal currents. The tides on the bank are dominated by the diurnal constituents. The water motion over the Bank is controlled dominantly by strong diurnal tidal currents. These currents brings cold water on the bank from its source - Okhotsk dichothermal layer. The tidal temperature fluctuations are about 1.2°C at the flanks of the bank. There is residual circulation of the order of 10 cm/s. The maximum velocity is about 164 cm/s at the top of the bank. Tidal-induced mixing is responsible for ventilation of the cold intermediate layer of the Sea of Okhotsk. Strong tidal mixing creates a well-defined tidally mixed front around the bank. This front acts like a barrier separating well-mixed water on the bank from stratified water on its flanks. Strong fortnightly variations of the amplitude of the diurnal currents primarily due to the K1-O1 interaction, dominates on the bank. This leads to strong fortnightly modulation of the tidal mixing and changes of water column stratification. This fortnightly modulation of the vertical mixing appears to be a critical factor for supply of nutrients and sustain phytoplankton growth. Chlorophyll *a*, primary production and oxygen concentration have maximum during the stratified periods. Enhanced biological production occurs at this tidal ergocline as the consequence of the resonance of physical scale with biological scale. The life cycle of the dominant zooplankton species on the bank (*Oithona similis*) matches the fortnightly modulation of the tidal currents.

8AM1999-BIO/CCCCtopic16 oral

## SEASONAL, DECADAL AND INTERDECADAL FORCING OF TEMPERATURE AND SALINITY IN THE NORTHERN GULF OF ALASKA

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As part of GLOBEC retrospective studies in the Northeast Pacific Ocean, the 29 year long time series of temperature and salinity versus depth to 250 m at the mouth of Resurrection Bay, Alaska (60 N, 149 W) (GAK 1) is used to evaluate the ocean forcing due to Southern Oscillation Index (SOI), local and remote wind forcing, and freshwater discharge. It is found that the mid-depth temperatures respond to SOI with increases following SOI by 7-8 months. There are no comparable salinity changes. Internal Kelvin waves can account for these temperature changes and their time of arrival matches the propagation speed of 0.4 to 0.6 m/s. Horizontal alongshore excursions of 500-700 km are predicted for these waves. The 1997-8 ENSO event produced the largest temperature elevation since 1970 (1.4 C) at 250 m. Local winds, as indicated by upwelling indices, have little influence on salinity. However, increased downwelling (coastal convergence) leads to decreased temperatures 2-3 months later in the upper 150 m. Coastal freshwater discharges are well correlated with not only salinity changes but also temperature changes. This suggests that increased freshwater discharge accelerates the coastal baroclinic transport and heat advection. The freshwater discharge was a record low in the early 1970s, when the upper column salinities were abnormally high and the corresponding temperatures were abnormally low. Since the mid-1980s, the discharges have been above normal. The duration of these recent high discharges (14 years) exceeds the duration of any prior high discharges

8AM1999-BIO/CCCCtopic17 oral

## LONG-TERM MONITORING OF WESTERN NORTH PACIFIC ECOSYSTEMS DURING THE SUMMER OF 1979-1997

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Research on community structure and dynamics over large areas of the northern North Pacific Ocean is needed to understand the present and future ecological responses to changes in climate. Since 1979, *T/S Oshoro Maru* and *Hokusei Maru* of Hokkaido University have been conducting summer monitoring surveys of oceanography and ecology of the northern North Pacific using micronekton and zooplankton samplings, research driftnets and hydrographic observations. The monitoring is repeated yearly in June to early August at transects in the western Pacific along 155°E, 170°E, 175°30', and 180°. The large data set collected over two decades from a large area of the North Pacific is unique. In the present study, we present some results of long-term monitoring of subarctic Pacific ecosystems in the summer of 1979 to 1996.

Along 180° (37-48°N), the position of the southern boundary (Subarctic Boundary) of the transition domain fluctuated between 39°N and 42°N with a period of ten years, but the position of the northern boundary (Subarctic Front) remained constant. Primary production levels in the subarctic domain were higher than in the subtropic and transition domains. However, zooplankton biomass was higher in the transition domain than in the other domain, suggesting the importance of grazing on phytoplankton in the transition domain. Salmonids inhabited the northern subarctic and Subarctic Front waters. The total population size of chum salmon (*Oncorhynchus keta*) has increased remarkably in recent years, while the size and growth rate have gradually decreased. Neon flying squid (*Ommastrephes bartramii*) and Pacific pomfret (*Brama japonica*) migrated north across the Subarctic Boundary during the summer. In the early 1990s, the abundance of both species decreased. Since the mid-1990s, neon flying squid has increased in abundance, while pomfret abundance remains low. These stock fluctuations may be due to changing ocean conditions, such as those caused by El Niño, and impacts of fishing, such as the intensive driftnet fishing that occurred before 1992.

8AM1999-BIO/CCCCtopic18 oral

## **GEOGRAPHIC VARIABILITY OF CHL *a* SEASONALITY IN THE SUBARCTIC NORTH PACIFIC OCEAN**

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To make understood clearly the Geographic variability of Chl *a* seasonality in the subarctic North Pacific Ocean, we compared the seasonal variation in biological and physical conditions among waters. Two data sets used for this study were downloaded from JODC (Japan Ocean Data Center) web site, and Oceanographic data collected by Japanese high seas salmonids research. Total number of the observation station is 86267, and period is 1920-91. The subarctic North Pacific is divided for the Oyashio, Sea of Okhotsk, Western Pacific, Central Pacific, Eastern Pacific, Bering basin water, and Bering shelf water. Chl *a* concentration was converted from Secchi disc depth using the equation of Falkowski & Wilson (1992). The spring blooming appeared in the Oyashio, Sea of Okhotsk, Bering shelf water. On the other hand, western, central, eastern Pacific and Bering basin water did not have spring blooming and showed relatively high values in summer. MLD (mixed layer depth) of the Oyashio and sea of Okhotsk was reached at 40m depth at April. However, the MLD of western, central, eastern Pacific, and Bering basin still existed at under 100m depth at April. The timing of the seasonal pycnocline formation may play the important role for the Chl *a* seasonality in the subarctic North Pacific.

8AM1999-BIO/CCCCtopic19 oral

## **U.S. GLOBEC NORTHEAST PACIFIC LONG TERM OBSERVATION PROGRAM IN THE MARINE ECOSYSTEM OF THE NORTHERN CALIFORNIA CURRENT**

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The goal of the long-term observation program (LTOP) within the Northeast Pacific GLOBEC program is to provide the fundamental seasonal description of the physical, chemical and biological environment at a few critical locations. The LTOP also aims to provide information on interannual variability and long-term changes. The specific objectives of the LTOP in the Northern California Current region are: seasonal sampling (five times per year) of two dimensional temperature, salinity, density, velocity, dissolved oxygen, nutrient, chlorophyll and zooplankton fields through September 2003; to determine whether characteristics of the upwelling ecosystems north and south of Cape Blanco differ significantly; to determine whether the 1976-1977 regime shift in the large-scale climate is reflected in significant differences between contemporary (1997-2003) and historical (1961-1973) observations of the marine ecosystem off central Oregon. Results from 1997-1999 and plans for continued LTOP sampling will be presented. In addition, the expansion of work to include mesoscale surveys and process studies will be described.

8AM1999-BIO/CCCCtopic20 poster

## DISTRIBUTION OF MICROBIAL ORGANISMS AND PRIMARY PRODUCTIVITY NEAR THE POLAR FRONT IN THE EAST SEA

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A study on the distribution of microbial organisms and their productivities near the polar front of the East Sea was carried out at 21 stations near Ulleung Island in November 1994. Average standing stocks of phytoplankton in the surface layer was less than 10 cells ml<sup>-1</sup> in the front area by the strong influence of Tsushima Surface Water. However High standing stocks of phytoplankton over 100 cells ml<sup>-1</sup> were observed in the warm eddy area at station D1 and E10-E12. In this warm eddy area, phytoplankton community showed high diversity and composed of various oceanic warm water species due to the Eastern Korean Warm Current. Bacteria standing stocks in this study area were over 1x10<sup>6</sup> cells ml<sup>-1</sup> in the eutrophic zone. The spatial distribution of bacteria standing stocks were similar to those of chlorophyll *a*. The cyanobacteria standing stocks ranged from 4,360 cells l<sup>-1</sup> to 50,600 cells l<sup>-1</sup> showing low abundance in the warm water area and high abundance in the cold water area. Average standing stocks of planktonic ciliates ranged from 590 cells l<sup>-1</sup> to 1,240 cells l<sup>-1</sup>. Bacteria production ranged from 26.45 mgCm<sup>-2</sup>d<sup>-1</sup> to 184.89 mgCm<sup>-2</sup>d<sup>-1</sup> and was 19.5% of average primary production having highest value of 1,853.17 mgCm<sup>-2</sup>d<sup>-1</sup> in warm eddy area and lowest value of 423.56 mgCm<sup>-2</sup>d<sup>-1</sup> in the cold water region.

8AM1999-BIO/CCCCtopic21 poster

## SEASONAL VARIABILITY OF THE COPEPOD ASSEMBLAGE AND ITS RELATIONSHIP WITH OCEANOGRAPHIC STRUCTURE AT YAMATO TAI (JAPAN SEA)

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Abundance and species composition of the copepod assemblage at Yamato Tai (central Japan Sea), were investigated using samples obtained by vertical hauls (mainly 0-500 m depth) of a NORPAC net in February, April, June, August and October, 1995. Numerical abundance was influenced by seasonal variations of both cold- and warm-water species. A high abundance yet low diversity in spring was due to the dominance of cold-water species such as *Metridia pacifica*, *Pseudocalanus newmani* and *Oithona atlantica*. *Metridia pacifica* was the most abundant species during the study period. The total number of copepods reached a seasonal maximum (348 inds./m<sup>3</sup>) and widest range of densities (18-671 inds./m<sup>3</sup>) in April. In contrast, lower summer and autumn abundance were due to a decrease of the cold-water species. The copepod number decreased towards a summer minimum (53 inds./m<sup>3</sup>, range: 41-76 inds./m<sup>3</sup>) in August. However, the autumn copepod assemblage structure was more diverse because of the seasonal increase of warm-water species (40% of total number and 45 species in October). There was a very small increase (76 inds./m<sup>3</sup>, range: 46-112 inds./m<sup>3</sup>) in the total abundance in autumn. The seasonal change of copepod assemblage structure was closely associated with both their ecological significance and movements of the cold- and warm-water masses (i.e., "Subarctic Water", "Deep Water", and "warm Tsushima Current").

8AM1999-BIO/CCCCtopic22 poster

## **EFFECTS OF INTERANNUAL VARIATION OF CLIMATIC FACTORS ON MESOZOOPANKTON COMMUNITY STRUCTURE IN THE KUROSHIO, EARLY SPRING**

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Interannual variations of biomass and composition of mesozooplankters (Cnidaria, copepods, Crustacea other than copepods, Chaetognatha, Tunicata, and other mesozooplankton) in early spring in the Kuroshio off the Pacific coast of western Japan (the western Kuroshio) from 1971 to 1988 and those in the Kuroshio off central Japan (the central Kuroshio) from 1971 to 1989 were examined. In the central Kuroshio, there are two distinctive phases of the Kuroshio flow path, with and without a large meander of the path, and the temperature becomes high during the large meandering period. In each Kuroshio, the trend of interannual variation of biomass was different between Cnidaria and other mesozooplankters. In the western Kuroshio, biomass of mesozooplankters other than Cnidaria was larger in the first half of 1970s than those after the period, being related positively with wind speed and negatively with the temperature. While, in the central Kuroshio, the biomass was relatively large in the first half of both 1970s and 1980s, also being related positively with wind speed and negatively with temperature. Cnidarian biomass was related negatively with light condition in the western Kuroshio or negatively with wind speed in the central Kuroshio. In the Kuroshio, biomass of mesozooplankters other than Cnidaria seemed to increase with new production, while cnidarian biomass became large under the conditions such as flagellates could be dominated in the phytoplankton community. The local differences in the biomass trends were probably caused by differences in the dominant factors affecting the temperatures.

8AM1999-BIO/CCCCtopic23 poster

## **COMPARISON OF NUTRIENTS, CHLOROPHYLL *a* AND PHOTOSYNTHESIS IN APRIL AND JUNE AROUND KUROSHIO EXTENSION**

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We have researched the variation of Pacific saury in VENTFISH (Comprehensive study of the Variation of the oceanic Environment and FISH populations in the Northwestern Pacific) as the Japan-GLOBEC like program since 1997. Our subject is the photosynthesis in relate to the production of small copepods around the Kuroshio Extension (KE) since larvae of Pacific saury are known to feed on warm-water small copepods around KE when they move from subtropical to transition area through KE. We examined the distributions of chlorophyll *a* (Chl *a*), nutrients and photosynthesis as well as physical elements such as water temperature in June 1996 and in April 1997 around KE. The concentration of Chl *a* was high in the north region of KE in the both months. The concentration was higher in April than in June in the south region of KE. The concentration of nutrients in surface layers was high in some station and exhausted in another station in April and exhausted always in June. The assimilation No. (AN:mgC/mgchl<sub>a</sub>/hr) was higher in April than in June. The ANs were almost constant from 100% to 10% of under PAR (photosynthetic available radiation) in June but they were proportioned to under PAR in April. We thought that the AN in April was proportioned to under PAR because of the existence of nutrients but that in June could not be high because of the exhaustion of nutrients.

**THE GULF OF ALASKA ECOSYSTEM MONITORING (GEM) PROGRAM: A PERMANENT FUND FOR THE MANAGEMENT AND CONSERVATION OF THE NORTHERN GULF OF ALASKA MARINE ECOSYSTEM**

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Using funds now set aside in the Exxon Valdez oil spill (EVOS) Restoration Reserve, the EVOS-Trustee Council established a perpetual, inflation-proofed endowment, from which the earnings would support long-term ecological monitoring and research in the EVOS area and adjacent northern Gulf of Alaska. This interdisciplinary program will be designed to improve understanding, conservation, and management of the living marine resources of the northern Gulf of Alaska. Minimum annual cost would be \$5-6 million dollars, inclusive of all aspects of the program. The GEM Program would aim to:

- track lingering oil spill injury (e.g., oil exposure in sea otters) and apply what is learned to injury assessment and response to future oil spills (e.g., NRDA/contingency planning);
- identify and understand annual and long-term changes in the marine ecosystem, distinguishing natural variability from human influences (e.g., wide swings in salmon, marine mammal, and seabird populations);
- develop new fish and wildlife management tools (e.g., genetic stock identification in commercially important fish species);
- provide integrated and synthesized information on the status, trends and health of fisheries and other marine resources, including water quality and contaminants in fish and wildlife consumed by people (e.g., produce annual "state of the gulf" report, with periodic updates as new information becomes available);
- support the identification and protection of important marine habitats (e.g., assist with siting of marine industrial and mariculture facilities; establish protected reserves); and,
- foster efficiency through interagency coordination and scientific leadership and the leveraging of GEM funds to guide uses of funds from other sources (e.g., the NOAA/NSF GLOBEC program on climate change and the oceans).

8AM1999-REXworkshop01

oral

## **A COMPARISON OF ECOSYSTEM DYNAMICS THAT AFFECT PACIFIC HERRING ABUNDANCE IN THE STRAIT OF GEORGIA AND OFF THE WEST COAST OF VANCOUVER ISLAND**

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The abundance of Pacific herring off the west of Vancouver Island was low in the 1990s as a result of Pacific hake predation. Hake abundance in this area increased in relation to ecosystem changes that included increased water temperatures. The abundance of herring in the Strait of Georgia approached historic high levels during the same period even though hake abundance and water temperatures also increased. The opposite response of herring in these two areas is not related to fishing, but to changes in climate. We propose that year class strength of herring is determined by the availability of copepods at the time of first feeding and by predation on juveniles. The differing response of herring in the two systems is attributed to the predation on herring during their first year of life.

8AM1999-REXworkshop02

invited

## **INTERACTIONS BETWEEN FISH AND EUPHAUSIIDS AND POTENTIAL RELATIONS TO CLIMATE AND RECRUITMENT**

David M. Checkley, Jr.

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The interaction of euphausiids and fish is complex. Each at times may be the predator, prey, or competitor of the other. However, certain interactions may be dominant. Here, I present preliminary data consistent with one such interaction, predation by euphausiids on sardine eggs in the California Current Region. High resolution maps of near-surface distributions of euphausiids and the eggs of the Pacific sardine, *Engraulis mordax*, were made during CalCOFI cruise 9603JD using the Continuous, Underway Fish Egg Sampler, CUFES. Despite sampling caveats, including possible avoidance of the near-surface intake of the CUFES pump by euphausiids, the pattern of sardine eggs and euphausiids were complimentary, consistent with euphausiid predation on sardine eggs. These results and those of others indicated that variation in the abundance and distribution of euphausiids may significantly affect survival of planktonic eggs and larvae and hence recruitment of sardine and other species of fish. Predation and competition require overlap in distributions of species populations which, in turn, depend on habitat. Climate variation will affect interactions between fish and euphausiids in part through expansion, contraction, and overlap of such habitats and hence the distributions of the species involved. A high priority should be given to characterizing such habitats and their variation.

8AM1999-REXworkshop03 oral

**QUALITATIVE TEXTURE CHARACTERISTIC OF HERRING (*Clupea pallasii pallasii*) PRELARVE DEVELOPED FROM THE NATURAL AND ARTIFICIAL SPAWNING-GROUNDS IN SEVERNAYA BAY (PETER THE GREAT GULF)**

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As some authors consider anomalies nature of prelarvae texture and the first ones quantity are good indicators of future young animals viability and to a considerable extent determine a spawning effectiveness afterwards.

So the relative contents of normal and anomalous just hatched herring prelarvae originated from natural and artificial spawning-grounds have been determined in Severnaya Bay.

The maximal quantity (94%) of well developed prelarvae hatched from roe of net spawning substrate but in the case of weed *Zostera marina* as a substrate their number didn't exceed 25%.

The essential anomalies were detected for prelarvae originated from natural substrates; they included absence (4,2%) or great water content (16,6%) of yolk sac. The principal anomalies of prelarvae from artificial substrates were curvature of trunk (8%), head and tail parts (5% and 10%). It was established that approx. 50% of curved prelarvae had recovered about one day after hatching.

8AM1999-REXworkshop04 oral

**SPATIAL, TEMPORAL AND LIFE-STAGE VARIATION IN HERRING DIETS IN BRITISH COLUMBIA**

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Contents of herring stomachs were examined from several areas of British Columbia, at different seasons and at different life history stages: larvae, juveniles and adults. In some areas, such as the shelf waters of southern BC, euphausiids were the main diet of adult herring. In other areas, particularly in northern areas, the diet was varied, and consisted mainly of copepods or other zooplankton. Analysis of larval herring diets indicates that they feed mainly on copepod eggs and nauplii. Juveniles in their first year of life (< 12 months) eat mainly copepods, and probably the species composition changes substantially in time and space. Young juveniles are too small to eat euphausiids. Juveniles in their second year of life do eat euphausiids, however, and these may be their main diet in some areas. The premise of this workshop is that fluctuation in euphausiid biomass has a direct impact on the biomass or dynamics of herring populations, although the impact may be mediated through effects on herring predators and through competition. While this general premise may be correct, the analyses of guts presented here shows that the responses of herring vary geographically (or by population) and by different life history stages.

8AM1999-REXworkshop05 oral

### **ABOUT RELATION BETWEEN EUPHAUSIACEA AND SAKHALIN-HOKKAIDO HERRING IN THE SEA OF JAPAN, TATAR STRAIT**

Elza R. Ivshina and Irina Y. Bragina

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Sakhalin-Hokkaido herring is under deep depression period for a long time. For the one of the main component of the herring feeding - zooplankton crustaceans (Euphausiacea) has been characterized relatively small biomass quantities during 80-90s also. In the present work the relations were investigated between numbers of the herring generations, herring numbers in the 1 year age (estimated data) and biomasses of the small, large size fraction for the Euphausiacea, biomass of the zooplankton predators (with predominant species *Parasagitta elegans*) in spring and fall periods during 1986-1992. Since 1983 the 1988 generation was most largely in the quantities against other Sakhalin-Hokkaido herring generations with very reduced numbers. During 1986-1992 the relatively increased biomasses of the Euphausiacea were obtained in the spring and fall of the 1990 and 1992 and a smallest were registered during 1988 (spring and fall both). 1988 had the smallest predators zooplankton biomass and negative temperature anomaly at the south of the Tatar strait mostly in the spring time.

No clear relation between herring quantities and Euphausiacea biomass had been obtained during searching period. That, probably, was the reason of the common declining of the Euphausiacea during Sakhalin-Hokkaido herring depression. The main component in the herring feeding during her life cycle are Copepoda (*Calanus plumchrus* and *Pseudocalanus minutus*). Meanwhile the weak direct correlation between biomass of the large size fraction Euphausiacea (*Euphausia pacifica*, *Thysanoessa inermis*, *Th. raschii*, *Th. longipes*) and 1 year age Sakhalin-Hokkaido herring number was discovered for the fall period.

8AM1999-REXworkshop06 invited

### **FISH PREDATION ON KRILL AND KRILL ANTIPREDATOR BEHAVIOR**

Stein Kaartvedt

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Krill constitute a key component in oceanic food webs. They have a diverse diet and are prominent prey for fish. The search strategies of fish foraging on krill differ among species, locations, and time of day and may involve visual search as well as ambush feeding based on hydrodynamic signals created by the swimming prey. This talk compares the feeding behavior of herring foraging on krill with that of other planktivorous fish. Possible krill antipredator behavior will be evaluated. I will argue that acoustic studies hold yet unexploited opportunities for studies of fish-krill interactions and for understanding of both krill and fish behavior.

8AM1999-REXworkshop07 oral

### **EUPHAUSIIDS IN THE KOREAN WATERS AND ITS RELATIONSHIP WITH MAJOR FISH RESOURCES**

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General distributional patterns of euphausiid are discussed in the Korean waters. Also, this study attempts to clarify not only the regional patterns of the interannual variation in euphausiid abundance but also the relationship between euphausiid and fish abundance in the South Sea of Korea.

The following 10 species were identified from the Korean waters: *Euphausia recurva*, *E. mutica*, *E. pacifica*, *E. nana*, *E. tenera*, *E. similis*, *Pseudeuphausia latifrons*, *Stylocheiron affine*, *S. carinatum*, and *Thysanoessa longipes*. Of these species, *E. pacifica*, *E. nana* and *P. latifrons* were numerically dominant. Seven other species were associated with the influx of the Tsushima Warm Current. *E. pacifica* showed the discontinuous distributional patterns. It was found in 1) the Sea of Japan and the northern part of the Korea Strait and 2) the Yellow Sea. *E. nana* occurred in the intervening area, with some overlapping with *E. pacifica* in the east and west.

Regarding the results on the mean abundance of euphausiids during 1978-1998 in the South Sea of Korea, euphausiids were densely populated in the coastal area and the western area of Cheju Island in April and June. Although their abundance was very low, they usually aggregated in the coastal area in February, August and October.

Annual mean of abundance was 2.52 inds./m<sup>3</sup>. The euphausiids showed increasing trend since 1990 with peak in 1992, while *Engraulis japonica* remarkably increased in 1993. *Scomber japonicus* and *Engraulis japonica*, the major fish resources in the South Sea of Korea, begun to increase since 1992.

*Abstract of Michio J. Kishi, Hitoshi Motono and Kohji Asahi (An ecosystem model with zooplankton vertical migration focused on Oyashio region) can be found in the BIO/CCCC abstracts (#8AM1999-BIO/CCCCtopic09).*

8AM1999-REXworkshop08 oral

#### **LONG TERM FLUCTUATION OF THE CATCH OF PACIFIC HERRING AROUND JAPAN**

Tokimasa Kobayashi, Keizo Yabuki, and Masayoshi Sasaki

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Ecologically characterized two types of Pacific herring distribute around Japan. One is the population group, which spawn in the high salinity shallow waters along the coast and another population group spawn in the brackish lakes or inlets. Hokkaido-Sakhalin population which belongs to former group has been in extremely low stock condition. Amount of catch of this population reached about one million-ton in 1897 however no spawning has been observed since 1950 except 1987 and 1988. The 1983-year class was appeared at the middle level of year class strength for this population. Fluctuation pattern of catch of Ishikari Bay population and Mangoku-Inlet population, both belong to former group, showed that no synchronism with Hokkaido-Sakhalin population. Relatively strong year classes were appeared in 1980s for Mangoku-Inlet population and in 1995 to 1997 for Ishikari-Bay population. In these years the cold water mass covered the spawning area of these populations while spawning season. Lake Notoro population, one of the brackish water-spawning groups, had extinguished after accomplishing the open gate in the mouth of the lake. The density of salinity changed to be high almost same as outside of the lake. It suggests that these environmental changes may play an important role, which are favorable or unfavorable for formation of year class strength of this species.

8AM1999-REXworkshop09 oral

#### **EUPHAUSIDS IN HERRING'S FEEDING IN THE WESTERN BERING SEA**

N.I. Naumenko

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The paper is based on long-term information (1939-1998) from 110 thousand herring's stomach content field examination, quantity-weight method examination of 2997 stomach content from 117 coastal stations in Karaginsky Bay, Olyutorsky Bay, Olyutorsky-Navarin area, 1486 stomach examination at 9 daily stations. Rations were calculated by three modes: according daily stations data; physiological method by well-known

Vinberg equation; through found by us tight dependence between herring's daily ration, mass, stomach fullness index, water temperature.

Korfo-Karaginsky herring's feeding composition and trophic activity are very labile by years, seasons, areas, age cohorts. Herring's feeding (without larya) contains 70 species of marine animals of 13 classes. The leading role in feeding plays Copepods. Herring annual ration consists of more than a half (51,7%) of this animals. The portion of euphausiids in feeding spectra fluctuates by years from 9,8 to 70,7% with average value 42,1%. In May - September the herring feed mainly by Copepods - from 49,9% in September to 88,4% in July. During other months, euphausiids contribute 68-88% of stomach content.

The variability of herring feeding spectrums during the life period is conditioned by fish distribution according to age composition. During summer-autumn feeding period 0+2+ aged individuals inhabits mainly in Karaginsky Bay; 3+ - Olyutorsky Bay, 4+7+ - adjacent to Koryak Coast/Elder herring reaches far eastern areas and during high abundance periods inhabits in offshore waters. Feeding composition is in high conformity with fishes abode: 4-year-old and older than 8-year-old individuals feeds more euphausiids; the others - Copepods.

Annual consumption of euphausiids by the population is from 1,3 (depressed condition) to 8,7 (high stock abundance) million tons. Every average statistical individual feeds from 0,39 kg (32,000 individuals) to 0,54 kg (45,000 individuals) of these class organisms.

8AM1999-REXworkshop10 oral

## **HOLOCENE FOSSIL FISH REMAINS FROM SAANICH INLET, BRITISH COLUMBIA, CANADA**

Jacqueline M. O'Connell

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Fish scales collected in high-resolution sediment cores from Saanich Inlet, British Columbia, Canada, record the last 110-years of deposition. Scales of Pacific Herring (*Clupea harengus pallasii*) and Pacific Hake (*Merluccius productus*) are most common and frequency counts of scales for these two taxa are used as indices of relative abundance. Data smoothing and spectral analyses identify low and high frequency trends, cycles and peaks. When related to time series of oceanographic change and historic fisheries records, the fish scale record provides unique insight into the relative importance of fish species interactions, the local environment, and the effects of fishing on long-term fish population dynamics. Aleutian Low Pressure (ALP) explains much of the high-frequency variance in the scale data and is postulated to affect juvenile herring and hake survival and recruitment at a four- to seven-year periodicity. Predator-prey dynamics and a diatom proxy of primary production also explain some of the low and high frequency variation in the scale deposition data. These parameters all vary at ALP periods. The well-documented crash in herring stocks in the late 1960s is recorded in the sedimentary record of Saanich Inlet and fishing is speculated to be a primary cause. Lastly, regime shifts, particularly the 1976 climate shift, are clearly expressed in the fish scale record. Overall, scale records provide insight into the role of ALP and other factors in driving fluctuations in herring and hake, and confirm that these stocks (especially herring) are volatile in the face of anthropogenic pressure.

8AM1999-REXworkshop11 oral

## OVER WINTER ENERGY CHANGES IN HERRING FROM PRINCE WILLIAM SOUND, ALASKA

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We examined the whole body energy content (WBEC) of Pacific herring *Clupea pallasii* from Prince William Sound (PWS), Alaska. The WBEC and length vs. capture site exhibited a wide range of values. Young of the year (YOY) recruits first appeared in July with WBEC of 2-3 kJ g<sup>-1</sup> wet wt. They fed intensively through the fall, then relied on stored energy to over-winter. In the fall YOY recruits had an WBEC of 5.7 kJ g<sup>-1</sup> vs 8.0 for age 1 and 9.4-10.2 kJ g<sup>-1</sup> for herring of ages 2 to 7. Changes in WBEC of captive YOY herring forced to fast were compared to cohorts from the field. Fish captured on 1 December and held without feeding until 1 April had an WBEC that changed from 5.2 to 3.2 kJ g<sup>-1</sup>. Captives that died during fasts had WBEC values of 2.8 -3.6 kJ g<sup>-1</sup>. During March the WBEC of field collected YOY herring 3.8 kJ g<sup>-1</sup>, with 40% having WBEC 3.6 kJ g<sup>-1</sup>. Thus, by March the average recruit had used most of its energy reserves and many were nutritionally near death. These observations determined that in PWS storing enough energy to survive the first winter is an important step in the recruitment process.

8AM1999-REXworkshop12 oral

## ECOLOGICAL ZONATION OF EUPHAUSIIDS OFF CENTRAL OREGON

William T. Peterson, Leah Feinberg, and Julie Keister

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Two euphausiids dominate the macrozooplankton off the Oregon coast, *Thysanoessa spinifera*, and *Euphausia pacifica*. During the summer upwelling season *T. spinifera* are almost entirely restricted to shelf waters and *E. pacifica* to slope and oceanic waters. We have been sampling euphausiids in the coastal zone off Oregon during biweekly cruises since 1996 and will present results on year-to-year variations in abundance and production of these euphausiids. Recruitment of the coastal species, *Thysanoessa spinifera*, has been very low over the past few years, in agreement with results published by Tanasichuk (Mar. Ecol. Prog. Ser. 173:181-195). Poor recruitment is related to the extended El Niño conditions that have prevailed in the Pacific Northwest since 1991 and to the "El Niño of the century" in 1997-1998. During the 97-98 El Niño, three euphausiid species that ordinarily are found in Pacific Central waters occurred in shelf waters off Oregon waters (*Euphausia recurva*, *E. mutica*, and *E. gibboides*). This is the first record of these species off Oregon. Another unusual event is that the *E. pacifica* population occupied shelf waters during the El Niño. In 1999, upwelling has been very strong due to the La Niña so we expect greatly increased recruitment and production of *Thysanoessa spinifera* in shelf waters. Thus, at the workshop we will discuss effects of the El Niño - La Niña cycle on euphausiid production. As part of another research program, we sample juvenile salmonids and other pelagic fishes off the Washington and Oregon coasts along six transect lines, in June and September, using a large rope trawl. Results of those cruises in terms of distribution and abundance of herring in coastal waters will be presented as will preliminary results of herring stomach content analysis.

8AM1999-REXworkshop13 oral

## EUPHAUSIID CRUSTACEANS OF COLD SECTOR OF THE JAPANESE SEA AS A FODDER RESOURCE OF A HERRING

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Practically all pelagic and some demersal fishes in waters of the Sea of Japan eat the euphausiid crustacean (Euphausiacea, Crustacea). Three species of this krill from four (*Euphausia pacifica*, *Thysanoessa Inermis* and *Th. raschii*) inhabiting in the northern Japan Sea are the allcat filtrators, consuming the primary organic matter and the small organic matter of the primary consumers. They transformed economically the fine food in rather large (10 - 30 mm of length), shrimplike bodies rich by albumins and fats. The fourth species *Thysanoessa longipes* is considered as a predator. The limiting length of a body of this specimens is more, than such at three other species:

The euphausiids in epipelagial of the northern Japan Sea (Tartar strait) in IKMT-10 catches made in May up to 40, in August - September - 26 - 41 and in November about 30% of a biomass, and the occurrence frequency of the crustaceans on the stations - accordingly 78, 60-87 and 97%. In August their biomass in Tartar Strait epipelagial (IKMT-10) was no less than 1 million tons.

The biotopic basis of *Th. raschii* population is the aquatic area of northern and west-northern part of a Tartar Strait, at *Th. inermis* - northwestern part of the Sea of Japan from a of mixture water zone up to the northern shore part of a strait, at *Th. longipes* - from northern half of Tartar Strait up to of a zone of mixture and more to the south, and at a *E. pacifica* - practically all basin of the Sea. The krill making of the fodder bases of a ekastrii's herring population in spring-summer is formed at the expense of *Th. raschii* and *E. pacifica*, at Peter the Great Bay population - *Th. Inermis*, *Th. Longipes* and *E. pacifica* and at the Sackhalin - Hokkaido herring population - also this three species without *Th. raschii*.

8AM1999-REXworkshop14 oral

## SHALL WE EXPECT THE KORF-KARAGINSKY HERRING MIGRATIONS INTO THE OFFSHORE WESTERN BERING SEA?

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Daily food ration was calculated at 3,0-5,1% BW for the Korf-Karaginsky herring sized 25-35 cm in summer of 1998. Euphausiids portion varied from 35,6 to 100%. Mature herring fed 2% ( $21,5 \times 10^3$  tons) from total euphausiids biomass on feeding area. Besides, euphausiids are consumed by herring juveniles, pollock, salmon, and other fishes. Despite high euphausiids productivity, some tightness is imminent in correspondent links of shelf fish community trophic web. Extension of feeding area is inherent for pelagic fishes during high abundance. Whether herring will migrate in the offshore western Bering Sea for utilize its food resources or not?

The cases against are following:

1. Basing on 1986-1998 data, annual Korf-Karaginsky herring diet totals  $24,3 \times 10^6$  tons at herring biomass in  $1,7 \times 10^6$  tons. It noticeably less than plankton production in shelf areas.
2. Herring feeding strategy envisages consumption of abundant and less motile organisms. In summer, copepods predominate among planktonic crustaceans. Herring also feed pteropods (25,2%), hyperiids (13,8%), pollock and capelin underyearlings (3,7-4%).
3. After-spawning herring feeding peak (daily ration 11,7%BW) is related to euphausiids spawning migration upon shelf, in particular from offshore waters.
4. Last years euphausiids biomass increased on herring feeding area and reached 309 mg/m<sup>3</sup>. The case "for" is in historical records. The Korf-Karaginsky herring migrations in offshore waters are fixed for 1960s, for the eastern Bering Sea herring - in 1992. Atlantic-Scandinavian herring feeding area is chiefly situated above 1000-meters depth. Therefore, feeding migration route seems possible for herring in the Bering Sea offshore waters.

8AM1999-REXworkshop15 oral

## **ENVIRONMENTALLY FORCED VARIABILITY IN LARVAL DEVELOPMENT AND STAGE-STRUCTURE: IMPLICATIONS FOR THE RECRUITMENT OF *Euphausia pacifica* IN THE SOUTHERN CALIFORNIA BIGHT**

Scott M. Rumsey

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Recruitment of *Euphausia pacifica* exhibits considerable intra/interannual variability. The extent to which this variability is driven by fluctuations in the developmental regime of larvae has yet to be established. Life-history modelling I have conducted suggests that developmental variability during the egg, and furcilia I-II stages is crucial in determining overall larval survivorship. These results highlight the importance of the timing/location of egg release in determining egg viability and subsequent recruitment. Additionally, indirect developmental pathways during the furcilia I-II stages may also be associated with diminished recruitment success.

*E. pacifica* was sampled in the Southern California Bight during two cruises (2/96 and 1/97) to assess the predictions of the models. MOCNESS and CTD-fluorometer transects were taken across persistent sea-surface temperature fronts identified from AVHRR satellite imagery. Samples show that spawning occurred within the upper 100 m, and was restricted in depth relative to the distribution of females. This suggests that the vertical location of egg release was directed in response to specific physical-biological cues. Differences in furcilia I-II developmental pathways among stations were associated with horizontal temperature gradients. Direct pathways were associated with warmer water masses, and indirect pathways were associated with colder water masses. The association of such spatial variability in larval developmental and stage-structure with physical-biological conditions, and its implications for eventual recruitment success, are discussed.

8AM1999-REXworkshop16 invited

## **INVERSE MODELLING OF DEVELOPMENTAL PARAMETERS IN *Euphausia pacifica*: THE RELATIVE IMPORTANCE OF SPAWNING HISTORY AND ENVIRONMENTAL FORCING IN LARVAL STAGE-FREQUENCY DISTRIBUTIONS**

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Variability in larval stage-frequencies associated with physical-biological oceanographic conditions are indicative of varying developmental success and survivorship, and illustrate the importance of larval processes to eventual recruitment success in *Euphausia pacifica*. Inverse modelling of vital demographic parameters was employed to evaluate the relative importance of variability in losses during larval development and variability in spawning histories to larval population-structure (observed in the field). The method however, is not aimed at providing quantitative estimates of vital parameters as with more complex models employed in the literature. In conjunction with biological insight and a detailed description of the developmental regime, this method provides a means for the relative comparison of demographic parameters (developmental and specific-mortality rates and egg input) among sampled stage-frequency distributions.

*E. pacifica* stage-frequency distributions from two winter cruises in the Southern California Bight were used to evaluate those factors which likely produced within-year and between-year differences in larval development and larval population demography. Within-year, among-station variability in larval stage-frequency distributions were more likely associated with spatial variability in larval developmental or mortality rates than with spatial variability in egg inputs. Interannual, between cruise, differences in larval population demography, however, are highly consistent with temporal variability in onset of egg release and sampling during different points of a spawning pulse. Though clearly not the sole mechanisms of generating recruitment variability in *E. pacifica*, at certain temporal-spatial scales environmental forcing of developmental variability impacts larval population dynamics and recruitment.

8AM1999-TCODEworkshop01 oral

## **THERMAL SEA SURFACE STRUCTURES ON NOAA IR-IMAGERY: TIME-SCALING VARIABILITY AND ASSOCIATION WITH SEA SURFACE FLOWS**

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Qualitative analysis of thermal structures on the sea surface by satellite images is a promising approach to turbulence nature studies. A method for marking thermal structures on the sea surface by satellite IR-images has been created some years ago. The procedure is based on an approach for extraction of oriented texture from images. Satellite images of the sea surface might be considered as a set of oriented textures in the temperature field, assuming that the field nature is related to the sea dynamics. The oriented texture is a 2D-image with a calculated dominant direction of the radiation contrast at each point. The method evaluates the dominant orientation of the radiation contrasts and estimates the appropriate coherence level (coincidence of the separate orientations) of the local gradient field in the vicinity of every point. The direction of the radiation contrast is determined as an orthogonal representation of the radiation gradient vector.

The method has been successfully used for the last years in the Satellite Centre of the Far-Eastern Branch of the Russian Academy of Science located in Vladivostok providing information for researches, navigation assistance of fishing and scientific expeditions in the Eastern Asian marginal seas. Comparison study demonstrates good agreement dominant orientations and sea surface velocity orientations. The reason is in the displacement character of velocity field, according those dominant orientations (i.e. statistically significant tangents of isotherms) stretch along flow.

The method of oriented textures has been developed in this work. The problem to receive composed charts of thermal structures is considered. There are discussed following questions:

- dominant orientations time variability;
- time variability dependence of thermal structures and sea surface velocity values;
- dominant orientations as an estimation of sea surface velocity directions.

8AM1999-TCODEworkshop02 invited

## **COASTAL BAYS TO CORAL REEFS: VISUALIZATION OF A SPATIAL MULTISTOCK PRODUCTION MODEL**

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Contemporary focus on sustainable resource management requires broadening the bases of fisheries assessment to encompass understanding of ecosystem structure, function and dynamics, and how biology and physics couple to affect spatial and temporal production dynamics for multispecies communities. But such "new" foci have placed many assessment scientists on overload because of explosive technological growth and expanded sensor capabilities that produce a plethora of real-time data streams. Data proliferation continues to produce bottlenecks in the management process due to persistent limitations in analysis and interpretation using traditional assessment methods. To address these problems, we use scientific data visualization in a quantitative systems framework that integrates sampling, data assimilation, visualization, statistics, and mathematical modeling with modern fishery management theory to show how visualization tools are effective for maximizing researcher efficiency and conveying complex technical information about data and models to decision makers. We focus our analyses on a multispecies coral reef fishery in the Florida Keys set in a high-dimensional tropical marine ecosystem, and develop spatial models of multistock dynamics that use a bioenergetic framework to explicitly couple fish ontogenetic behavior with the biological-physical ocean environment extending from coastal bays to coral reefs. We use these models to determine the 'spatial growth rate potential' of reef fishes, and are now employing the

concept as a strategic basis for the design and analysis of marine protected areas in the Florida Keys National Marine Sanctuary.

8AM1999-TCODEworkshop03 oral

### **THE VISUAL TYPES OF THE SATELLITE IR DATA AND THEIR USING FOR OCEANOGRAPHICAL RESEARCHES**

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The different types of satellite infra-red (IR) data visualization and the reflection by them of the oceanic behaviours are examined in this paper. The black-white IR images and the IR images are presented in false colours and connected with the ship deep-sea data received in short time, give most complete information about the surface temperature (SST) distribution and on the location of maximum SST gradients (temperature fronts) and the dynamic behaviors of the different scale (from 10 to 1000 km) and origin. But they don't give the quantitative values of the SST and surface currents. The charts of the frontological analysis show the location of the temperature fronts, and the charts of the thermal structures, constructed by the method of the oriented textures permit to distinguish the large and mesoscale behaviors more objectively. The charts or separated vectors of surface current serve as a natural addition for these types of information. The SST charts may reflect the large and mesoscale behaviors, reflect only the largest and stable formations or not reflect any dynamic formations in dependence of time and space averaging. They give an idea of the temperature values, but the location of SST fronts and SST gradient values are defined not exactly.

The every type of visualization of the satellite IR data has its merits and demerits. That's why it is necessary to select their various combinations in dependence of the research task.

The examples of visual satellite information using for oceanic variability study are given.

8AM1999-TCODEworkshop04 oral

### **SOFTWARE FOR ACCESSING AND EXTRACTING OCEANOGRAPHIC DATA FROM CD-ROMs "WOA94" AND "WOD98" SERIES**

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The new interactive system for browsing, extracting and writing oceanographic data from the "World Ocean Atlas - WOA94" and "World Ocean Database - WOD98" (OCL/US NODC) to EXCEL/TXT files is created. This system ensures flexible and fast access to data of various type and allows export of data to application programs in required formats. All of the modules are screen and menu oriented. Developed software was used for creation of POI integrated database on the western North Pacific. Software demonstration for inclusion it to the list of "OceanPC Project" production is supposed.

8AM1999-TCODEworkshop05 oral

## **DEVELOPMENT OF INTEGRATED POI OCEANOGRAPHIC DATABASE ON THE NORTHERN PACIFIC**

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In the recent years two versions of databases were introduced on PC for information support of POI investigations:

- Database of Russian and foreign historical observations over a temperature and salinity on the Northern Pacific, including marginal seas (DB "OCEAN-1").
- Database of the own POI cruises data (hydrology, hydrochemistry, hydrobiology) (DB "OCEAN-2").

Technical possibilities of the created DB are demonstrated on practical examples for a Commission of experts from IOC UNESCO that in February 1998 conducted inspection of databases of the region within the framework of the Project NOWPAP/UNEP.

Information basis of DB "OCEAN-1" comprises historical data of deep-water observations carried out by Russian and foreign expeditions, collected from all accessible sources. These files comprise a greater part of Russian and foreign data accumulated for a period of expedition investigations from the beginning of this century to 90s.

Works on creation of DB "OCEAN-2" were carried out with a technical support within the GODAR Project. As a result of inventory of archives they prepared a complete catalogue of expeditions of the Institute and observation data. This data were transferred to PC carriers and put in a database. Copies of formed files of data were passed to Rus. NODC and via it to the IODE system.

Fragment of the integrated DB on the western North Pacific is now created under PARADOX software. Connection of POI database to Internet channels and creation of interactive visualization software is being provided.

8AM1999-TCODEworkshop06 oral

## **LOW-COST STEREOSCOPIC VIRTUAL REALITY FOR PHYSICAL AND BIOLOGICAL MODEL VISUALIZATION**

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Modern scientific laboratories have a compelling interest in finding clear ways of visualizing large volumes of scientific data, from observational networks and model output. Two-dimensional plots along horizontal or vertical planes have served oceanographers and meteorologists well in the past but fail to capture many of the subtleties present in three-dimensional data sets. For example, the elevation of the sea surface simultaneously contains both large and small-scale patterns. If the large-scale patterns have a stronger amplitude than small-scale ones, a simple contour plot of sea surface elevation will obscure the small-scale pattern, since contour levels will reflect the stronger signal. If, on the other hand, we render sea surface elevation as a surface in three-dimensional space, we can see both the large and small-scale signals simultaneously.

Stereoscopic vision strongly enhances our ability to visualize such three dimensional objects, by providing depth cues. Virtual reality software allows us to fly around three dimensional objects and view them from multiple angles. Here we demonstrate low-cost methods for visualizing surfaces, vectors and particle trajectories in three dimensions with stereoscopic virtual reality. Stereoscopic visualization is not new, but software and hardware developments have now put this technology within reach of scientists with modest resources (specifically, a PC

and a few hundred dollars). We demonstrate these economical methods and how they enhance the visualization of numerical model output.

8AM1999-TCODEworkshop07 oral

### **MULTIMEDIA OBSERVATION OF FISH RESOURCE AND ENVIRONMENT USING SATELLITE, ACOUSTICS AND ROV REMOTE SENSING**

Kohji Iida, S. Saitoh, Y. Sakurai, T. Mukai, K. Miyashita, T. Hokimoto, Y. Fujimori, J. Yamamoto, and K. Yamauchi

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To investigate the relationship between fish resource and marine environment, multimedia observation using satellite remote sensing and acoustical underwater remote sensing and ROV (Remote Operated Vehicle) direct sensing have conducted simultaneously around Hokkaido coastal waters, northern Japan.

Data obtained include sea surface temperatures, phytoplankton distribution, fishing boat light distribution by satellite remote sensing, and spatial distribution of spawning walleye pollock (*Theragra chalcogramma*) by the echo-sounder and sonar, and large zooplankton (*Euphausia pacifica*) and their predator, walleye pollock by ROV direct observation.

Visualization of these data integrating satellite, acoustics, and ROV using GIS technique is useful for interpretation the mutual relationship between fish resource and production environment.

8AM1999-TCODEworkshop08 invited

### **VISUAL ANALYSIS AND KNOWLEDGE DISCOVERY USING COLLABORATIVE VIRTUAL ENVIRONMENTS**

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Recent advances in sensors and platforms supporting remote, towed, and moored observations have resulted in environmental data sets which are rapidly increasing in size and complexity. Scientists, educators, students and program managers must have the ability to interact with these data sets in a way that is understandable, repeatable, and perhaps most importantly share-able. New paradigms of information visualization are rapidly evolving to provide an integrated approach to visual exploration, analysis, synthesis, and dissemination of georeferenced data sets. For example, concurrent advances in graphical, computational, and networking technologies have made possible the implementation of realistic, three-dimensional collaborative virtual environments (CVEs). These computer-generated 3-D representations allow multiple users to simultaneously interact with data streams from archived repositories, numerical simulations, real-time remote instrumentation, and other sources in an intuitive visual manner independent of the location of the user or data. Current and future uses of CVEs as a strategic framework supporting knowledge discovery for coastal observing systems will be discussed.

8AM1999-TCODEworkshop09 oral

## **FACILITATING ANALYSIS OF MULTI-DIMENSIONAL DATA FROM A SPATIALLY-EXPLICIT, BIOPHYSICAL, INDIVIDUAL-BASED MODEL OF MARINE FISH EARLY-LIFE HISTORY USING SCIENTIFIC VISUALIZATION TOOLS**

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Use of individual-based models (IBM), as an ecological modeling paradigm, are being used widely in the analysis of fish populations in marine ecosystems. The flexibility and power of IBM's with respect to building detailed and realistic biological models have encouraged recent and important extensions which include explicit spatial dynamics and biophysical forcing of certain life stage processes. Unfortunately, the usefulness of individual-based numerical simulation models are often negated by the difficulty in digesting and analyzing their voluminous and complicated output. Scientific visualization tools offer the capability to remedy this problem.

In this presentation we briefly describe our model, its data input and output characteristics and the off-the-shelf visualization tools we used to help facilitate analysis and interpretation of the model. A stand-alone, easy-to-use, post-processing, graphic user interface is described that permits rapid examination and integrated visualization of multi-dimensional model output. Specific examples are provided showing how scientific visualization, as a research tool, provided valuable assistance in untangling complex model dynamics, assisted with diagnostic analyses related to model validation, helped investigate trends and apparent oddities in the data, and facilitated the communication of model results.

8AM1999-TCODEworkshop10 oral

## **DATA PRESENTATION FOR ANALYSIS OF CATCHING VESSELS ACTIVITY**

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The main goal of this work is to create a technology for data visualization and presentation in the field of catching fleet activity analysis. The RDBMS Oracle7 and ArcView GIS 3.0 are used to calculate the density of a total catch and to present it as a GIS theme. The daily data from ships are stored in Oracle tables. PL/SQL procedures extract information and create output tables which contain central point coordinates of polygons with a total catch for a given time interval. ArcView GIS uses these tables to create greed themes and presents them for the future analysis. Time series of such themes make possible to perform the analysis of catching vessels activity, not only qualitative, but quantitative one. Some examples are presented.

8AM1999-TCODEworkshop11 oral

## TEMPERATURE AND SALINITY DISTRIBUTION CHARACTERISTICS IN THE SUBARCTIC NORTH PACIFIC, AND STATISTICAL PARAMETERS WHICH MAY BE USED IN A VISUAL QUALITY-CONTROL SOFTWARE

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In order to use in a visual quality-control software, we determined several parameters for range check on temperature and salinity values. The temperature and salinity distribution characteristics in the southern margin of the subarctic Western North Pacific (Mixed Water region between Oyashio and Kuroshio Fronts) are very complicated and skewed because three kinds water masses, Oyashio Water, Tsugaru Current Water and Kuroshio Water, intrude into this region. The ranges set used by NODC to compile WOD98 appear to be too large if we confine our attention to the limited area we analyzed. However, vertical gradient range for temperature, and the density inversion range used NODC are too severe for this region. The 3 sigma (standard deviation) criterion often used for higher quality control procedure cannot be applied due to skewed nature of the distribution. We set several parameters to be applied in this region, and designed graphical display panels to be used in MIRC quality-control software.

8AM1999-TCODEworkshop12 oral

## SYSTEM OF REGISTRATION, ACCUMULATION AND SECONDARY PROCESSING OF ACOUSTIC MEASUREMENTS DATA

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Last years in laboratory of fishing hydroacoustics of TINRO-Centre the works on creation of new information technologies and systems of processing of the acoustic data with reference to estimates of stock of aquatic animals is carry out. For information support and development of the system approach to use of acoustic measurements in tasks of forecasting of stocks of fishing objects and management of a thought, forms algorithmic and software of new information-system of accumulation and processing of the acoustic data. The first version of interactive system FAMAS (Fisheries Acoustic Monitoring and Analyses System) is developed. The system is established on a platform IBM PC or the compatible computer with Windows-95 operation system and is guided to work with digital scientific echo sounders of SIMRAD EK-500 type.

The system FAMAS is intended for the decision of a wide class of tasks of forecasting both diagnostics of sea hydrophysical and biological objects, including estimation of spatial distribution and stock abundance of aquatic animals, as element of system acoustic monitoring of environment and sea objects. At a present level of realization the system FAMAS provides the following basic functions:

- Visualization and accumulation of acoustic measurements data in the real time;
- Means of secondary processing and analysis of the acoustic images;
- Organization and conduct of database of acoustic and biological measurements.

User interface of system allows to carry out the remote control and setting of parameters EK-500, compression of the registered data with the subsequent processing without a decompression, converting data from formats EY/EP-500 in a format of the data SIMRAD BI-500 and back, recording current navigating data and vesselBs route, file of events etc.

The industrial tests of the first version of FAMAS, which is not having nowadays of analogues in Russia, was carried out in the cruise of R/V *Professor Kaganovsky* during acoustic survey of walleye pollock in western part of the Bering Sea in October, 1998.

8AM1999-TCODEworkshop13 oral

### **QUALITY CONTROL SOFTWARE WHICH IS EASILY APPLICABLE TO OCEANOGRAPHIC DATA PROCESSING IN DATA ORIGINATORS**

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The Marine Information Research Center (MIRC) developed a quality control (QC) software, which runs on Microsoft Windows. The results of quality check displayed graphically in various ways, and so erroneous data are easily found and corrected even by non-experts, such as part-time workers in local data-originating agencies. The POD (data format designed by Japan Fisheries Agency) formatted data of each agency are re-arranged in time-serial data set, and then are divided into cruise data by identifying several days interval between stations. Header information and ship-track are displayed for each cruise, and erroneous information such as extraordinary ship speed are indicated with red colored tracks. The error data can be corrected in window directly. This procedure is very efficient to find errors in header information such as position, date, time and so on. Then, temperature, salinity and density profiles can be shown for selected observation point(s). Range and gradient checks and density inversion check can be easily made in this window: erroneous data detected by criterions set by Ocean Climate Laboratory of US-NODC are shown also with red colored curves automatically. The T-S diagram, horizontal and vertical quantity distributions are also obtainable through this software. The quality control software will be demonstrated, and its usefulness will be shown from analysis of the data obtained by Wakayama Prefectural Fisheries Experimental Station from 1975 to 1995.

8AM1999-TCODEworkshop14 oral

### **GYPERMEDIA INFORMATION SYSTEM "OCEAN-FAREAST ON-LINE**

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The developing of information system (IS) assumes the creation of server with its own information resources, storage and exchange on the national and international levels, of marine data using the Internet, on-line, Web-technologies (WEBSITE, protocols z39.50, IP, IPX), Windows NT platform, "client-server" structure. The visualization of marine data sets (a temperature, a salinity, stations, of the vessels, etc.), provides the personal access to every scientist (of the climate modeling, marine ecologists, biologists, prognostic of the natural calamity and consequences of ecological catastrophes to the cumulated information, more effective using the unified information, for analysis purposes of marine systems. The regional database of "Ocean-2" is about the Pacific Ocean and the Far Eastern seas on the base of the material of the years long deep-sea hydrological observations, of the national and international expeditions, data from the archive of the POI and other sources for the period since 1900 till 1992. The number of the information centers of common using of such IS are not limited. The actuality of such systems in the Far Eastern Department of RAS is very high.

8AM1999-BIOpaper01

oral

## PRODUCTION, METABOLISM AND PRODUCTION/BIOMASS (P/B) RATIO OF *Metridia pacifica* (CRUSTACEA; COPEPODA) IN TOYAMA BAY, SOUTHERN JAPAN SEA

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Population production and P/B ratio of the most abundant copepod *Metridia pacifica* in Toyama Bay, southern Japan Sea, were estimated based on their biomass and population structure data collected from every 2-week samplings from 1 February 1990 through 30 January 1991 (363 days). The annual life cycle of *M. pacifica* in Toyama Bay is characterized by a short growing period in January-May, followed by a long aestivation for the rest of the year. Mean biomass (B) over the sampling period was 233 mgC m<sup>-2</sup>. Population production during 363d was calculated as a sum of somatic (Pg), molt (Pe) and egg (Pr) productions, which were 442, 45 and 240 mgC m<sup>-2</sup>, respectively (i.e. P = Pg + Pe + Pr = 727 mgC m<sup>-2</sup>). Population metabolism (M), based on oxygen consumption data, was 2794 mgC m<sup>-2</sup>. From these results, mean daily P/B and P/M ratios were computed as 0.0086 and 0.00072, respectively. Similar calculations for the growing period only (103 d) yielded 297 mgC m<sup>-2</sup> for B, 658 mgC m<sup>-2</sup> for P (Pg: 378, Pe: 40, Pr: 240), 1344 mgC m<sup>-2</sup> for M, 0.0215 for mean daily P/B and 0.0048 for mean daily P/M. Regional production comparisons imply suppressed production potential of *M. pacifica* in Toyama Bay primarily by their prolonged aestivation during summer-autumn. The importance of *M. pacifica* in secondary production in Toyama Bay is discussed.

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## ABOUT HYPERIIDEA (AMPHIPODA, CRUSTACEA) IN THE NORTHERN JAPAN SEA IN THE SUMMER

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For the first time, the distribution of hyperiid amphipods was investigated in the northern Japan Sea (Tatar Strait, 46 - 50 N) in the summer 1981 on board the R/V *Pulkovsky meridian*. The macroplankton samples were collected with IKMT-10. A total of 96 samples were obtained from 82 stations. The incidence of hyperiids at stations was 73% and their biomass was 5.4 gr/1000m<sup>3</sup> on average (maximum: 31). Contribution of hyperiids to macroplankton biomass was about 7% (maximum: 40%). Hyperiids were represented by six species. Among them, *Themisto japonica* (12159 specimens as a total of all samples) and *Primno macropa* (2395 specimens) were most common, *Hyperia galba* (36 specimens) and *Vibilia australis* (26 specimens) were rare, and *Lycaea pauli* (7 specimens) and *Granocephalus scleroticus* (1 specimens) were extremely rare. Of these six species, *H. galba*, *V. australis*, *L. pauli* and *G. scleroticus* are the first record from the northern Japan Sea. *V. australis* are considered to be brought to the Tatar Strait with salps (*Cyclosalpa bakeri*).

8AM1999-BIOpaper03

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## ABOUT THE CTENOPHORA FAUNA OF THE COLD SECTOR OF THE SEA OF JAPAN

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Until the beginning of 90s, only ctenophore known from the cold sector (=northwest) of the Japan Sea was *Beroe cucumis* Fabricius although possible occurrence of *Hormiphora palmata* Chun was also suggested by some workers. Our studies now establish that the cold sector of the Japan Sea of Japan is inhabited by two species of

sea cucumbers (Atentaculata, Beroidea) - *B. cucumis* and *Beroe abyssicola* Mortensen - and one species of tentaculifera ctenophores (Tentaculifera, Cydippida) - *H. palmata*. In Amurskii Gulf, Vostok Gulf and southwestern part of the Peter Great Bay, a lobate ctenophore (Tentaculifera, Lobata) of genus *Bolinopsis* (= *Bolina*), similar to *Bolinopsis micado* Moser occurs. Details about spatial and temporal distribution patterns together with ecological and biological features of these ctenophores will be given. Among four ctenophores, the first three species are considered to occur in subarctic waters of other Far East seas and northern North Pacific.

8AM1999-BIOpaper04

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## GELATINOUS PLANKTON OF THE COLD SECTOR OF THE SEA OF JAPAN

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The pelagic fauna of the northwestern (=cold sector) Sea of Japan, has been investigated intensively by Russian scientists. However, no special studies on gelatinous plankton (medusae, siphonophorae, salpae, doliolidae and ctenophorae) has been carried out in this area. By the early 1980s, planktonic surveys of the cold sector of the Sea of Japan have revealed 12 hydrozoan medusae, 3 scyphozoan medusae, 6 siphonophores, 1 salp, 1 doliolid and 2 ctenophores. Our research has revealed 6 medusae, 1 salp and 2 ctenophores, which extends the checklist of the cold sector of the Sea of Japan. The fauna of medusae and ctenophores is typically boreal in nature, while salps are considered as allochthonic component of subtropical origin. The data on the ecology and phenology of the most common gelatinous species will be given.

8AM1999-BIOpaper05

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## CHEMICAL FLUXES AND MASS BALANCES IN THE SEDIMENT BELOW A MARINE FISH CAGE FARM OFF TONG-YOUNG, SOUTH COAST OF THE KOREAN PENINSULA

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During the rapidly growing season of fish, benthic chambers and sediment traps were deployed at two sites of a marine fish cage farm in order to investigate fluxes and cycling of biogenic elements: 1) cage site, directly under the fish cages of the farm at a 18 m water depth, and 2) control site, about 100 m away from the farm at a 32 m water depth. In June, 1995, large organic carbon input (6400 mg C m<sup>-2</sup> d<sup>-1</sup>) and high benthic respiration rate (>220 mmol O<sub>2</sub> m<sup>-2</sup> d<sup>-1</sup>) were observed at the cage site. About 40% of carbon input flux (2400 mg C m<sup>-2</sup> d<sup>-1</sup>) seemed to be decomposed on the sediments and released to overlying waters. Relatively small influx of organic carbon (4000 mg C m<sup>-2</sup> d<sup>-1</sup>) and low respiration rate (<80 mmol O<sub>2</sub> m<sup>-2</sup> d<sup>-1</sup>) were observed at the control site despite of short distance away from the farm and 20% of organic carbon was released to overlying waters. Like organic carbon, input fluxes of nitrogen and phosphorus (1188 mg N m<sup>-2</sup> d<sup>-1</sup> and 242 mg P m<sup>-2</sup> d<sup>-1</sup>) to the sediment were higher at the cage site than those (664 mg N m<sup>-2</sup> d<sup>-1</sup> and 45 mg P m<sup>-2</sup> d<sup>-1</sup>) of the control site. Of the total nitrogen input flux, 17% was decomposed on the sediments and released to overlying waters at the cage site and 10%, at the control site. For organic phosphorus, 27% was regenerated and diffused out from the sediments at both sites. On the other hand, dissolution of siliceous materials occurred more intensively at the control site in spite of low organic matter input, which can be ascribed to longer exposure on the water and sediment interface due to lower sedimentation rate.

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### **LIFE HISTORY OF *Eucalanus bungii* IN THE WESTERN SUBARCTIC PACIFIC**

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*Eucalanus bungii* is one of the most dominant copepods in the subarctic Pacific. However, their life history, especially in the western Pacific, is less known compared with *Neocalanus* copepods. Seasonal sampling was carried out from July 1996 to July 1998 by oblique tows from 500m with a bongo net (70cm x2-mouth opening, 330mm mesh opening). Analysis on *Neocalanus plumchrus* and *N. flemingeri* has been presented at PICES 6th Annual meeting.

*Eucalanus bungii* has a dormancy, indicated by narrow intestine, from August to March at copepodite stage between C3 and C6 female. Then, C5 males started molting to adult, and C5 female followed it. Peak abundance of adult male was observed in April, and spawning by females were observed from April and August. Young copepodites (C1 and C2) abundantly occurred in June. C5 individuals in June showed the characteristic of dormancy, suggesting a biennial life cycle. However, growth pattern were different within the observed years. Although the copepod returned to dormancy in August 1996, spawning by females and copepodite recruitment were observed in August 1997. Thus, it is difficult to determine that major population of *E. bungii* having an annual life cycle or a biennial life cycle as suggested in the eastern gyre. It is safe to suggest that *E. bungii* has much flexibility in life cycle strategy, including timing of dormancy, periods of copepodite growth and spawning by females. Life history strategies of *E. bungii* will be compared with those of *Neocalanus* species at the presentation.

8AM1999-BIOpaper07

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### **DECREASE OF QUANTITY OF A ZOOPLANKTON IN THE SEA OF OKHOTSK IN 1997-98**

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From 1984 to 1998 the following tendencies have been noted in the epipelagic zooplankton of the northern shelf of the Okhotsk Sea:

1. The gross stock of small-sized zooplankton has decreased from 37.3 to 14.0 million t.
2. The gross stock of middle- and big-sized zooplankton increased in 1980s, and decreased in 2-3 times during 1997-98. In fact, euphausiids stocks have decreased in 3-4 times, but they have practically stable in 1997-98. Amphipods stocks have decreased until 1997, reaching its "historical" minimum 3.8 million t., in 1998 amphipods stocks have risen almost in 3 times both in eastern and western areas. Copepod stocks have increased until the late - 1980s, then reached their minimum in 1997-98. Chaetognaths stocks were not stable, archiving their minimum in 1997, then nearly doubled. Thus, nutritive base (small- and mid-sized plankton) status of chaetognaths, ery and young fish and squids has been declined essentially. As to macroplankton, the situation is ambiguous. Chaetognaths stocks fluctuations are quite regular. Low copepods stock level with declining tendency is rather unfavorable for herring, immature walleye pollock, salmon and other species. Increasing of amphipod stocks up to maximum might be favorable first of all for salmon. Euphausiids stocks have still remained at the 1997 low level, so we can expect increasing of trophic storage, because euphausiids are the main forage object for many species of nekton.

8AM1999-BIOpaper08

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## **STUDY ON POPULATION DYNAMICS OF PHYTOPLANKTON IN THE BOHAI SEA**

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Data on the species composition and distribution of phytoplankton in the Bohai Sea was analyzed based on a large number of samples collected during the "enhancement of fishery resources" surveys in 1959, 1982-83 and 1992-93. About 70 species belonging to 32 genera were recorded in 1992-93 survey, and most of them were temperate offshore species. Compared with 1959 and 1982-83 surveys, a fair reduction in both generic and species numbers were apparent in 1992-93. Throughout these surveys, Bacillariophytoplankton was predominant in terms of cell number and species, making up more than 90% of the total. The abundance of phytoplankton, especially *Coscinodiscus* spp., was abundant in Laizhou Bay as compared with other bays within the Bohai Sea, which may be due to the higher nutrient salts in Laizhou Bay. The seasonal variations in phytoplankton abundance were marked with its peaks in spring and autumn, which may be interpreted by the seasonal accumulation of nutrient salts during river flood season and during winter. Thus, spatial and temporal variations of phytoplankton were closely related with the supply of nutrient salts in the Bohai Sea, i.e. high nutrient salts in estuaries usually create phytoplankton-dense areas its nearby waters.

8AM1999-BIOpaper09

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## **DISTRIBUTION AND PARTITIONING OF ORGANIC CARBON AND NITROGEN OFF THE OREGON COAST**

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During the first year of the Northeast Pacific GLOBEC program we examined the spatial and temporal distributions of dissolved and particulate organic carbon and nitrogen off the Oregon coast of North America. Eleven east-west transects were sampled from nearshore waters to 190 km offshore. Dissolved organic carbon (DOC) concentrations as high as 180  $\mu$ M were observed in the Columbia River plume. Patterns in the DOC distribution were also associated with upwelling regions, an offshore coastal jet, and an oligotrophic water mass in the northern portion of our study area. From July 1997-July 1998 samples were collected on weekly and seasonal time scales at NH-05, located 9 km offshore from Newport, Oregon. Changes in the partitioning of organic matter during the development and decline of a phytoplankton bloom were observed. During the bloom particulate organic carbon (POC) increased dramatically, but DOC decreased. Possible explanations for the decrease in DOC and for changes in the C/N ratio of the dissolved organic material will be discussed.

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## **THE DISTRIBUTION OF PHYTOPLANKTON AND PRIMARY PRODUCTION IN WARM CORE EDDIES IN THE SEA OF JAPAN (SPRING 1999)**

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The satellite observations analysis and the numerical modelling results show the Sea of Japan water structure is characterized by abundance of synoptical and mesoscale vortical formations. (Lobanov et al. 1997).

The distribution of phytoplankton and its productive characteristics in warm core eddies was received in the 32<sup>nd</sup> cruise of the R/V *Pavel Gordienko* (14-23 April 1999) in the region between 39°50' -43°00' N and 130°30' - 134°30' E. Hydrological data were collected with the CTD sound of Rozet. The samples for the primary production definition in column of water collected from the horizons which were chosen after the preliminary sounding by CTD sound. The primary production was determined by the delayed fluorescence method (Zakharkov et al. 1985).

The pigments concentration in samples of water was determined by the standard spectrophotometric method. The samples of specific composition at crossing of warm streams and core eddies collected either from the superficial horizons or from horizons with maximum phytoplankton concentration.

The concentration of chlorophyll *a* in core eddies varied: 1) from 0.055 mg/m<sup>3</sup> to 1.031 mg/m<sup>3</sup> (stations 32-40; 26-29); 2) from 0.228 mg/m<sup>3</sup> to 0.832 mg/m<sup>3</sup> (stations 41-44); 3) from 0.212 mg/m<sup>3</sup> to 0.420 mg/m<sup>3</sup> (st. 46-52, 55-58), and sum of phytoplankton pigments (chlorophylls A, B, C and carotenoids) varied in core eddies: 1) from 0.086 mg/m<sup>3</sup> to 9.162 mg/m<sup>3</sup> (st. 32-40; 26-29); 2) from 0.142 mg/m<sup>3</sup> to 1.114 mg/m<sup>3</sup> (st. 41-44); 3) from 0.078 mg/m<sup>3</sup> to 1.054 mg/m<sup>3</sup> (st. 46-52; 55-58). The concentration of chlorophyll *a* outside of core eddies varied from 0.146 mg/m<sup>3</sup> to 6.032 mg/m<sup>3</sup> and sum of phytoplankton pigments varied from 0.026 mg/m<sup>3</sup> to 12.433 mg/m<sup>3</sup>.

It was showed that these core eddies and warm streams generated by them (core eddies) served as a phytoplankton associations forming ways. The study of these core eddies is necessary for the productivity forming ways understanding of the northwest part of Sea of Japan.

8AM1999-BIOpaper11

poster

### **ADDITIONAL DATA TO BIODIVERSITY OF THE TERTIARY FLORAS OF PRIMORYE AND PRIAMURYE, SOUTHERN FAR EAST (RUSSIA)**

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Compilation of existing data on the systematic composition of the Tertiary floras of Primorye and Priamurye taking into account new palaeontological gathering within Shkotovskaya (the Eocene Smolyaninovskaya flora; Ablaev et al., 1996), Artyom-Tavrichanskaya (the Eocene Bolotninskaya flora; Ablaev, MS), and Khasanskaya (the Miocene Kraskinskaya flora; Ablaev, Vassiliev, 1998) Carboniferous depressions in a coastal belt of Primorye has been carried out.

The examined floras show the progressive declining biodiversity - and the declining of the biomass accordingly - with general cooling trend during the Cenozoic stage. In process evolution the systematic composition of the Tertiary flora underwent radical alternations marked in subsequent elimination the mesothermal and subtropical coenoelement with Asian area type (including Bolotninskaya and Smolyaninovskaya floras) and substitution by the warm-temperate taxa (the Kraskinskaya flora with Engelhardia and the well-known age analogues in the Japan Sea Region). The row of the Tertiary floras is completed by the Pliocene temperate floras (the Botchinskaya flora; et al.) similar to the recent floras of investigated territories which is exclusively defined by the deciduous summer hardwood forms and boreal conifers trees.

**WATER MASSES AND ZOOPLANKTON DISTRIBUTIONS IN THE NORTHERN EAST CHINA SEA IN SUMMER OF 1997 AND WINTER OF 1998**

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As a part of the multidisciplinary oceanographic survey of the Northern East China Sea, zooplankton distribution was studied in the summer of 1997 and winter of 1998. An 1 m<sup>2</sup> MOCNESS was used for vertically stratified sampling of zooplankton. Distributional patterns were compared with those of water masses of which boundaries were identified by T, S distributions.

In summer the boundaries of the different water masses were depth specific while those in winter were depth integrated (that is, vertically well mixed). In both seasons three major water masses were distinguished in the study area. They were Yellow Sea surface water (Type I), diluted water influenced by the Yanzee river runoff with high temperatures and low salinities (Type II), and waters influenced by the Kuroshio with high salinities (Type III). Clusters of the zooplankton assemblage could also divide the region into three subregions although the boundaries were not exactly identical with those defined by the T, S distributions.

Total abundances of zooplankton (indiv. m<sup>-3</sup>) showed high values in order of type II, I and III in summer (ca. 2200, 1400 and 300 indiv. m<sup>-3</sup>, respectively), but they were in the order of type III, I, and II in winter (ca. 200, 100 and 50 indiv. m<sup>-3</sup>, respectively). The type III influenced by the Kuroshio showed little seasonal variation. Seasonal difference was characterized by winter time vertical mixing with low total abundances contrast to summer time vertical stratification with high total abundances.

In summer, dominant taxa were *Clausocalanus furcatus*, *Sagitta enflata*, *Calanus sinicus* and *Noctiluca scintillans* in type I assemblage, *Penilia schmackeri*, *Temora stylifera*, *Temora turbinata* and *Sagitta enflata* in type II, and *Noctiluca scintillans*, unidentified fish eggs, copepodite of *Euchaeta* spp. and *Eucalanus subtenuis* in type III. In winter they were different. That was, type I assemblage was characterized with dominance of *Calanus sinicus*, *Paracalanus aculeatus*, copepodite of *Calanus* spp. and Ephemerozoan larva, the type II with *Calanus sinicus*, copepodite of *Calanus* spp. and *Sagitta* spp. and the type III with Ostracoda, Siphonophora, and *Paracalanus aculeatus*. Other differences in community structures were discussed.

**A PRELIMINARY STUDY ON THE SQUID FISHERY STOCK ASSESSMENT IN KOREA WATERS**S.K. Cho, J.H. Lee, and G.J. Pierce*Institute of Fisheries Sciences, Pusan, Korea and Department of Zoology, University of Aberdeen, Tillydrone Avenue, AB24 2TZ, UK e-mail: sk.Cho@abdn.ac.uk*

Cephalopod data, obtained from Korean Fisheries Statistics Yearbook, are analyzed with the aim of giving an overview of the recent status of the most important species, short-finned squid (*Todarodes pacificus*) and cuttlefish (*Sepia esculenta*), in the cephalopod fisheries in Korean waters. Short-finned squid (Ommastrephidae) and long-finned squid (Loliginidae) are not treated separately, and therefore landings of long-finned squid are unknown. Data from the fishery, on the annual landings, economic value, monthly variations of landings, type of gear and fishing effort of these resources are described. The main points are as follows. During the period 1980-1996, there has been increase in squid landings and decrease in cuttlefish landings. The value of the Korea squid landings also increased throughout the same period while cuttlefish decreased. Landings showed consistent monthly patterns, being more plentiful in late summer and autumn for squid and in winter and spring for cuttlefish. The jigging and trawling fisheries account for most squid landings while cuttlefish are caught by a range of different gears. Catch per unit effort for both jigging and trawling fisheries increased progressively between 1990 and 1996 although there was a decrease for two gears in 1994. Squid has not been assessed and managed up to now available data are poor for stock assessment.

**REPRODUCTION JAPANESE GIZZARD SHAD *Konosirus punctatus* (CLUPEIFORMES, CLUPEIDAE) IN PETER THE GREAT BAY (JAPAN SEA) IN 1996-1998**Svetlana V. Davidova*Pacific Scientific Research Center (TINRO-Center), 4 Shevchenko Alley, Vladivostok, Russia. 690600 e-mail: root@tinro.marine.su*

Japanese gizzard shad *Konosirus punctatus* is long-migrating subtropical species, widely distributed in the Pacific Ocean from East China Sea to Peter the Great Bay and Island Sado, and also at east coast Island Honshu. The last few years this species active spawn during spring and summer in Peter the Great Bay. Ichthyoplankton cruises conducted in the Amurskiy Bay (Peter the Great Bay) in 1996-1998 have shown that the eggs of this species occurred in ichthyoplankton samples when surface water warming up to 11.9. Eggs catching period has increased with one (July) in 1996 up to four (May - August) months in 1998. Number of eggs in the Amurskiy Bay has increased in 8.5 times during three years. In connection with lowering of eggs sensitiveness to influence of the environmental factors the part of normally developing eggs in sampling has increased from 1% on I stage up to 98,5% on IY stage of development. Therefore at the end of summer, when eggs were at the last stages of development, percent of the live embryos was highest for all spawn period. Accumulating mortality rate during embryonal period of Japanese gizzard shad for all spawn season reached 99 - 99.9%. The temperature of waters is main parameter determining success of development *Konosirus punctatus* in embryonal period. The most favorable conditions for successful development Japanese gizzard shad in early life were in 1997. This year was warmest of three years.

**CHUM AND PINK SALMON DOWNSTREAM MIGRATION OF THE LANGRY RIVER**A.N. Ivanov*Sakhalin Research Institute of Fisheries and Oceanography (SakhNIRO), 196 Komsomolskaya Street, Yuzhno-Sakhalinsk, Russia. 693016 e-mail: elsa@tinro.sakhalin.ru*

A freshwater period is the most important stage of ontogenesis of Pacific salmon. By the number of migrated juveniles a forecast of possible withdrawal in Sakhalin-Kuril region is elaborated.

The Langry River is the main watercourse of the northwestern Sakhalin. Since 1989 up to 1991 Pacific salmon juvenile migrants have been caught by two traps simultaneously, near the bottom and at the surface.

Pink and chum juvenile downstream migration starts at the beginning of May and finishes at the end of June. 80% of pink and 90% of chum juveniles are migrating downstream for 10 days after a spring flood. About 1% of pink juveniles and 5% of chum ones migrate actively in daytime.

At first 75% of pink and 90% of chum specimens migrate near the bottom. At the end - near the surface (95 and 65%, respectively). Pink salmon prefer the littoral sites with small rate (0,3 - 0,6 m/sec), chum choose sites with the current of 0,8 - 1,1 m/sec.

Mass migration of fish of both species takes place from 0 to 6 a.m. At the beginning and at the end of pink downstream migration two peaks are observed - at about 1 a.m. and before dawn. In the period of intensive migration the greatest activity of juveniles is fixed at about 2 a.m.

Mean sizes of migrants differ weakly during the period of downstream migration and by years.

**GEOGRAPHICAL PATTERNS OF ANCHOVY AND HAIRTAIL EARLY LIFE STAGE AND THEIR RELATIONSHIP WITH WATER MASS IN THE EAST CHINA SEA**Jin-Yeong Kim, Young-Shil Kang, Hyun-ju Oh, Young-Sang Suh, and Jae-Dong Hwang*National Fisheries Research and Development Institute, 408-1, Shirang-Ri, Kijang-Kun, Pusan, Republic of Korea. 619-900*

Geographical patterns of anchovy and hairtail early life stage and their relationship with water mass in the east China Sea were investigated using ichthyoplankton and oceanographic characteristics in the northern east China Sea (32°N 124°E-33°N 128°E) during May and August in 1998.

Anchovy and hairtail were dominant species in the ichthyoplankton survey. Anchovy eggs were distributed in the western area, whereas hairtail eggs were distributed in the eastern area. Their abundant area were extended to the eastward by development.

Thermal gradient between 15 ° and 20 ° was inclined from the surface of western area to the 30m-bottom layer of the eastern area, whereas 34.0-33.4 isohaline was distributed from the surface of eastern area to the bottom of middle area during May. Strong thermocline between 14 ° and 28 ° in the western area was weakened in the eastern area during August. Chlorophyll *a* and zooplankton were abundant respectively in the western and eastern area of East China Sea during May, but they were densely populated in the western area during August.

Anchovy eggs and larval distribution had significantly positive relationship with chlorophyll *a* and zooplankton biomass, and negative relationship with temperature and salinity respectively. Hairtail eggs and larval distribution had significantly positive relationship with zooplankton biomass and salinity gradient.

Therefore geographical patterns were indicated as follow: anchovy population is spawning in the frontal area between east china sea shelf water and coastal waters influenced by Yangz River, whereas hairtail is spawning in the frontal area between east china sea shelf water and Kuroshio warm current.

## ESTIMATION OF POPULATION ECOLOGICAL CHARACTERISTICS OF SUNSET SHELL, *Nuttallia olivacea* IN DADAEP0 SHORE, KOREA

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This study is to estimate population ecological parameters, including growth parameters, survival rate, instantaneous coefficients of natural and fishing mortalities, and age at first capture of the sunset shell, *Nuttallia olivacea* in Dadaepo shore, Korea. For describing growth of sunset shell, von Bertalanffy growth model was employed and the parameters were obtained from a nonlinear regression as  $L_{\infty}=38.6\text{mm}$ ,  $K=0.479$ , and  $t_0=-0.453$ . Annual survival rate (S) of the shell was 0.199 with a SD of 0.009. The instantaneous coefficient of natural mortality (M) was estimated to be 1.116/year and the instantaneous coefficient of fishing mortality (F) for the recent year was calculated as 0.498/year. Using length-converted catch curve the age at first capture ( $t_c$ ) was estimated as 1.7 years. Based on the area-swept method, the population biomass and the 95% confidence interval were estimated to be  $1,291 \pm 112\text{mt}$ .

## COMPARATIVE CHARACTERISTICS OF BOTTOM ICHTHYOCENES OF CONTINENTAL SLOPE AREAS OFF THE WESTERN BERING SEA, THE NORTHERN KURIL ISLANDS AND SOUTHEASTERN KAMCHATKA

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The comparative analysis of taxonomic biodiversity of bottom ichthyocenes, distribution and abundance of some commercially important groundfishes on continental slope off the western Bering Sea (WBS), and northern Kuril Islands and southeastern Kamchatka (NKSEK) was made.

Materials were collected during the research cruises of VNIRO, SakhNIRO, KamchatNIRO, and TINRO-Center aboard the same type of vessels by "Hokkuten" during 1992-98 off NKSEK and 1995-98 in WBS in depth of 100-850 m. The data was processed using softwares "MapDesigner" (VNIRO) and "Surfer" (Golden Software Inc.). The Pacific halibut, Kamchatka flounder, Greenland turbot, Pacific ocean perch, shortraker and rougheye rockfishes, shortspine and broadbanded thornyheads, sablefish, giant and popeye grenadiers, Atka mackerel, and skates were involved in this analysis. Other species such as walleye pollock, Pacific cod, rock and flathead soles were excluded from the analysis because the most part of their biomass was distributed outside of the research area.

Within continental slope of NKSEK more than 150 benthic and benthopelagic fish species related to more than 80 genera and 30 families were identified. Species composition of bottom and benthopelagic ichthyofauna of continental slope of WBS is much worse. For example, the representatives of some heat-loving families (Notacanthidae, Trichiuridae, etc.) were absent here and most families were represented by smaller number of species.

List of commercially important groundfishes in both compared areas are similar. Available part of halibuts, grenadiers, and shortraker rockfish stocks distributed within continental slope of WBS is repeatedly larger than off NKSEK area. Moreover, population characteristics, size composition, etc. of species considered differed essentially, too. Also, the skates biomass in WBS is more than two times larger than off NKSEK. In the same time available part of Atka mackerel, Pacific ocean perch, and broadbanded thornyhead stocks in NKSEK is repeatedly larger than that of WBS.

Probably the center of distribution of halibuts and shorttraker rockfish in the Northwestern Pacific is continental slope of the Bering Sea because their distribution within considered areas is continuous and their biomass is repeatedly larger in WBS. In the same time the center of distribution of Pacific ocean perch in the Northwestern Pacific placed off the Kuril Islands, and that of Atka mackerel - off the Aleutian Islands. The abundance of Atka mackerel in the Kuril-Kamchatka region probably depends on their stock condition in the Aleutians area.

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**INTERANNUAL CHANGE IN DISTRIBUTION OF COD (*Gadus macrocephalus*), POLLACK (*Theragra chalcogramma*), ROCK SOLE (*Lepidopsetta bilineata*) AND ALASKA PLAICE (*Pleuronectes quadrituberculatus*) AT THE ANADYR BAY IN FORAGING PERIOD**

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Space changes of some commercial fishes depending on oceanological conditions at the Anadyr Bay in September-October of 1995-1998 are analyzed.

Three water masses are observed at the Anadyr Bay in summer (Khen, 1996). The Crest Bay water mass is localized in the northern part with Temperature less  $-0.5$  C and Salinity = 33.5-34.5 psu. Lavrentivskaya subsurface water mass (T less 0 C and S=31.8-32.5 psu) is disposed in the southern part of the Anadyr bay. These water masses are divided by water mass of the Navarin current (T=0.5-2.8 C and S=32.8-33.3 psu).

The Navarin water mass is characterized by the most fish productivity and the Crest bay waters mass - the least. The last one is eroded gradually by the Navarin current in summer and at the end of September it disappears entirely. As a consequence pollack, cod and flounders are displaced to the shallow water of the Navarin Bay. Speed of their displacement depends on the intensity of the Navarin current. By high intensity of this current the Crest bay water mass is eroded quicker and above mentioned fishes move to the Navarin Bay to forage.

The densest accumulations were formed in 1997 when the Navarin current was more powerful. By relatively weak current in 1996 and 1998 the density of accumulations was comparatively low.

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**DETERMINATION OF INFLUENCE OF ENVIRONMENTAL CONDITIONS ON GROWTH RATES OF THE SEA SCALLOPS USING SHELL MICRORINGS**

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Microsculpture elements of the outer surface of the sea scallops form microrings (growth layers). Their appearance and the width of the microrings represent the direct reaction of the organism on the environmental changes. The periods of the growth layer formation are determined for different scallop species. They are daily, 5-7-day, two-week, monthly, annual. The methods of the retrospective determination of the individual age and growth rates were developed for 8 scallop species using the revealed seasonally regularities of the alternation of the growth layers of different widths (and/or appearances). The age composition of the scallop populations, growth of the scallops in natural conditions with various environmental factors were investigated by these methods. The dependence of the width of the daily increments of the *Patinopecten* (*Mizuhopecten*) *yessoensis* shells on the water temperature and salinity were determined. Size- and age-frequency distributions, and growth rates of the *Swiftopecten swifti* from the Holocene deposit, living population and dead assemblages were compared. Age composition of the Holocene sample is similar to the one of the living population. Maximum age

and size of the *S. swifti* at present and 3-5 thousands ago are practically the same. The growth rates of this species has not changed during this time period. Most probably, the appreciable climate variability during last 3-5 thousands years were not in the studied region (northwestern part of the Sea of Japan).

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oral

## SPECTRAL STRUCTURE OF OSCILLATIONS IN CATCHES OF KAMCHATKA SALMONS

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The spectra for 60-year time series of salmon catches were computed. These spectra represent the dynamics of 6 species from 12 regions. 24 cyclic components were found in these spectra. Procedures of clusterization have aggregated these components into 3 groups: highly-, middle- and low-frequency cycles. Average periods in these groups are equal to  $3.36 \pm 0.28$ ,  $9.02 \pm 1.16$  and  $30.4 \pm 1.8$  years respectively. These numbers do not differ certainly (t-test was used) from periods, equal to 11/3, 11 and 33 years respectively. A mathematical model was developed for the explanation of these cycles. This model is presented by equation  $d(dy/dx)/dx - ab(1 - y^2/2) * dy/dx + y + ac * y^2 * y = A * \cos(Wx)$ , where  $a, b, c, A, W$  are const,  $x$  is relative time,  $y = \ln(N/N_s)$ ,  $N$  is population abundance,  $N_s$  is equilibria level of  $N$ . Parameter  $W = T/t$ , where  $T$  is intrinsic period of population oscillations,  $t$  is external period of environmental oscillations. Resonances at frequencies  $W$  near to 1/3, 1 and 3 are demonstrated by the model. It is supposed that salmon dynamics in Kamchatka shows resonance oscillations, and they conjugate with 11-year cycle of solar activity. This resonance is considered as primary (main) resonance. It is supposed also that these populations oscillate with two secondary (additional) resonance cycles. One of these cycles is three times shorter (11/3 years), and other cycle is three times longer (33 years) than 11-year solar cycle.

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oral

## EFFECTS OF TEMPERATURE ON ENERGY BUDGET OF TWO KINDS OF SEMI-DEMERSED FISHES IN BOHAI SEA

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The genuine porgy (*Pagrosomus major*) and black porgy (*Sparus macrocephalus*) are two kinds of fishes widely distributed in the Bohai Sea, and as carnivorous they are representative one in semi-demersal fishes of the waters. The researches of their ecological conversion efficiencies ( $E_g$ ) and energy budget not conduce to reveal the same kinds of fish's bioenergetics feature, but determine their top-down effect on the energy flow and matter cycle in Bohai Sea ecosystem, which would present basic data for TROPHIC DYNAMICS / GLOBEC being carried out in Chinese Bohai Sea.

The  $E_g$  and energy budgets of two kinds of the fishes were determined by continuous-flow simulating method in laboratory under different temperatures. Results showed that, within range of the experiment temperature, their  $E_g$  changed like U shape with temperature's rise, and all of their food consumption energy (C), excretion energy (U), total metabolism energy (R) and growth energy (G) tended to decelerating increment with temperature's rise. Their energy budget models could be separately expressed with following formulas:

$$\begin{aligned} \text{genuine porgy: } & 11.2 \pm 1.98 \square 100C \square 4.48F + 9.55U + 80.19R + 5.78G \\ & 14.7 \pm 0.57 \square 100C \square 2.28F + 8.99U + 74.56R + 14.16G \\ & 19.4 \pm 0.44 \square 100C \square 2.73F + 8.00U + 63.23R + 26.03G \end{aligned}$$

$$23.1 \pm 1.43 \square 100C \square 2.94F + 7.61U + 66.38R + 23.07G$$

black porgy:  $11.2 \pm 1.98 \square 100C \square 6.09F + 9.38U + 77.56R + 7.02G$

$$14.7 \pm 0.45 \square 100C \square 6.76F + 8.75U + 72.77R + 11.82G$$

$$19.8 \pm 0.47 \square 100C \square 2.75F + 8.94U + 73.52R + 14.79G$$

$$25.0 \pm 0.50 \square 100C \square 1.16F + 9.18U + 77.30R + 12.81G$$

The models two kinds of the fishes changed remarkably with temperature. In the models, assigning rates of total metabolism energy changed like U shape with temperature's rise, but that of growth energy turned out contrary to it. They should belong to fishes of lower growth efficiency and higher metabolism consumption in comparison with fish's average energy budget formula offered by Cui et al. in 1990.

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oral

### **NEW APPROACH TO ESTIMATION OF FISH STOCKS USING THE AREA METHOD, AS ILLUSTRATED BY THE WHITE SPOTTED GREENLING (*Hexagrammos stelleri*) OF PETER THE GREAT BAY (SEA OF JAPAN)**

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Trawling survey data are widely used for the direct estimation of fish stocks (Aksutina, 1968; Nikolskiy, 1974). In this method, three parameters are determined by specific measurements - catch size, the area of trawling and the area of zone surveyed; and only the trawl net efficiency is as a rule taken priorily. Values of the coefficient are assumed to be constant for a particular species.

In 1991-1998 in Peter the Great Bay 8 trawling surveys were carried out to determine the efficiency of trawl. Our research revealed the dependence of net efficiency coefficient on fish size and stocks density. The fish size and net efficiency relationship has the form of a domeshaped asymmetrical curve. With increasing density, the coefficient also increases.

Previously, the net efficiency coefficient for greenling was taken to be 50%. Stock estimates for white spotted greenling using this coefficient value varied from 1.19 to 4.99 million specimens, i.e., they differed by 4.2 times.

Variations of stock values calculated using differential coefficients of net efficiency, proposed by us, are significantly smaller; maximum value exceeds minimum by two times. Variation of stock estimates based on the standard net efficiency coefficient was due to its low resolution because variability of stock density and size structure of fish is not taken into account. Hence, counts of age groups are reliable only with the differential net efficiency coefficient. Secondly, average catch size is not proportional to stock. The value of abundance and biomass of greenlings calculated by our method were respectively 6.7 and 5.8 times higher then estimates obtained using the generally accepted technique.

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oral

### GASTRIC EVACUATION RATE OF RED SEA BREAM (*Pagrosomus major*)

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To implement the China's GLOBEC Project, gastric evacuation rate of red sea bream (*Pagrosomus major*) weighing 40-60g, was determined at 18°C in the laboratory. Stomach contents of 5 fish were serially sampled every 2 hours after feeding *Ammodytes personatus* until empty stomach appear. The change of stomach contents (Y) was described by the linear model, exponential model and square root model. The result indicated that all the three kinds of model fitted to experiment data. When stomach contents were expressed by wet weight, the model was  $Y = 103.67e^{-0.15t}$  ( $r^2 = 0.89$ ,  $p < 0.001$ ) by dry weight, the model was  $Y^{0.5} = 10.45 - 0.45t$  ( $r^2 = 0.82$ ,  $p < 0.001$ ). According to those models, gastric evacuation of red sea bream is 5-6% of consumed food per hour or 15-16% of remain food per hour at 18°C.

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poster

### SPAWNING GROUND FORMATION OF HORSE MACKEREL IN THE EAST CHINA SEA

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The annual catch of horse mackerel (*Trachurus japonicus*) in the East China Sea and Japan Sea by Japanese fisheries was at high level of over 200 thousand tons in 1990s, but it was at low level of only 40 thousand tons in years around 1980. The stock abundance and the recruitment fluctuated greatly among decades. It is assumed that the main spawning ground of this stock might be located at the East China Sea, based upon little knowledge of the ecology. We compiled the catch and CPUE data (1973-1998) of horse mackerel caught by Japanese large- and medium scale surrounding net fishery. The distributions of spawning adults and juveniles just recruited were processed by a GIS application. Environmental data such as sea surface temperature (NOAA/AVHRR), ocean color (ADEOS/OCTS, SEASTAR/SeaWiFS) and currents were piled by layers upon fisheries data and the relationships among them were analyzed to identify the spawning area and period. Also, the mechanism of spawning ground formation was investigated with special reference to ocean condition. Results suggest that the main spawning ground is formed along the marginal part of continental shelf, between the Kuroshio frontal regions and Continental Coastal Diluted Water, from early spring to summer and its distribution is related to factors such as sea surface temperature and ocean color (containing elements of chlorophyll and turbidity). Changes in the spawning season and area over the last three decades will be discussed.

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poster

### INFECTION OF FISH BY MYXOSPORIDIAN PARASITES IN DEPENDENCE ON HOSTS' ECOLOGY

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Infection of anadromous and sea-water bottom and near-bottom fishes by Protozoa Myxosporidian parasites was investigated on the data obtained in Peter the Great Bay (Japan Sea) in 1987-1998 by complex surveys.

There was defined that some flounders as *Hippoglossoides dubius*, *Acantopsetta nadeshnyi*, *Glyptocephalus stelleri* and pricklebacks *Stichaeus grigorjewi* were the most intensively infected by various species of Myxosporidias. According to Vdovin, Zuenko (1997), all these species belong to pseudo-alitoral-benthal

ecological group, characterized by bottom habitation at the depth to 200 m. The various Myxosporidian species have common features of their vegetative forms (they had long pseudopodias) and spores (they had special membranous formations and large-size polar capsules).

Other flounders as *Platichthys stellatus*, *Limanda yokohamae*, *L. punctatissimus*, *L. herzensteini*, *L. aspera*, and some sculpins as *Myoxocephalus stelleri*, *M. brandti*, *Gymnocanthus pistilliger* were high-infected by less number of Myxosporidian species. These fishes belong to alitoral-benthic ecological group characterized by bottom habitation as well but with summer migration to shallows. There were other common features of the Myxosporidian species' vegetative forms (they had large volume and contained numerous spores) and spores (they had relatively small-size polar capsules and small external formations).

Other investigated mass fishes as wahna cod, pacific cod, and pollack had very poor Myxosporidian fauna and was low-infected. These fishes belong to pseudo-alitoral-near-bottom and pseudo-alitoral ecological groups characterized by near-bottom habitation. Obviously, bottom fishes are infected easier than near-bottom ones.

Anadromous fishes as mullets and carps *Tribolodon brandti* and *T. hakonensis* had sharply different fauna of Myxosporidia with inclusion of some fresh-water species. These Myxosporidias have certain localization in the organs of the host and some common features of their vegetative forms (they were huge and had a lot of spores) and spores (they hadn't any external formations).

Thus, intensity of Myxosporidias infection and their species composition depend on hosts' habitation, and structure of parasites is adapted to hosts' ecology. We suppose that character of external membranous formations corresponds to life strategy of Myxosporidia in deep-water, shallows, or estuaries.

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poster

## **SPAWNING OF THE SUBTROPICAL SPECIES IN PETER THE GREAT BAY IN 1991 - 1998**

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More than 290 species of fishes inhabit in Peter the Great Bay. The majority of them is the representatives of the boreal ichthyofauna. However the Bay is a region of spawning of the subtropical species. There are Japanese anchovy (*Engraulis japonicus*), mackerel (*Scomber japonicus*), Japanese sardine (*Sardinops sagax melanostus*), Japanese gizzard shad (*Konosurus punctatus*) and etc. Main spawn regions of these fish are the Yellow, East China Seas and southern the Sea of Japan. During the high number of population these species can spawn in more northern regions up to the Kurils and Sakalin Island. In Peter the Great Bay subtropical fish occur beginning with the temperature of water more than 11.

Spawning of these species proceeds from May to September. The annual intensity of spawning of these fish in Peter the Great Bay is determined by the state of population and peculiarities of oceanographical conditions in Japan sea, namely, intensity of Tsushima current branches. Ichthyoplankton investigations conducting from 1991 to 1998 have shown that spawning intensity of Saury (*Cololabis saira*), Japanese gizzard shad is increased in this period. The spawning intensity of anchovy is at a high level, but can vary year after year. Japanese sardine has stopped spawning in Peter the Great Bay since 1996. This fact can be explained by low number of the population. Fishing of spawning mackerel in Peter the Great Bay was conducted in the years of high number. The lack of any eggs and larvae of mackerel in Peter the Great Bay in 1991 - 1998 years testify that population of mackerel is in depression.

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poster

## **YEAR-TO-YEAR VARIABILITY OF THE JAPANESE FLYING SQUID FEEDING IN THE JAPAN SEA (ON MATERIALS 1997-1998)**

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The materials on Japanese flying squid, *Todarodes pacificus* Steenstrup 1880, (Tp) feeding was collected on board of R/V *Chokai-Maru* in summer 1997-1998. The analysis of contents from 2290 stomachs has shown, that food spectrum of Tp includes up to 50 species relating to various taxon groups of plankton and nekton. The ratio of these groups from different regions of the sea essentially changed, that testifies about high food plasticity of Tp. The comparison of results within 1997-1998 has shown the variability in the ratio of main feeding objects. In 1997 squids, Amphipoda and fish were 94 % on weight in sum (48, 31,15 % accordingly), and in 1998 these animals have made less than 80 % (22, 30 and 25 % accordingly). In 1998 the portion of squids has decreased twice, while the share of the fishes increased in 1.6 times, and portion of Euphausiacea increased from 6% in 1997 to 21% in 1998. In 1998 food spectrum of Tp included almost twice less species, than in 1997. The change ratio of dominant groups in its food, probably, is connected with interannual changes in a structure of plankton and nekton communities. The comparison of food spectrum on various populations of Tp has shown, that its have considerable difference in the ratio of main food components and index of stomach fullness.

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poster

## **STRUCTURE OF BOTTOM AND DEMERSAL FISH COMMUNITIES ALONG THE SHELF AND SLOPE OF NORTHERN PRIMORYE**

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Along the Northern Primorye shelf in bottom trawl catches there occur 114 bottom and demersal fish species of 23 families. The most representative by the number of species are Cottidae -21, Pleuronectidae - 13, Stichaeidae - 9, Agonidae - 9, Zoarcidae - 7, Cyclopteridae - 6 and Liparidae - 6. Species of the above named families, share of which is about 74% of species composition (by average many years data), are the characteristics of bottom fish fauna along the Northern Primorye shelf, but number of species in family composition is not stable for each year.

According to the average many years data a group of constantly occurred high abundant species of Gadidae - 46%, Pleuronectidae - 18%, Clupeidae - 10%, Hexagrammidae - 11%, Cottidae - 6% makes up 95% of biomass base. There are significant differences in biomass by years. It happens because of bathymetric and spatial redistribution of mass fishes. Influence of species abundance fluctuations and fishery press are not excluded as well. There are special peculiarities of bathymetric distribution for different species groups in dependence on season. Not all species show conservatism to their place in ichthyocenosis. It is characteristic for coastal and pelagic fishes. For some bottom fishes it is typical the "eurybathic" kind of wide range of bathymetric distribution. Fishes of this group are present in composition of all ecological groups.

The analysis of distribution of different fish species depending on oceanological conditions indicate to their relating to waters of definite hydrological features. But there are some species of indifferent relation to water mass structure. These species are of high or low abundance and form a rather large group. Some ichthyocenosis depending on season conditions are able to disintegrate but new ones may be formed instead of the first. Water mass divisions are the ichthyocenosis boundaries. Only those ichthyocenosis being in upper sublittoral or mesobenthic biotop are the most conservative to definite oceanological zones. The majority of ichthyocenosis are well congregated in space and occupy the definite vast areas of Primorye shelf or slope. The stability of "eurybathic" ichthyocenosis is clearly shown relatively to vertical distribution but not in space. These species are present in the majority of ichthyocenosis in different ratios.

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poster

## REPRODUCTION OF SEA URCHINS NEARSHORE OF THE NORTHERN PRIMORYE

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Studies on the sea urchins reproductive process were carried out in the commercial sites of the Northern Primorye coast taking into account the environment ecological conditions. The gonads of these animals inhabiting in different communities were examined in different depths with different sea urchins density. The sea urchins stages of active gametogenesis and prespawning were analyzed. We have determined that ripening of sea urchins gametes strict correlates with water temperature. The active growth of sex cells begins with increasing of water temperature. Volume of acinuses and cells elements quantity in the acinuse increase. All cells of gametogenetic line are present in the gametes of male and female in the active gametogenesis stage. In prespawning stage the acinus of female are filled with eggs ready for sweep, filled sperms predominate in males. Gonadosomatic index increases in the process of gonads ripening. It is a fishery index for sea urchins catch to be started. Animals which inhabit well warm shallows are spawning earlier than in deep water. In the result of conducted histophysiological research there have been defined the potentials of sea urchins gamets and analyzed the reproductive possibilities of their reproduction in different communities depending on biotic and abiotic factors. The mechanisms of reproductive process of these animals have been determined. We came to conclusion that temperature is the main factor in reproduction of sea urchins. It activates the gonads development and controls the reproduction periodicity of grey intermedium urchins.

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poster

## ADAPTIVE REACTIONS OF *Laminaria japonica* ARESCH. IN THE PRIMORYE REGION

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The ecological plasticity of a commercial species *Laminaria japonica* Aresch. is the mechanism of maintenance of viability and reproduction of plants in various habitats. The morphological variability of fronds, anatomic structure and reproductive status of 2-year-old *Laminaria japonica* is analyzed. The sampling in 7 areas along 800 km of coast of Primorye with same type of kelps and similar habitats was carried out. Nine parameters of the fronds with anatomic structure and status of reproduction tissue of 1750 two-years plants were analyzed with use of Statistica and Systat packages. The northern cenopopulations are characterized by a higher sizes and higher degree of variability of morphological characters. Morphological peculiarities connected to growth, reduction of meristematic and conducting tissues and increase storage tissue are revealed for northern coast plants. The reduction of specific mass of plants from 3,0-3,5 up to 2,2-2,4 is occurred in the direction of north. The process of sporogenesis begins in southern areas of coast and gradually advances on north. The early stop of growth of fronds and forming spore-bearing, and also short period of its development and simultaneously of exit zoospores in September is characteristic of plants of southern areas. In southern areas of Primorye the reproduction tissue ripens on 25-30 of day before northern. The analysis of interpopulation variability of morphological characters, anatomic structure and the reproductive status has shown, that the maximal differences are observed between populations of southern and northern areas. This is adaptive reaction of a species allowing to exist in dynamical conditions of coast.

**ABOUT THE AGE STRUCTURE OF THE NORTH-WESTERN SAKHALIN CHUM SALMON**A.N. Ivanov

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Rational exploitation of species stock is impossible without the knowledge of its biology and dynamics of number, which components are an individual age and age structure of population being cropped.

For spawning, summer chum salmon return to rivers of the northwestern Sakhalin at the age of 3-6. More than half of them are fourth-year fish (3+). The third-year fish specimens are the smallest in number age group (1%).

On the 17th of August 1996 in catches of the Rybinsky barrier there was found a chum female with one annulus and a second-year growth on scales, that indicated the age of yearling. In this period fishing of summer chum salmon went to the end. Catches consisted of fish specimens differed a little from the chum salmon entering Sakhalin rivers.

A fork length (AC) of the female was 49.3 cm, mass - 1480 g. Mass of gonads - 104 g, absolute individual fecundity - 1200 eggs. Like other females, elder by age, its sexual products were at 3-4 stages of maturity. The number of sclerites in the first-year annulus varied from 21 to 25. For 15 scales they averaged  $22.9 \pm 0.25$ . In the second-year growth - 17-22, averaged  $19.1 \pm 0.38$ .

The cases of chum salmon yearling catch in the Amur Estuary are extremely rare. The analogous catch of a male-yearling was recorded in 1958 (Krykhtin, 1958).

Thus, a spawning population of summer chum salmon of the northwestern Sakhalin may include yearling fish, but very rare.

**SPECIFIC COMPOSITION OF FISHES IN THE POSSJET BAY (JAPAN SEA)**Denis V. Izmyatinsky

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Materials from three registration trawl surveys having been carried out on July-August in 1995 by the MRTK "Laukuva" as well as on July-August in 1996 and on August-September in 1998 by the MRS-5005 were taken as base of this work. During the three surveys in the Possjet Bay between 1995 and 1998, 55 species were identified among 18 families. The greatest number of species has been registered in families Pleuronectidae - 11, Cottidae - 11, Stichaeidae - 7, Agonidae - 5. There were 1-3 species in other families in that period. Families of fishes encountered in catches can be divided into three groups. Pleuronectidae, Hexagrammidae and Cottidae involving dominating species with high biomass are appertained to the first group. The second group - Gadidae, Stichaeidae, Hemitripterae, Clupeidae, Agonidae, Osmeridae, Cyprinidae, Scorpaenidae, Liparidae unites species which are common fishes for this area. Third group is formed by rare species from families Tetraodontidae, Lamnidae, Stromateidae, Engraulidae, Monacanthidae, Squalidae. All species from these families are typical subtropical fishes migrating to Peter the Great Bay in warm period of year.

During the time of research number of species in surveys was practically constant. 36 species were encountered in each of two years: in 1995 and 1998, but in 1996 we registered 35 species of fishes, though - quantity of species in separate families changed significantly in different years. There are five dominating species in the Possjet Bay. These are *Pleuronectes yokohamae*, *P. punctatissimus*, *P. herzensteini*, *Myoxocephalus jaok* as well as *Pleurogrammus azonus*.

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poster

## **IMITATION MODEL OF FISH RESOURCES EXPORT-IMPORT BETWEEN TWO COUNTRIES**

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The report considers the problem of fishery in the economic zone of Russia and fish export (for example to Japan). According to the official data provided by the State Committee for Statistics of Russian Federation 1997, the registered volume of export from Russia was several times less than the registered volume of import to ports of Japan.

The report suggests the simple non-linear imitation model of export - import of fish resources between two countries. The theoretical basis of the model is system dynamics (by analogy with the model suggested by J. Forrester - see "World Dynamics"- Cambridge: Mass., 1971). The input parameters are the following: the allowed quota of fishing out, the difference in value of fish resources in the exporting and importing countries, the assigned probability of illegal export, the fine amount for infringement of borders.

The model is realized using the Monte-Carlo method. The modeling process results in the following parameters: legal and illegal incomes, the real volume of catch and the ecological damage (i.e. the catch exceeding the quota).

The report also shows a dependence of the output parameters on variation of the input parameters. The purpose of the research is minimization of the ecological damage in the sphere of fishing: one of the most effective methods to solve the problem is creation of an international information center for the control over the ecological and economic situation with the sea resources in our region.

8AM1999-FISpaper24

poster

## **IMPACT OF CLIMATIC CHANGES ON CHUM SALMON ABUNDANCE IN THE NORTHWEST PACIFIC**

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This paper is a continuation of research on impact of climatic changes in the North Pacific during the last 40 years on abundance of different salmon stocks. In previous years we were concentrated on pink and sockeye salmon stocks in the Northwest Pacific. Now we considered the changes in West and East Kamchatka chum salmon stocks in relation to climate fluctuations. Spatial and temporal features of climatic variations in the whole North Pacific region were considered based on data from Russian Hydrometeorological Center and US National Data Center. The combined analysis of all available data allowed to identify several climatic regimes in the region. We think that the last regime shift occurred in 1997-1998. This in some extent is confirmed by changes in character of SST and atmospheric circulation patterns. There is a good correspondence between decadal variations in abundance of chum salmon stocks and climate. Some mechanisms for possible climate impact on chum salmon stocks will be proposed.

8AM1999-FISpaper25

poster

### **PROSPECTS OF *Laminaria japonica* AND SEA URCHINS JOINT CULTIVATION**

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The investigations on ways of keeping of sea urchins (*Strongylocentrotus intermedius*, *Strongylocentrotus nudus*) stocks at the period of their regular catch became presently more active in the Far East. It has been developed the long-term program of TINRO-Center and industry cooperative works on sea urchins' catch. The first results of this program have shown that commodity qualities of sea urchins' gonads depend on type of food supply. While feeding Detritus, Lithothamnion, Lithophyllum, Bossiella or Phyllospadix, the weight of sea urchin gonads is very low during a year, the color is brown or gray. While feeding Laminaria, somatic and gonad growth of sea urchin increases, reproductive effect and fecundity raise. New sprouts of Laminaria are the most effective food, while feeding them sea urchins have value of gonad somatic index 20-25% in comparison with sea urchins, feeding Corallinaceae algae and having value of index 5-8%.

Based on received results it was made an attempt to create the fields of Laminaria new sprouts up to March - April for sea urchin active feeding. It yielded a good result. Young sea urchins, taken from areas with poor supply food were transplanted to Laminaria fields and cultivated to trade stage. Young urchins settled in rhizoids of adult plants with favorable conditions of feeding, growth and protection from enemies. So, creating the Laminaria fields in places of sea urchin inhabitation it is possible to improve their commodity quality, to make natural nursery for young sea urchins, and to receive the harvest of algae.

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poster

### **COMPUTER AIDED MIDWATER TRAWL NET DESIGN SYSTEM**

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The midwater trawl is a method used in today's most developed and important fisheries. The size of net used on the fishing field is becoming larger than the traditional gear and its shape is also rapidly changing, but the principles of the net design is obscure owing to the lack of systematic studies, and poor knowledge for the real gear shapes and catching efficiency according to the towing speed. Therefore, there are many aspects to be improved for fishing gear design and operation processes. This paper deals with the development of a computer aided midwater trawl net design system that uses analytical methods for determining the design parameters of fishing gear. This midwater trawl net design system was developed using graphical user interface tools for the fishing gear design and the evaluation of gear performance was created by using computer graphics. With this system it is possible to predict the movement of the gear in accordance with the change of the parameters related to the gear design and to analyze the gear shape by reproducing the movement of the gear using a computer simulated interface.

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poster

### **ESTIMATION OF POPULATION ECOLOGICAL CHARACTERISTICS OF CLAMS IN THE HADONG INTERTIDAL AREA IN KOREA**

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This study is to estimate population ecological parameters, including growth parameters, survival rate, instantaneous coefficients of natural and fishing mortalities, and age at first capture of the soft-shell clam, *Mya*

*japonica* and the duck clam, *Dosinorbis japonicus* in the Hadong intertidal area in Korea. For describing growth of the clams the von Bertalanffy growth model was adopted. The von Bertalanffy growth parameters estimated from a nonlinear regression were  $L_{\infty}=16.04$  cm,  $K=0.165$ , and  $t_0 = -0.298$  for the soft-shell clam and  $L_{\infty}=9.70$  cm,  $K=0.306$ , and  $t_0 = -0.371$  for the duck clam. Survival rates (S) of the clams were 0.253 (SD = 0.019) for the soft-shell and 0.260 (SD=0.039) for the duck clam. The instantaneous coefficients of natural mortality (M) were estimated to be 0.340/year for the soft-shell and 0.513/year for the duck clam. The instantaneous coefficients of fishing mortality (F) were calculated as 1.035/year for the soft-shell and 0.835/year for the duck clam. The age at first capture ( $t_c$ ) was estimated from the length-converted catch curve and the estimates were 1.8 years for the soft-shell and 1.5 years for the duck clam. The mean density of the soft-shell clam was 6.02inds./m<sup>2</sup> (SE=1.30) and that of the duck clam was 0.92inds./m<sup>2</sup> (SE=0.29) respectively.

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poster

### **SOME PECULIARITIES OF GROWTH RATE OF WALLEYE POLLOCK *Theragra chalcogramma* (PALLAS)**

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Research carried out during 1988-98 showed that the line of regression of body length (AC) on scale back radius of walleye pollock from Primorye (Japan Sea), northern Okhotsk Sea (without western Kamchatka and Shelichov Bay) and Navarin region (Bering Sea) is described with the S-form curve. Using direct observations, growth parameters for body length of walleye pollock have been calculated in different areas of the species range. It has been noted that mean population indices of yearly growth parameters gradually decrease till mass sexual ripening. Then, in contrast to individual growth rate they increase again. The high maturation rate is characteristic to walleye pollock from Primorye and Navarin region. Walleye pollock from the northern Okhotsk Sea has slower maturation rate. So, while in the first two areas the increase of common population growth indices occurs on the fifth year of fish life, in third - in fishes 7-10 years old. In Primorye the increase of growth rate occurs on the 5-8th years of life, and then growth rate decreases. Judging from frequency distribution of fish length, coefficient of asymmetry has been calculated for different age groups. Data analysis showed that coefficient of asymmetry was negative till the age of mass sexual maturity, and was positive after maturation. These facts suggest that slow-growing specimens are predominant during first years of fish life, while after maturation fast-growing fish are most numerous. The possible reason for high elimination of slow-growing fish is their quick emaciation after spawning.

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poster

### **DISTRIBUTION AND YEAR-CLASS STRENGTH OF SPANISH MACKEREL (*Scomberomorus niphonius*) IN THE EAST CHINA SEA**

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Spanish mackerel is one of important fishes for Japanese fisheries in the East China Sea. The catch of Spanish mackerel by the Japanese fisheries was over 40 thousand tons in 1985, but has decreased since the latter half of 1980s.

Fishing ground of Spanish mackerel was found in the waters off northwest Jeju island in December, and the ground moved to southward in following months. The fishing ground formed in the waters at the central area in the East China Sea in April. These migration patterns of the fishing ground was similar to that of the chub

mackerel, *Scomber japonicus* (Asano & Kiyomoto, 1998). There were no fishing ground for Spanish mackerel by Japanese fisheries during May to November in the East China Sea. Probably, Spanish mackerel move to the area off the Changjiang estuary in early summer, and migrate to the Yellow Sea and Bohai Sea.

The catch of 0-age Spanish mackerel was more than 10 thousand tons in 1984 and 1985, but has become less than 10 thousand tons since the latter half of 1980s, except 1989. In 1990s, the catch of 0-age Spanish mackerel was about 1 thousand tons. Then, the 0-age Spanish mackerel was decreasing successively. As a result, the strong year-class of Spanish mackerel did not appear from 1989.

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poster

## **LONG-TERM CHANGES IN CATCH COMPOSITION AND RATES OF GROUNDFISHES ON THE PACIFIC UPPER CONTINENTAL SLOPE OFF THE NORTHERN KURIL ISLANDS**

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The comparative analysis of published data on groundfish catch composition and rates on the Pacific upper continental slope (200-400 m) off the northern Kuril Islands during 1960-80s and original data collected during 1993-98 bottom trawl surveys in research cruises of VNIRO, SakhNIRO, KamchatNIRO, and TNRO-Center was made.

Changes in the total catch rates during the last 30 years in the area considered did not exceed two times and are for present period similar to that of 1960-69.

The share of walleye pollock in the total catch groundfishes changed from 28.8% (1960-64) to 88.7% (1975-79) and constitutes now 63.5% (similar to 1970). The Pacific cod shared 2.7 to 18.2% of total catch, and in 1990s - about 3.0%. The catch rates of Greenland turbot continuously declined from 2.9% in 1960s to 0.3% in 1990s. On the contrary, the catches of Kamchatka flounder increased from 0.1-0.2% in 1960-80s to 0.7% in present time. The share of Pacific halibut in the total catch varied from 0.1 to 0.7% and constitutes now 0.5%. The flathead sole catches during the almost whole period considered were insignificant except for 1970-74s, when they shared 4.7%. The catches of rock sole declined from 12.9% in 1970-74s to 2.4% in 1990s. The share of snailfishes in the total catch during 1960-1980s varied from 0.2-1.4% and reaches 5.0% in 1990s. Skates catches in 1990s are largest (10.0%) during the period considered, in 1960-1980s they shared 0.4-5.0% of total catch. The maximum catch of greenlings was characteristic of 1970-74s (10.9%) and now is similar to that of 1975-79s. The 1960-64s were characterized by domination of rockfishes in the total catch (54.8%), then their share decreased and reaches 0.1% of total catch. In 1990s rockfishes shared 6.8% of total groundfish catches. The fluctuations of abundance of species considered occurred in various regions of the North Pacific. The decline in rockfishes abundance during considered period is probably associated with the overfishing. Abundance of other species fluctuates probably in connection with long-term climatic changes in the North Pacific Ocean.

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poster

## **FISH PRODUCTION AND FISHERIES RESOURCES IN THE ADJACENT WATERS AROUND TOKTO ISLAND, KOREA**

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This study is to provide fundamental data and information for developing a rational fishery management scheme in the adjacent waters around Tokto Island, Korea. The state of fisheries and fisheries resources in the area were reviewed, based on the literature and fisheries statistics. Two field surveys were conducted using trammel nets and pots in May of 1998 and 1999, and relative abundances in terms of catch per unit effort (CPUE) and size compositions of major fisheries resources were obtained. In the first (1998) survey, the number of species was a total of 35 (20 fishes, 5 echinoderms, 3 crustaceans, 7 mollusks), the mean CPUE was 33.0 kg per 100m trammel net. However, in the second (1999) survey, both the number of species and the relative abundance were smaller than the first survey. The number of species from the second survey was 27 (15 fishes, 5 echinoderms, 1 crustaceans, 6 mollusks) and the mean CPUE was 30.9 kg per 100m trammel net. In particular, Japanese butterfish (*Hyperoglyphe japonica*) was the most dominant species in both surveys. Other dominant species were threadsail file fish (*Stephanolepis cirrhifer*), black scraper (*Navodon modestus*) and sea urchin (*Anthocardia crassispina*).

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poster

## **EFFECT OF DYNAMITE EXPLOSION WORK NOISE ON THE BEHAVIOR OF ISRAELI CARP IN THE CAGE OF AQUACULTURE**

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This paper describes the relationship between the behavior of the Israeli carp, *Cyprinus carpio* of 28 cm long and the environmental noise level due to the dynamite explosion work. The experiment is conducted in the cage (L10 x W4 x D4 m) of aquaculture located at Chungjoo Lake, Chechon, in 1997. The fish trajectory was obtained by the telemetry system in which a pulsed ultrasonic pinger (50 kHz,  $\phi 16 \times L 70$  mm) attached onto the dorsal was tracked three dimensionally and the underwater noise levels were measured. The results of this study are as follows: 1) The underwater noise levels measured at a distance of 400 m from the source of noise increased by 40 dB (re 1  $\mu$ Pa) compared to the levels before explosion. 2) The average speeds of the fish before and during the works were measured as 1.1 times and 1.9 times of the body length.

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poster

## **THE BIOLOGY, DYNAMICS LONG-TERM SUPPLEMENT OF A TRADE STOCK AND FISHERY FOR KING CRAB FROM THE WESTERN KAMTSCHATKA SHELF**

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The western Kamtschatka population of king crab has been replenished with seven high yielding generations during 1958-1998 years period. This was due to high share of five years old males in 1958, 1963, 1970, 1975, 1980, 1988, and 1993-1994. The number of crabs recruited into fishery was 1.5 times higher in 1996-1998 than in proceeding 20 years.

The fall in recruitment to the exploitable stock of king crab as well as reduction in number of commercial size males is expected after 2000. This will be due to low yielding generations, which are going to dominate in the king crab fishery.

Over half of all legal males and 20% of females migrated south to 54°N in 1996-1998. Such a long southern migration had not been detected since 1964. 90-95% of all males and females were usually concentrated north to 54°N. As a consequence, the number of females and young animals decreased in northern areas, and their number increased in central and southern areas of the western Kamtschatka shelf.

High bycatch (up to 80 %) of females and youngsters of king crab has been detected on the fishing grounds due to their migration the southern shelf. One of the possible reasons for such a redistribution of the crab could be long-term changes in natural conditions. Research conducted in the northern Okhotsk Sea in 1990-s showed that certain changes in pelagic communities took place following to fluctuations in climatic and oceanologic parameters. Suchlike changes occur in benthic communities as well, though bottom fauna especially crabs is very much influenced by fishery.

To reduce harmful effects of fishery on the king crab population we suggest limiting the time of fishing operations down to 4-5 months during a year, and confine them to winter – spring period.

8AM1999-FISpaper34 poster

## **LONG-TERM CHANGES IN THE ICHTHYOFAUNA OF NORTH-WESTERN PART OF THE PACIFIC OCEAN ON THE PHONE OF DYNAMICS OF ATMOSPHERIC AND OCEANOLOGICAL FACTORS**

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The long-term (1949-1998) changes in the ichthyofauna of northwestern part of the Pacific Ocean were analyzed on the phone of a global changes in the atmospheric and oceanic circulation.

In 1949-1970, anchovy larvae prevailed in the ichthyoplankton (about 50%). By the end of the 1960s (1967-1969) the number of anchovy larvae has decreased, but at the same time the sardine larvae have appeared. In 1970-1980, the number of sardine larvae has increased and has reached its maximum in 1984-1985. After 1985, the number of sardine larvae has visibly decreased, while the number of anchovy larvae has increased.

The predominance of warmwater fish species (from 50 up to 80%) in the ichthyoplankton was observed in 1973-1980 eastwards from Japan. The number of boreal species did not exceed 10%. In this period, the planetary high-altitude frontal zone (PVFZ) took place latitudely. As a result, the north position of the Kuroshio front and its anticyclones took place. At the same time the coast Oyashio branch was poor developed.

In 1981-1986, PVFZ displaced to the South of Japan and meandried. The Kuroshio front stayed at the average annual level. The ratio of boreal and warmwater species in ichthyoplankton composition was balanced.

Remarkably that in 80th the number of the tropical fish species penetrations into the northwestern part of the Japan Sea was minimal. This fact is in accordance with the location of lower atmospheric ridges of cold over the South Japan in this period. In the 1990s (1994-1998), the new wave of the tropical fish species penetrations has been registered. Simultaneously the lower atmospheric ridges of warmth over the northwestern region have been marked.

8AM1999-FISpaper35

poster

## **SELECTING TARGET SPECIES FOR TAC-BASED MANAGEMENT IN KOREAN OFFSHORE FISHERIES**

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Korean government employed a TAC-based fisheries management system recently and started a demonstrating practice for selected species in January 1999. As a part of studies on the TAC-based fisheries management system, a method for selecting target species for the management was suggested. Four factors were identified as selection criteria for TAC target species, and relative weight was given to each factor. The identified factors were economic importance (30%), ease of monitoring and enforcement (30%), quality and quantity of data and information (20%), and current stock condition (20%). According to these factors each species was scored. We considered economic importance as the total revenue of the annual production for each species. For the ease of monitoring and enforcement, we examined the complexity of the fishing gears involved and the number of species caught by involved fishing gears. For the factor of the quality and quantity of data and information the availability used for the quality levels of stock assessment models was employed. Stock condition was determined by the trend of catch per unit effort (CPUE) of involved fisheries. As the result, the species in score order was as follows: 1) common mackerel, 2) blue crab, 3) file fish, 4) hairtail, 5) small yellow croaker, 6) Spanish mackerel, 7) jack mackerel, 8) squid, 9) sea eel, 10) puffer. Currently, five species are managed by the TAC-based system. They are common, jack, and Spanish mackerels, sardine, and red crab. In the near future blue crab, file fish, hairtail, and small yellow croaker could be added for the Korean TAC-based management system as target species..

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poster

## **AGE ESTIMATION OF FOUR OCEANIC SQUIDS, *Ommastrephes bartramii*, *Dosidicus gigas*, *Sthenoteuthis oualaniensis*, and *Illex argentinus* (Cephalopoda, Ommastrephidae) BASED ON STATOLITH MICROSTRUCTURE**

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Statolith preparation and observation methods adopted in Japan were reviewed for four ommastrephid squids, *Ommastrephes bartramii*, *Dosidicus gigas*, *Sthenoteuthis oualaniensis*, and *Illex argentinus*. Relationships between mantle length and age were exponential at the early life stages and almost linear at the subadult and adult stages.

8AM1999-MEQpaper01 oral

## **METAL POLLUTION OF PACIFIC AND TECHNOSPHERE APR**

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The pollution atmosphere, landscape, marine and fresh water systems by metals is typical for technosphere and ecosphere in west part of Pacific. According to calculation over conditioned toxic matter (index UCRM - universal criterion reduction mass) cardinal pollution in atmosphere of west Pacific and APR (Asiatic Pacific Region) is lead. It quota of relativity danger varied from 58 to 98% for different industry region. The global source - motor transport, mining and industry plants.

The coastal landscape and water systems northwest Pacific pollute by Prymory technosphere following metals Cu>Cr>Zn>Fe in volume, conformity: 3900 toñe, 1850 tone, 1700 tone, 1200 tone (index UCRM). Spring source - metal-worker industry and mining complex of region. Compound of this metal have heightened dissolubility in sour environment. Soil-factors of Prymory (sour of soil) and climatic alteration (raising sour of precipitation) increase weight of ecology after-effect. Infection coastal water and marine sediment by radioactivity materials is stress-peculiarity of Pacific. Source of radioactivity back in APR shelf are mining industry systems objects of nuclear energy. Most unfavourable in radiation pools is Sea of Japan. Leading pollution of technosphere have tendency to accumulate in marine organism. The concentration of chromium, zinc and lead in oysters from Avachinskay firth and Peter the Great Bay increase limited permissible concentration at two order. The increase of radioactive elements concentration in hidrobiont is being observed in this region. Pollution from the Pacific, penetrate into human organism by trophic chains, hit and infect it. The effective methods to protect the Pacific from pollution are necessary.

8AM1999-MEQpaper02 oral

## **As, Ba, Se AND U ENRICHMENTS IN SEDIMENTS OF THE LA PAZ BAY, BAJA CALIFORNIA, MEXICO**

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148 samples of sediments of shallow zone of the La Paz Bay were studied using the neutron activation analysis, with special attention to regional geochemical indicators (Fe, Sc, Ba, Ca, Sr, rare earth elements) and environmentally important elements (As, Co, Cr, Sb, Se and Zn).

Average concentrations of As, Ba, Ca, Sb, Sr, Se and U in the sedimentary material were found to be relatively high in comparison with earth crust. Their spatial distributions on the floor reveal the existence of three zones with distinct textural and geochemical characteristics of the sediments.

The first zone is located on the western part of the bay, influenced by episodic input of products of the erosion of the nearby San Pedro, San Isidro and Commondu geologic formations, constituted by volcanic and volcano-sedimentary rocks. Coarse grained sediments of these area are mainly terrigenous particles with elevated contents of both terrigenous (Fe, Co, Cr, Cs, Rb, Sc) and volcanogenic (As, Ba, Sb, Se, Zn) elements, as well as positive Eu anomaly.

The second area is in the east of the bay, near of the Espiritu Santo Island and along the Peninsula of Pichilingue. Coarse grained marine biogenic carbonates (calcareous skeletons of algae, corals and fragments of broken sea shells) are predominant here causing relatively low content of trace elements, except highly abundant Ca and Sr.

The third includes more deep, central part of the La Paz Bay composed by fine sedimentary material (mainly grey and green clays), which reveals the U natural enrichment (probably diagenetic), especially in the southern portion of this zone.

8AM1999-MEQpaper03 oral

### **TRITIUM IN THE NORTHWEST PART OF THE JAPAN SEA**

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The results of tritium measurements from the end 80 to beginning 90 years in northern deep-water part of the sea and in Ussury bay and in Sovietskaya Gavan bay are presented. The using problems of this isotope for study the deep-water formation process in the Japan Sea are discussed.

The vertical tritium distribution in Japan Basin was characterized by an intermediate maximum 2.5 TU on depth of 300-400 m and undersurface minimum 1.7 TU on depth of 200-250 m. The tritium concentration in the surface layer was 2.4-3 TU. Below 500 m with increase of depth the tritium concentration is smoothly decrease, but remains rather high 0.5-1 TU to depth of 1500 m. Average concentration in a layer of 2000-3500 m was about 0.2 TU.

The correlation tritium with the dissolved oxygen was found.

In the Ussury bay in summer the water with temperature  $-0,5^{\circ}\text{C}$ , and salinity 34.12 ‰ and density 27.43 on depths more than 25 m was found. Tritium concentration in this water was 2.5 TU. Concentration of tritium in surface layer was 2-4 TU. The concentration of tritium in the rivers running in Ussury bay was 10-17 TU. The correlation of tritium with salinity was observed only in summer for low salinity waters in the top bay.

The tritium concentration in the Sovietskaya Gavan bay was varied from 4.5 TU up to 21 TU. The correlation of tritium with salinity in this area was good with the correlation factor equal 0.986. That is affected the intensive inflow of the high tritium fresh water.

8AM1999-MEQpaper04 oral

### **PHYSICO-CHEMICAL MODELING OF BEHAVIOR OF COBALT AND MERCURY IN THE MIXING ZONE OF RIVER AND SEA WATERS**

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The behaviour of chemical elements under mixing of sea and river waters is of a considerable interest for the geochemists and ecologists. There is a shift of the forms of migration of a lot of chemical elements, and also their removal from solution in this a zone. Authors have carried out physico-chemical modelling of behaviour of a cobalt and mercury in the estuary zone of the Amour bay - Razdolnaya River (near Vladivostok). The process of simulation was made by two software - SELECTOR - C and PRODEFA2/MINTEQA2.

As a result of the modelling was established, that the  $\text{Co}^{2+}$ ,  $\text{CoCl}^+$ ,  $\text{CoSO}_4^*$ ,  $\text{CoCO}_3^*$  are dominating in the sea water. The organic complexes are presented at minor quantity. In the seawater the cobalt is predominantly in

the dissolved form. The dominating forms of mercury in the seawater are different chlorine complexes, but organic ones do not play a significant role. Practically all mercury is adsorbed on suspended matter. In the river water the cobalt is predominantly as  $\text{Co}^{2+}$ , the organic complexes do not play a significant role. Up to 13% of a cobalt is in suspended matter. The mercury in a river water exists in main as organic fulvic and humic complexes and practically all is adsorbed on suspended matter.

On the basis of modelling of adsorption process of a cobalt and mercury in mixing zone is established, that the decrease of total concentration of mercury from a river water to seawater under of passing through a geochemical barrier is connected with its adsorption on a suspension and deposition last. The processes of adsorption on decrease the total cobalt concentration do not render considerable influence. The decrease of its concentrations is connected with it codeposition with ferric and manganese hydroxides.

8AM1999-MEQpaper05 oral

### **AN ECOSYSTEM STUDY OF ACID MINE DRAINAGE EFFECTS IN A BRITISH COLUMBIA ESTUARY**

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The Britannia copper mine on the shores of Howe Sound, a fjord estuary in British Columbia, operated for about 80 years before closing in 1974. Since closure, acid mine drainage (AMD) from the tunnels and workings has entered the Sound via a subsurface outfall and a creek. The combined discharges are currently recognized as one of the largest point sources of pollution in North America, with maximum loadings of up to about 425 kg/day of copper, 1.4 kg/day of cadmium, and significant amounts of other metals. pH levels less than 5.0 are common in the brackish water at the creek mouth. In our study we assessed the effects of the AMD on the ecosystem and habitats supporting chum salmon (*Oncorhynchus keta*) fry which migrate to the sea along the shoreline of Howe Sound. Chum salmon fry abundance at the creek mouth was very low relative to reference areas. Bioassays and caged fish studies showed the water was extremely toxic to fish. Rockweed (*Fucus gardneri*) is an intertidal algae important in the structure and function of the intertidal ecosystem as this species provides habitat for invertebrates used as food by chum salmon fry. The algae was transplanted at varying distances from the creek mouth and a reference area to test for survival, growth, and uptake of copper. Rockweed transplanted near the creek mouth showed poor survival and copper was accumulated in the plants in less than a month. Transplant experiments with mussels (*Mytilus edulis*) showed similar results, indicating possible impairment of growth because of reduced phytoplankton productivity. The transplant experiments and field survey data showed approximately 2 km of shoreline is affected by the AMD. Because the chum salmon fry are adapted to use shallow water as a migratory pathway, all the fry moving to sea on the east side of Howe Sound are at risk from the AMD. A treatment plant using conventional technology is proposed to resolve this major pollution problem but because the mine is abandoned and is an 'orphan', there are legal and financial constraints to the plant's construction and operation.

8AM1999-MEQpaper06 oral

### **EFFECTS OF ATMOSPHERIC INPUTS ON MICROELEMENT CONTENTS IN COASTAL ZONE OF THE VLADIVOSTOK**

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One of the most intensive and constantly acting sources of receipt of various substances in the ocean is the atmosphere. In northwestern part of the Pacific region western winds play a large role in carry of atmospheric

aerosol particles on large distances. In the Primorsky Krai (Vladivostok city) the yellow dust is observed not only with arrival of a spring, but also in the winter, as far as strong western winds bring a particle of a dust from the Asia. Its content natural and polluting substances.

The sampling of atmospheric aerosols is carried out uniformly on Japanese installations on a technique, adopted in the international program SEAREX. Besides, rain and snow (after melting), river and waste waters were sampled in polyethylene bath and then particulate and dissolved forms of matter were separated by filtration through nuclei filters with pore diameter nearly 40 microns. Element concentrations in aerosol, rain and snow were determined by neutron-activation and atomic-activation methods of the analysis

The Vladivostok City is placed on south end of Muraviev-Amurskiy peninsula between the Amurskiy Bay (northwest direction) and Ussuriyskiy Bay (southeast direction). Climate of Vladivostok are under influence of monsoons when in winter atmospheric winds are observed mainly from Siberia (northwest) and in summer from the Sea of Japan (southeast). Highest atmospheric precipitation of water were observed in August (168 mm) and lowest - in January (10-12 mm).

The analysis of data shows, that for Vladivostok a increase of the aerosol contents in winter (November - December) and spring months is observed. Law of a increase of the element contents (such, as K, Ba, Fe, Al, Ca, Na and other) in atmosphere of Vladivostok in a winter-spring period is marked. In table 1 element concentrations in atmospheric inputs in coastal zone of the Vladivostok are demonstrated. Comparison of effects of different sources on element content in coastal waters are demonstrated in table 2.

**Table 1. Element concentrations in atmospheric inputs**

Element	Dissolved form		Particulate form	
	snow, $\mu\text{g/l}$	rain, $\mu\text{n/l}$	$\mu\text{g/g}$	% of total flux
Zn	3,4	4,5	386	25
Pb	1,0	1,7	135	28
Cu	2,1	9,6	67	8
Cd	----	0,6	---	---
Ag	0,003	----	1,64	44
Ni	0,48	----	58	26
Mn	9,78	5,2	995	23
Co	0,06	---	6,5	25

**Table 2. Element inputs from different sources (in%) to coastal zone of Vladivostok**

Element	Amurskiy Bay			Ussuriyskiy Bay		
	river	waste	atmo	river	waste	atmo
Zn	29	57	14	25	25	50
Pb	28	64	8	28	35	38
Cu	13	80	7	22	44	34
Cd	12	76	12	5	39	55
Ag	27	73	---	33	63	4
Ni	10	88	2	18	73	9
Mn	80	5	15	55	2	43
Co	71	28	1	66	25	9
Partic. matter	52	39	9	56	6	38

We observed that atmospheric element inputs to coastal zone are in dissolved form. Anyone can see that most strong effect on element concentrations demonstrate waste waters. For the Ussuriyskiy Bay where the total input of waste waters in coastal zone is less 15 times smaller then in Amurskiy Bay the atmospheric inputs influence on fluxes of Zn, Pb, Cu, Cd, Mn and particulate matter.

We believed that for the Sea of Japan the atmospheric inputs are the most important source of different toxic substances in marine environment.

8AM1999-MEQpaper07 oral

## **METHANE IN FAR-EASTERN TRANSITION ZONE**

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Now different scientists remark that formation of ozone holes and green house effect can be explained by large variations of methane in atmosphere which connect with natural and antropogenic sources of methane. We studied natural methane in water Far-Eastern seas and Primorsky land. Authors determined that at regions of the Sakhalin shelf and at the Okinawa trog the significant intrusions of methane in sea water (5000-15000 nl/l). It associates with strong seismic activities at these regions. These investigations emphasize the importance of methane flux in seismic active zones. Sources of methane are oil-gas deposits and gas hydrates.

The authors studied the methane distribution in Primorskiy region at last decade. The average of data was done for various groups: a) marine coastal surface water (3000 nl/l), surface fresh water (20000-30000 nl/l), such as spring water, brooks, sand-pits, lakes and rivers are practical sources of methane input in atmosphere from land; b) underground water (400000-4000000 nl/l) such as draw-wells, bore-wells and well-pits characterize the potentialities of methane input from land;

Thus there are big area in Far-Eastern transition zone with methane flux from interior to water and to atmosphere.

8AM1999-MEQpaper08 oral

## **SPRING METHANE MAXIMUM IN WATER OF THE NORTH-EASTERN SAKHALIN SHELF OF THE SEA OF OKHOTSK**

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Methane concentrations within water columns of the northeastern Sakhalin shelf, slope and central part of the Derugin basin were defined during all seasons on the cruises of RV *Professor Gagarinsky* (autumn, 1998), *Akademik Lavrentyev* (summer, 1998), *Utyos* (spring, 1999), a helicopter (winter, 1999). Studying of methane distribution in water of that region is carried out under the German-Russian Project KOMEX, subprogram "Methane monitoring".

Methane investigations revealed that

1. seasonal methane content variations were observed only in the upper layer at the deep stations with depths of more than 1000 m;
2. at the slope stations with depths of 100-1000 m methane concentrations changed in the surface and middle (200-400 m) layers;
3. at the shelf stations with depths of 20-100 m the greatest variation of methane concentrations was found in the water column. In spring the highest methane concentrations (2000-3000 nl/l) were found in water of the shallow shelf. These concentrations are 2-5 times larger than in other seasons. High methane concentrations are accompanied by acoustic anomalies registered as "flares" by the echosounder. Methane distribution in the water column was uniform from the bottom to the surface. It points to the convective shelf water mixing during cold seasons and a significant methane amount coming from the sediments into the water. Since the equilibrium water-air methane concentration is 80-100 nl/l and methane content in the shelf water exceeds the equilibrium concentration 20-30 times, great methane amount emanates from the water into the atmosphere.

8AM1999-MEQpaper09 oral

## NEW HEAVY METAL DATA FOR THE SURFACE SEDIMENTS OF THE LA PAZ LAGOON, SOUTHERN BAJA CALIFORNIA MÉXICO

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Having the aim to elucidate the causes affecting the state of contamination of the La Paz Lagoon, concentrations of the environmentally important elements Zn, Cr, As (neutron activation analysis), Hg, Pb, Cd and Cu (atomic absorption spectrometry) were determined in 81 surface sediment samples and in 16 soil samples of the beds of dry streams episodically draining adjacent land. The resulting conclusion is that As ( $11 \pm 8 \mu\text{g/g}$ ), Cr ( $22 \pm 16 \mu\text{g/g}$ ), Cu ( $10 \pm 8 \mu\text{g/g}$ ), Hg ( $0.020 \pm 0.011 \mu\text{g/g}$ ), Pb ( $50 \pm 14 \mu\text{g/g}$ ) and Zn ( $32 \pm 20 \mu\text{g/g}$ ) concentrations in the sediments were within the typical range for marine coastal environments not subjected to human alteration.

In opposite, a few samples of sediments taken near the urban zone of the City of La Paz were found to have a relatively elevated concentrations of Pb ( $89 \mu\text{g/g}$ ). Additionally, As and Cd showed a slightly elevated values (up to  $44 \mu\text{g/g}$  and  $5.7 \mu\text{g/g}$ , respectively) in the northern part of the lagoon near the narrow isthmus of the El Mogote Peninsula. This was probably related to the natural accumulation of phosphate minerals originating from San Gregorio Formation.

8AM1999-MEQpaper10 oral

## ORGANOCHLORINE AND LIPID LEVELS IN BIOPSY BLUBBER SAMPLES OF FREE-RANGING GRAY WHALES (*Eschrichtius robustus*) SAMPLED OFF THE NORTHWEST WASHINGTON COAST

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The gray whale (*Eschrichtius robustus*) is a coastal migratory baleen whale (*Mysticete*) with a benthic feeding strategy. On the west coast of North America, gray whales make an annual migration between their breeding grounds in Mexican waters and their feeding grounds in Eastern North Pacific waters. Some whales spend considerable time in bays and estuaries, such as Puget Sound, WA. The Puget Sound gray whales are different from those found off the Washington coast, based on photo-identification work. For three consecutive years, blubber samples were acquired by biopsy from gray whales sampled off the Northwest Washington coast during the fall field season. These blubber samples were analyzed for organochlorines (OCs), including selected polychlorinated biphenyls (PCBs) and DDTs, to provide baseline chemical contaminant data for free-ranging whales. Lipid levels were also determined to provide an indication of the physiological condition of the whales.

The total DDT concentrations ( $\Sigma$ DDTs), based on wet weight or lipid content, were not significantly different in whale biopsy samples collected in 1996, 1997 or 1998. However, significantly higher total PCB levels ( $\Sigma$ PCBs), based on lipid content, were measured in 1998 whale blubber compared to the concentrations in the 1996 samples. The lipid data from our study indicated that a greater percentage of whales sampled in 1998 may be in poorer nutritional condition (low-lipid stores) compared to the whales sampled the previous two years. In addition, several gray whales recently stranded off the Washington coast and in Puget Sound, WA from December 1998 through June 1999. Blubber samples of the stranded gray whales were analyzed for OCs and lipids and were compared to the levels measured in blubber of gray whales previously analyzed by our laboratory, including the biopsy blubber samples.

8AM1999-MEQpaper11 poster

### "CHROMIUM SYNDROM" IN POLLUTION AREA OF WATER OF THE SEA OF JAPAN END OKHOTSK NORTHWEST PACIFIC

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Technogenical spillways to sea of northwest Pacific from APR - states (Asiatic Pacific Region) begin cause an "allergy" among the population - "chromium syndrom". It depends on growth of industrial pollution, tendency of accumulating toxic matters in marine sediments and bioorganisms, increase nervous, mental and oncology illness in nearcoastal countries. From Primorie technosphere by fresh water systems to the Sea of Japan, Sea of Okhotsk in Pacific was dumping about 9000 tones toxic metal substances. In these toxic metal substances relativity danger chromium has 29% quote. The chromium quote of relativity danger in technical spillways to Razdolnaya and Tumannaya Rivers is about 63%. In Primorie water-systems chromium is on the second place after copper in toxic effect. On the mining territories of Krai accumulated big volume of solid metal-containing waste productions at slag-heaps and tilt-repository. They amount in conditioned toxic substances above 78,05 million tones their quota-stress by chromium occur from base and temporary place for keeping. The volume dumping at area water take place in case of Primorye floods and burst the dam of tilt-repository.

It is election accumulate toxic chromium some marine organisms and alga, which used as foods. For example, at Pacific oysters the chromium concentration is above two order height limited permissible concentrations. Thus, topicality of problem is in: chronic accumulated active chromium in environment outline sea of Pacific, high relativity danger of chromium for biosphere, tendency to accumulate in marine organisms and alga. In chromium presents the toxic-effect of Hg, Pb, As, Co, Ni, Cu are increasing. The ecology mine, named "chromium syndrom", cocked in technosphere, biosphere, noosphere of the northwest Pacific.

8AM1999-MEQpaper12 poster

### FABRICATION OF FIBER OPTIC CHEMICAL SENSOR FOR ORGANOTIN DETECTION

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Organotin compounds have found widespread commercial use as pesticides, fungicides and stabilizers of plastics. Studies have shown that organotins produce very high toxicity upon different species of animals. Therefore the need for better and quick analytical methods capable of speciation of various trace organotin compounds in environment is apparent.

Remote sensors using fiber optics and spectroscopic techniques offer advantages in a variety of applications to monitor water contamination. Therefore, the main aim of present study is to develop fast, sensitive and cost-

effective method for continuous monitoring and early detection of organotins probably escaping from a disposal site and appearing time to time in sea water or in biological samples. The base problems which have been solved in this context are:

1. the chemical compound which can be used as a fluorescent chemical sensor for organotins was found ;
2. investigation of the physical-chemical and optical properties of this compound and its interaction with different types of organotins was made; and
3. fabrication of fluorescent fiber-optic chemical sensor prototype was done.

Chemical sensor probe was fabricated on base of membrane with immobilized 2',3,4',5,7-pentahydroxyflavone (Morin). S2000-FL Fiber optic fluorescent spectrometer (Ocean Optics, Inc) equipped with LS-450 light-emitting pulsed diode as a excitation source was used to detect emitted fluorescence. Method allows to detect dialkyltins (especially dibutyltin) in the concentration range of 2-10 ng/ml. Application of this technique for continuous environment monitoring is discussed.

8AM1999-MEQpaper13 poster

### SCREENING FOR ANTIFOULING AGENT FROM SEAWEED EXTRACTS

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Marine fouling organisms contribute significantly to the fouling community on a wide range of immersed substrates; ship hulls, nets, pipes, of cooling systems of power stations and mariculture facilities. Copper and tributyltin oxide (TBTO) have been developed as antifoulants, but environmental problem associated with these compounds has raised serious concern. Thus, we have screened new antifoulants from seaweed extracts using macroalgae *Enteromorpha prolifera* and mussel *Mytilus edulis* as assay system. In *E. prolifera* assay system, the methanol extracts of *Ishige foliacea*, *Colpomenia bulbosa*, *Sargassum horneri*, *Endarachne binghamiae*, and *Grateloupia prolongata* inhibit spore germination more than 0.5 fold and inhibit the tissue growth by 0.6 fold. In *M. edulis* assay system, the methanol extracts of *I. foliacea*, *Scytosiphon lomentaria*, *C. bulbosa*, *Ecklonia cava*, *Symphyclocladia latiuscula*, and *Monostroma nitidum* showed foot-stimulating activities of 100%, 100%, 94%, 94%, 82% and 84%, respectively. Methanol extracts of *I. foliacea*, *C. bulbosa* and *Scytosiphon lomentaria* have been screened for the antifouling agents against both of *E. prolifera* and *M. edulis*.

8AM1999-MEQpaper14 poster

### ALGICIDAL ACTIVITY AND PARTIAL SEQUENCE OF 18S-rDNA FROM THE SEAWEED *Corallina pilulifera*

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Extracts of seaweeds from the coast of Korea have been tested *in vitro* for algicidal activity against the growth of the toxic microalga *Cochlodinium polykrikoides*. Among the Korean seaweeds, The extracts of *Corallina pilulifera* showed strongly growth inhibition of *Cochlodinium polykrikoides*. The dried tissue also showed strongly algicidal activity. We have tested an effect of photosensitizer (UVA, VIS), pre-treatments, product through tissue culture to improve algicidal substances, and genetic analysis of partial 18S-rDNA. The methanol extract of *C. pilulifera* showed photosensitizer effects by UVA and VIS, slightly, but the water extract did not show. Condition of pre-treatment is Temperature, light and pH. Temperature, light and pH to improvement anti-red tide substances for 1 day were 15°C, 2000LUX, pH 7 ~ 8. Conditions of tissue culture to improvement anti-red tide substances was 15°C, 3000LUX. *Corallina* sp. of Korea showed similar according to 18S-rDNA. Conditions of pre-treatment

to improve algal activity were 15°C, pH 7-8, 2000LUX for 1 day culture. The best conditions of tissue culture were 15°C, 3000LUX, Finally.

8AM1999-MEQpaper15 poster

**DEVELOPMENT OF 16S rRNA TARGETED PCR METHODS FOR THE DETECTION OF *Vibrio vulnificus* IN AQUATIC ANIMALS**

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Efficient and rapid methods for the detection of human pathogen, *Vibrio vulnificus*, using the PCR methods were described. The set of specific primers for the detection of *V. vulnificus* was designed against variable region of 16S rRNA of *V. vulnificus*. The PCR amplification with designed primers was able to detect both biotype 1 and biotype 2 without cross reaction with Vibrionaceae and other bacteria. Moreover, it was possible to differentiate the genetic type A and type B of *V. vulnificus* by the combination of different primers. On the comparison of sensitivities with PCR, RT-PCR, nested PCR and nested RT-PCR, the last one was the most sensitive and could detect 3cells/ml on deduction from the extracted total nucleic acid of *V. vulnificus*. To avoid the complicated steps of nucleic acid extraction, it was also demonstrated the nested RT-PCR with a whole cell bacteria as a template of amplification. This method with a whole cell template for nested RT-PCR could detect 30cells/g in the homogenate of oyster tissue artificially inoculated *V. vulnificus* without enrichment and within 6 hours. This nested RT-PCR assay, which did not require nucleic acid extraction, may facilitate the detection of *V. vulnificus* when present in aquatic animals and reduced the effects of PCR inhibitor presented in the aquatic animals.

8AM1999-MEQpaper16 poster

**ACID-RESISTANT LIMIT AND PROTEIN EXPRESSION OF THE SEAWEED *Porphyra yezoensis***

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In the seaweed *Porphyra* culture farm, we usually treat acidic organics to remove epiphyte on the thalli. Thus, we have selected an acid-resistant mutant of *P.yezoensis*, and composed the protein profiles after acid treatment. Using monospores and thalli of the wild strain citric acid was added to PES medium not containing a buffer to give the acid stress for 1min or 5min, then cultured at 200 under 2500lux(L:D=14:10). Both of the monospores and thallus cells died at 1.2M of citric acid. When added citric acid in PES and cultured for 7d, both cells died at 1mM. From protein profiles expressed by the acid stress for 1 min, 4 different sites of proteins have been appeared on 2D SDS-PAGE after rehabilitated time of 30min-4h in seawater.

8AM1999-MEQpaper20 poster

## **GEOCHEMICAL ASSESSMENT OF ENVIRONMENTAL QUALITY OF SEDIMENTS OF THE COLORADO RIVER DELTA AND ADJACENT UPPER GULF OF CALIFORNIA**

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To contribute in the understanding of recent environmental changes on the drainage basin of the Colorado River, in its delta and adjacent portion of the Upper Gulf of California, the contents of Fe, Ca and 30 trace elements in sediments of this area were determined using instrumental neutron activation analysis technique.

Spatial distributions of the concentrations of iron, potassium, calcium, organic carbon, lantanides and some other trace elements reveal in the southwestern sector of the Upper Gulf of California the existence of the zone of the accumulation of fine-grained sedimentary material, enriched in Fe, Zn, Cr, Co and organic carbon. Lithological and chemical composition of sediments of the Colorado River delta and in adjacent marine environment are controlled mostly by intensive tidal movements of water masses with high importance of resuspension - deposition processes which rework sediments supplied there by the Colorado River in past times before the artificial regulation of the freshwater discharge of the Colorado River.

<sup>210</sup>Pb chronology of vertical profiles of elements for sediment core taken from the Upper Gulf of California elucidate the absence of anthropogenic contamination of the area by environmentally important trace elements Cr, Zn, Co, Ni, Sb and As. On the contrary, almost double decrease of contents of Fe, Sc, Cr, Co and U in upper horizons was registered in horizons of the core corresponding to last four decades of this century characterized by almost total disappearance of the freshwater input in this area of the Gulf of California.

8AM1999-MEQpaper21 poster

## **EVOLUTION OF RADIOACTIVE CONTAMINATION OF BOTTOM SEDIMENTS IN THE ECOSYSTEM OF THE BIGHT CHAZMA OF THE JAPAN SEA**

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The results of investigation of radioactivity distribution in the bottom sediments and dynamics of radioactive contamination in the submarine nuclear accident in 1985 year are summarized. Radioactive contamination by sharp heterogeneity is characterized and in the sediments of layer 0-30 cm is concentrated, and with Co-60 (>99 %) mainly is caused. The maximal specific activity cobalt (to 10<sup>8</sup> Bq/kg) in the epicenter zone of accident is observed. The "hot" particles representing porous alloyed formations identified as particles of nuclear fuel, which include elements characteristic also for stainless steel from sediments were allocated.

Density of radioactive contamination of bottom sediments on an underwater path changes from  $4.7 \times 10^7$  Bq/m<sup>2</sup> in zone of explosion to  $2.9 \times 10^4$  Bq/m<sup>2</sup> on exit of the bight. Outside of the bight in the bay Strelok density of pollution does not exceed  $10^4$  Bq/m<sup>2</sup>.

The general charge of emergency Co-60 in bottom sediments on 1997 makes  $4.7 \times 10^{11}$  Bq. From them  $0.5 \times 10^{11}$  Bq in sediments adjacent of water area of the Strelok is concentrated. Transport and deposit Co-60 in the bay Strelok can get 20 % from a general charge. The good concurrence of meanings of average value of transport Co-60 from the bight -  $6.4 \times 10^9$  Bq/year (from them  $2.1 \times 10^9$  Bq/year on a suspension) and mean quantity for year of deposit Co-60 ( $3.8 \times 10^9$  Bq/year) in sediments adjacent of water area of a bay Strelok is received. The influence-transport by water exchange on a charge of Co-60 in the Chazhma bight on the order is lower, than its reduction by radioactive decay.

The estimations of time of achievement of a threshold level of density of contamination- $3.7 \times 10^4$  Bq/m<sup>2</sup>: from 55 years in the epicenter zone of accident and to 8 years near by exit of the bight are made. For local sites and layers of the maximal contamination of bottom sediments in the epicenter this time increase to 100 years. The time for which the general charge Co-60 in the bight Chazhma will decrease up to 1 % from observable now on the water exchange 50-200 m<sup>3</sup>/s on the average 30 years makes.

In biological objects (Polychaeta *Tharyx pacifica* and Nematoda *Sabatieria palmaris*) in the epicenter zone of accident and in control samples from bight Vostok essential of distinctions in a level of a radioactivity is not revealed.

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## THE ROLE OF A LIGHT SPECTRAL COMPOSITION IN THE PROCESS OF SYNTHESIS AND ACCUMULATION OF UV-PROTECTING MYCOSPORINE-LIKE AMINO ACIDS

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Last decades the increase of an amount of UV radiation, reaching the surface of the Earth is watched in connection with decrease of ozone layer. The accumulation of UV-absorbing mycosporine-like amino acids (MAAs) in algae both tropical, and moderate latitudes, which play the role of the biological sunlight filter (Karentz et al., 1991), may be a mechanism for the reducing of the destructive effect of UV radiation. There is not too much information about synthesis and biological significance of these substances. The aims of this study was to find out what region of solar spectrum initiates the synthesis and accumulation of mycosporine-like amino acids in common and economically important rhodophyte *Chondrus crispus* from subtidal zone around Helgoland Island, North Sea. Deepwater *C. crispus* from natural habitat used in our experiments has never exposed to UV radiation during their life cycle and never shown the existence of MAAs. After 3-4 h excessive photosynthetically active radiation (PAR) or UV exposure we observed the appearance of MAAs with absorption maximum at 325-334 nm. But the repeated high doses of PAR did not cause the accumulation of MAAs. At the same time, the synthesis of MAAs continued in UV treatment. However, the algae were not capable to cope with the powerful flow of radiation and lost. Possibly, it is happened because the number of MAAs was by order lower in compare with *C. crispus* inhabiting in the intertidal zone and the algae need enough high concentration of these pigments to display the suncreening effect. In the PAR treatments, at intensities equalled the natural ones and 2 times lower those, we also observed the synthesis and accumulation of MAAs. However, it was happened later (second experimental day) and with lesser intensity than in UV treatments. The level of MAAs contents in UV treatments was 4-5 times higher than in PAR treatments. PAR is selectively attenuated with depth (Jerlov, 1976), and possibly, deepwater algae are lacking the required signal of specific region of PAR for MAAs synthesis. This suggestion is confirmed by the samples taken from enough high depth which possess no even the tracks of MAAs.

**DISTRIBUTION OF DIFFERENT CHLORAMPHENICOL RESISTANCE GENES MEDIATED BY R PLASMID IN FISH PATHOGEN**

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Chloramphenicol-resistant isolates of fish pathogen obtained from various locations in the Korea were studied to determine the distribution of the CAT gene. Specificity of PCR with primers designed to identify the kinds of CAT gene appeared very effective and sensitive method. Out of the 134 isolates examined, 10 showed resistance to chloramphenicol, tetracycline, streptomycin, ampicillin, colistin, nalidixic acid, oxolinic acid, kanamycin. One out of 10 multidrug resistance bacteria contained transferable R plasmid encoding chloramphenicol, tetracycline and cryptic plasmid encoding ampicillin and kanamycin resistance. Almost all of the clinical isolates of fish pathogen, *Edwardsiella tarda* and *Vibrio sp.*, resistant to chloramphenicol from East Sea carried CAT<sub>I</sub> and CAT<sub>II</sub> genes, respectively. Moreover all clinical isolates, *Edwardsiella tarda*, from South Sea carried only CAT<sub>I</sub> gene. It suggested that CAT gene in the resistant bacteria was dependent on the area and was originated from very limited environmental or biological sources. We also had analysed the conjugation effectiveness of the R plasmid in the isolated multiple antibiotics resistant bacteria identified as *V. damsella*. The transfer frequency of R plasmid appeared to be temperature and time related for mating, with high frequencies at 300, for 24 hours. Donor isolates with R plasmid was shown to transfer the plasmid to *Escherichia coli* and *Edwardsiella tarda* at fairly high frequencies.

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## **LONG-LIVED OCEAN EDDIES IN ALASKAN STREAM**

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Long-lived anticyclonic eddies, or meanders, in the Alaskan Stream are observed in sea surface anomalies computed from TOPEX/POSEIDON (T/P) satellite altimetry data, September 1992 - September 1998. The T/P sea level data were detided using an enhanced harmonic analysis method, with improved nodal modulation and SVD covariance matrix to monitor tidal aliasing. A typical eddy diameter is about 150 km, with sea-surface elevation up to 70 cm in the center. Their life span is between 1 and 3 years as they move westward along the Stream at an average speed of 3.1 km/day. Eddies often grow in surface elevation while they are trapped in the Alaskan Stream along the continental slope, but decay within a few months once they drift away from the Stream. Of the five eddies observed, only the last two were formed after the first T/P observations in September 1992. Of these, eddy "4" was set up along the Alaskan Panhandle in January of 1995, drifting across the northern Gulf of Alaska before entering the Alaskan Stream, while "5" was formed in the Stream near Kodiak Island, nearly at same location (157W) and about 3 months after the break up of eddy "4" in March 1996. Eddy "5" remains visible (about 20 cm high) and nearly stationary just east of the dateline at the time of writing (July 1999). The longest continuously-observed was eddy "3", appearing in the first T/P cycle in September 1992 in the northern Gulf of Alaska (147W) and decaying before reaching the dateline in July 1995.

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## **VARIATIONS OF WATER AND AIR TEMPERATURE IN THE PETER THE GREAT BAY AREA OVER THE CENTURY PERIOD (THE SEA OF JAPAN)**

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This work is devoted to the analysis of variations in hydrometeorological regime of coastal waters of the Peter the Great Bay on the basis of multiannual observation series at four hydrometeorological stations (HMS) of the State Hydrometeorological Service Network for the following period of instrumental observations (HMS Possyet - since 1931; Gamov - since 1954; Nakhodka - since 1932; Vladivostok - since 1882).

The results provide statistical characteristics of the average multiannual water and air temperature at the HMS and corroborate a previous assumption on a prevalence of the advective factors determining the temperature variations over the climatic ones.

Analysis of interannual variations of the Peter the Great Bay area coastal waters temperature regime allows us to single out and to assess the climatic trends in water and air temperature distribution. By the analysis of linear trend of air temperature at all the stations a global positive trend was found only at Vladivostok. The use of sliding polinoms made possible to reveal the periods of temperature up and down, for the entire observational period. Climatic trends were built and assessed on bold sections of the temperature curve. A positive trend of 1 percent significance level is traceable for all stations since 1983. Time spells which display trends of significance in mean annual temperature variations have been analyzed for the contribution of temperature of warm and cold seasons.

**FORMATION OF THE OKHOTSK SEA INTERMEDIATE WATER**Sergey Gladyshev<sup>1</sup>, Stephen C. Riser<sup>2</sup>, and Masaaki Wakatsuchi<sup>3</sup><sup>1</sup> *Pacific Oceanological Institute, 43 Baltiyskaya Street, Vladivostok, Russia. 690041*<sup>2</sup> *School of Oceanography, University of Washington, Seattle, WA 98195, U.S.A.*<sup>3</sup> *Institute of Low Temperature Science, Hokkaido University, Sapporo, Japan 060-0819*

Five CTD surveys including dissolved oxygen and silica data completed between 1989 and 1998 are used to examine the process of the formation of Okhotsk Sea Intermediate Water (OSIW). OSIW originates in the Okhotsk Sea and plays an important role in modification of the North Pacific Intermediate Water (NPIW). We apply isopycnal analysis as the main tool to define and compare OSIW properties within the Okhotsk Sea and with North Pacific Intermediate Water (NPIW). CTD observations show that OSIW is located in a density range 26.6-27.55  $\sigma_\theta$  that corresponds to depths 130-1500 m. Comparison of its basin-wide thermohaline and hydrochemistry properties reveals well-known features of the Okhotsk Sea oceanography: (a) the main inflow of the North Pacific water occurs through Kruzenshtern Strait, where NPIW undergoes the first stage of strong modification due to tidal mixing to become part of OSIW, and then spreads over the northern and central parts of the Okhotsk Sea; (b) this water replaces OSIW in the western part of the Okhotsk Sea, which is passing through the second stage of modification, mixing with cold, dense, shelf water (DSW), produced in coastal shelf polynyas, and which flows to the south to the Deep Kuril Basin (DKB), completing gross cyclonic gyre in the Okhotsk Sea; (c) the third stage of modification occurs in the DKB, where the upper part of OSIW is ventilated by Forerunner Soya Water (FSW), and where its lower part is cooled and oxygenated; (d) finally, ventilation of OSIW by DSW and FSW occurs in the density range 26.6-27.0  $\sigma_\theta$ .

According to observations, the role of the Kuril straits is as follows. Strong tidal mixing in the Kuril straits produces a pycnostad in the upper part of the OSIW, which Yasuda (1997) called Okhotsk Sea Mode Water (OSMW). The lower part of OSIW permanently mixes in Bussol and Friza straits. In particular, the 40-km wide Friza Strait is an excellent natural trap for the lower part of OSIW. This water is sucked and intensively mixed by tides but can not pass through this strait because of a 500-m submarine ridge on its North Pacific side. We believe that some water parcels undergo many cycles of tidal mixing in Bussol and Friza straits. In general, the lower part of OSIW mixes with OSMW and Okhotsk Sea Deep Water (OSDW), and both are colder and richer in oxygen in comparison with the former. Thus, mixing in Bussol and Friza straits leads to reduction of temperature and an increase in oxygen in the lower part of OSIW. According to our CTD surveys and historical data presented by Moroshkin (1966), Kruzenshtern Strait always contributes as the inflow strait for the Okhotsk Sea, while Bussol Strait appears to be as two-way exchange strait. We assume, based on the temperature and salinity observations, possible seasonal variability of water exchange in Bussol Strait, when inflow to the Okhotsk Sea develops in summer. When NPIW flows in through Kruzenshtern or Bussol straits to the Okhotsk Sea, a steady state can not be reached and a complicated, albeit quasi-periodic detachment of anticyclonic eddies appears to take place. These eddies are permanently observed in the vicinity of Bussol and Kruzenshtern straits and have thermocline structure to the water in the straits. We suggest that such anticyclonic eddies are the main cause of the general deepening of isopycnals in the Okhotsk Sea.

**ON THE TENDENCY FOR FRESHER SEA SURFACE WATERS AROUND THE WESTERN SUBARCTIC CIRCULATION AFTER 1994**Yasuhiro Kawasaki*Hokkaido National Fisheries Research Institute, 116 Katsurakoi, Kushiro, Hokkaido, Japan. 085-0802 e-mail: ykawasak@hnf.affrc.go.jp*

Yearly changes in hydrographic features of the western subarctic circulation (WSC) was analyzed using CTD data collected along the 165°E meridian (165E-line) in early July, 1992-1998, along a transect across the subarctic front to the Okhotsk Sea through the Bussol' Strait (NU-line) in early September, 1988-1998, and along a transect

across the Oyashio, south-east of Akkeshi, Hokkaido Japan (A-line) in Jan., Mar., Apr., May, July, Aug., Oct., 1987-1998. After 1994, there was a tendency for colder and fresher waters around the WSC shallower than 26.5 sigma-theta, whereas there was a warm and saline tendency in the subsurface layer beneath the 26.5 sigma-theta. There was a general tendency for less saline water along 165E-line and NU-line after 1994. On the other hand, less saline surface water were observed along A-line during the period from 1995 to 1997. These indicated that tendencies for fresher sea surface waters are found around the whole WSC area. This suggests that the cause of the recent freshening of the surface water and the warming of the subsurface water would be sought in the East Kamchatka Current Water or in the whole WSC area in the North Pacific Ocean.

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### **HYDROGRAPHIC STRUCTURES OF INTERMEDIATE WATER AND TRANSPORTS OF THE KUROSHIO OFF THE BOSO PENINSULA**

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Hydrographic structures and transports of the Kuroshio along the TOPEX/Poseidon Satellite track off Boso peninsula in the southern coast of Japan were described with CTD and lowered acoustic Doppler current profiler (LADCP) surveys performed in May 1998.

At the northern part from 31N to 35N the northeastward transport along Kuroshio was 19.9Sv in the potential density range 26.6-27.5 sigma-theta and at the southern part from 30N to 31N the southwestward transport was 10.9Sv. And incoming Kuroshio water was 9.7Sv and that of Oyashio was -0.7Sv under the assumption of isopycnal mixing in this density range. The water mass structure dramatically changed at 32N, that is, anomalous salinity and oxygen profiles in which isopycnal mean values are extracted have shown different meridional distribution. Salinity shows positive anomaly at northern part of 32N and negative at southern part in the density range 26.0-27.5 sigma-theta, on the other hand oxygen shows negative anomaly at northern part of 32N and positive at southern part in the density 26.0-27.0 sigma-theta, but shows reverse distribution in the density 27.0-27.5 sigma-theta. This oxygen negative anomaly in the southern deeper region (27.0-27.5 sigma-theta) is possibly due to that incoming Oyashio water has less oxygen than the subtropical water which Kuroshio transports originated from the Antarctic Intermediate Water (AAIW) with higher oxygen centered at around 27.2 sigma-theta.

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### **OCEANOGRAPHIC CONDITIONS IN THE NORTH-WESTERN JAPAN SEA IN SPRING**

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The results of the cruise of r/v *Pavel Gordienko* implemented by the POI in collaboration with FERHRI, SIO and UW on 14-23 April 1999 are discussed. On the base of CTD hydrographic measurements and hydrochemical analyses included nutrients and carbonate system parameters the distribution and properties of water masses over

the Peter the Great Bay, continental slope area and deep Japan Basin are demonstrated. Relatively cold saline and dense wintered water was found at some hollows of very bottom layer of the bay, at the steps of adjacent continental slope canyons and in the thin bottom layer at the edge of the deep Japan Basin. Distribution of nutrients confirmed that the direct influence of this water on the properties of the Japan Sea deep water is most probably insignificant. Intensive mixing and layering of the bay water and the open sea water occurred over the slope. However both hydrographic and hydrochemical data indicated no intrusion of the sea water into the bay at that period. Three anticyclonic mesoscale rings of diameters from 40 to 90 km located to the north of the subarctic front were sampled in details. By the differences of water properties inside and outside the eddies they were traced down to the bottom layer (3000-3500 m) having relatively warm fresh and oxygen rich core in the upper layer (0-300 m) and a secondary core of comparatively vertically homogeneous and high oxygen layer between 500 and 900 m.

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### **SEASONAL VARIABILITY OF TEMPERATURE AND SALINITY IN ACTIVE LAYER OF THE JAPAN SEA**

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The seasonal parameter variations in the active layer of the Japan Sea are considered. The boundaries of this layer are the surface and depth, on which the seasonal oceanographic parameter variations are absent or they are not statistically significant. For the work all available deep sea oceanographic observations of the Russian Institutions and data from S. Levitus' Atlas (1994) and JODC have been used. The total number of stations is about 140 thousand. Parameters of the upper quasi-homogeneous layer (temperature, salinity, vertical extension, as well as their average square biases) are analyzed. They show that in the warm period maximal thickness, temperature and upper quasi-homogeneous layer salinity are the typical features of water in the southern and eastern part of the sea. In the cold period this distribution is more compound. The maximal development of convective processes is observed from January till March. In this period of a year the area of maximal deepening of the lower boundary in the upper quasi-homogeneous layer is located near the continental slope. The maximal seasonal sea water temperature variations (lower than 21°C) are found in the surface layer between 39° and 43°N. The maximal seasonal salinity water variations are distinguished in the surface waters of the north and northwest parts of the sea. With the depth increasing the amplitude of the seasonal temperature and salinity variations in the Japan Sea decrease. The maximal surface water warming is observed in August mainly. At subsurface levels it shifts to the later months. The surface and subsurface waters are the coldest near the northwest coasts in January and February and near Japan in February and March. The minimal salinity of the surface water is observed, as a rule, in August-September. The maximal salinity of the surface water is found in the southern part of sea in April-May, in the central part of the sea from January till March, in the northern part of the sea from May till September. The calculation accuracy of the average multi-year monthly values of temperature and salinity for different levels has been estimated.

**SOME FEATURES OF VARIABILITY OF WATER THERMAL CONDITIONS IN THE TATAR STRAIT (THE SEA OF JAPAN) IN THE 80-90S**A.A. Nikitin, T.A. Shatilina, T.V. Dyomina, and B.S. Dyakov*Pacific Research Fisheries Centre (TINRO-Centre), 4 Shevchenko Alley, Vladivostok, Russia. 690600 e-mail: root@tinro.marine.su*

The data on water temperature for continental slope of the Tatar Strait: stations of Zolotoy Cape, Sosunovo and Rudnaya Pristan (1980-1995), and the western coast of Sakhalin: Kholmsk (1913-1995) and Alexandrovsk - Sakhalinskiy (1961-1985) in January, July and October are analyzed. In January, July and October of the 90s it was traced the brightly expressed trend of warming in the coastal waters of Primorye, water warming in the western coastal Sakhalin was marked in January, but not in July and October. The warming of Primorye coastal waters coincides with the rise of water temperature at the Sangarskiy section in the layer of 200 m and reaches its peak in the 90s. Water warming in the northwestern part of the Japan Sea is traced by satellite data. Fall of water temperature is marked at the Antonovski section nearshore of the western Sakhalin in the layer of 200 m.

This anomal warming of the Primorye coastal waters is possible to be connected with the change of atmospheric circulation over the Japan Sea and adjacent areas. These changes are shown in the growth of anomalies of geopotential H 500 over the northern part of the Japan Sea in January of the 90s.

**THE SEA OF JAPAN PROPER WATER INHOMOGENEITY AND WARMING IN THE 90s**Vladimir I. Ponomarev<sup>1</sup>, A.N. Salyuk<sup>1</sup>, V.B. Lobanov<sup>1</sup>, S. Sagalaev<sup>1</sup>, P.Y. Tishchenko<sup>1</sup>, and L.D. Talley<sup>2</sup><sup>1</sup> *Pacific Oceanological Institute, 43 Baltiyskaya Street, Vladivostok, Russia. 690041*<sup>2</sup> *Scripps Institution of Oceanography, University of California, San Diego, La Jolla, CA 92093-0230, U.S.A.*

This paper presents new data on temperature, salinity and oxygen spatial and temporal variations in the deep and bottom waters of the Japan Sea based on the results of the joint cruises implemented by the Pacific Oceanological Institute under a few international programs carried out over 1992-1999. Our results confirm the increasing of potential temperature and decreasing of dissolved oxygen content of the Proper Water in a whole layer below 2000 m observed at all deep basins of the sea during the 90th. The rate of the potential temperature rise is higher for the upper layers than for the bottom layers. This leads to the growth of a vertical stability of the Proper Water in general. The depth of main pycnocline has a tendency of lowering especially in the southern area. It was found that horizontal inhomogeneity of the bottom water characteristics through the deep basins of the Japan Sea has significantly increased over past decade. Maximum positive heat flux into the deep and bottom layers is found at the Yamato Basin and is mainly caused by the eddy dynamics over the features of bottom relief. The coldest bottom water is located at the Japan Basin where also extremal vertical fluxes were connected with the topography (marginal areas, edges of the bottom rises and sea mounts).

## INTERANNUAL VARIABILITY OF CHARACTERISTICS OF OYASHIO CURRENT IN SUMMER OF 1989-1998

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Based on the data obtained from research cruises (about 2500 stations) in summer (July - September) of 1989-1998 in the Pacific side off the Kuril Islands the interannual variability of the Oyashio Current is considered.

The data were averaged in 1-degree squares for the summer season of every year. Seasonal charts of dynamic topography 0/500 db were constructed and velocity and water transport of geostrophic component of the Oyashio Current was calculated. As characteristics of the Oyashio Current (Table 1) the follows were accepted:

- presence (+) or absence (-) of branches of the current,
- velocity of the current at the surface,
- water transport for selecting section in the layer of 0-500 m.

Let us notice, that the section (located southward of the Shikotan Island) did not cross all the Oyashio Current. Therefore it is impossible to identify the water transport received on the section with the transport of all the current. However, the section got out so, that it passed through main flow of the current, and the length of the section was constant. Hence, the comparable between themselves characteristics of the Oyashio Current, giving representation about velocities and intensity of water transport in the main flow of the current were obtained:

Table 1.

Interannual variability of the characteristics of Oyashio Current in summer season

Year	1-st branch	2-nd branch	3-rd branch	4-th branch	Velocity, cm/s	Water transport, Sv
1989	+	-	+	-	2.4	0.10
1990	+	+	+	-	4.7	0.59
1991	+	-	+	-	x	x
1992	+	+	+	+	5.7	1.01
1993	+	+	+	+	2.8	0.57
1994	+	+	+	-	1.4	0.03
1995	+	+	-	+	9.1	1.85
1996	+	+	-	+	3.9	1.53
1997	+	-	-	-	2.6	0.05
1998	+	+	+	+	11.6	1.44
1964-1997	+	+	+	-	3.0	0.49

x - data are absent.

The analysis of the obtained results was carried out.

## TIME AND SPATIAL VARIATIONS OF THE UPWELLING COLD WATER IN THE EASTERN COAST OF THE KOREAN PENINSULA IN THE SUMMER SEASON

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Daily time series of longshore wind at 8 stations, sea surface temperature (SST) at 11 stations in the eastern coast of the Korean peninsula during 1983-1997 and the NOAA/AVHRR satellite data during 1990-1998 were used in order to study the time and spatial variations of the upwelling cold water which occurred in the summer season.

When the cold water occurred SST comes down more than 50 in a day. The maximum RMS amplitude of daily variation of SST when the cold water occurred was 9.5 at Sockcho coastal area at 211 Julian day during 1983-1997.

The cold water occurred frequently in eastern coastal areas such as Soimal, Kijang, Ulgi, Kampo, Pohang, Youngduk, Chukbyun, Chumunjin and Sokcho.

We got the cross correlation coefficients among 11 coastal stations. The cross correlation coefficients were higher than 0.5 in between Sokcho and Chumunjin in the northern part of East Sea and among Soimal, Kijang, Ulgi, Kampo and Pohang in the southern part of East Sea. In late July, 1995 the cold water occurred at Ulgi coastal area and extended to Ullung Island which is located 250 km from Ulgi coast.

Even though the distance between Soimal and Ulgi coast area is more than 120 km, the cross correlation coefficient related to the anomalies of SST due to upwelling cold water was the highest (0.7) in the southeastern coastal area of the Korean peninsula. This may be due to the cyclonic circulation of the Tsushima Current in this area and the topography of the ocean rather than the local south wind which induced the coastal upwelling.

## PRELIMINARY RESULTS FOR HYDROGRAPHY AND CIRCULATION OF THE JAPAN/EAST SEA IN SUMMER, 1999

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A two-ship survey of the Japan (East) Sea was undertaken in June-August, 1999. Horizontal coverage of most of the region was achieved. All sampling was to the ocean-bottom, and every station included sampling for water chemistry as well as temperature, salinity and oxygen. At every station a complete velocity profile was collected using a lowered acoustic doppler current profiler, and shipboard ADCP data were collected while underway.

Preliminary findings from the Revelle cruise include a description of the water mass properties in terms of oxygen and nutrients as well as salinity and temperature. These features will be reviewed in the talk, including the use of deep oxygen and nutrient signals to indicate direction of flow and sources of the deep and intermediate waters. The Khromov cruise has not occurred as of the deadline for this abstract and will highlight Japan Basin circulation.

Of extra note from the Revelle data, augmenting the well-known features of the Japan (East) Sea are:

(1) a relatively large amount of nitrite in the Ulleung Basin and off the coast of Japan below the euphotic zone to about 500 meters and in a layer of about 100 m thickness at the ocean bottom at depths less than 1500 meters, coinciding with a small decrease in the (high) oxygen content and increase in the alkalinity;

- (2) incursion of high salinity and warm temperatures to 500 meters depth west of Hokkaido, which is likely linked to mixing between Tsushima Current water and subpolar water, but which might also have a Tatar Strait source;
- (3) major influence on the water properties, flow and subpolar front during this period by the Yamato Rise and the Noto peninsula as evidenced also in SST from satellite images;
- (4) concentration of geostrophic shear in and above the pycnocline at about 200 m depth, but with weak extension of shear of the same sign to the bottom at most locations, suggesting that most flow structures extend from top to bottom;
- (5) evidence of deep mixing in the northern (Japan) Basin reaching 1200 meters from the bottom with the most homogeneous and coldest water in the center of the basin.

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oral

### **NORTH PACIFIC INTERMEDIATE WATER IN THE KUROSHIO-OYASHIO INTERFRONTAL ZONE**

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Recent observational results using CTD-LADCP surveys in the Kuroshio-Oyashio Interfrontal Zone are described, focusing on the Oyashio water transport and the formation of the North Pacific Intermediate Water (NPIW). From the 1998 May-June cruise by R/V *Soyo maru* (National Research Institute of Fisheries Science: NRIFS), the southwestward Oyashio transport near the south coast of Hokkaido was 10.1 Sv in the density of 26.6-27.5: 2.5 Sv from the Okhotsk Sea and 7.6 Sv from the Pacific Ocean. The Oyashio northeastward counter current was 4.9 Sv, and the water was significantly modified from the incoming Oyashio. The transport of the Oyashio water component south of the Subarctic Front to 39N was 2.0 Sv. The cross-gyre Oyashio transport across 39N was thus estimated to be 7 Sv, which could mostly explain the salinity profile of NPIW in the Kuroshio-Oyashio Interfrontal Zone under the assumption of isopycnal mixing with 13.1 Sv of the Kuroshio water south of Boso Peninsula; most of the cross-gyre Oyashio water flowed eastward along the Kuroshio Extension. The incoming Oyashio was lower in oxygen than in the subtropical areas in 26.9-27.6, possibly due to the influence of the Antarctic Intermediate Water (AAIW) that transports oxygen-rich water along the western boundary of the North Pacific Ocean and along the Kuroshio Extension, increasing the oxygen in the areas south of the Subarctic Front; thus the AAIW significantly contributes to the formation of lower part of NPIW.

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oral

### **HEAT AND SALT BALANCE STUDY IN THE COASTAL AREA OF THE JAPAN SEA**

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Heat and salt balance of 3 water layers (superficial, surface, and deep ones) was investigated for 2 points located in the coastal area of the Japan Sea near Vladivostok on the data of weekly surveys obtained in May-August of 1998, daily meteorological data of Vladivostok station, and monthly data on river discharge. One point (depth 48 m) was located off-shore and was not influenced by river run-off directly, other point (6 m) was in estuarine zone.

Weather conditions were classified for 4 types. Two types were typical for cyclone passing: Type 1 for frontal part of cyclone (cloudy, rainy weather with strong southern wind), Type 2 for its back side (relatively cold, wet

weather with northern wind); other two types - for calmer monsoon weather: Type 3 with clear sky and morning fogs, and Type 4 with clouds and drizzle.

Heat and salt budget of water columns was estimated for periods between surveys and for each weather type. Investments of solar radiation, long-wave radiation, air-sea heat transfer were calculated with usage of standard empiric relations with date, latitude, cloudiness, and sea surface and air temperature. Wind-driven advection, evaporation, and precipitation influences as functions of wind velocity and humidity were estimated as rests of the budget in certain cases (for example, the case without advection if no wind). Vertical heat and salt exchanges between 3 layers because of their thickness fluctuations were evaluated as well, and the rests of vertical transfers were interpreted as turbulent flows of heat and salt.

There was determined that solar radiation, heat advection, and heat loss by evaporation were the most important investments for the heat budget of water column. The main mechanism of heat and fresh-water pumping to deep layer was the surface layer thickness fluctuations, but turbulent flow was not considerable. Besides of natural main investments of the salt budget (precipitation, evaporation, wind-driven advection, and river run-off), the strong horizontal flow of fresh water directed off coast was detected.

Empirical equations were created for all main relations.

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poster

### **TIDAL STIRRING IN EKATERINA STRAIT AS ECOLOGICAL FACTOR**

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Advection and water stratification in the Ekaterina Strait within twenty-four hours is strongly modified due to tidal currents in all the strait area. High tidal activity results in the tidal stirring, whose strength depends on different conditions. Due to this phenomenon, the classic water mass distribution characteristic for the strait area in the summer-fall period (warm and salt water of the Soya Current is located in the western half, colder and less salt water originated from Oyashio - in the eastern part) could be taken only for the quasi-stationary one which does not reflect a real oceanological situation. As far as the Soya Current due to seasonal variability has become more active (July), it dams the strait with its warm waters (August-September). The expressed infra-daily (tidal) variability considerably transforming the Soya Current waters, however, is to open slightly the strait zone for a short time within the tidal cycle what may be very important for passageway of some kinds of fish (like: saury, pilchard, salmon) migrating through the Ekaterina Strait, and the latter fact is to be considered in the fishery practice.

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poster

### **INTERANNUAL VARIABILITY OF ICE FORMATION IN THE OKHOTSK AND BERING SEAS DURING 1995-1999**

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The analysis of weekly SST maps constructed at VNIRO on the basis of satellite data for the 1995-1999 period was carried out. As it is known, formation of ice interrupts the process of air-sea interaction delaying the extension of winter convection into deep water. Ice cover acts as an isolator preventing the sea from cooling. In this paper I consider duration and dates of beginning and ending of ice period of various aquatories of the Okhotsk and Bering seas during 1995-1999. In the eastern Sea of Okhotsk the duration of ice margin staying south of 53

N was selected as a criterium of ice cover extension. The constant tendency (except for 1998) toward increase in duration of ice cover from 10 days in 1995 to 105 days in 1999 was noted. Also, tendency toward shift in dates of the maximal ice cover area in the Sea of Okhotsk is observed (from late February in 1995 to early April in 1999). The difference in days of crossing 57 N by the 0°C isotherm and the ice margin (when the ice cover extends to the south) was used as a conventional parameter of the winter cooling in the Sea of Okhotsk. This difference increased constantly from 19 to 50 days (again except the 1998). In 1997 and 1999 this parameter had the maximal values and correspondently in these years sea waters were the coolest. In the southwest Sea of Okhotsk the constant tendency toward more rapid warming up to 5°C was observed (from 70 days in 1995 to 32 in 1999). In the Bering Sea ice conditions during the period under consideration varied significantly. Duration of ice cover around the St. Matthew Island ranged from 49 days in 1998 to 136 days in 1996. Duration of staying of the northern ice margin south of 62 N changed from 153 days in 1996 to 74 days in 1998. In the both seas 1998 may be considered as the year with the least ice cover area during the 1995-1999 period.

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poster

## **A LIGHT DYNAMICS MODEL TO STUDY PARTICULATE ORGANIC CARBON VARIABILITY IN EASTERN SUBARCTIC PACIFIC**

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The oceans role in the global carbon cycle is ultimately linked to the spatial and temporal variability of particulate organic carbon (POC). POC cycling, which is forced by physical and chemical factors of marine environment, is a direct product of biological processes, such as primary production and grazing and its spatial dynamics and temporal variability therefore, can be a good indicator of how the marine biogeochemical cycle responds to changes in physical environment. The new optical method of POC determination (Bishop, 1999) was applied to study spatial and vertical structure of POC in Eastern Subarctic Pacific. The important factors governing the production of carbon biomass were considered, such as the mixed layer depth (dynamics and history of mixing), availability of light for marine phytoplankton and grazing. The significant spatial variability of POC was found, with the values varying from 500 to 5000 nmolC/l and strong vertical POC gradient at the halocline. To investigate the main factors governing the shape of vertical POC profile, the simple model of light dynamics was built. Analysis of vertical POC profiles shows that POC is high in the mixing layer and decreases dramatically below. It suggests that light availability related to stirring of the upper ocean is the primary factor leading to phytoplankton growth and hence POC production. History of mixing (e.g. previous mixing events) is another important factor for the interpretation of POC profiles. The utility of optical method of particulate organic carbon measurement was shown in getting POC numbers and investigating POC field on temporal and spatial scales not attainable with direct sampling methods. The directions of future research in the Subpolar Pacific could include the analysis of POC fields on larger spatial scales and studying the seasonal POC cycle in order to understand what processes drive the spatial and temporal POC variability.

### References:

Bishop J.K.B. (1999) Transmissiometer measurements of POC. *Deep Sea Research*, Vol. 46, NO 2, pp. 355-369.

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## **TWO TYPES OF HYDROLOGICAL REGIME IN THE SEA AROUND THE NORTHEASTERN SHELF OF SAKHALIN**

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Analysis of interannual variability of spring and early summer seawater regime on the northeastern Sakhalin shelf has added some interesting results. Systematization of dynamic height fields and integral hydrophysical parameters has revealed two major types of seawater structure and corresponding three-dimensional distribution of hydrophysical parameters. The first traditional climatic type is characterized by the well-developed coastal East Sakhalin and the near-slope south-directed currents, shoreward decreasing surface density and salinity, relatively high values of horizontal density gradients (0.1 to 0.25 conventional units of density/km) and pycnocline intensity (up to 1.2 conventional units of density/m), and relatively lower depth of pycnocline (predominantly in 6-10m interval). The second non-traditional type is peculiar to north-directed coastal and near-slope currents, increasing coastal salinity and density (coastal upwelling), relatively low frontal density of water structure (about an order lower than the one of the first type), and deeper pycnocline (approximately twice deeper). On dynamic topography maps this situation is diagnosed over a meridionally oriented large-scale cyclonic eddy in the vicinity of the northeast Sakhalin and blockage of the East Sakhalin Current around 53°N. During some years the same situation was also observed early in summer. The first record of the north-directed currents on the northeast Sakhalin shelf is dated by 1981, however only in 1997 this phenomenon was supported by instrumental measurements. Those were the long-term current measurements of Sakhalin Energy Investment Company specialists carried out for Piltun-Astokhskoye oil field. According to them in June 1997 surface and near-bottom shelf currents of North East Sakhalin were characterized by stable monomodal regime (general direction of currents were north-northwestern, probability came to 66%, modal velocity of 20-60 cm/sec).

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## **SCHEME OF SURFACE WATER CIRCULATION OF THE NORTHERN JAPAN SEA**

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In spite of the long-term study of sea currents with various methods, it is possible to allocate only three original schemes of surface water circulation. Most known (and most cited) is the generalized scheme of M.Uda (1934). As a basis for it the charts of density distribution (not of dynamic heights) were used. The scheme of V.Yarichin (1980) is a free composing of the several published schemes (including the scheme of M.Uda). The scheme of A.Ostrovskii (1994) was based on the SST (September, 1993) analysis.

In the base of proposed by us the scheme of surface water circulation were used the data of buoy drifts and SST charts. Its main features are the currents along the northwestern thermal front and the large-scale meander of the Tsushima Current west of Hokkaido.

**THE CHARACTER OF THE POLYCYCLIC PROCESSES IN THE NEARSURFACE ATMOSPHERE ABOVE THE JAPAN SEA**V.B. Darnitskiy, V.M. Petruk, and S.M. Varlamov*Pacific Research Fisheries Centre (TINRO-Centre), 4 Shevchenko Alley, Vladivostok, Russia. 690600 e-mail: root@tinro.marine.su*

The purpose of the present message is the research of the short period climatic fluctuations of some characteristics of near surface atmosphere above the Japan Sea. The atmospheric influences as cyclones and anticyclones determining the character and duration of cycles of short period fluctuations of an ocean climate and, accordingly, of production cycles, to the greatest degree effect on the near surface part of ecosystem, located in the top boundary layer of ocean, i.e. layer of photosynthesis. We have investigated the repeatability of cyclones near the Earth surface at grid point of 5\*5 degree for a period of 1959-1990 and calculated the vorticity of geostrophic speed at grid point of 5\*10 degree for a period of 1947-1988 by a field of atmospheric pressure. The cyclones repeatability was calculated to the north and south from the Subarctic front, which conditional border was accepted without the account of variability along 40 S. Not concerning the inneryear (seasonal) variability, which has its features, it has been ascertained, that the interannual variability is characterized by polycyclic processes both in northern and in southern parts of the Japan Sea. The short period fluctuations of cyclonicity maxima have the alternating periods with duration of 1-3.5 year with the obvious tendency of easing the cyclones activity in the second half of the 80s (after 1986), both in the northern and southern parts of the sea. The cyclic strengthenings and easing of atmospheric influences on a sea surface can be both in a phase and in counterphase to the north and to the south of Subarctic front. The cycles have the alternating character in the chronological order of their following with prevalence of quasi-two year cycle. Calculation of vorticity of geostrophic speed with one month averaging on a long time series has shown that the cyclic processes have also brightly expressed inneryear dynamics. In the Japan Sea in January the significant cycles are 4,6,12,16-year, in February 3,12,16-year, in March 2,6, 13-year, in April 2,14-year, in May 10,20-year, in June 3,5,7,10-year, in July 2,7,9,12,15-year, in August 2,5-year, in September 2,4,7,10-year, in October 2,5,9,21-year, in November 3-year, in December 3,6,10,16,21-year. The spatial differentiation of cycles on aquatorium of the Japan Sea is observed also both in W-E and N-S directions. Multitude of polycyclic processes, besides their objective nature known also in other regions of the planet depends, apparently, on scales of averaging of calculating parameters as well. In this case horizontal scale was commensurable with scale of atmospheric cyclones.

**THE CHARACTER OF THE LONG-TERM CYCLIC PROCESSES IN THE ATMOSPHERE ABOVE THE SEA OF OKHOTSK NEAR THE EARTH'S SURFACE**V.B. Darnitskiy, V.M. Petruk, Y.D.Sorokin, S.M.Varlamov.*Pacific Research Fisheries Centre (TINRO-Centre), 4 Shevchenko Alley, Vladivostok, Russia. 690600 e-mail: root@tinro.marine.su*

The Aleutian depression is the basic center of an atmosphere action above the northern Pacific in the winter period. However, the main zone of the temperature contrasts is located in the northwest Pacific in area of the Okhotsk and Japanese seas, therefore the conditions both for frontogenesis and cyclogenesis are expressed here even in a greater degree. In the spring the region of the maximum cyclogenesis above the Okhotsk sea is displaced to southwest, disappearing to summer. In the autumn the area of the maximum cyclogenesis is displaced again to the Okhotsk Sea. This general climatic regularity cannot be carried out, obviously, without changes during the long periods. For study of this question we investigated the interannual changeability of repeatability of cyclones at grid point of 5\*5 degree in days according to the atlas of Voronina (1987) for the period 1959-1990 (data are prolonged till 1990).

Also the values of geostrophic speed were calculated at grid point of 5\*10 degree on a technique stated in (Volkov, Muha, 1990) by a monthly mean fields of atmospheric pressure. By results of the analysis of seasonal

and interannual cyclone repeatability above the Okhotsk Sea it is possible to conclude that the increase of maximal cyclone repeatability was observed till 1961 (up to 137 - in 1961 the maximum for 27 years), then the decrease of repeatability followed till 1978-90 in 1967. After the next cyclonicity strengthening to 1969-1971 (111-112) it was observed again the trend to cyclone decrease till 1976, for which it was followed the next increase of cyclone quantity up to 115 in 1977. From the end of 70s and till 1986 it was observed the increase of amplitude of change of cyclone repeatability, and in the period of intensive ENSO - event (1982-1983) the repeatability of cyclones above the Okhotsk Sea has increased up to 124-126 (in 1981-1983). At last, after sharp decrease of repeatability of cyclones (up to 75) in 1984 it has reached the second maximum in 1985 (131) for one year before the next ENSO in 1986-1987. As a whole it is possible to notice that the increase of cyclonicity and of the amplitude of variability was observed in the years close to the periods ENSO (for exception of 1960-61). The chronological intensifications of Zn also were observed with close periodicity (2-4 years) to periodicity of Southern Oscillation. During 1976-1986 the increase of amplitude of change of the Zn repeatability was observed above the Okhotsk sea (up to 111) in relation to the previous decades (on the average up to ~30%).

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poster

## **TYPES OF SYNOPTIC SITUATIONS AND ACCORDING WEATHER CONDITIONS ABOVE THE OKHOTSK SEA**

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The analysis of 10-days averaged charts of the surface pressure for the period of 1984-1998 has shown, that the weather conditions above the Okhotsk Sea (mainly, direction of wind transport) were determined by seven types of synoptic processes:

type I - weak-graduated field without strong winds;

type II - a cyclone above the continent (Far-Eastern Depression), causing southern winds above the Sea (summer monsoon);

TYPES III - the Arctic cyclone above Chukotka, at which western winds are above the Okhotsk Sea;

type IV - rear trough of the Bering Sea cyclone with east winds in north of the Okhotsk Sea and western winds - in the south of the Sea;

type V - meridionally orientated gradient zone between the Siberian maximum and Aleutian depression determining steady north transfer above the Okhotsk Sea (winter monsoon);

type VI - influence of the northern part of the Pacific cyclone with east winds above the most part of the Okhotsk Sea;

type VII - a cyclone above the Okhotsk Sea causing advection of heat above the Western-Kamchatka shelf and advection of cold above the eastern areas of the Sea.

Two types (I and II) are classified as summer ones, IV and V types occur most frequently in winter months, and the remaining situations (III, VI and VII types) are referred to processes of the transitional period.

Increasing of type II duration (and simultaneous decreasing type I duration) was observed in 1986-89, 1995.

Variation of winter types IV and V duration in 80s had contrary phases but in 90s they were coherent: the highest number of type IV was observed in 1989, 1991-1993 and 1997, and the highest number of V type was observed in 1986, 1990-91 and 1997.

The interannual variability of repeatability of all types both in the sum for a year and separately for the first and second half of a year is considered. There is marked that the changes of annual repeatability of types had periodic

fluctuations with periodicity 2-, 3.5-, 4.6-, 7- and 14-years. Thus, the climatic regime of the Okhotsk Sea usually varies in dependence on frequency of each type.

The correlation analysis has shown that frequency of some types within a year and within a half of a year was correlated satisfactory. However, the frequencies in different halves of a year were not correlated between each other.

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### **ENSO SIMULATION AND PREDICTION WITH INTERMEDIATE COUPLED MODEL**

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The oceanic component of the presented intermediate coupled model (ICM) consists of a three baroclinic mode model and a mixed layer, in which temperature is governed by the three-dimensional advection and by the surface heat flux anomaly, assumed proportional to the local SST anomaly. It is coupled to the Gill's (1980) tropical atmosphere. Simulation is performed for the period 1980-1998. The response of the atmosphere to the simulated SST is analyzed and compared to the observations.

The predictive skill of the coupled model is investigated. Using simulated fields from the ICM forced run over the period January 1970 - February 1999 as initial conditions, series of two-year forecasts are computed. The ensemble of 349 predictions is used to find out the predictive skill of the model for each decade beginning of 1970. The coupled initialization procedure by Chen et al. (1995) is used to improve simulation of the SST anomalies in the Eastern Pacific, however the wind anomaly variability is too large, and observations lead the predicted winds by 4-5 months. Two different atmospheric models are used to produce more realistic wind anomaly variability, and results are compared for the periods of 1982-1983 and 1997-1998 El Niños.

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### **LONG TERM PROGNOSE OF WIND CHARACTERISTICS FOR THE SAKHALIN ISLAND**

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The calculation of wind characteristics is important for various applied problems, gaining especial importance with development of oil and gas complex on northeasterly shelf of the Sakhalin Island. Long-term prognosis of estimated average and extreme wind velocities is necessary for designing the industrial objects, veins, transport communications, communication links, etc.

We used for analysis the observed data from the meteorological stations of the Sakhalin Territorial Administration for Hydrometeorology. We valued the monthly mean vectors, nature of their seasonal variability. The estimation of stability of obtained values was done. Also we studied the nature of direction of wind vectors rotation.

The most attention was devoted to calculation of extreme wind velocities of rare recurrence winds. It is well known that in Russia till medium of the 70s the weathervanes were used for wind measurement (the most of the known reference manuals are based on weathervanes data). At the same time the modern anemorumbometers gives slightly low values of velocity. Therefore the calculation was conducted on two data sets for each station. That allows to get reliable estimations and compare information available in reference manuals with modern data.

**PROCESSING OF INSTRUMENTAL DATUM SERIES DESCRIBING NORTH EASTERN SAKHALIN SHELF CURRENTS. SOME RESULTS**Igor E. **Kochergin**<sup>1</sup>, S.I. Rybalko<sup>1</sup>, V.P. Putov<sup>2</sup>, and G.V. Shevchenko<sup>3</sup><sup>1</sup> *Far Eastern Regional Hydrometeorological Research Institute (FERHRI), Vladivostok, Russia*<sup>2</sup> *Ecological Company of Sakhalin, Ltd. (ECS), Yuzhno-Sakhalinsk, Russia*<sup>3</sup> *Institute of Marine Geology and Geophysics (IMGG), Yuzhno-Sakhalinsk, Russia*

Instrumental measurements of currents in the area of the Piltun-Astokhskoye and Arkutun-Daginskoye oil fields are analyzed with the aim of current regime understanding and construction of prognostic dependencies for engineering purposes. The number of analyzed datum series of 14-109-day duration collected in 1979, 1989, and 1996-1998 within 52° 20' and 53° 00' at 20-25 m horizons and 10-30 km away from a shoreline totals nine, with seven of them being accompanied by simultaneous wind measurements.

The relating dispersions of tidal and nontidal components are studied for different seasons and distances from a shoreline. Interyear variability of statistic distribution of current velocities and general current directions are analyzed.

Turbulent pulsation parameters of nontidal velocity series, which probably correlate with inhomogeneity and vortical structure of a current, are assessed for engineering calculation of pollutants transport.

Correlation coefficients are assessed for synchronous current measurements fulfilled at different sites in 1997 and 1998. Correlation of residual current and wind regimes, with synchronous observations from stationary rigs, is studied.

**EDDIES OF THE OKHOTSK SEA SOUTH REGION IN SUMMER 1991**Ludmilla K. **Kramareva***Pacific Oceanological Institute, 43 Baltiyskaya Street, Vladivostok, Russia. 690041 E-mail: pacific@online.marine.su*

Analysis of the 10 CTD and XBT surveys has demonstrated that the eddies moved in the north-east direction covering the distance of 180 miles during 2 months and increasing the speed from 2.3 to 7.4 miles per day. The TS-analysis showed that there is a high salinity "lense" in the center of the eddy at the depths of 150-200 m. The eddies swirl speed structure was obtained by means of three successive series of moorings. At the beginning of the experiment the core of the eddy was at the 200-400 m depth, and swirl speed was about 30-35 cm/s. At the end of the investigation, the mean swirl speed increased up to 50-70 cm/s, while the lower boundary of the maximum speed layer sank to 700 m. At the same time the eddy was compressed. The area of 1.5 C isotherm at 500 m depth was reduced by 3.5-4 times during the 2.5 months period.

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## **INVESTIGATION OF DYNAMICS OF EDDIES STRUCTURE IN THE FRONTAL ZONE OF THE PACIFIC OCEAN**

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Experimental investigations, carried out during 1975-1990 years in northwest zones of the Pacific Ocean show, that the volume transport by stream currents in the ocean induces temporal changes of different scales.

Analysis of the currents map of these two polygons shows a significant correlation between the volume transport of stream current and the variability of eddy field disturbances on synoptical scale in the ocean.

This paper deals with the response (in numerical terms) of the ocean to various impacts of stresses dependent on time and coordinates.

The processes of eddy formation in the stream current by different time scales of the wind fluctuation are studied. There has also been found time scale in the process of formation of meanders of stream current and their separation from the most intensive main flow. Different types of the boundary conditions are considered on vertical boundaries of the basin, and it is shown, that formation of eddies does not depend on the type of conditions that have been set at the vertical boundary-slip and no-slip. The conducted numerical experiments show that the non-stationary boundary conditions (time-depending) generate synoptic disturbances. This mechanism is different from the mechanism of hydrodynamics instability. The physics of the process in this case is determined by the generation disturbances such as the Rossby waves on large-scale flows of changing intensity. The non-linear interaction of waves and currents lead to the meander cut-off and formation of eddies and subsequent evolution to absorption of eddies by large-scale currents.

Thus, this study presents the new mechanism of eddies formation in the ocean.

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## **THERMOHALINE STRUCTURE OF THE INTERMEDIATE LAYERS OF THE SUBARCTIC AND SUBTROPICAL PARTS OF THE NORTHERN PACIFIC**

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74 thermohaline sections crossing the Subarctic Front (SF) in the northern part of the Pacific Ocean are analyzed. The initial data are obtained from 13 cruises done by the research vessels of the Academy of Sciences, USSR, in 1980-1993.

The analysis of the upper 1000 m layer is carried out with the purpose to study possible mechanisms of an exchange by the subtropical and subarctic waters through the SF in the Western and Central Parts of the North Pacific.

There is no unequivocal interpretation of the large-scale interaction of subarctic and subtropical waters through SF area. The analysis of salinity field at the intermediate depths of 300-600 m allows us to assume that the low-salinity waters afflux from the subarctic area into the subtropical one is possible on all extension of the Subarctic Frontal zone. Specific thermohaline structure to the south and to the north of the frontal zone shows, that the front can act as a "pump", transporting the low-salinity waters of the subarctic upper layer into the intermediate depths of the subtropical area. This process can occur on the large extension of the front from 160 E to 155 W.

The power estimations are performed.

**WATER STRUCTURE IN THE NORTHWESTERN BERING SEA**V.V. Maslennikov<sup>1</sup>, E.I. Ustinova<sup>2</sup>, and V.M. Petruk<sup>2</sup><sup>1</sup> *Russian Federal Research Institute of Fisheries and Oceanography (VNIRO), 17 V. Krasnoselskaya, Moscow 107140, Russia. 107140 e-mail: akrovnin@mx.iki.rssi.ru*<sup>2</sup> *Pacific Research Institute of Fisheries and Oceanography (TINRO-Centre), 4 Shevchenko Alley, Vladivostok, Russia. 690600*

In the northwestern Bering Sea the continental slope is the main element of bottom topography which determines the very high variability of hydrological regime. The existence of very pronounced Navarin canyon and adjacent ridge results in deviation the Eastern Bering Slope Current (EBSC), formation of anticyclonic or cyclonic eddy in the top of Aleutian Basin (depending on deviation of the Central Branch), development of the Navarin Current which transport waters from the open sea and continental slope to the very vast shallow aquatory of the Anadyr Region. This system is very unstable that is reflected in distribution of different water types. The identification of water types was based on the analysis of T,S-curves for stations carried out in different years (1996-1998) and different seasons (summer, autumn, and winter) during the Russian-Japanese expedition and two expeditions by TINRO-Centre on board R/V *Professor Kaganovsky*. First of all, the results show the high variability of hydrological conditions in the Navarin-Anadyr region. These variations are mainly regulated by development of the Navarin Current and Anadyr Anticyclone, character of interaction of these dynamic systems and corresponding water types. Thus, if summer 1996 was characterized by very extensive spreading of Navarin current waters, in autumn 1998 it was limited by rather narrow stream, the source of which was associated with divergence of Central EBSC branch on the Koryak slope. Correspondingly, the area of Anadyr Anticyclone waters either increased or decreased. The characteristics of extremes in the Warm Intermediate Layer (WIL), Cold Intermediate Layer and in the surface layer which determine the structural type of water, demonstrate some peculiarities of interannual variations. First of all, they are associated with continuing increase in T<sub>max</sub> in WIL and decrease in its depths. The data under consideration are of great interest because they represent the pre-El Niño (1996) year, year of its maximal development (1997) and the post-El Niño year (1998). However, we cannot interpret the changes occurred as a reaction on El Niño event.

**MONITORING OF HYDROMETEOROLOGICAL FIELDS VARIABILITY IN THE NORTHERN PART OF THE PACIFIC OCEAN**Valentina V. Moroz and A.M. Polyakova*Pacific Oceanological Institute, 43 Baltiyskaya Street, Vladivostok, Russia. 690041 e-mail: pacific@online.marine.su*

Based on the forty-year observations above temperature fields of the ocean surface, atmospheric circulation and ice-states of the Okhotsk Sea, the complex research of the Pacific Ocean northwest part condition and atmosphere was carry out.

Using the temperature anomaly distribution analysis in the 20°-50°N, 130°-180°E region the state and variability of the temperature field on the ocean surface was investigated. On the data of hydrological observations the evaluation of the Kuroshio Current condition and variability was conducted, the position of the stream Kuroshio Current was determined. Based on the data of the weather synoptic maps quarterly reviews above water surface of the Pacific Ocean northern part the evaluation of the atmospheric circulation (as a duration of an operation of typical synoptic situations in day) condition and variability was conducted. The correlation between atmospheric processes, hydrological mode of the Pacific Ocean northern part and the "response" to critical oscillations of the phenomena El Niño were investigated.

Connection between extreme hydrological conditions in a northwest part of the Pacific Ocean northern part and the total annual duration oscillations of the "Cyclones above ocean" and "Okhotsk-Aleut" atmospheric circulation

types (by A.M. Polyakova classification) was determined. The total duration increase tendency the type of atmospheric circulation "Cyclones above the ocean" and the decrease tendency of the "Okhotsk-Aleut" type can indicate the coming such extreme situations, like appearing El Niño, heavy ice conditions of the Okhotsk Sea, and negative temperature in the Kuroshio current system zone. The revealed connections can be used for prognoses of these extreme situations.

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### **CHARACTERISTICS OF VERTICAL FINE STRUCTURE IN THE FAR-EASTERN MARGINAL SEAS AND ITS EFFECTS ON BIOPRODUCTIVITY**

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Vertical probing of temperature and salinity was performed in many expeditions of the Pacific Oceanological Institute in the South China, East China, Japanese, Okhotsk, and Bering Seas. Compiling and processing the data gives the possibility to analyze the most important differences in the buoyancy vertical structure of these seas. Especially interesting are changes of the vertical structure on transects through the shelf boundary. In the southern seas the thermocline is thick and rather smooth, and the differences between the shelf and open sea waters are not prominent. When we move to the Japanese Sea, we observe principal changes of vertical structure in both open sea and shelf zone. The main feature here is a narrow and sharp thermocline in the open sea, changing to rather wide and fine-structured thermocline in the shelf zone. In the Okhotsk Sea the vertical structure of buoyancy is especially complicated, the thickness of many stable layers being of order 1 m. The peculiarities of vertical structure along the Kuril Islands and Kamchatka are due to the depth profiles and to influence of many mesoscale eddies.

It was noted in the author's previous works that plankton concentrations in the Subarctic Front zone are correlated in horizontal and vertical with fine structure intensity. The same kind of dependence is observed for the frontal zones between the shelf and open sea waters, but substantial differences exist for the marginal seas mentioned, and they are analyzed in the paper.

8AM1999-POCpaper32 poster

### **SEASONAL CLIMATIC THERMOHALINE CHARACTERISTICS OF WATERS OF ACTIVE LAYER OFF KURIL ISLANDS**

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The investigation is based on the data of hydrological observations obtained in the Pacific Ocean off Kuril Islands in 1963-1998 (about 13.5 thousand stations). Charts of temperature and salinity distribution at the horizons 0, 50, 100 and 200 m were built for each season by means of data averaging in 1-degree squares. On these charts the borders of the main water masses were determined and their average thermohaline characteristics were calculated. The following main water masses are considered: Oyashio Current water (i), Subarctic water (SA), Transformed Subtropical water (ôSô), and also water of Kuril-Kamchatka Current (ëë), that, according to common representations, occupies the northeast part of the region northward from the Bussol Strait. Let's note that despite of 1-degree square averaging, the main fronts in all seasons were allocated rather clear both in the fields of temperature and salinity. Following regularities were revealed in seasonal variability of climatic characteristics of water masses:

- normal seasonal changes of temperature with a minimum in winter and a maximum in summer at the sea surface, and with a minimum in winter and a maximum in autumn at horizons 50 and 100 m were observed in all water masses. At 200 m horizon seasonal variability of temperature was observed in the TST zone only with a minimum in spring and a maximum in autumn.
- normal seasonal changes of salinity with a maximum in winter and a minimum in summer was observed in the zones of ẽẽ and Sá. In ôSô zone the seasonal changes had 2 minima - in winter and summer, and 2 maxima - in spring and autumn. No regularities were revealed at horizons 50-200 m because of a small annual variability.

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poster

### **ON POSSIBILITY OF LARGE-SCALE CYCLONIC MEANDER FORMATION NEAR THE SOUTHERN COAST OF JAPAN**

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As known, the large-scale cyclonic meander formation of Kuroshio to the south of Honshu is sufficiently a reliable indicator of long-term changes of water regime in the northwest Pacific Ocean. Methods of prediction of this unique phenomenon present both scientific and practical interest. Using the data of 1965-1990 the combined analysis of long-term variations of the Kuroshio axis and changes of the subarctic water amount at the section along 149 E between 43-33 N in the 0-1000 m layer has been conducted. It was noted that the "anomaly" of Kuroshio in 1969 and 1976 had occurred 3-4 years later the maximum development of subarctic waters at 149 E. If the process of formation of Kuroshio cyclonic meander coincides with the period of decreasing of tideforming Moon force potential (19-year rhythm) then this phenomenon will be presented for some years (the same was observed for the last period of the Kuroshio large-scale meandering). Otherwise the meander would disappear not reaching its maximum sizes as it was in 1965 and 1969. The last maximum development of subarctic waters at 149 E was observed in 1994. The second half of the 90 coincides with the period of decreasing the Moon potential. Consequently, the formation of the Kuroshio large-scale meander near the southern coast of Honshu can be expected in the near future.

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poster

### **ATMOSPHERIC CIRCULATION OVER THE KUROSHIO REGION IN WINTER SEASONS OF 1994-1999**

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The Kuroshio region is one of the most energy-active in the World Ocean. Active exchange between the atmosphere and the ocean is observed in winter. Cyclonic activity over the northwestern part of the Pacific in winter period indirectly reflects the Kuroshio regime (its heat content, spatial position of the main flow and large anticyclone vortices). In the present work, some peculiarities of cyclonic activity in the region 30-40 N and 130-150 E in January-March of 1994-1999 are considered. The monthly averaged data of the frequency of cyclones (days) for 5 degree squares is used as an index. Significant interannual changes in frequency of cyclones have been distinguished. So, a relatively high frequency was observed in 1994 (49). Then it decreased up to 27 and 28 in 1996 and 1997 respectively. A sharp increase of frequency of cyclones was traced in 1998 (53) and a decrease again in 1999 (34). Time interval between the maxima is 4 years that is close to known spatial Kuroshio fluctuation at the eastern coast of Honshu. Same changes of cyclone frequency and temperature anomalies at the sea surface (30-35 N and 140-150 E) witness that when the Kuroshio subtropical water temperature increases

cyclonic activity intensifies and otherwise. Location of the "hearths" of the highest cyclone frequency changes from year to year. It was caused by spatial displacements of Kuroshio and anticyclonic eddies. It is necessary to note that years under study the most powerful "hearth" of frequency of cyclones was observed in the majority of cases (11 of 18) in the region 35-40 N and 145-150 E. This fact reflects that in the given area warm subtropical waters were presented.

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## **ON INFLUENCE OF ATMOSPHERIC PROCESSES ON ICE CONDITIONS OF THE SEA OF OKHOTSK**

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A comparative analysis of cyclonic activity over the sea of Okhotsk and ice conditions in January-March, 1994-1999 has been carried out. Average monthly charts of cyclone frequency (days) at the Earth in the region 45-60 N and 140-155 E are used as an index of atmospheric activity. Monthly averaged sea ice charts were constructed on the basis of satellite information. From the beginning of the 80s the tendency to a considerable decrease of ice cover was traced. Ice processes in 1995-1997 were developed by a type of small ice years. The historical minimum of ice cover was observed in 1996 (about 33% of sea surface). At the end of the 90s the contrary process is observed. Two anomaly situations have been established on some relatively short observations. When cyclones from the Japan Sea or the Kuroshio region spread mainly to the north and the north-east the extent of ice cover in the Sea of Okhotsk decreases, on the contrary, when they move at the considerable distance from the Kuril Islands, the ice square is relatively high. This correlation is especially distinguished for February. So, in February 1996, eight cyclones with pressure less 990 mb have displaced to the Sea of Okhotsk. Otherwise, in February 1998 no deep cyclone moved across the Sea of Okhotsk. As a result, the extent of ice cover was two times higher than in 1996.

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## **SALINITY CHANGE IN THE TATARSKY STRAIT IN WINTER AS A RESULT OF ICE FORMATION**

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The formation of aquatic masses of the Japanese Sea essentially depends on conditions of winter hydrometeorological processes in water of the area. It is caused not only by cooling of the sea and change of wind conditions, but also by magnification of salinity of waters owing to the formation on some of its part of an ice cover. Under the action of cooling and magnification of salinity the surface water gains negative buoyancy and falls, being intermixed with underlying strata of water. As a result the layer of water with characteristic attributes is formed: at the low temperature (down to the negative), high salinity and raised contents of oxygen. This layer is brightly distinct to depths of 300-500 m. It is known as a layer of convection, intermixing. According to available information the convection intermixing can reach depths of 1000 m and greater, but as a result of permanent contact of the lowered waters with neighbouring waters they are transformed. Except for the direct convection intermixing and intermixing owing to mixture of waters of different characteristics, cold and the salt waters can "slip" under the angle to the bottom not losing the properties at significant depths. As a result of their further mixture with deep waters the intermediate and deep aquatic masses are formed. For clearing up the character of this process and its intensity it is necessary to know: a possible quantity of salts incoming to the sea

owing to the formation of ice; most typical areas of inflow of cold waters of the raised salinity. In work the account of quantity of ice formed in cold and warm winters, quantity of salt outlined is effected thus, possible magnification of saltiness of waters. The results obtained are compared to the hydrological information for a series of years obtained by the data of observations. The absence of observations immediately on areas of formation of ice and small quantity given on the eve of formation of ice (autumn) and after scouring the sea from ice (spring) does not allow univalently to state about a leading role of winter processes in forming aquatic masses of the Japanese Sea. Their significant role at the same time is shown.

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poster

### **VARIABILITY OF COLD INTERMEDIATE LAYER IN THE OKHOTSK SEA**

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Last years it is devoted more and more attention to research of intermediate layer of waters in Okhotsk Sea. It is caused by its large influence on hydrological processes occurring in Okhotsk Sea during year. The presence of archive of the hydrological data on Okhotsk Sea allows now to allocate spatial - temporary parameters of this layer and their variability. However owing to transformation of the characteristics of this layer the allocation of its borders is a serious d intermediate layer), which consists of water masses with negative temperature. As a first approximation spatial - temporary parameters of this nucleus can characterize all intermediate layer. In present work the long-term data of observations since May till October are used. For each month the accounts of depth of the top and bottom borders, thickness of a layer, depth of least temperature and their spatial distribution are made. Their variability from one month by another is also made. The received characteristics allow to make not only general opinion about average condition of a cold intermediate layer, but also to reveal a general orientation and intensity of processes occurring in the sea in the warm period of year. They can be used also for definition of character and intensity of processes occurring during concrete year. The examples of the similar analysis also are given in present work.

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poster

### **ON THE ROLE OF THE MESOSCALE CO<sub>2</sub> VARIABILITY IN THE NORTH PACIFIC**

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According to different estimations, the mean air temperature has increased on 0.5-1.0 grad.C during the last 100 years. Concentration of the most important greenhouse gas (other than water vapor). CO<sub>2</sub> has risen by 20-24% during the same time. Identification of the main CO<sub>2</sub> source and sink areas is difficult. So, it is very important to estimate the role of the oceans and especially the Pacific Frontal Zone in the CO<sub>2</sub> balance.

Many different processes with large spatial and temporal variations control the air-sea exchange. Usually, oceanographers study the CO<sub>2</sub> chemistry and CO<sub>2</sub> air-sea variations along macroscale profiles. Then macroscale estimations of CO<sub>2</sub> in the balance between air and sea are being fulfilled. However, these macroscale estimations of the CO<sub>2</sub> global balance are not in good agreement. Also, it is discussed which process is dominant in the CO<sub>2</sub> air-sea exchange: biological or physical?

Here we present our result of the first mesoscale CO<sub>2</sub> - system investigation in the Pacific Subarctic Frontal Zone (PSZ) (38-42 N, 150-157 E). This area was surveyed twice during one summer: in June and August (1987). The water samples were taken along 8 meridian sections from horizons 0, 10, 25, 50, 100, and 150 m. The mesoscale

dynamics of the pCO<sub>2</sub> (based on the pH-SCO<sub>2</sub>) and dissolved O<sub>2</sub>, P-PO<sub>4</sub> was studied in the similar study area. More than 700 measurements of pH and SCO<sub>2</sub> by dual catalyst frame ionization chromatography were made. It was shown that the-PSZ is the mosaic region of the invasion-evasion of CO<sub>2</sub>. Evolution of the CO<sub>2</sub> chemistry in the cold cyclone ring was studied. Analysis of biological and physical factors in the carbonate chemistry changes was made. It was shown that the mesoscale CO<sub>2</sub> variations might play a significant role in the CO<sub>2</sub> variations and CO<sub>2</sub> balance between air and sea, especially in Frontal Zone.

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poster

## **SIMULATION OF WATER CIRCULATION ON THE OKHOTSK SEA SHELF OF SAKHALIN ISLAND**

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Simulation of water circulation on the Okhotsk Sea shelf of Sakhalin Island was executed using mean fields of temperature and salinity obtained from the data base "Atlas" which includes around 12000 hydrographic stations implemented in the coastal 100 miles zone during 1948-96. The calculations were executed with the help of linear quasi-geostrophic model which takes into account baroclinicity, bottom relief and Coriolis force. To obtain a more detailed picture of water circulation and taking into account location of standard hydrographic sections of historical data, the simulations were conducted for three regions of the Okhotsk Sea shelf with a different step of a computational grid. The step of a grid was taken 10 by 10 km (along latitude and longitude correspondingly) for La Perouse Strait, 10 by 20 km for the southeastern part of Sakhalin shelf including Terpeniya Bay and 10 by 50 km for the northeastern part. The calculations were conducted on standard horizons for spring, summer and autumn. The analysis of calculation results has shown good conformity of the calculated characteristics (direction, position) of the East-Sakhalin and Soya currents with parameters of these currents reported earlier in the literature. At the same time, some differences were obtained in the sign of the eddies of 30-60 miles spatial scale located in the south-eastern part of the shelf and circulation in Aniva Bay which seems to be anticyclonic during the warm period according to our results.

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poster

## **FORMATION OF COMPLETE DATA BASE OF THE ICE SHEET FOR THE ANALYSIS AND SUBSEQUENT USE IN THE FAR EAST SEAS**

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The information about ice sheet, accumulated to the present time (air reconnaissance's, satellite images etc.) differs by initial incompleteness. It is connected to cloudiness presence at visual fixation of an ice cover, irregularation of imagering, observer's mistakes etc. Thus, practically, there is no period with a complete set of all elements full enough describing conditions of an ice cover.

The stages of development, floe sizes, roughness and, in a little bit smaller measure, snow cover of ice concern to basic elements reflecting a condition of an ice cover and most frequently used in hydraulic engineering calculations.

For optimum restoration of fields of ice elements the algorithm s of decomposition on an empirical orthogonal components (EOC) and subsequent optimization were used. The essence them was reduced picking up instead of

the initial magnitudes, missed such meanings, which at decomposition of initial fields on an EOC and subsequent restoration would satisfy them minimax requirements.

By results of test accounts it is possible to conclude, that the realization of similar procedure has allowed to receive complete fields of ice sheet elements close to real. At use as criterion of optimization of other parameters, in particular sum of squares of deviations the restored fields turned out close to average long time period.

The complete archives of the data on all listed ice elements submitted on 156 homogeneous enough areas on which were received was broken the Bering Sea for the period 1960-1998 years.

The received data further can be used for realization of the subsequent analysis of spatial-temporal structure of ice sheet of the Bering sea and also for various engineering calculations.

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poster

## **THE SIGNS OF THE EL NIÑO PHENOMENON IN THE JAPAN SEA**

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To study a teleconnection between the El-Niño phenomenon and hydrometeorological processes in the Japan Sea the data sets of water surface (SST) and air ( $T_a$ ) monthly mean temperature anomalies for the period 1949-1997 years at 12 coastal stations of Russia and Korea, monthly mean coordinates and atmospheric pressure of the Honolulu High centre, Southern Oscillation index (SOI) for the same period and also values of volume transport integrated characteristic in warm currents system Tsushima- Tsugaru for the period 1961-1980 years were used.

Spectral analyses suggest that oscillation of the Japan Sea SST is linked to processes with several cycles: with 2-2,5, 3-5 and 9-12-year's periods. The first fluctuations correspond well known quasi two-year's cycle, the thirds reflect influence of a 11-year's solar activity cycle. The second is associated with the Southern Oscillation phenomenon. It proves to be true by presence of similar cycle with the same period in SOI spectrum. Cross-spectral analyses between SST and SOI has shown existence of enough close connection between these characteristics with coherent coefficients about 0.70-0.75 at this period.

The obtained connection has allowed to consider in more details the influence of one of the Southern Oscillation phases (El Niño) on SST variations in the Japan Sea. Eleven El Niño cases observed in 1951, 1953, 1957-1958, 1965, 1969, 1972, 1977, 1982-1983, 1987, 1991-1992, 1997 years were chosen. The distribution of annual averaged SST values has shown that in 9 cases the negative anomalies and in 2 cases only (1957-1958, 1991-1992) the positive anomalies were observed. This fact gives the basis to believe that in 80 % of cases the El Niño results in background fall of water temperature in the Japan Sea.

The joint analysis of temporal variability SST and SOI for the 9 El Niño cases has shown their good coordination. At this time steady negative SST anomalies (about 6-12 months duration) are observed with delay 3-7 months of extreme temperature fall in comparison with the maximal El Niño development. The maximal SST anomalies can reach  $-3^{\circ}$  -  $-3.5^{\circ}$  C.

The possible mechanism of the found out connection is following. The investigations have shown that in most cases the El Niño is accompanied by displacement of a Honolulu High to the south sometimes with western or east component. The analysis of  $T_a$  variability during El Niño testifies that displacement can results in air temperature fall. Besides the Honolulu High displacement causes deviation of the main Kuroshio flow to the east in moderate latitudes and as a consequence weakening of a branch Kuroshio - Tsushima current with decrease of warm waters entering in the Japan Sea. The latter is confirmed by temporal variability of the volume transport integrated characteristic of warm currents system Tsushima- Tsugaru. The cases of flow weakening are well coordinated to the El Niño phenomena.

Thus the considerable and long enough negative SST anomalies with 3-5 year's period in the Japan Sea are the signs of the El Niño and determined by two major factors: the air temperature fall and weakening of warm waters entering in the Japan Sea through the Korean strait.

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## **TWO MODELS OF SEASONAL CHANGES OF SEA SURFACE TEMPERATURE IN THE AREA OF SOUTH KURIL (ON THE BASE OF SATELLITE DATA)**

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Sea surface temperature is a very important parameter for the marine biology, fishing, exact prognoses of salmon, etc. So, Sakhalin Fishing and Oceanography Institute has installed in 1996 TERASCAN system for SST investigation.

The satellite SST data (NOAA-12, NOAA-14, 1997 and 1998) were analyzed to estimate parameters of seasonal changes in the area of Kuril Islands. The data of coastal hydrometeorology stations (Kurilsk and Yuzhno-Kurilsk) were used to control the obtained results.

The seasonal changes of SST were analyzed by the EOF method. The initial satellite data were averaged to the centers of 0,25 deg trapezia, with 15-day, time interval. The first two vectors were used to describe the spatial variability of the SST in the area of Kuril Islands (the first vector gives about 90-92% of total variance). The results of 1997 and 1998 were compared to a separate zone of 'stable' and 'instable' prediction on the basis of the obtained vectors.

Another way to estimate the seasonal changes of the SST is the harmonic analysis. We have fixed several points in the area of Kuril Islands. The series of the daily average SST included from 62 to 86 values per 1997 and from 43 to 73 per 1998 because of the very cloudy weather in this region. The least square method was used to estimate amplitudes and phases of the annual harmonic. The annual harmonic is very expressive - it describes about 90-95% of variance of the daily mean SST. The results of 1997 and 1998 are very close. Amplitudes in the Sea of Okhotsk are about 7-8°C, and about 4-5°C in the Pacific. The results of the satellite data analysis were compared with parameters of the annual harmonic calculated on the basis of the coastal stations (Kurilsk and Yuzhno-Kurilsk).

Results of both methods can be used to predict the SST (and also for the marine biology and fishing prognoses) in the area of Kuril Islands.

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## **WIND-INDUCED UPWELLING ON THE NORTHEASTERN SHELF OF SAKHALIN ISLAND**

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Dynamic process studies on the northeast shelf of Sakhalin Island present a significant interest in connection with development of industrial activity on the marine oil and gas-bearing fields in this region. Satellite monitoring of the sea surface temperature with the use of NOAA-12 and NOAA-14 satellites data is combined with instrumental observation on floating bore pontoons, which are usually installed on the shelf for a period of July-September.

The data analyzed comprise the sea current measurements on two spots on Piltun-Astokh and Dagi marine oil and gas-bearing areas in the upper, intermediate and nearbottom layers, the series of wind speed and direction, temperature and salinity of water.

The initial satellite data were averaged to the centers of 0,25 deg trapezia with a 15-day time interval. Correspondingly the series of velocities of the wind and sea currents were divided into intervals of duration of 15 days, and on their basis the roses (distribution on gradations of velocity and directions) were built. It is interesting to note that the southern and southeastern winds usually dominant in summer have the alternating periods of reinforcements and weakening. At the time of reinforcements a flow from the coast increases in the upper layer, while in the nearbottom layer, on the contrary, aside coast. There are no regularities observed in the intermediate layer flow. Changes of water temperature range from 2 to 14°C and salinity from 24 to 33 psu in the upper layer. According to the satellite data, the expansion of the coast band of cool water corresponds to these moments on satellite images that is in accordance with the idea on presence of upwelling event induced by the wind.

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poster

### **LONG-TERM VARIABILITY OF ICE COVER AND AIR TEMPERATURE IN THE FAR-EASTERN SEAS**

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Accumulation of the long-term data series of meteorological and hydrological observations by the end of the 20th Century encourages for the study of multiscale climate variations. Data on ice cover and air temperature from the meteorological stations located at the coast of the Far-Eastern Seas are the longest time series of relatively regular and homogeneous hydrometeorological information. Statistical estimations (trends, spectra, co-spectra, correlation functions and coherency) were obtained for the long-term variability of ice cover and air temperature.

Statistically significant spectral peaks in the time series of ice coverage of Bering Sea, the Okhotsk Sea and the Tatar Strait were found on the quasi-decadal scale, the ENSO scale and for the period of about 20 years. Oscillations with periods of about 50 years were detected in the time series of the largest ice extent in the Okhotsk Sea. On the basis of the periodical components had obtained, the time series of the largest ice extent in the Okhotsk Sea may be approximated with the correlation coefficient  $R=0.7$  and extrapolated for the next decade. It is possible to allow an increasing the largest ice extent in the Okhotsk Sea in the next decade. The contrast in oscillations phases between the average monthly ice coverage of Bering and the Okhotsk seas were observed in December-April, but the maximum negative correlation coefficient was small ( $R=-0.40$  in February). Shift of oscillation phases was about 4 years. The quasi-two-year oscillations were typical of the air temperature at the Far-Eastern Seas coast. Statistically significant oscillations with the ENSO scale and the quasi-decadal scale in time series of air temperature were detected, too. Regime shift accompanied by changes of character of the climatic parameters interconnection (for example, relation between ice coverage of Bering and the Okhotsk Sea).

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## **CORRELATION BETWEEN THE HYDRODINAMIC SYSTEMS AND THE TYPES OF THE ATMOSPHERIC PROCESSES IN THE SOUTH-KURIL REGION**

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Using the main types of the atmospheric processes the numerical experiments have been carried out to calculate the jet-streams on the basis of the quasigeostrophic baroclinic model. The input data for calculation are the five types of the atmospheric processes: the northwestern (NW), the Okhotsk-Aleutian (OA), the Latitude-Aleutian (LA), the South-Latitudinal (SL) and the cyclones over the ocean (CO). Using the results of the calculation, the corresponding maps of the transport stream functions have been created. Common for all the maps is the cyclonic vorticity around the islands of Kunashir and Iturup. The straits between them are the main suppliers of cold water to the Pacific Ocean. It is correlated with NW, SL, CO types of the atmospheric processes. Freeze and Bussol are the main suppliers of warm water to Okhotsk Sea. It is correlated with NW, OA, SL, CO types of the atmospheric processes. In addition to this, each of the considered maps is characterized by its specific features.

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poster

## **A REASON OF DESALTING OF WATERS IN THE SOUTHERN PART OF THE SEA OF OKHOTSK IN SPRING**

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The observations in the south part of the Sea of Okhotsk show, that in spring there occurs desalting of waters. One contributor supposes that these waters arrive from the Japanese Sea, other - from adjacent regions of Pacific Ocean.

We take into account the amount of ice, which is carried out, from north in a southern part of Sea of Okhotsk through the latitude lines of Yelizavety, Terpeniya and Aniva capes. The results have shown that the ice, thawing in the south of the sea, is capable to desalt the surface waters by 0,2 - 0,4? up to depth of 100 m. Therefore, the main reason of desalting of waters in the southern part of the Sea of Okhotsk in spring is the thaw ice from the Sea of Okhotsk.

## **PICES Acronyms**

<b>BASS Task Team</b>	<b>Basin Scale Studies Task Team</b>
<b>BIO</b>	<b>Biological Oceanography Committee</b>
<b>CCCC</b>	<b>Climate Change and Carrying Capacity Program</b>
<b>EC/IP</b>	<b>Executive Committee / Implementation Panel for CCCC</b>
<b>F &amp; A</b>	<b>Finance and Administration Committee</b>
<b>FIS</b>	<b>Fishery Science Committee</b>
<b>GC</b>	<b>Governing Council</b>
<b>IFEP</b>	<b>Iron Fertilization Experiment Panel</b>
<b>MEQ</b>	<b>Marine Environmental Quality Committee</b>
<b>MODEL</b>	<b>Conceptual / Theoretical and Modeling Studies Task Team</b>
<b>MONTIOR</b>	<b>Monitor Task Team</b>
<b>PC</b>	<b>Publication Committee</b>
<b>POC</b>	<b>Physical Oceanography and Climate Committee</b>
<b>REX</b>	<b>Regional Experiments Task Team</b>
<b>SB</b>	<b>Science Board</b>
<b>TCODE</b>	<b>Technical Committee on Data Exchange</b>
<b>WG</b>	<b>Working Group</b>