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Keynote Address

Far-eastern sea shelf ecosystems of yesterday, today, and tomorrow

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Systematical research of the far-eastern shelf began in 1950 with the cruises of the famous R/V *Vityaz*. These studies provided the outline for shelf and continental slope areas, composition and distribution of bottom sediments, general characteristics of physical conditions, fish and invertebrates abundance and distribution. The total area of the far-eastern seas shelf exceeds 1 million km^2. The shelf is extremely rich in living resources, including about 362 million tons of macrozoobenthos, 25 million tons of macrophytobenthos, 165 million tons of macrozooplankton and about 100 million tons of planktonic algae in the warm season. Some of these estimations need a more accurate definition due to the progress of sampling methods and techniques. Benthos quantity estimations can be increased due to the underestimation of bivalve mollusk abundance. Meanwhile, benthic surveys in large parts of the far-eastern shelf conducted at about 20-year intervals have confirmed the relative stability of benthos quantitative characteristics. Fish biomass in the shelf zone could reach 12.5 million tons with a predominance of common pelagic species. Many commercial fish species use the shelf zone as spawning and nursery areas which emphasizes the shelf's significance in the fish productivity. Resources of micro- and meiobenthos, bacterio- and microzooplankton, and large gelatinous macrozooplankton still remain an enigmatic value.

Some important processes and phenomena were recently revealed which can affect shelf biotopes, communities, and ecosystems functioning on long-term time scales. Silt accumulation seems to be a fluctuating process, changing with water circulation intensity under the climate change. Sedimentation rates can vary and are sometimes higher than estimated by sediment core studies. Regular acoustic surveys of bottom type and characteristics are promising in the study of these processes. Changes in biological diversity and composition of the shelf communities often reflect the current processes of sea floor landscape deformation. Kelp bushes and sea grass bed replacement by coralline algae, so-called "isoyakes", occur even in areas where human impact is not heavy. The question remains whether these processes are reversible in the long-term.

The shelf zone is first, and to the greatest degree, involved with the anthropogenic activity at sea. Artificial reef installations are widely applied around the world. This activity creates the necessity to accelerate studies of man-made material biodegradation and biofouling. The territory of the shelf around Russia exceeds 6.2 millions square kilometers, of which 4 million square kilometers are promising for oil and gas development. The initial extracted resources of hydrocarbon raw materials from the shelf are evaluated at 136 billion tons of standard fuel (25% of world-wide resources of hydrocarbons). The Ministry of Natural Resources of Russia plans to increase the federal budget expenditure for regional works in shelf exploration from 700 million rubles in 2005 to 2,8 billion rubles by 2020. Dissolved oxygen deficiency, pollution due to toxic organic chemicals and heavy metals can be expected, if shelf resources are to be explored in a reckless way.

PICES XIV

Abstracts

S1

Science Board Symposium
Mechanisms of climate and human impacts on ecosystems in marginal seas and shelf regions

Co-Convenors: Kuh Kim (SB), Michael J. Dagg (BIO), Yukimasa Ishida (FIS), John E. Stein (MEQ), Michael G. Foreman (POC), Igor I. Shevchenko (TCODE), Jeffrey M. Napp (MONITOR), and Harold P. Batchelder and Suam Kim (CCCC)

There are many examples of statistical correlations that demonstrate relations between climate or human impacts and ecosystems. While retrospection may be informative in revealing patterns, it rarely leads to mechanistic understanding required for eventual prediction. This session, instead, will focus on physical and biological mechanisms in the marginal seas and shelf regions. Many coastal species have life histories/cycles that rely on specific geographic features and they may be particularly vulnerable to the effects of human activities and climate variability. In order to predict the impacts of climate and human activities, we need to understand the mechanisms responsible for shifts in ecosystem structure and function. We will consider "wind to whales" in this session. This theme will provide opportunities to address questions such as: How widespread is bottom-up control of fluxes? At what spatial and temporal scales are: 1) trophodynamic demands and food supply in balance?, 2) signals amplified in food webs?, and 3) physical processes most important in impacting marine populations? The human impacts that could be considered include fishing and fisheries enhancement, changes in biodiversity, petroleum development, eutrophication, mariculture, non-point source pollution, and others.

Monday, October 3, 2005   11:30-18:00

11:30-11:40	**Introduction by Convenors**
11:40-12:10	**Franz J. <u>Mueter</u>, Jennifer Boldt, Bernard A. Megrey and Randall Peterman** (Invited) Spatial and temporal scales of variability in the productivity of Northeast Pacific fish stocks (S1-2479)
12:10-12:40	**Tetsuo <u>Yanagi</u> and Mitsuru Hayashi** (Invited) Numerical model on the changing dominant species of red tide in Osaka Bay from 1990 to 2000 (S1-2264)
12:40-14:00	**Lunch**
14:00-14:30	**Sok Kuh <u>Kang</u>, Joseph Y. Cherniawsky, Michael G.G. Foreman, Sinjae Yoo, Hong Sik Min, Cheol-Ho Kim and Hyoun-Woo Kang** (Invited) Patterns of recent sea level rise in the East/Japan Sea and their ecological implication in the Ulleung Basin (S1-2331)
14:30-14:50	**Xue-Ding Li, Cai-Yun Zhang, Shao-Ling <u>Shang</u> and Zhen-Bin Lu** Seasonal migration of fishing grounds in the southern Taiwan Strait (S1-2486)
14:50-15:10	**Vyacheslav <u>Lobanov</u>, Vladimir Zvalinsky, Pavel Tishchenko, Anatoly Salyuk, Sergei Zakharkov, S. Ladychenko and E. Shtraikhert** Mechanisms of fast changes in physical and biological fields along the Primorye coast in the Japan Sea (S1-2475)
15:10-15:30	**Chun-Ok <u>Jo</u> and Kyung-Ryul Kim** Effects of melting sea ice in the Tatarskiy Strait on spring bloom along the Primorye coast in the East Sea (S1-2613)
15:30-15:50	**Hyun-cheol <u>Kim</u>, Sinjae Yoo and Im Sang Oh** The relationship between the mixed layer depth and surface chlorophyll in the Japan/East Sea (S1-2451)
15:50-16:10	**Coffee Break**

16:10-16:30	**Masahide Kaeriyama, Sei-ichi Saito and Akihiko Yatsu** Comparison of the growth pattern for Japanese chum salmon in the Okhotsk Sea and the Bering Sea (S1-2307)
16:30-16:50	**Liqi Chen, Zhongyong Gao, Liyang Zhan and Suqing Xu** Carbon cycling in the Bering Sea and its impacts on marine ecosystems in the subarctic waters and the western Arctic Ocean (S1-2515)
16:50-17:10	**Elizabeth A. Logerwell, A.B. Hollowed, C.D. Wilson, P. Walline, P. Munro, M.E. Conners, S. McDermott, S. Neidetcher, D. Cooper and K. Rand** Fish movement plays a key role in understanding the potential for commercial fishing to impact prey fields of endangered Steller sea lions (S1-2428)
17:10-17:30	**John A. Barth, Stephen D. Pierce, Timothy J. Cowles and William T. Peterson** Flow-topography interaction and its influence on ecosystem dynamics in the northern California Current System (S1-2506)
17:30-17:50	**William Peterson, Rian Hooff and Robert Emmett** Extreme climate variability in the northern California Current: Can we explain the current anomalous warm state and its effects on the coastal upwelling ecosystem off Washington and Oregon? (S1-2546)
17:50-18:00	**Summary by Convenors**

Posters

Tatyana A. Belan and Ludmila S. Belan
Composition, quantitative distribution and long-term changes of the macrozoobenthos in Amursky Bay (the Sea Japan) (S1-2251)

Zhongxin Chu, S.K. Zhai and X.F. Chen
Preliminary analysis of the response of sediment features from the Yangtze River into sea to water storage in Three Gorges Project reservoir (S1-2208)

Zhongyong Gao, Liqi Chen and Suqing Xu
Comparisons of carbon cycling between the Bering Sea and bipolar regions: Distributions of pCO$_2$ in the surface sea water and their control (S1-2423)

In Seong Han, Hee Dong Jeong, Ki Tack Seong and Ju Lee
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Dmitry D. Kaplunenko, Vladimir I. Ponomarev and Antonina Polyakova
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Hey-Jin Kim, Art Miller, Doug Neilson and John McGowan
Stratification changes and upwelling efficiency in the southern California Current (S1-2501)

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Hydrodynamic influences on macrobenthos structural characteristics of the northeastern Sakhalin shelf (S1-2607)

Jae-Young Lee, Chung Il Lee and Kyung-Ryul Kim
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Changes in biogenic elements of the Yellow Sea and their influences on its ecosystem (S1-2472)

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Sources and transportation of suspended particles: Evidence from particulate organic carbon isotopes and the ecological significance (S1-2478)

Mikhail V. Simokon and Lidia T. Kovekovdova
Spatial distribution of heavy metals in bottom sediments of Peter the Great Bay (Sea of Japan) and related environmental complications (S1-2265)

Elena I. Ustinova, Natalia I. Rudykh, Yuri D. Sorokin and Vladimir I. Ponomarev
Variability of thermal regime and various climatic indices in Far East Seas (S1-2328)

PICES XIV   *S1-2506*   *Oral*

Flow-topography interaction and its influence on ecosystem dynamics in the northern California Current System

John A. Barth[1], Stephen D. Pierce[1], Timothy J. Cowles[1] and William T. Peterson[1,2]

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During spring and summer 2000 and 2002, mesoscale mapping cruises were carried out in the northern California Current System between 41.9° and 44.6°N and between the shallow, inner continental shelf and up to 150 km offshore. Measurements were made using a towed undulating vehicle equipped with a conductivity-temperature-depth instrument and a chlorophyll fluorometer, and a towed four-frequency bio-acoustics instrument. A shipboard acoustic Doppler current profiler measured water velocities, and surface drifter trajectories and satellite sea surface temperature imagery provide context for the mesoscale maps. Two major topographic features perturb the wind-driven, alongshore flow in this region: a submarine bank offshore of a straight coastline (Heceta Bank) and a large coastal cape (Cape Blanco). Interaction of the flow with these features leads to: 1) displacement of the upwelling jet and front seaward leading to large off-shelf flux of coastal water and the material it contains (chlorophyll, zooplankton); 2) increased mesoscale variability downstream of the topographic perturbations; and 3) creation of lee regions with more quiescent flow and increased primary and secondary production. Flow-topography interaction and its year-to-year modulation by large-scale climate variability have profound influence on the local ecosystem from creation of nearshore hypoxic zones to increased frontal habitat.

PICES XIV   *S1-2251*   *Poster*

Composition, quantitative distribution and long-term changes of the macrozoobenthos in Amursky Bay (the Sea of Japan)

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Data on species composition, trophic structure and distribution of macrozoobenthos in Amursky Bay obtained in 2001 are presented. Long-term changes of the benthos have also been analyzed. The average benthos biomass in Amursky Bay in 2001 was 157.9 g/m^2, and it was formed mainly by large bivalves (64.5%) and polychaetes (21.3%). Fifteen years ago the benthos biomass (73.9 g/m^2) was created by polychaetes (65.0%) and the contribution of bivalves was about 19.0%. Despite the increase in benthos biomass in 2001, species richness has declined, with statistical significance, compared with the 1980s. Benthos trophic structure in the 1970s, 1980s and in 2001 was characterized by a prevalence of deposit-feeders. The whole structure of the benthos is evaluated as eutrophic. Eutrophication of the Bay is considered to be the most probable reason for the negative changes of benthic communities in 2001, as well as 15 years ago.

PICES XIV   *S1-2515*   *Oral*

Carbon cycling in the Bering Sea and its impacts on marine ecosystems in the subarctic waters and the western Arctic Ocean

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The 1st and 2nd Chinese National Arctic Research Expedition (CHINARE) has been carried out respectively in 1999 and 2003 in summer to survey the Bering Sea and western Arctic Ocean. The partial pressure of CO_2 in surface water (pCO_2) was continually measured by using a Li-Cor 6262 CO_2/H_2O infrared analyzer on aboard the icebreaker R/V *Xuelong*. Distributions of pCO_2 show obvious differences with geography, with lower

values on the continental shelf, increasing values with slope and higher values for the abyssal plain such as the Canada Basin. Major driving forces were analyzed and attributed to biological or physical processes. The Chukchi Sea appears to be a significant region for the absorption of atmospheric CO_2 in summer and is characterized by processes such as rapid sea ice melting, high primary production on the continental shelf and marginal ice zone (MIZ), and transformed water from the Bering Sea, *etc*. Concentrations of pCO$_2$ appear to sharply fluctuate on the Chukchi continental shelf, which can be traced to inflows from the Bering Abyssal Plain and the Alaska Coastal Current (ACC) which bring higher pCO$_2$ water to the shelf. In the Bering Strait adjacent area (66–69°N), pCO$_2$ in mid-August is much lower than that at the end of July due to algae blooms during this season. From 68.5–69°N at 169°W, pCO$_2$ in August is much higher, along with higher SSTs, than in July which can be attributed to water mass transport from the ACC. In August in the MIZ, pCO$_2$ showed a slight increase and the temperature also increased a little because SST is a major driving force during the melting of sea ice and contributes to the recession of the pack ice zone.

In order to understand air-sea interaction of greenhouse gasses in the role of global climate change and to make a contribution to the IPY (International Polar Year) 2007/08, CHINARE will conduct the third and fourth Expeditions in 2006 and 2008, respectively, to especially focus on the air-sea flux of greenhouse gasses such as carbon relative to climate variability and impacts to sub-Arctic marine ecosystems in the Bering Sea and the western Arctic Ocean.

PICES XIV   S1-2208   Poster

Preliminary analysis of the response of sediment features from the Yangtze River into sea to water storage in Three Gorges Project reservoir

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In June and October 2003, water was stored in the Three Gorges Project (TGP) reservoir at the dam at heights of 135m and 139m, respectively. In order to examine the response of sediment features from the Yangtze River into sea to the storage of water in the TGP reservoir, annual and intra-annual changes in water discharge, mean suspended sediment concentration (SSC), mean median grain size of sediment, and sediment load at Datong (the controlling hydrological station of the Yangtze River into sea) in 2003 are compared with those in 2002 and 2001, as well as those of the means of many years, respectively. In general, compared with those in 2002 and 2001 as well as those of many years' worth of means in the past five decades, annual mean median grain size of sediment, annual mean SSC, and annual sediment load at Datong station in 2003 are all reduced, although the annual water discharge in 2003 has not changed much. In general, compared with those in the corresponding month for 2002 and 2001, as well as those of the means from 1968-1997, the mean SSC and sediment load at Datong in June and November 2003 are all reduced, although water discharge in the corresponding months does not change much. These results indicate that sediment features were significantly affected by water storage in the TGP reservoir in 2003.

PICES XIV   S1-2423   Poster

Comparisons of carbon cycling between the Bering Sea and bipolar regions: Distributions of pCO$_2$ in the surface sea water and their control

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With data collected from the 16th Chinese National Antarctic Research Expedition (CHINARE-XVI 1999.11–2000.4) and the 1st and 2nd Chinese National Arctic Research Expeditions (1999.7–9 and 2003.7–9) respectively, for the analysis and comparison of pCO$_2$, as well as other relevant elements, along the cruise tracks of the R/V *Xuelong*, the characteristics of the distribution of pCO$_2$ and their main driving forces were compared and the characteristics of carbon cycling in the Bering Sea and bipolar regions were discussed. Results showed that all three regions developed into sinks for atmospheric CO_2 in summer, of which the characteristic was high primary

production. However, there are marked differences among the regions with respect to distribution features and controls. In the Southern Ocean, biological effects in summer could control the distribution of pCO$_2$, in general, though some outstanding hydro-physical processes still affected it locally. In the Bering Sea, however, circulation was the main driving force affecting the distribution of pCO$_2$, though low pCO$_2$ on most of the shelves was still caused by high production. The situation in the western Arctic Ocean is more complicated because the ocean not only affected by local circulation and the production, but also by flow from the outside, namely Bering Sea flow and by local hydro-physical processes, for example, melting ice.

PICES XIV   S1-2596   Poster
Mass mortality of the scallop *Haliotis gigantean* affected by high frequency fluctuations around the eastern coast of Korea

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Mass mortality of the scallop *Haliotis gigantea* has frequently occurred around the shelf of the East/Japan Sea. This mortality is thought to be caused by the sudden change in oceanographic conditions around the bottom of the shelf. On the other hand, it is well known that strong barotrophic tidal currents, the steep topography and stratification structures influence the generation of internal tides. These internal waves, which have a semidiurnal period and the wavelength generally about several tens kilometers, is thought to be caused by tidal forcing generated around the shelf break. These long time-scale internal waves tend to cause short time-scale internal waves. These high frequency internal waves can generate a change in stratification, vertical mixing and resuspension of deposits. Around the shelf break in the East/Japan Sea, high frequency internal waves were frequently observed. The National Fisheries Research and Development Institute (NFRDI) has carried out a mooring array for the production of available forecast information and coastal farm monitoring of shellfish on the shelf of East/Japan Sea. This mooring array is attached to three thermometers and an ADCP (Acoustic Doppler Current Profiler). During April in 2003, significant temperature fluctuations were observed and vertical mixing occurred at the intermediate layer on the shelf of East/Japan Sea. The occurrence of high frequency internal waves corresponded to the period of the spring tide. We also found an ageostrophic current, which flowed across the isobath, within the inertial period. This short time-scale fluctuation is considered to influence the ecosystem around the bottom layer.

PICES XIV   S1-2471   Poster
Ocean color variability in the East China Sea: Time series of satellite remote sensing and *in situ* observations

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The AVHRR, OCTS and SeaWiFS data sets were used to study the physico-biological features of the East China Sea (ECS). Time series of sea surface temperature, surface chlorophyll *a* and primary production in the ECS were derived by satellite data and an improved Vertically Generalized Production Model (VGPM). The 8-year (1997-2004) time series showed variability at various scales. The physico-biological oceanographic annual cycle was driven by a counterclockwise circulation system which consists of the Kuroshio-Tsushima Current-Yellow Sea Warm Current on the eastern side, and the Coastal Current on the western side. The former, coming from the tropical ocean, brings oligotrophic water with low chlorophyll *a* concentrations and primary production; the latter has a low salinity but high nutrients, chlorophyll *a* concentrations and primary production. The interannual variation of primary production showed that there is a bimodality character in the whole ECS which is related to the blooming of phytoplankton in the ECS in spring and the existence of the biological front of the Changjiang River Estuary in summer. In different regions of the ECS, seasonal variation of physico-biological characteristics was different. We also found that primary production decreased in most regions of the ECS, except in the Changjiang (Yangtze River) dilution zone during the El Niño period (1998) when the El Niño would make the seasonal variation smaller in most areas.

Interannual variation in the winter-spring plankton community in the late 1990's: Relationship between communities in the "slope water" and Kuroshio axis

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Japanese sardines spawn in the "slope water" area, between the Pacific coast of Japan and the Kuroshio, and eggs/larvae are transported by the Kuroshio to grow in the northern area of the eastern North Pacific. In the Kuroshio axis, winter biomass of the large copepod *Calanus sinicus* increased in 1999 and 2000, which suggests correspondence with the 1997/1998 regime shift in the North Pacific (Nakata and Hidaka 2003).   Since *C. sinicus* inhabits mainly the slope water which is transported into the Kuroshio, changes in the slope water should be helpful understanding the biomass increase in the Kuroshio. We investigated the changes in copepod biomass, biomass of *C. sinicus*, and surface chlorophyll concentration in 1990's. In the slope water region, the biomass of copepods and *C. sinicus* is generally higher than that in the Kuroshio axis and the year-to-year change in biomass is modest. Surface chlorophyll concentrations increased in 1999 but decreased in 2000. Thus the scenario of Nakata and Hidaka (2003) (intensified wind - intensified vertical water mixing - increase in plankton biomass) cannot be applied to the slope water and other mechanism for the increase of *C. sinicus* biomass in Kuroshio axis, *e.g.* changes in the degree of transportation from the slope water, should be suggested.

Recent variations of the thermocline in Korean waters

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Water temperature has gradually increased by about 0.8~0.9°C at the surface layer, while it has gradually decreased by about 0.8°C in the intermediate layer in the last 40 years in Korean waters. These differences in long-term temperature trends between the surface and the intermediate layer should influence the long-term trend of vertical temperature structure in the water mass. It is thought that primary productivity and fisheries resources are also influenced by the change of vertical temperature structure. In this study, the long-term changes regarding the depth of thermocline formation and the temperature gradient around the thermocline were examined using the temperature data of a series of oceanographic investigations by NFRDI (National Fisheries Research and Development Institute) from 1970 to 2004. To discuss the change of permanent thermocline and seasonal thermocline, the maximum temperature gradients deeper than 50m, in February, and shallower than 50m, in August, were computed, respectively. The strengths of permanent and seasonal thermoclines have increased slightly during the last 35 years, though they have weakened in some areas. The depth of seasonal thermocline formation has mainly risen by about 5~10m during the summer in Korean waters. The permanent thermocline, which is formed mainly by the East Korea Warm Current, has risen by about 50m during last 35 years. To verify the ascending trend of the permanent thermocline, the long-term changes in the depth of the isothermal line formed at 7°C, where the thermocline is usually formed by the East Korea Warm Current, was examined in the East/Japan Sea. The isothermal line at 7°C has also ascended by about 50m during the last 35 years.

Effects of melting sea ice in the Tatarskiy Strait on spring bloom along the Primorye coast in the East Sea

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Spring bloom occurs in April and May in the East Sea and is formed by water column stratification owing to temperature increase and wind stress decrease. However, spring bloom along the Primorye coast is observed from the beginning of March according to SeaWiFS images. Therefore, conditions for spring bloom formation

might be different from that of the other regions. Sea ice forms during winter in the Tatarskiy Strait is almost melted by April. The source of the Liman Current that flows along the Primorye coast is low salinity water from the melting of sea ice in the Tatarskiy Strait from January to March. We investigated conditions for bloom formation at the beginning of March in 2000 by using observation data of the R/V *Professor Khromov* and the relationship between total sea ice area and spring bloom from 1998 to 2003 by using SSM/I and SeaWiFS data. Low salinity based stratification was formed within the euphotic depth when spring bloom occurred. The low salinity water was supplied by melted sea ice in the Tatarskiy Strait. The magnitude of the spring bloom was associated with the total area of sea ice. The magnitude of spring bloom was abnormally high in 2001 when total sea ice area was the maximum and low in 1999 when it was the minimum. Spring blooms started after maximum melting of sea ice. However, the bloom timing was delayed when wind stress was strong after maximum melting.

PICES XIV   S1-2307   Oral
Comparison of the growth pattern for Japanese chum salmon in the Okhotsk Sea and the Bering Sea

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The present paper discusses the relationship between climate change and life history strategy in controlling the growth pattern of Japanese chum salmon. Japanese chum salmon spend their first summer in the Okhotsk Sea after their early marine life in coastal waters, then move to the Western Subarctic Gyre for their first winter at sea. Thereafter, they migrate between summer feeding grounds in the Bering Sea and wintering grounds in the Alaskan Gyre for a period of usually up to four years, and finally return to their natal rivers to spawn. Annual somatic growth by age of adult chum salmon returning to the Ishikari River was estimated using the back-calculation method from scales. Their somatic growth in the first year in the Okhotsk Sea was better in the 1990s than in other years, related to the reduction in the ice cover in the sea in the 1990s. On the hand, the somatic growth of chum salmon in the third and fourth years in the Bering Sea has decreased since the end of 1970s because of the population density dependent effect. These results suggest that the life history strategy of Pacific salmon offers a useful framework for evaluating not only inter- and intra-specific interactions but also climate-related risk factors around the North Pacific Rim.

PICES XIV   S1-2331   Invited
Patterns of recent sea level rise in the East/Japan Sea and their ecological implication in the Ulleung Basin

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Patterns of recent sea level rise in the East/Japan Sea (EJS) are investigated through the analyses of TOPEX/ Poseidon (T/P) sea level anomalies, thermosteric sea level (TSL) and tide gauge data. The 9-year long T/P analyses reveal average trends of 5.4 ± 0.3 mm yr^{-1} for all of the EJS, which is much larger than the global rates of 3.1 ± 0.4 mm yr^{-1} found by Cabanes *et al.* [2001]. This T/P rate compares relatively well with those from TSL data and tidal sea level gauges, indicating that sea level rise in the EJS is due mainly to thermal expansion. The southern EJS shows a non-uniform sea level trend pattern, with larger rates in the Ulleung and Yamato basins. This non-uniform pattern is discussed in terms of variable thermal expansions arising from a recent decadal trend in the temperature anomaly in the upper layer of the two basins. The 40-year-long TSL time series also reveals a decadal oscillation in the Ulleung and Yamato basins. It is hypothesized that the long-term oscillation in the southern EJS may be related to decadal variability of the heat content anomaly in the upper 300 m of the Pacific Ocean, as reported by Levitus *et al.* [2000], and to eddy fluctuations in the southern EJS. Whether or not the ecosystem in the EJS is responding to these changing physical signals is discussed by comparing surface chlorophyll-a and temperature structure in the Ulleung Basin.

Mesozooplankton responses to regime shifts associated with the changes in oceanographic conditions in the eastern area of the Yellow Sea

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Mesozooplankton responses to regime shifts in 1977, 1989 and 1998 were studied from long-term data taken from 1965 to 2004 in the eastern area of the Yellow Sea. In particular, the study was focused on the new state after the 1998 regime shift with concentration on an El Niño event in 2002/03. Mesozooplankton biomass and abundance of four taxa, such as copepods, chaetognaths, amphipods and euphausiids, and temperature and salinity were used to detect responses. Mean values were calculated for the four time periods divided by the regime shift, the 1965/67~76 (PI), 1977~88 (PII), 1989~97 (PIII) and 1998~2004 (PIV). Mesozooplankton biomass decreased during PI to PII and then increased continuously to PIV. The increasing trends were gradual in PIII and sharp during PIV. By contrast with the increasing trends in PIII and PIV, 1997 and 2003 showed low biomasses, particularly in June and August. Of the four major taxa, copepods gradually increased from PIII to PIV, and amphipods showed a sharp increase during PIV. On the other hand, chaetognaths showed a decreasing trend in PIV. Sea surface temperature (SST) slowly decreased during PI and PII, especially in February and April, and then gradually increased to PIV, with interannual fluctuations. Compared with the SST, the temperature at 50 m decreased steeply after the end of PIII in June, August and October but increased from PIII in February and April. Salinity at the surface and at 50 m depth sharply increased during early PII and then remained at a steady state from PII to PIII. The salinity in PIV decreased steeply.

These results suggest that mesozooplankton responded strongly to PIII, PIV and an El Niño event in 2002/03 even though the mesozooplankton biomass showed a continuous increasing trend during PIII and PIV. It is evident that the increasing gradients between PIII and PIV were very different, and chaetognath and amphipod abundance changed rapidly after PIII. Oceanographic conditions also showed the striking changes in salinity and temperature around PIII and PIV.

Study of climate oscillations at different time scales in the North Pacific

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The role of the North Pacific in regulating extratropical climate on a wide range of time scales is now widely discussed. North Pacific sea surface temperature (SST) and atmospheric circulation have a strong influence on weather and climate in both Eurasia and North America, identified by the Pacific Decadal Oscillation (PDO) and its possible long-term modulation of El Niño impacts on the regional climate. Thus it appears useful to analyze factors related to the known oscillations of the El Niño–Southern Oscillation (ENSO) (3-7 years), decadal (8-20 years) and interdecadal (21-50 years) time scales.

Using EOF principal components of NCEP-NCAR and GHCN surface air temperature, GLBSST and HadISST Sea Surface Temperature (SST), wavelet analysis of their temporal components and monthly occurrence of six types of synoptic (meteorological) situations over the North Pacific developed by Polyakova (1992, 1997, 1999) we analyzed SST and air temperature modes which variability are either independent of, or cannot be explained by the El Niño forcing alone. It has been found that some of Polyakova's types are strongly related to the EOF-modes of SST and air temperature and may have some connections with the oscillations of decadal and interdecadal time scales.

PICES XIV S1-2501 *Poster*
Stratification changes and upwelling efficiency in the southern California Current

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The California Current System (CCS) is highly variable and very productive. Many physical processes interact with various temporal and spatial scales, and with the marine ecosystem. Long-term changes of the biological response to physical climate forcing are one of the main issues of interest because the nonlinear ecosystem may not be linearly related to persistent environmental disturbances (Hsieh *et al.*, 2005). Roemmich and McGowan (1995) showed unique observations of long-term physical-biological interaction in the southern California Current and suggested that surface warming forced increased stratification, which capped the cold nutrient-rich upwelling cell, and consequently resulted in a 70 % decrease in macrozooplankton biomass in the southern California Current. However, the linkage between stratification changes and zooplankton biomass is still not well understood. This study analyzes patterns of long-term stratification changes quantitatively in terms of mixed layer depth and thermocline depth with the *in-situ* dataset of the 55-year CalCOFI (California Cooperative Oceanic Fisheries Investigations), and examines the upwelling efficiency and primary production related to the stratification changes by *in-situ* data and modeling studies.

PICES XIV S1-2451 *Oral*
The relationship between the mixed layer depth and surface chlorophyll in the Japan/East Sea

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The spatial distribution of surface chlorophyll in the Japan/East Sea varies from year to year and from season to season. To explain the variability, we hypothesize that the stability of the water column might control light conditions in the spring season and nutrient resupply in fall season. To test this, we compared the time series of surface chlorophyll and mixed layer depth at stations from four sub-regions in the Japan/East Sea: the Primorye coast, Japan Basin, Ulleung Basin, and Yamato Basin. An 8-day time series of MODIS/Terra chlorophyll, photosynthetically active radiation (PAR) and sea surface temperature from 2000 through 2004 were used. For the mixed layer depth during 2000 to 2004, modeled data (data produced by the scheme of Karra *et al.*, 2000) were used. QuickSCAT data were used for wind. The results show that spring growth can be explained largely by the seasonal evolution of the mixed layer depth while the fall growth cannot be explained in the same way. The reason for the difference and alternative explanations are discussed.

PICES XIV S1-2607 *Poster*
Hydrodynamic influences on macrobenthos structural characteristics of the northeastern Sakhalin shelf

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It is obvious that hydrodynamics influences the structural characteristics of the macrobenthos of the near-shore zone. Data were obtained during complex ecological surveys of the Sakhalin Research Institute of Fisheries and Oceanography in the northeastern part of Sakhalin shelf of the Okhotsk Sea in summer 2000-2004. A distinct vertical replacement of macrobenthic and trophic groups has been found in the northeastern Sakhalin shelf zone, which is connected with peculiarities of the nearbottom hydrodynamics. Tidal currents of a 24-hour range were ascertained to be the main parameter of the marine environment, which determines the structural stability of macrobenthic communities on the northeastern Sakhalin shelf. The calculated negative correlation is significant at a depth range of 30-90 m. The impact of the tidal current is absent at a depth of more than 90 m. The defined influence of waves is noticed at 15 m depth by the linear velocity of orbital particles of 0.045 m/sec near the bottom.

Effects of climate change on physical and biogeochemical elements in the East/Japan Sea

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Concerning the effect of climate change on oceanographic environments, temporal variations of both physical and biogeochemical elements were investigated with extracted data from the World Ocean Database (WOD01) and various climate change indices such as the Southern Oscillation Index (SOI), Pacific Decadal Oscillation (PDO) and Monsoon Index (MI). Standard depth data of sea water temperature, nutrients (nitrate, phosphate and silica) and dissolved oxygen from 1971 to 2000 were used in the analysis. Even though temperature variations in the East/Japan Sea are highly correlated with El Niño events in a typical period of from 4 to 8 years, these variations, especially in the surface layer down to 200m, are also affected by variations in the Tsushima Warm Current which originates from open sea. The effects of climate change resulting from temporal variations in the physical elements in the East/Japan Sea are also found in variations of biological elements, especially in the magnitude of primary production. In relation to the relative importance of light and nutrient conditions in the water-column, temporal changes of primary production magnitude were investigated in the study.

Mechanisms of fast changes in physical and biological fields along the Primorye coast in the Japan Sea

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Fast changes in the physical and biological regime along the Primorye coast in the northwestern region of the Japan Sea occur in the transition period of monsoon winds (September-October) and are associated with coastal upwelling and the beginning of sea surface cooling and convection. Satellite data from various sensors were collected during the fall period of 2000. During the same period, ship hydrographic, chemical and biological observations were implemented in the area. In the background of SST cooling during the fall period, a drastic change in circulation pattern, formation of mesoscale eddies and upwelling events were revealed. These events enhanced horizontal water transport toward and off the coast and ventilation of the shelf area by deep sea water. *In situ* observations confirmed prominent changes in the hydrographic field, nutrients and primary production (PP). It was found, however, that an increase in PP was not observed in the cold upwelled water tongues, while it was found in the areas where subsurface horizontal advection induced by mesoscale eddies had happened. This could be explained by decreasing stratification and deepening of the upper mixed layer in the upwelling. On the other hand, subsurface intrusion of cold, saline and nutrient-rich deep sea waters onto the shelf increased stratification and moved the pycnocline upwards which creates favorable conditions for plankton. Thus horizontal advection associated with eddy dynamics is most effective mechanism for the fall plankton bloom in the coastal area of Primorye. Interannual variations of the upwelling index should be accompanied by information on eddy activity in the coastal area for correct estimation of ecosystem dynamics.

Fish movement plays a key role in understanding the potential for commercial fishing to impact prey fields of endangered Steller sea lions

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The Fishery Interaction Team (FIT) at the Alaska Fisheries Science Center (National Marine Fisheries Service, USA) was formed in 2000 to investigate the potential ecosystem effects of commercial fishing. FIT researchers are presently interested in interactions between commercial fisheries and endangered Steller sea lions. The

objects of our current research projects are to: 1) test the hypothesis that commercial fishing results in localized depletion or disruption of sea lion prey fields, and 2) evaluate the efficacy of trawl exclusion zones designed to mitigate competition between commercial fishing and sea lions. The research activities of FIT currently focus on three commercially fished groundfish species in Alaska: Pacific cod, Atka mackerel and walleye pollock. To investigate whether fishing impacts prey fields, we conducted at-sea experiments that used a before-after, treatment-control type design to compare the change in fish abundance within heavily-trawled areas during the fishing season to the change within adjacent no-trawl zones. These studies focused on Pacific cod and walleye pollock. To evaluate the efficacy of trawl exclusion zones at maintaining sufficient quantities of prey for sea lions, we used tag release-recovery methods to estimate local fish abundance and movement rates inside and outside the zones. This study focused on Atka mackerel. Results to date indicate that fish movement plays an important role in determining the potential for commercial fishing to cause localized depletions of fish. Fish movement is also key to assessing the efficacy of trawl exclusion zones at maintaining local concentrations of fish for foraging sea lions.

PICES XIV   S1-2479   Invited
Spatial and temporal scales of variability in the productivity of Northeast Pacific fish stocks

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One of the key questions to be addressed by this symposium asks "At what spatial and temporal scales are physical processes most important in affecting marine fish populations?" The answer first requires an understanding of the spatial and temporal scales of variability in both the physical environment and in the dynamics of marine fish populations. We argue that the scales of significant covariation among measures of productivity of different stocks or species provide an estimate of the dominant scale of environmental influences. We analyzed lengthy data sets for two productivity measures (indices of survival rate and recruitment) of fish stocks within three large marine ecosystems (eastern Bering Sea including Aleutian Islands, Gulf of Alaska, and California Current region). We found that positive spatial covariation in the productivity of salmon, herring, and groundfish stocks is largely confined to regional spatial scales of hundreds of kilometers (salmon and herring) or to certain coastal ecosystems (groundfish). Therefore, large-scale climate effects on fish productivity appear to be mediated through regional-scale processes. Temporal patterns of variability suggest that the dominant environmental influences on productivity occur primarily at short-term, interannual time scales. However, decadal-scale influences on productivity are evident in aggregate measures of productivity across multiple stocks or multiple species and may reflect constraints on overall ecosystem productivity.

PICES XIV   S1-2472   Poster
Changes in biogenic elements of the Yellow Sea and their influences on its ecosystem

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During 1976~2000, the annual mean of dissolved inorganic nitrogen (DIN) in the Yellow Sea increased by 2.95 μmol L^{-1}, while those of dissolved oxygen (DO), phosphorus (P) and silicon (Si) decreased by 59.1, 0.1 and 3.93 μmol L^{-1}, respectively. In the 1980's, particularly in between 1985 and 1989, concentrations of P and Si dropped to near the ecological threshold for growth of diatoms. The N: P ratio increased from 4 in 1984 to over 16 in 2000. The positive trend of DIN was probably attributable to precipitation and partly to the Changjiang River discharge. The negative trends of P and Si were due to the decreases in their concentrations in seawater that flowed to the Yellow Sea from the Bohai Sea. As a result, N: P ratios greatly increased in the waters of the Yellow Sea.

The influence of changes in biogenic elements on the ecosystem of the Yellow Sea was obviously displayed, *i.e.* the strengthening nutrient limitation resulted in a series of variations, such as the decrease in chlorophyll-*a*,

primary production and phytoplankton abundance, succession of dominant phytoplankton species from diatoms to non-diatoms, and changes in fish community structure and species diversity.

PICES XIV   S1-2210   Poster
Coastal productivity bloom with biodiversity changes induced by ground water fluxes and climate variability

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In constructing water budget and mass flux estimations for coastal margins, submarine ground water discharge is often overlooked but it can be substantial to influence oceanic chemistry. The west coast of India had ground water seepage to the Arabian Sea through a narrow parallel strip of submerged porous lime shell bed supplying nutrients to the coastal waters. Chlorophyll-*a* showed "greening" of the near-shore waters, with values 3 times greater than peak reported values. These ground water fluxes depend on climatic (monsoons) variability which controls fresh water to backwaters, providing the necessary force to overcome frictional resistance of porous lime shell deposits; human factors such as the land-use mosaic, socio-economic and sanitary conditions; and tidal factors, such as controlling hydraulic differences between sea and lake. Suitable conditions prevail during the monsoon season, coupled with the sea level at its annual low. Flash floods seem to be high with climate variability (monsoons), and critical conditions can occur during other seasons and at other locations in the coastal region. The differences in the land-use mosaic among sub-watersheds result in differences in nutrient loading to groundwater and hence to receiving coastal waters. Ground water fluxes induce seasonal variability in coastal water quality, primary productivity and slow change in species diversity. Any noticeable change of the current oligothrophic nature of the coastal region contributes to a removal of atmospheric carbon through photosynthesis, planktonic grazing and sinking. Phytoplankton blooms slowly alter the food chain and the impacts of climate variability gradually adjust the overall coastal ecosystem.

PICES XIV   S1-2464   Poster
Estimation of primary production in the Yellow Sea

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The existing estimates of the primary productivity based on *in situ* measurements in the Yellow Sea show a large range of values from 11.78 to 2,694 mg C m^{-2} d^{-1}. Such high variability is remarkable considering that the Yellow Sea is a small shallow marginal sea and its circulation pattern is not complex. The large variability in the estimates reflects the highly variable environmental conditions such as turbidity and water column stability. The Yellow Sea is a good example that demonstrates the difficulty in estimating primary productivity with a reasonable accuracy.   The difficulty includes inaccurate retrieval of chlorophyll and light attenuation coefficients from satellite data. Photosynthetic parameters are also highly variable due to the diverse light environment. Here, we attempt to overcome some of these problems by dividing the Yellow Sea into two different regions in terms of light, and turbid and stratified regions. The results and problems using such an approach are discussed.

Extreme climate variability in the northern California Current: Can we explain the current anomalous warm state and its effects on the coastal upwelling ecosystem off Washington and Oregon?

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Nature dealt California Current scientists a grand experiment: throughout the 1990s, coastal waters were anomalously warm, zooplankton biomass in the CalCOFI region was 1/7 of climatological values, and zooplankton species in the northern California Current were composed of above-average biomass of subtropical species. While sardines increased in abundance, salmon stocks declined severely. This extended period of warm conditions ended suddenly in autumn of 1998. By spring 1999, the northern California Current ecosystem had changed to a "cold water" community and salmon began to recover. In 2000, zooplankton biomass doubled and cold water species dominated. By 2001 coho salmon runs had increased by an order of magnitude and returns of spring Chinook salmon to the Columbia River reached historically high levels not seen since 1937. However, in late 2002, the "recovery" weakened and warm water copepod species again became abundant, and by spring 2004 and 2005, the northern California Current ecosystem closely resembled one experiencing a severe El Niño. However, at the equator, El Niño conditions were neutral. In this paper, we ask, "What is going on in the northern California Current?", "What physical mechanisms account for the presence of "El Niño-like conditions"?" We review the status of physical and biological anomalies off the Pacific Northwest, Oregon, discuss potential mechanisms which have led to a "subtropical" northern California Current, and suggest the need to replace the expression "El Niño-like conditions" with new terminology.

Seasonal migration of fishing grounds in the southern Taiwan Strait

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In order to understand the fluctuations in marine fish stocks, which is important for the management of fisheries, numerous attempts have been made to demonstrate links of fish stock fluctuations with oceanographic and climatic variability. Less attention has been paid to the coastal sea. Taiwan Strait, a shallow channel linking the East China Sea with the South China Sea, is one of the main fishing grounds in China. As a first step to address the responses of fish stocks to the oceanographic variability, the seasonal migration of fishing grounds in relation to oceanographic measures such as Sea Surface Temperature (SST) and Chlorophyll a (Chla) for the southern Taiwan Strait is described on the basis of logbooks of the purse-seine fishery from 1986-2002 and SST and Chla as revealed by AVHRR and SeaWiFS. The distribution of catches higher than 75 tons, which may represent the location of fishing grounds, changes between seasons while the spatial pattern of Chla and SST changes, too. It seems likely that fishing grounds move with the Chla isoline of 0.6mg/m3 whereas there are weaker links with SST.

Sources and transportation of suspended particles: Evidence from particulate organic carbon isotopes and the ecological significance

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The concentrations of total suspended matter (TSM) and the compositions of organic stable carbon isotopes of TSM and bottom sediments were analyzed to study the sources of TSM and sediments and the transportation processes. For this study, 284 TSM samples and 64 sediment ones taken from 67 stations along 7 transects and

in 5 layers were collected in the southern Yellow Sea on a cruise in May, 1998. The main sediment transportation pattern in the southern Yellow Sea was obtained by analyzing the distribution characteristics of TSM concentration and particulate organic carbon $\delta^{13}C$ values. It was confirmed from the pattern that the bottom layer plays a more important role than the surface one in the transportation processes of terrigenous material to the central deep-water area of the southern Yellow Sea. The Yellow Sea circulation is an important control factor in determining the sediment transportation pattern in the southern Yellow Sea. The carbon isotope signals of sedimentary organic matter confirmed that the main material in sediments with high sedimentation rate in the Shandong subaqueous delta originated from the modern Yellow River. The terrigenous sediments in the deep-water area of the southern Yellow Sea are mainly from the abandoned Yellow River and the modern Yellow River, and a small portion of them are from modern Yangtze material. The amount of terrigenous material from Korea Peninsula and its influence range are relatively limited. The conclusions derived from TSM and stable carbon isotopes were further confirmed by another independent material source tracer — polycyclic aromatic hydrocarbons (PAHs).

PICES XIV   S1-2265   Poster
Spatial distribution of heavy metals in bottom sediments of Peter the Great Bay (Sea of Japan) and related environmental complications

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The content of Ag, Al, As, Cd, Co, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Se, Zn in bottom sediments of Peter the Great Bay (Sea of Japan) was investigated. Thirty-seven stations were selected in Ussuriysky Bay, forty stations in Amursky Bay and four stations in the Bosphorus Eastern Strait, connecting both bays, which are all parts of Peter the Great Bay. Sampling of bottom sediments was carried out from 2003–2004. Multivariate analysis revealed that two groups of elements entered the bay – terrigenous, including Al, Co, Cr, Fe, Mn, Ni, Zn and anthropogenous, including Cd, Cu, Hg, Pb. The method of geochemical normalization established locations of bottom sediments which increased in comparison with background concentrations of toxic metals. These increases are influenced by pollution from the domestic and industrial wastes of Vladivostok. The source of terrigenous elements was river runoff and concentrations gradually decreased from estuary to the open part of these bays. Metal concentrations also had an impact on habitat conditions. The mussel *Mytilus trossulus* from Amursky Bay showed increased concentrations of Fe, Mn, Cu in its soft tissues relative to it's known background levels. Concentrations of Fe in the muscles, Fe and Cu in the liver, Cu, Fe, Hg, Mn and Zn in the bones of the flounder *Liopsetta pinnifasciata* from Amursky Bay were higher, with statistical significance $\alpha = 0.05$, than those for the flounder *Cleistenes herzensteini* from Ussuriysky Bay. Thus, human impact has caused local heavy metal pollution of the coastal waters of Peter the Great Bay and some metals have been included into the trophic chains of impacted ecosystems.

PICES XIV   S1-2328   Poster
Variability of thermal regime and various climatic indices in Far East Seas

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Variability in the atmosphere and hydrosphere are closely interrelated and frequently one is depicted with various climatic indices. Considered are long time series data on ice coverage, river discharge, water and air temperatures, and several atmospheric and climatic indices (*e.g.* repeatability of atmospheric circulation types, intensity of Far-Eastern centers of atmosphere action, the winter monsoon index, global and Northern Hemisphere average surface air temperatures, the Pacific Decadal Oscillation PDO index, *etc.*). Low-frequency variability is found to be different for water and air temperatures. Quasi-decadal fluctuations are more evident in the cold season. Seasonality is very important for the climatic activity in the considered area. Therefore, the significance of the correlation between climatic parameters and climatic indices differ from season to season. Thus ice coverage in the Okhotsk Sea and Tatar Strait show good correlation with the intensity of the Far-Eastern centers of atmosphere action in January ($r > 0.6$). The linkages between the atmosphere and ocean processes in Far East seas are different for different temporal and spatial scales. The changes in ice cover in the Okhotsk Sea have the closest connection with the variations in global and Northern Hemisphere average surface

air temperatures for a time scale of more than 7 years, but for the short-term scale, large ice cover anomalies appear in fast response (with a 10- to 20-day delay) to strong winter atmospheric anomalies over the Far-Eastern region. Also, ice coverage correlates better with the Victoria index (second component) then with PDO index – the first component.

Numerical model on the changing dominant species of red tide in Osaka Bay from 1990 to 2000

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The frequency of occurrence of the non-diatom red tide in Osaka Bay was very high in the early 1990s but it drastically decreased in late 1990 and the diatom red tide is dominant now.   The reason for this remarkable change was investigated using the numerical ecosystem model which includes nitrogen, phosphorus and silicate cycling.

The model area is the head of Osaka Bay, Japan where the red tide has occurred every summer.   The box model was applied to this area, the advection (u and w) and diffusion (Kh and Kv) for this model area were estimated by the salt and water budgets using the observed river discharge (R) and salinity data (So, Su and Sl), and the ecosystem model was coupled to this box model.

The calculated results showed that the year-to-year variation in the ratio of diatom and non-diatom red tides in Osaka Bay is well reproduced.   Such a change is due to the decrease of phosphate concentrations in Osaka Bay by the regulation of phosphorus loading from land, that is, the growth rate of non-diatom species decreased in the late 1990s because it has a higher half-saturation concentration for phosphate compared to that for diatoms.

This suggests that regulations put forth by the government regarding phosphorus loading is very useful for water quality management in the Seto Inland Sea, Japan.   Phosphate concentrations have decreased due to the enforcement of this regulation and the main species of red tide has changed from the harmful non-diatom one in the early 1990s to the non-harmful diatom red tide in the late 1990s.

S2

BIO Topic Session
Life history and ecology of euphausiids in coastal and oceanic waters around the Pacific Rim

Co-Convenors: Michael J. Dagg, William T. Peterson (U.S.A.) and Anatoly Volkov (Russia)

Euphausiids are among the most important links in coastal and oceanic food webs, transferring energy from primary and secondary producers to higher trophic level animals such as salmon, herring, sardines, mackerels, Pacific whiting, sablefish, many rockfish species, auklets, shearwaters, and whales. Given their importance in the food chain, euphausiids may be regarded as keystone sentinel taxa. Moreover, many PICES scientists are interested in formulating ecosystem models that better parameterize the euphausiid component. This session invites scientific papers that review and discuss results of research on the ecology and life history of euphausiids in the North Pacific Ocean, with a focus on comparative studies in continental shelf and slope waters around the Pacific Rim.

Thursday, October 6, 2005   08:30-12:30

08:30-08:40   **Inroduction by Convenors**

08:40-09:10   **Kenji Taki**   (Invited)
Distribution and life history of *Euphausia pacifica* off northeastern Japan (S2-2290)

09:10-09:30   **Irina Yu. Bragina, Liudmila Yu. Gavrina and Valery N. Chastikov**
Change in habitat conditions of euphausiids as a cause of sharp decline in the Aniva Bay productivity (La Perouse Strait) (S2-2541)

09:30-09:50   **Sonia Batten, David Welch and Doug Moore**
Seasonal distribution of euphausiids on a transect from the Gulf of Alaska to the Bering Sea (S2-2292)

09:50-10:10   **Leah R. Feinberg, William T. Peterson, C. Tracy Shaw and Jaime Gomez-Gutierrez**
Euphausiid reproduction off the Oregon Coast, U.S.A. (S2-2439)

10:10-10:30   **Coffee Break**

10:30-11:00   **C. Tracy Shaw, Leah R. Feinberg and William T. Peterson**   (Invited)
Seasonal variations in intermolt period and growth of *Euphausia pacifica* and *Thysanoessa spinifera* in the coastal Pacific Northwest (S2-2438)

11:00-11:30   **Se-Jong Ju, H. Rodger Harvey, William T. Peterson, Leah Feinberg and Tracy Shaw** (Invited)
Understanding the nutritional status, diet, and demographic structure of *Euphausia pacifica* through multiple organic markers (S2-2233)

11:30-11:50   **Jaime Jahncke, Benjamin L. Saenz, Chris Rintoul and William J. Sydeman**
Krill and krill-predators: Habitat associations in the dynamic Gulf of the Farallones, California (S2-2447)

11:50-12:30   **Discussion of potential for a future "Year of the euphausiid" study**

Posters

Jinho Chae, Doo-Jin Hwang, Young-Ok Kim, Dongsung Kim and Jae-Hac Lee
Euphausiid distribution near Uljin with special reference to its importance as a food source of demersal fish and impingement on the cooling water intakes of a power plant (S2-2497)

Jaime <u>Gómez-Gutiérrez</u>, Carlos J. Robinson and Karmina Arroyo Ramírez
Egg production and molting rates of the subtropical sac-spawning euphausiid *Nyctiphanes simplex* in the southern part of the California Current System (S2-2584)

Se-Jong <u>Ju</u>, H. Rodger Harvey, Jaime Gómez-Gutiérrez and William T. Peterson
The role of lipids during egg development in *Euphausia pacifica* and *Thysanoessa spinifera* (S2-2234)

Jinhui <u>Wang</u>, Yawei Sun, Caicai Liu, Xiangshen Chen and Ren Xu
Quantitative distribution of euphausiids in the East China Sea and the Yangtze Estuary in relation to the environmental conditions (S2-2414)

Zhao-Li <u>Xu</u> and Chunju Li
Species composition and diversity of pelagic euphausiids in the East China Sea (S2-2534)

Zhao-Li <u>Xu</u> and Chunju Li
Study on abundance distribution of euphausiids in the East China Sea (S2-2535)

Zhao-Li <u>Xu</u> and Ya-Qu Chen
Study on the dominant species of euphausiids in the East China Sea and their ecological adaptability (S2-2533)

Change in habitat conditions of euphausiids as a cause of sharp decline in the Aniva Bay productivity (La Perouse Strait)

Irina Yu. **Bragina**, L.Yu. Gavrina and V.N. Chastikov

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The study area is situated in the northern part of the La Perouse Strait (Okhotsk Sea). Zooplankton community of the bay is formed under the influence of the Okhotsk (East - Sakhalin Current) and Japan (Soya Current) seas and redistribution of waters from the northern Japan Sea caused by upwelling (near Opasnost Rock) and anticyclonic circulation in the southern part of the bay. There is a developed neritic complex of planktonic organisms in the bay due to its shallow waters.

In 1987-2005, 29 surveys were conducted by a standard scheme of stations. A total of 669 zooplankton samples were collected using Juday nets (0,1 м^2, 0.112 mm) towed vertically from near the bottom to the sea surface.

Based on samples collected from 1987-1995, Aniva Bay was determined as the most productive subregion around Sakhalin Island. The cold-water euphausiid *Thysanoessa raschii* (*Th. inermis* in the extremely cold period) was found to be a dominant in spring. The highest-density zone of euphausiid aggregations coincided with the northern periphery of the quasi-stationary anticyclonic eddy A1. Under the two-core structure of this eddy, a zone of aggregations coincided with that of the deep water rising between two anticyclonic eddies. The low water temperature (-2 - 0ºC) and high oxygenation (117-123% in the subsurface layer) were common for a zone of euphausiid aggregations.

In autumn, the cold-water (CW) medium-size copepods (*Pseudocalanus minutus*, *Ps.newmani, Acartia longiremis*) dominated as usual. However, during a significant positive SST anomaly, the moderately-cold-water neritic copepod *Centropages abdominalis* dominated the biomass. On the whole, zooplankton biomass in autumn was significantly lower compared to spring.
By the results obtained during 2001–2005, it was concluded:
a) substitution of large cold-water euphausiids and chaetognaths for copepods of the same ecological group (*Pseudocalanus minutus, Ps. Newmani* and *Acartia longiremis)* in the Aniva Bay zooplankton community took place in the spring period, and a total zooplankton biomass in spring decreased significantly;
b) along with the gradual rise of SST, there was intensive development of a neritic copepod complex, which resulted in shifting of the annual maximum of total biomass dynamics for the autumn period;
c) south - boreal, subtropical and tropical copepod species increased in biomass in the Aniva Bay waters, and their distribution was observed up to the northern coast of the bay;
d) zones with high concentration of euphausiids *Thysanoessa raschii* and *Th. inermis* were observed to be formed in late autumn – winter.

Changes in euphausiids taxonomic composition and age structure, as well as hydrochemical indices and oceanological conditions of their habitat will be discussed.

Euphausiid distribution near Uljin with special reference to its importance as a food source of demersal fish and impingement on the cooling water intakes of a power plant

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Diel and seasonal variation of vertical and horizontal distribution of euphausiids in the vicinity of Uljin, the eastern coast of Korea was examined from the autumn of 2002 to summer of 2003, and during the spring of 2004 using a multiple opening and closing net and an echosounder equipped with a 200 kHz transducer. *Euphausia pacifica* dominated the biomass and often aggregated near the bottom at 100-200 m depth and/or the

submarine channel (>200 m depth approximately) during the day time from the autumn to winter, and performed active diel vertical migration, showing shallow depth distribution around mixed layers at night. The distribution shifted to near-shore during the springs of 2003 and 2004 when the maximum chlorophyll *a* concentration markedly increased (3.6 µg l^{-1} and 15.5 µg l^{-1}, respectively, while showed range of 0.2-0.9µg l^{-1} during the autumn and winter and 0.6 µg l^{-1} in the summer). Samples coincident with acoustic scattering layers in the springs contained high number of eggs and metanauplii accompanied by matured individuals in breeding condition. Thus, intake impingement of euphausiids at Uljin nuclear power plant may relate to the breeding activity. The gut content analysis of dominant demersal fish in the study area, *Pleurogrammus azonus,* also showed that euphausiids played an important role as a food source (100.0 % of food item frequency).

PICES XIV   S2-2584   Poster
Egg production and molting rates of the subtropical sac-spawning euphausiid *Nyctiphanes simplex* in the southern part of the California Current System

Jaime **Gómez-Gutiérrez**[1], Carlos J. Robinson[2] and Karmina Arroyo Ramírez [1]

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Nyctiphanes simplex is the most prominent euphausiid from the neritic region of the southwest coast of Baja California peninsula, México. During three oceanographic cruises (Mar, Jul & Dec, 2004) females were incubated under shipboard laboratory conditions (48 h, 16-18°C, 24 h dark, without food) to measure brood size, interbrood period and molting rates. Females ready to spawn (9-16 mm length, older than 60 days) have a pale pink ovary that extends from the back of the stomach to the first abdominal segment, filling most of the haemocoel. This sac-spawning species produces one batch of oöcytes per cycle of the ovary, leaving an 'empty' space in the cephalothorax where the spent ovary is located. After spawning, the embryos develop in the ovigerous sac and hatch as nauplius stage, but they leave the ovigerous sac as metanauplius stage five days after spawning. Females are not ready to spawn again until at least two days after the previous batch of embryos leaves the ovigerous sac. Brood size (BS) had a significant linear association with female length (r^2=0.24, p<0.001). *N. simplex* spawned between 7 and 105 eggs per ovigerous sac, with larger BS in March and July and significantly smaller BS during December (<30 eggs fem^{-1}), when spawning of unfertilized eggs was common. The interbrood period (IBP) observed ranged between 7 and 15 days. The IBP is about one fourth to half than was previously assumed for this species, suggesting a significant underestimation of its fecundity. If the average female reproductive life-span is about 6 months, producing between 12 and 24 ovigerous sacs, and the average BS is 50 eggs fem^{-1}, the female life-span fecundity likely range between 600 and 1200 eggs fem^{-1}. Instantaneous growth rate calculations indicate this species has a significant increase in body size in spring and summer when upwelling events are intense. Negligible body growth or even negative instantaneous growth occurred during winter associated with the northward advection of warmer Equatorial water mass, characterized by deep thermocline and oligotrophic conditions.

PICES XIV   S2-2447   Oral
Krill and krill-predators: Habitat associations in the dynamic Gulf of the Farallones, California

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We tested the hypothesis that krill and krill-predators aggregate at predictable locations in the continental shelf and slope waters of the Gulf of the Farallones. We conducted research cruises in 2004 (May-October) and 2005 (February-July). We characterized the physical oceanography using CTD casts and continuous CT and fluorometry measurements. We concurrently determined the distribution and abundance of krill using hydroacoustics and nets, and of krill-predators (*i.e.,* birds and mammals) using standardized transects. Physical oceanographic conditions varied greatly between months and years. Strong northwest winds resulted in upwelling and elevated fluorescence early in 2004, but these events were delayed in 2005. Acoustic backscatter indicated strong habitat association for krill along the shelf break-slope region with large aggregations near

canyons and other topographic features. Acoustic backscatter in the upper 50-m increased as a positive function of SST, decreased with distance from Cordell Bank, and increased with high fluorescence. Cassin's auklets *Ptychoramphus aleuticus*, a krill-eating seabird, foraged in large numbers at the upwelling front during strong upwelling conditions in 2004, but were widely dispersed along the shelf break when upwelling was absent in late 2004 and 2005. Auklet habitat affinities in 2004 showed positive associations with Cordell Bank, the Farallon Islands, and the shelf break and with increasing salinity, the latter indicative of foraging near the upwelling plume off Point Reyes; however, this model was not validated by data collected in 2005. Among marine mammals, humpback *Megaptera novaeangliae* and blue whales *Balaenoptera musculus* were generally sighted near the shelf break and Cordell Bank.

PICES XIV S2-2234 Poster

The role of lipids during egg development in *Euphausia pacifica* and *Thysanoessa spinifera*

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To understand the role of lipids during early embryogenesis, major lipid classes together with individual fatty acid and sterol composition was determined in eggs from three different embryonic development stages of *Euphausia pacifica* and *Thysanoessa spinifera*. Average lipid content in eggs of *E. pacifica* and *T. spinifera* from the earliest stage (multiple cells) were 4.45 and 3.69 µg egg^{-1}, respectively. Phospholipids were the dominant lipid class throughout all embryonic stages with rapidly decreasing concentrations during the later embryonic stages during embryo development, lipid content decreased at the similar rates in the eggs of both species. Lipids were slowly utilized without preferential usage of specific lipid classes prior to the gastrula stage. Yet more than 60 % of lipids, mainly phospholipids were lost (or consumed) between blastula or gastrula and early or late limb-bud stages for both species. Total fatty acid and sterol contents showed similar trends as lipid content during early embryogenesis. Among fatty acids, 16:0, 16:1ω7, and 20:5ω3 were dominant with significant changes during early embryo development. Grouped fatty acid composition found that polyunsaturated fatty acids were preferentially metabolized throughout early embryogenesis. An exception was 22:6ω3, which remained at constant levels or only decreased slightly through all stages. Cholesterol was the dominant sterol (>82% of total sterols) found in euphausiid eggs with minor changes during embryogenesis. The appearance of algal sterols, however, together with phytol in *T. spinifera* eggs suggests significant direct lipid transfer from adult krill. Although egg density calibrated using chemical composition of egg showed significant changes through early embryo development for both species, egg sinking rate changes only slightly with the exception of later stages (*i.e.* limb-bud stage). These results suggest that, in terms of biochemical components, lipid of eggs is related to energetic and nutritional requirements, but not strongly associated with egg density and sinking rate during embryogenesis.

PICES XIV S2-2233 Invited

Understanding the nutritional status, diet, and demographic structure of *Euphausia pacifica* through multiple organic markers

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Euphausia pacifica is one of the most abundant krill species in north Pacific coastal waters and plays a key link between primary producers and top predators. However, their ecology and vital rates remain difficult to understand due to the strong spatial and temporal heterogeneity of their physical environment. In this study, a suite of organic markers (including algal pigments and lipids) in animals and seston were analyzed to better understand the feeding ecology and nutritional status of *E. pacifica* and thus trophic transfer of energy. Pigment distributions indicate that large diatoms were the most abundant algal species in nearshore upwelling regions while a greater diversity and smaller sized algal communities were found offshore, both displaying both

temporal and spatial variability. Lipid levels and compositions in krill were closely linked to their life cycle (*i.e.* reproduction) and environmental condition (*i.e.* food availability). The lipid composition of *E. pacifica* collected across shelf transects reflected the varied food resources available in the water column, but also suggested selective feeding. Other lipid markers (fatty acids and sterols) are well correlated with algal pigment signatures including the distribution of diatom specific fatty acids (*i.e.*16:1(n-7) and 20:5(n-3)). Combined results of algal pigment and lipid analysis show substantial changes in many of these markers in animals and seston along physico-chemical features and coastal topography, most notably in upwelling regions where diatoms are important. To assess growth and recruitment as well as to determine how changes in environmental conditions alter their condition and distribution, an additional understanding of precise demographic structure in *E. pacifica* is needed. Since age determination of euphausiids cannot be accomplished using traditional approaches, we evaluated the potential of age pigments (collectively termed lipofuscin) to determine the demographic structure of the field population of *E. pacifica*. Lipofuscin was extracted from neural tissues (eye and eye-stalk), quantified and normalized to protein content to allow comparisons across animal sizes. Lipofuscin contents in known-age krill reared for over 1 yr were significantly correlated with chronological age (correlation coefficient=0.85; n=46, p<0.01). Field-collected krill contained variable levels of lipofuscin dependant on size and age. Based on biochemical measures of age, the lifespan of *E. pacifica* in the northeast Pacific is no longer than 2 yrs. The results suggest that the application of multiple molecular organic indices allows a more detailed understanding of the feeding ecology and population age structure of *E. pacifica* and thus its role in dynamic ecosystems.

PICES XIV   S2-2439   *Oral*
Euphausiid reproduction off the Oregon Coast, U.S.A.

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Few will argue that we have not found a satisfactory way to accurately quantify the adult biomass of euphausiids in an oceanic environment. Extreme patchiness, interannual variability, ontogenetic and diel migrations, and imperfect sampling methods all contribute to our lack of confidence. However, we now have the tools, and most of the information to allow us to quantify euphausiid production through reproduction. Through 10 years of biweekly sampling off the Oregon coast we have defined the length and variability in the spawning season for *Euphausia pacifica* and *Thysanoessa spinifera*, and have developed an index of egg and larval abundance. Regular incubation of gravid females has allowed us to parameterize brood size for the two species, with averages close to 150 eggs per brood for both species. Long-term laboratory incubations of *E. pacifica* females have provided a median interbrood period of 5 days. All of the above measurements include a tremendous degree of variability, which allows us to calculate average, minimum and maximum production, and to compare production among years, seasons and some geographical areas. Using these data we can estimate the seasonal fecundity of an individual female off Oregon, and make first order predictions of total reproductive effort. These numbers are available for use in modeling at several levels of detail and though inherently variable, are quite reliable compared to direct measurements of adult biomass.

PICES XIV   S2-2438   *Invited*
Seasonal variations in intermolt period and growth of *Euphausia pacifica* and *Thysanoessa spinifera* in the coastal Pacific Northwest

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Euphausia pacifica and *Thysanoessa spinifera* are the two dominant species of euphausiids in coastal North America. Moulting rate experiments on these two species were conducted using animals collected off the coasts of Oregon, Washington and Northern California throughout 2001-2004. This time period encompasses some distinctly different oceanographic conditions with 2001 and 2002 being relatively cold and productive years, while 2003 and 2004 were warmer and less productive. Potential responses by the animals to environmental

changes will be investigated. Moulting experiments determine change in length and intermoult period (IMP) and allow us to calculate growth in mm per day. Positive growth ranged from 0 to 0.9 mm per day. Negative growth occurred during all seasons, usually in larger animals of both species. Negative growth during the reproductive season may be a result of reproductive activity rather than of poor environmental conditions. Individual growth tended to decrease as animals got larger but was highly variable. There was no clear relationship between growth and surface chl concentration or water depth. IMP was fairly constant over all size classes for both species, but varied seasonally. IMP tended to be shorter in summer months and longer during the winter, averaging approximately 6.9 d and 10.6 d respectively.

PICES XIV   S2-2290   *Invited*
Distribution and life history of *Euphausia pacifica* off northeastern Japan

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The abundance, spawning, growth pattern and life span of *Euphausia pacifica* were examined using widely collected samples off the Japanese coast of the North Pacific. Adults were widely distributed in the Oyashio area [OW; Temperature at 100 m depth (T_{100}) $\leq$ 5°C] and the transitional area (5°C $< T_{100} \leq$ 15°C) throughout the year, but the occurrence of large adults (> 15 mm) was limited to OW and the cold waters of the transitional area (CW; 5°C $<T_{100}\leq$ 10°C). Spawning occurred in OW and the transitional area throughout the year, especially in CW in spring, but rarely in winter. Two modal cohorts of adults were consistently recognized in OW and CW. Cohorts of small males and females (10-11 mm length), which newly appeared in spring, grew remarkably to ca. 17 mm from the following spring to early summer, followed by a long period of little growth during spring-winter. Then, both male and female cohorts grew slowly and steadily after summer to a maximum of 18-19 mm by the following spring. Then, the cohort of males disappeared after spring, but that of females (ca. 20 mm length) was recognized until late summer. If the cohort of small adults is assumed to develop mainly from the spring hatching, the life span of male and female *E. pacifica* can be estimated to be 24 months and 28 months, respectively, off northeastern Japan.

PICES XIV   S2-2414   *Poster*
Quantitative distribution of euphausiids in the East China Sea and the Yangtze Estuary in relation to the environmental conditions

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The quantitative distribution of euphausiids in the southern part of the Yellow Sea and in the shelf area of the East China Sea was studied based on the zooplankton samples collected during 2 cruises in Aug. 2002 and Aug 2003. Nine species were found including *Euphausia diomedeae, Euphausia mutica, Euphausia nana, Euphausia pacifica, Nematoscelis gracilis, Pseudeuphausia latifrons, Pseudeuphausia sinica, Stylocheiron affine, Stylocheiron carinatum, Stylocheiron microphthalma*. Among them *Pseudeuphausia sinica, Euphausia nana* and *Pseudeuphausia latifrons* were dominant. The *Pseudeuphausia sinica* was wide spread in the East China Sea with high abundance off the Zhejiang coast (41.5 ind·m $^{-3}$) and Yangtze estuary (86.67 ind·m $^{-3}$), the seasonal variation shows: Summer> Autumn>Spring> Winter. *Pseudeuphausia latifrons* was the dominant one distributed in the southern part of the East China Sea and was dominant in the outer - shelf waters but the high abundance center was in near-shore sea area. The other 6 species were rare. Most of them were warm water species with the exception of *Euphausia nana* and *Euphausia pacifica*. There are 7 species of euphausiids based on the investigation of 13 cruises during 1997 and 2004. Species diversity and abundance is higher in summer. *Pseudeuphausia sinica* was found all year around in Yangtze estuary.

Seasonal distribution of euphausiids on a transect from the Gulf of Alaska to the Bering Sea

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The Continuous Plankton Recorder was towed behind a commercial ship on a transect from British Columbia, across the Gulf of Alaska, through Unimak Pass and into the southern Bering Sea during 2002 and 2003 (June, October and December 2002, April 2003) collecting plankton samples. Cursory observations of the samples prior to detailed processing suggested that the abundance of euphausiids increased as the transect approached the Aleutian Islands shelf, irrespective of time of year. Given that this region is an important foraging ground for juvenile salmon (into at least the late autumn) as well as for marine birds and mammals, we investigated the euphausiid distributions in more detail. Ordinarily every 4th sample is processed for plankton taxonomic abundance but between 150°W and 175°W (the centre of the Alaska Gyre to the deep waters of the southern Bering Sea) all samples were processed to measure euphausiid abundances. Six species of euphausiid were identified: *Thysanoessa inermis, T. longipes, T. inspinata, T. spinifera, Euphausia pacifica, T. rachii* (just one individual). Although the five most abundant species were found all along the transect, we found clear differences in species distribution. Our expectation, based on our original observations, was that there would be a negative correlation between water depth and euphausiid biomass in both the Gulf of Alaska and Bering Sea, so that highest biomass would be found in shallowest water, *i.e.* over the Aleutian shelf. While this held true for the Bering Sea it was not the case in the Gulf of Alaska - in the fall and winter the highest biomass of euphausiids in the Gulf of Alaska were off the shelf, over the deep waters of the Aleutian trench. We speculate as to how this distribution may arise and its implications.

Species composition and diversity of pelagic euphausiids in the East China Sea

Zhao-Li **Xu** and Chunju Li

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Based on the data of four seasonal oceanographic censuses in the East China Sea 23°30´~33°N, 118°30´~128°E in 1997-2000, this paper discussed the species composition and the diversity of Euphausiids as well as their relations with environmental variables. Results showed that there in total 23 different species of Euphausiids, in which 16 occurred in spring and autumn respectively; 15 were present in summer and only 10 were observed in winter. According to the calculated alternation fraction (R), the species composition showed a clear seasonal alternation with the changes of seasons. Moreover, the environmental variables had different impacts on the distribution of Euphausiids in different seasons. The distribution in summer was not significantly related to water temperature and salinity. However, the surface salinity was a major determinant of the distribution in spring. In autumn, both surface and bottom temperature were influencing factors. The distribution in winter depended on salinity at the surface and 10-m depth as well as the temperature at 10-m depth. Regarding the seasonal variation of species composition, the variations in spring, summer and autumn were not so significant as that in winter. Except in summer, the species number changed with synchronous water temperature and salinity, as a result of the presence of warm currents in the East China Sea and the habitability of the dominant species. Since Euphausiids tend to aggregate, the distribution of different species was uneven, which was the major reason to the low diversity of Euphausiids in the East China Sea.

PICES XIV   S2-2535   Poster
Study on abundance distribution of euphausiids in the East China Sea

Zhao-li **Xu** and Chunju Li

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Based on the data of four seasonal investigations in the East China Sea (23°30´~33°N, 118°30´~128°E) from 1997 to 2000, the distribution and the seasonal changes of Euphausiacea abundance and the relationship between euphausiid and fish abundance are discussed in this paper through qualitative and quantitative methods. Results showed that the total abundance of Euphausiacea peaked in autumn, was the second highest in spring and lowest in winter. Since *Euphausia nana* in winter, spring, summer and *Pseudeuphausia sinica* in autumn contributed more to the total abundance, they were the species dominating the total abundance variation. Moreover, it was found that the total abundance in summer showed linear correlation with bottom water temperature and 10-m salinity, while the abundance in other three seasons did not show significant correlation with hydrographic factors. A region of abundance of Euphausiacea was located in the converging area of Taiwan warm current and other water masses in autumn, suggesting that the variation of the total abundance was dependent on the influence of water masses and the contribution of dominant species, which was also related to the ecological habits of dominant species. It was also found that the high abundance area nearly overlapped the feeding grounds of *Trichiurus lepturus, Scomber japonicus* and *Larimichthys polyactis.*

PICES XIV   S2-2533   Poster
Study on the dominant species of euphausiids in the East China Sea and their ecological adaptability

Zhao-li **Xu** and Ya-Qu Chen

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The aim of this paper is to study the ecological characters of the dominant species of Euphausiids in the East China Sea. Four oceanographic cruises were conducted in the East China Sea (23°30´~33°N、118°30´~128°E) during the period 1997 – 2000. Altogether four dominant species of Euphausiids were recorded in the East China Sea, *Euphausia nana* Brinton, *Euphausia pacifica* Hansen*, Pseudeuphausia sinica* Wang et Chen, and *Pseudeuphausia latifrons* (S. O. Sars). They were categorized according to their habitat conditions into two groups, temperate, sub-tropical and tropical species. During the winter and spring periods, the community is dominated by temperate species, *E. nana* and *E. pacifica*. Their densities peak in the spring for *E. nana*, winter for *E. pacifica*, respectively, and are low in the summer and autumn during which *E. pacifica* is not even represented. The dominant species during the summer and autumn are *P. sinica* and *P. latifrons*, both of which are represented in low density in the winter and peak in the autumn. The sub-tropical and tropical species exhibited higher abundances than the temperate ones. Mean densities in autumn were 95.46 ind/100m^3 for *P. sinica* and 37.77 ind/100m^3 for *P. latifrons*, while in the spring the maximum density of *E. nana* was only 35.55 ind/100m^3. In the spring, *E. nana* represented up to 85.5% of total species diversity.

S3

BIO Topic Session
Factors affecting distribution, foraging ecology, and life histories of top predators in the northwestern Pacific Ocean and its marginal seas

Co-Convenors: Hidehiro Kato (Japan), Alexander Kitaysky, William Y. Sydeman (U.S.A.) and Andrew Trites (Canada)

Top predators may integrate fluctuations in lower trophic levels and ocean climate, and may therefore serve as reliable indicators of change. But, how ubiquitous are these patterns, spatially and temporally? What are the time lags between the occurrence of an environmental change and the responses of top predators? What taxa, guilds and parameters would be best suited to serve as ecosystem "samplers" and "monitors?" This multi-disciplinary, multi-trophic level topic session will examine the oceanographic and ecological factors determining the distribution, foraging ecology, and life history dynamics of top marine predators in the northwestern North Pacific and its marginal seas, focusing on the Sea of Okhotsk/Oyashio and western Bering Sea. Focal organisms include predatory marine fish, marine birds and mammals, and their prey resources (copopeds, euphausiids, squids, forage fishes). We invite presentations describing spatio-temporal variation in distribution, abundance, life history, demography, and food habits of predators and/or prey species or communities in relation to atmospheric and physical oceanographic variability, including ice cover. In particular, we hope to deepen our understanding of the response of top predators to ocean climate variability and change in the northwestern Pacific Ocean regions. These questions are critical to future efforts to monitor the North Pacific, as well as important to fisheries oceanography in the Sea of Okhotsk and western Bering Sea.

Tuesday, October 4, 2005   08:30-12:30

08:30-08:40	**Introduction by Convenors**

08:40-09:10   **Konstantin Rogachev**   (Invited)
Physical forcing of marine ecosystems and long-term oceanographic changes in the Sea of Okhotsk (S3-2232)

09:10-09:30   **Andrew W. Trites and David A.S. Rosen**
Marine mammals in the North Pacific as indicators of ecosystem change (S3-2498)

09:30-09:50   **Yuri B. Artukhin**
Distribution of seabird colonies in the far-eastern region of Russia (S3-2261)

09:50-10:10   **Yutaka Watanuki, Motohiro Itoh and Hiroshi Minami**
Do parents of seabirds feed chicks with prey that is different from their own? (S3-2349)

10:10-10:30   **Coffee Break**

10:30-10:50   **Aleksey Yu. Merzlyakov, Elena P. Dulepova and Valerii I. Chuchukalo**
Modern state of pelagic communities in the Okhotsk Sea (S3-2330)

10:50-11:10   **Tomio Miyashita, Valery L. Vladimirov and Hidehiro Kato**
Current status of cetaceans in the Sea of Okhotsk (S3-2489)

11:10-11:30   **Valeriy I. Fadeev**
Benthos and food supply of the Okhotsk-Korean gray whale population (S3-2276)

11:30-11:50   **Yuri M. Yakovlev and Olga Yu. Tyurneva**
Photo-identification of the western gray whale (*Eschrichtius robustus*) on the northeastern Sakhalin shelf, Russia, 2002-2004 (S3-2353)

11:50-12:10 **Alexander S. <u>Kitaysky</u> and Elena Yu. Golubova**
Reproductive responses of planktivorous and piscivorous birds to climate variability in the northern Sea of Okhotsk (S3-2385)

12:10-12:30 **Edward J. <u>Gregr</u>, Stephen Ban, Ryan Coatta and Andrew W. Trites**
Ecological characterization of Steller sea lion rookeries and haulouts in the North Pacific (S3-2529)

Posters

Svetlana V. <u>Naydenko</u> and Natalia T. Dolganova
Estimation of hydrobiont consumption food by the basic nekton species in the upper epipelagic Russian economic zone of the Japan/East Sea (S3-2454)

Seong-Hwan <u>Pae</u>
Ecologically important areas for waterbirds in Yellow Sea (S3-2616)

Larisa A. <u>Zelenskaya</u>
Inter-annual and inter-colonial variability in the diet of Slaty-backed Gulls (*Larus schistisagus*) (S3-2351)

PICES XIV   S3-2261   *Oral*
Distribution of seabird colonies in the far-eastern region of Russia

Yuri B. **Artukhin**

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Herein, I review information on the distribution and abundance of colonial seabirds of the Russian Far East. More than 700 mixed-species colonies comprising ~25 million seabirds are known. The largest colonies are situated on the islands surrounded by dynamic water masses which promotes stable forage conditions. There are 3 colonies bearing over 1 million birds each. The dominant taxonomic groups are alcids and larids (75 and 14 percents respectively). Two species of auklets (*Aethia cristatella*, *A. pusilla*) comprise half of all nesting seabirds. The number of marine birds in the Sea of Okhotsk (including the northern Sea of Japan) is 2.2 times higher than in the western Bering Sea (including adjacent waters of the Chukchi Sea and the Pacific coast of Kamchatka). In the Sea of Okhotsk, planktivorous seabirds are 1.7 times more abundant than piscivorous seabirds, but their total biomass is almost 3.0 times less. In the Bering Sea, piscivorous seabirds dominate in number and biomass. Distribution and colony size of seabirds depends on several factors (space for colonies; forage base; protection from terrestrial mammalian predators; low levels of human disturbance, *etc.*). Extensive transformations of landscapes in the Russian Far East over recent decades has affected seabird populations, including their reproductive dynamics.

PICES XIV   S3-2276   *Oral*
Benthos and food supply of the Okhotsk-Korean gray whale population

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For a long time, the Piltun Area (PA) was considered the only western gray whale (WGW) feeding location of the east coast of Sakhalin Island during the summer and fall period. However, some WGW were discovered feeding in an area offshore Chayvo Bay on September 2001 by marine mammal observers. Subsequent aerial and vessel monitoring has indicated that this is an important feeding area (OA). This area is located 20-45 km offshore between the middle part of Chayvo Bay and the southern part of Niyskiy Bay, at depths of 30-50 m. The purpose of this study is to obtain information on the benthic communities that provide food resources for WGW in the main feeding grounds off the northeastern Sakhalin coast. Preliminary data on benthic fauna of the PA were the only information available; benthos in the OA had never been studied. The two summer feeding grounds for WGW differ in the structure of the benthic community. At PA, whales feed in shallow-water (5-20 m) on mostly amphipods and isopods. Mobile deposit-feeder amphipods distinguished by eurybiontic nature, short life cycles, and high growth rates are dominant in this area, Feeding whales in the OA are associated with the seston-feeder amphipod *Ampelisca eschrichti*. High abundance and aggregation in the spatial distribution of the dominant species are characteristic of ampeliscid amphipod colonies, which are a classic example of gray whale food objects in the North Pacific.

PICES XIV   S3-2529   *Oral*
Ecological characterization of Steller sea lion rookeries and haulouts in the North Pacific

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Steller sea lions (*Eumetopias jubatus*) range across the North Pacific rim, from Southern California in the east, to Russia and northern Japan in the west. They are consistently found at a few select terrestrial resting (haulouts) and breeding (rookeries) sites, which appear to have been continuously occupied for hundreds of years. We characterized the oceanographic habitat surrounding these sites in Canada, the United States, Russia and Japan to investigate how conditions at these sites might differ from conditions near sites in the North Pacific where sea lions did not occur. Environmental variables included depth, slope, monthly sea surface height, and monthly winds. We used supervised classification to identify the combination of oceanographic variables that were most

closely associated with the sites in the eastern North Pacific. We then predicted where terrestrial sites might be in the western North Pacific, and tested our classification-based predictions using a randomization test. We tested for significant differences between haulouts and rookeries, and between the eastern and western North Pacific. Preliminary results indicate that sea lions show preferences for terrestrial sites located near shallow waters and less-steep bottom slopes. Conditions closer to the terrestrial sites (1 – 5 km) provided a better characterization of occupied sea lion sites than conditions further away (over 10 km). No significant differences were found between sites in the eastern vs. western North Pacific, or between haulouts and rookeries.

PICES XIV   S3-2385   *Oral*
Reproductive responses of planktivorous and piscivorous birds to climate variability in the northern Sea of Okhotsk

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We used long-term (1987-2004) series of observations on seabird reproductive success and oceanographic change in Tauyskaya Bay (Okhotsk Sea, north-western Pacific) to evaluate the hypothesis that changes in marine climate may favor the productivity of one group of upper trophic level predators over another through fluctuations in the availability of their prey. We found that in the continental shelf ecosystems in the north-western Pacific (Talan I., northern Okhotsk Sea), birds foraging on macro-zooplankton and birds foraging on forage fish show opposite reproductive trends. This pattern was strongly correlated with inter-annual climate variability in the North Pacific. A positive North Pacific index of atmospheric pressure anomaly, early dates of ice disappearance, and warm local sea-surface temperature were positively correlated with productivity of piscivorous and negatively correlated with productivity of planktivorous seabirds. A "warm" regime was associated with high abundance of meso-zooplankton, which may in turn affect forage fish abundance. Macro-zooplankton organisms, which are the main prey of planktivorous seabirds, were more abundant during a "cold" regime. During a "warm" regime, when in-flow of oceanic waters into shelf areas was weak, proportions of oceanic copepods in seabird diets were lower compared to those during a "cold" regime when in-flow of oceanic waters was relatively strong. Thus, climate-driven alternations in a composition and timing of peak of zooplankton communities and abundance of forage fish probably represent causal mechanisms responsible for opposite trends in reproductive performance of piscivorous and planktivorous seabirds.

PICES XIV   S3-2330   *Oral*
Modern state of pelagic communities in the Okhotsk Sea

Aleksey Yu. **Merzlyakov**[1], Elena P. Dulepova[1] and Valerii I. Chuchukalo[2]

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We analyzed the dynamics of epipelagic plankton and nekton communities in the Okhotsk Sea ecosystem over 25 years, 1984 through 2004. Zooplankton abundance increased rapidly during the 1980s in both southern and northern portions of the sea. In the late 1980s, total abundance of zooplankton was assessed at ~282 million metric tons (mmt). In the 1990s, zooplankton abundance dropped to ~210 mmt, presumably as the result of environmental, particularly hydrological, change. These changes must have affected spawning of the most abundant zooplankton groups. Analysis of recent zooplankton dynamics suggests stocks were rather stable in the last few years. Maximum abundance of nekton was observed in the 1980s. Total biomass of nekton was assessed as ~27 mmt at that time, with walleye pollock being a dominant species. A sharp decrease of nekton to ~18 mmt was observed in the early 1990s due to a decrease in the biomass of walleye pollock. In years of generally low fish productivity, an increase in abundance of the Pacific herring has been observed. More recently, nekton biomass has decreased to ~11 mmt. In the last five years, nekton biomass was rather stable, fluctuating at about 10.3 mmt. A decrease in walleye pollock was followed by an increase in Atka mackerel, and increased migration of Japanese anchovy into the system. Schemes of trophic relationships in epipelagic nektonic communities were produced based on our estimates of nekton and zooplankton abundance. These schemes were constructed separately for three different time periods to describe the varying biomass of primary species.

PICES XIV   S3-2489   Oral
Current status of cetaceans in the Sea of Okhotsk

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We surveyed cetaceans in the Sea of Okhotsk in August and September. Since 1989, a total of 12 species of whales and dolphins were positively identified, including 6 baleen whales (common minke, fin, sei, humpback, gray and northern right whale) and 6 toothed whale species (sperm, Baird's beaked, killer, Pacific white-sided dolphin, Dall's porpoise and harbor porpoise). Beaked whales, except Baird's beaked, were also sighted, but species are un-identified. Dall's porpoises were the most abundant species and showed the widest distribution. *Truei*-type Dall's porpoises were dominant in the central waters, while *dalli*-types were more common in the north-east and south-west portions of the sea. Minke whales were widely distributed Fin whales were also distributed widely, but were more abundant in offshore (deep water) areas. The distribution of northern right whales was limited to the central/middle part of the sea. Killer whales were found in the shallow coastal waters in the all areas. Because the number of sightings of sei and sperm whales was very small, those species seem to be rare. Sperm whales were found only in the southern deep waters. Pacific white-sided dolphins are distributed only in the southern waters south of the Sakhalin Island and do not move into the northern waters. Gray whales were only sighted in the coastal waters off northern Sakhalin Island where there is a well-known feeding area These distribution patterns have been consistent over the past fifteen years.

PICES XIV   S3-2454   Poster
Estimation of hydrobiont consumption food by the basic nekton species in the upper epipelagic Russian economic zone of the Japan/East Sea

Svetlana V. **Naydenko** and Natalia T. Dolganova

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Qualitative and quantitative composition of food consumed daily by the major nektonic species in the upper epipelagic layer in the northwestern Japan/East Sea has been analyzed based on published data and the results of surveys conducted in 1980-2003. The amount of food consumed daily and seasonally by highly abundant nektonic species was calculated. The highest rate of food consumption, of about 14,738-32,965 thousand tons, was observed during the 1980s. In the 1990s, the consumption of prey organisms decreased to 7,986 thousand tons; consumption of copepod prey, in particular has decreased by a factor of 20-23. In 1985, the Japanese sardine, a major consumer of planktonic organisms, consumed roughly 73-88 % of all food consumed by nekton. In the mid-1990s, when sardine was not registered in the Russian Exclusive Economic Zone, and the Japanese common squid (*Todarodes pacificus*) was highly abundant, the latter species consumed up to 97 % of all food consumed by nekton. However, despite a rapid increase in abundance of the common squid and a somewhat slower increase in abundance of anchovy and saury, the total consumption of food organisms by the major nektonic species in the upper epipelagic layer in the northwestern Japan Sea is reduced by a factor of four in the 1990s compared to the 1980s.

PICES XIV   S3-2616   Poster
Ecologically important areas for waterbirds in Yellow Sea

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The Yellow Sea is a hotspot along the Asian Pacific flyway for waterbirds (shorebirds, waterfowl and and waders). Herein, I review information and data on waterbirds of the Yellow Sea. Ecologically Important Areas (EIA) for birds were identified as potential priority areas for protection. I used the following criteria to identify EIA in the Yellow Sea between China and Korea (representative species, endemism and unique species assemblages, threatened and/or protected spp. Ramsar criterion). Indicator species were selected and potential priority areas were delineated. Red-crowned cranes *Grus japonensis*, Hooded cranes *Grus monacha*, White-naped cranes *Grus vipio*, Black-faced spoonbill *Platalea minor*, Oriental white stork *Ciconia boyciana*, Chinese egret *Egretta eulophotes*, Baikal teal *Anas formosa*, Whooper swan *Cygnus Cygnus*, Saunders's gull *Laurs*

saundersi, Oystercatcher *Haematopus ostralegus* were selected as indicators of habitat quality. I compared potential priority areas with existing protected areas in coastal and marine regions which provides a "gap analysis" for conservation and has management implications. Baikal teal *Anas formosa* was selected as a locally endemic and unique species assemblages as over 90% of its world estimated population are regularly aggregated in reclaimed area Korea in the wintering period. I identified the Shuangtaihe estuary, Beidaihe, Yellow River delta, Yancheng coastal region (in China), Han river estuary, Tongjin river estuary, Cheonsu bay, Gyonggi bay (in Korea) were EIA area in Yellow Sea.

PICES XIV S3-2232 *Invited*
Physical forcing of marine ecosystems and long-term oceanographic changes in the Sea of Okhotsk

Konstantin **Rogachev**

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The Sea of Okhotsk is a highly productive sea located near the coldest place on the Asian continent. Sea ice and cold dense shelf water (CDSW) form in winter. Cold water is essential for the reproductive activities of the dominant zooplankton, such as the large copepod *Calanus glacialis*. Formation of CDSW in the Sea of Okhotsk, south-flowing waters of the Kamchatka and Oyashio currents and west-flowing waters of the Alaskan Stream are key components of circulation in the western sub-arctic gyre. Interannual changes in this system arise from interactions among large anticyclonic eddies and the mean flows. Warming in the Kamchatka Current meso-thermal layer has been recorded from 1994-2004. A warm-water link between eastern and western subarctic gyres likely impacts the Kamchatka Current and exchanges with water masses in the Sea of Okhotsk. These observations illustrate the importance of exchange with the Pacific on oceanographic variability in the region, and reveal a plausible mechanism for large temperature variations in the intermediate layers of the western subarctic gyre. Moreover, large diurnal and semi-diurnal tides result in significant dissipation of energy and enhanced nutrient fluxes, especially in shallow bays and above banks in the region. The transfer of tidal energy to shallow coastal regions is an important mechanism that affects the aggregation of plankton. Specifically, dense populations of dominant species of zooplankton (such as copepods, and pteropods) are concentrated in coastal regions by tidal mechanisms.

PICES XIV S3-2498 *Oral*
Marine mammals in the North Pacific as indicators of ecosystem change

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Marine mammals span most trophic levels (2.0 – 5.1) and feed on organisms ranging from plankton to large whales. They have few predators and are generally thought to integrate and respond to changes that occur at lower trophic levels. Some changes, such as a shift in prey abundance, can be detected in body sizes and individual behaviors (*e.g.*, foraging times) and physiologies (*e.g.*, metabolism and stress hormones). At a population level, food affects birth and death rates, which can cause overall numbers to increase or decrease. Such individual and population level variables are meaningful indicators that something has changed in the ecosystem—but they are not easily interpreted. A wide range of inter-related data need to be collected to effectively use marine mammals as indicators of ecosystem status, particularly to untangle the effects of changes in the quantity and quality of available prey (*e.g.*, population size, diet, body condition, body growth rates, stress hormone concentrations, abortions, birth rates, survival rates and foraging trip lengths). Using marine mammals as effective indicators of ecosystem change requires a commitment to long-term monitoring. The most valuable combination of parameters to measure appears to be population size, diet and individual body condition—particularly for *young* animals. As *K*-selected species, adult marine mammals tend to buffer the effects of decreases in quantity and quality of prey better than young animals, and are therefore less sensitive indicators of ecosystem change. Young animals however appear to be extremely sensitive barometers of changes in prey and are potentially a useful age group to monitor ecosystem change.

Photo-identification of the western gray whale (*Eschrichtius robustus*) on the northeastern Sakhalin shelf, Russia, 2002-2004

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Photo-identification studies of western grey whales have been conducted in two basic feeding areas on the northeast shelf of Sakhalin Island in 2002-04. Over three years, 121 whales have been identified. Analysis of these seasons indicates intraannual and interannual movement of grey whales within and between the "Piltun" and "Offshore" feeding areas.   Movements have been verified by repeated encounters with identified individuals.   The number of repeat encounters increased each year.   Replicate observations of individuals averaged 1.40 in 2002 and 2.38 in 2004. In 2004, an unusually low number of whales in the "Offshore" area was observed. Of the eight whales identified in the "Offshore" area in 2004, only two were identified in both areas; the others were sighted only in the "Offshore" area. Group size varied from one to eight individuals; group size increased in 2004 in comparison with 2003.

Do parents of seabirds feed chicks with prey that is different from their own?

Yutaka **Watanuki**[1], Motohiro Itoh[1] and Hiroshi Minami[2]

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Variability of diet is one of important factors determining reproductive performance of marine top predators. In seabirds, the diet for chicks is often studies since this data is easily obtained; the diet of adults is infrequently analyzed. We found that timing of the northward migration of Japanese anchovy *Engraulis japonicus*, the main prey item for chicks, determines chick production of a piscivorous seabird, Rhinoceros Auklet *Cerorhincaw monocerata*. Rhinoceros Auklets are an important top predator in the Japan/East Sea off Hokkaido, breeding at Teuri Island, in the hundreds of thousands. Timing of breeding however, did not always match with the timing of anchovy migration. To investigate if the diet of the adults during egg-laying or incubation affected timing of breeding, we analyzed stable isotope ratios of blood samples in relation to stomach contents collected by the water off-loading technique throughout the breeding season. Analysis of stomach contents revealed that parent auklets fed on krill *Thysanoessa longipes,* as well as various fish during the egg-laying and incubation periods. During early chick rearing period, the main diet of parents (and chicks) were 0 age-class sandlance *Ammodytes personatus* and juvenile Japanese Greenling *Pleurogrammus azonus;* the diet of both parents and offspring switched to anchovy in mid chick rearing season simultaneously. Stable isotope ratio confirmed that parents fed on prey at lower trophic level (zooplankton) during egg-laying and incubation than they did during chick rearing. This study demonstrates the need to establish diet for varying age classes in a population to understand interactions between the marine environment and top predators.

Inter-annual and inter-colonial variability in the diet of Slaty-backed Gulls (*Larus schistisagus*)

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Variability in the diet and the abundance of the main food habits of Slaty-backed Gulls can change in depending on climatic conditions, and specific of foraging base of concrete colony, that is inevitably reflected on the feeding ration of birds. The spectra of foods of Slaty-backed Gulls have appeared rather unlike even within the limits of one Tauiskaya Inlet (northern part of the Okhotsk Sea) on three island - colonies: Shelikan Island, Umara Island and Talan Island. The data on a feeding ecology of Slaty-backed Gulls were collected on Shelikan Island - in 1986 and 1987; on Umara Island - in 1994 and 1995. On Talan Island presents the total data L.F. Kondratyeva (2005) for 1988, and our data collected in 2002. Besides this, E. Golubova in 1998 kindly gave us 103 pellets from adult gulls from Matikil Island, which I identified and have included in the analysis.

The seasonal change of food per different years on each colonies can show a degree of foraging plasticity of Slaty-backed Gulls.

S4

CCCC/CFAME Topic Session
The comparative response of differing life history strategists to climate shifts

Co-Convenors: Hyung-Ku Kang (Korea) and Gordon A. McFarlane (Canada)

In recent years, we have come to accept that regime shifts are real and produce species and ecosystem-level responses, however not all species and ecosystems are equal. In particular, there is the need to move beyond correlative indices between climate variables and species indicators and consider the temporal and spatial scale of the mechanisms, especially as they may differ between different life history strategists within an ecosystem. We invite contributions which examine the scale of response of species to climate, especially from an east/west comparative perspective. We especially encourage papers investigating the underlying mechanisms of responses, with an emphasis on targeting critical life history stages and differences in sensitivity to climate for different life history strategists (for example, between equilibrium and opportunistic strategists). It is intended that selected papers (oral and poster) will be published in an international scientific journal.

Tuesday, October 4, 2005   08:30-17:30

08:30-08:40	**Introduction by Convenors**

08:40-09:20	**Kirk O. <u>Winemiller</u>** (Invited) Responses of opportunistic, periodic, and equilibrium life history strategies to climate-induced environmental regime shifts (S4-2425)

09:20-09:40	**Kazuaki <u>Tadokoro</u>, Toru Kobari, Hiroaki Saito and Hiroya Sugisaki** Interdecadal variability in body size of *Neocalanus* copepods in the Oyashio waters from 1960 to 2002 - A study of the Odate Project (S4-2516)

09:40-10:00	**David L. <u>Mackas</u> and Moira D. Galbraith** Appearance and rapid increase of the exotic copepod *Acartia tonsa* on the British Columbia continental margin (S4-2257)

10:00-10:20	**Coffee Break**

10:20-10:40	**Hiroya <u>Sugisaki</u> and Hiroshi Ito** Long term variation of species and life stage composition of zooplankton in the western North Pacific: Introduction of the Odate project (S4-2465)

10:40-11:00	**Alexander A. <u>Goryainov</u>, Tatiyana A. Shatilina, Guram Sh. Tsitsiashvili and Vera A. Kochetova** The relationship between atmospheric processes above the Asian continent and the North Pacific ocean and the abundance of Asian chum salmon and pink salmon in 20th century (S4-2241)

11:00-11:20	**Jacquelynne R. <u>King</u> and Gordon A. McFarlane** Life history strategies: Applications to fisheries management (S4-2612)

11:20-11:40	**Yongjun <u>Tian</u>, Hideaki Kidokoro and Tatsuro Watanabe** Differing response patterns of pelagic and demersal fish assemblages to the late-1980s regime shift in the Japan Sea (S4-2405)

11:40-12:00	**Kenneth A. Rose, Bernard A. Megrey, Francisco E. <u>Werner</u>, Yasuhiro Yamanaka, Maki Noguchi-Aita, Shin-ichi Ito and Michio J. Kishi** Interannual response of fish growth to the 3-D global NEMURO output with realistic atmospheric forcing. Part I: Latitudinal differences in Pacific herring growth (S4-2504)

12:00-12:20	**Shin-ichi Ito, Kenneth A. Rose, Maki Noguchi-Aita, Bernard A. Megrey, Yasuhiro Yamanaka, Francisco E. Werner and Michio J. Kishi** Interannual response of fish growth to the 3-D global NEMURO output with realistic atmospheric forcing. Part II: Pacific saury growth (S4-2412)
12:20-14:00	**Lunch**
14:00-14:40	**Shang Chen, Yoshiro Watanabe and Yan Ma** (Invited) Ecological regime shift events in the East China Sea (S4-2279)
14:40-15:00	**Guram Sh. Tsitsiashvili, Tatiyana A. Shatilina, Alexander A. Goryainov, T.A. Radchenkova and L.Yu. Matyushenko** Diagnosis and prognosis of extreme natural phenomena in the Russian Far East (S4-2242)
15:00-15:20	**Todd TenBrink, Anne Hollowed and Kerim Aydin** Evaluating the climate-moderated fishing vulnerability of different life history strategists in Alaskan waters (S4-2609)
15:20-15:40	**Vladimir V. Sviridov** Adaptive significance of spatial distribution patterns as reflection of life history strategy and density dependence in populations of some pelagic fish, squid and jellyfish species in Russian EEZ of North Pacific (S4-2267)
15:40-16:00	**Rubén Rodríguez-Sánchez, Daniel Lluch-Belda and Héctor Villalobos** Spatial dynamics of small pelagic-fish populations in the California Current system on seasonal and interannual scales during the last warming regime (1980-1997) (S4-2277)
16:00-16:20	**Coffee Break**
16:20-16:40	**Akihiko Yatsu, Hiroshi Kubota, Akinori Takasuka, Motomitsu Takahashi, Norio Yamashita, Hiroshi Nishida, Chikako Watanabe and Yoshioki Oozeki** Distribution and population dynamics of Japanese sardine, anchovy and chub mackerel in the Kuroshio/Oyashio system: Seeking for mechanistic responses to regime shifts (S4-2580)
16:40-17:00	**Julie A. Thayer, Yutaka Watanuki, Tomohiro Deguchi, Akinori Takahashi and William J. Sydeman** East/West comparative responses of a Piscivorous marine bird to oceanographic variability in the North Pacific Ocean: California versus Tsushima current systems (S4-2502)
17:00-17:30	**Discussion and summary by Convenors**

Posters

Miriam J. Doyle, Ann C. Matarese, Morgan S. Busby and Deborah M. Blood
Life history strategies of selected Gulf of Alaska fish species with reference to recruitment vulnerability under fluctuating environmental conditions (S4-2514)

Gordon A. McFarlane, S. Kim, J.R. King, R.J. Beamish, C. Zhang and J.H. Oh
Contrast in life histories of commercially exploited marine fishes off the coasts of Canada and Korea and changes in ecosystem structure (S4-2611)

Lubov N. Vasilevskaia, Pavel I. Khazantsev and Denis N. Vasilevskii
Annual changes of areas of trade of pollock in the Sea of Okhotsk and Bering Sea for the last thirty years (S4-2522)

Anatoliy Ya. Velikanov and Dmitriy Yu. Stominok
Changes in abundance and fish species composition of the Aniva Bay and La Perouse Strait (Sea of Okhotsk) in connection with climate (S4-2295)

PICES XIV   S4-2609   Oral

Evaluating the climate-moderated fishing vulnerability of different life history strategists in Alaskan waters

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In the United States federally-managed groundfish fisheries of the Bering Sea, Aleutian Islands, and Gulf of Alaska, target species (commercially-landed catch) represent a limited range of life-history strategies when compared to the diversity of life history strategies found within non-target species catch (*e.g.* incidental catch). However, current incidental catch policies are relatively uniform regardless of life history or ecosystem considerations. These non-target policies should be carefully evaluated, as the Bering Sea and Gulf of Alaska are subject to regime-scale climate fluctuations which may differentially affect each species' climate-moderated sensitivity to fishing pressure, depending on that species' life history. Here, we present a system of management evaluation which combines survey trends, fishing history, and life history characteristics in order to pinpoint vulnerable non-target species within a fishery. We present some preliminary results of testing this evaluation system under simulated climate scenarios for a range of life history strategists.

PICES XIV   S4-2279   Invited

Ecological regime shift events in the East China Sea

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Based on fifty-year catch data from Japan, the phase shift patterns of fish in the East China Sea (ECS) ecosystem are classified into five types: Sardine, Anchovy, Flounder, Seesaw and Round herring. Both biological and environmental evidence suggest that regime shifts did occur in the ECS. Sea surface temperature switched from a cold to cool regime in 1940 and then again from a cool to a warm regime in 1983. Ecological regime shifts have occurred in the ECS three times since 1950: in 1958-62, in 1976-82 and in 1988-93. The 1976-82 shift is the most significant. From 1959 to 1978, the ECS is considered a Jack/Anchovy regime. In 1978 it shifted to a Sardine dominated regime until 1997. Although the ECS is part of the Northwest Pacific, its regime shift pattern is similar to that identified in the Northeast Pacific.

PICES XIV   S4-2514   Poster

Life history strategies of selected Gulf of Alaska fish species with reference to recruitment vulnerability under fluctuating environmental conditions

Miriam J. **Doyle**[1], Ann C. Matarese[2], Morgan S. Busby[2] and Deborah M. Blood[2]

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The impact of climate on fisheries is highly variable, indirect and complex, and control of recruitment depends on the status of a continually changing ecosystem. Early life history dynamics of marine fish species represent a major portion of this complexity. Since 1972, ongoing studies in the Gulf of Alaska explore the complexity of northeast Pacific fish life history strategies. This study focuses on six species chosen for their dominance in the Gulf of Alaska ecosystem. Capelin (*Mallotus villosus*), Pacific sandlance (*Ammodytes hexapterus*), and northern lampfish (*Stenobrachius leucopsarus*) are ecologically important forage fish. Pacific cod (*Gadus macrocephalus*), arrowtooth flounder (*Atheresthes stomias*), and starry flounder (*Platichthys stellatus*) are important components of the groundfish resources in the Gulf of Alaska. These species have diverse life history strategies. Details of their life history and early life stages, and an evaluation of their individual adaptation and vulnerability to prevailing and fluctuating oceanographic conditions in the Gulf of Alaska is presented.

The relationship between atmospheric processes above the Asian continent and the North Pacific Ocean and the abundance of Asian chum salmon and pink salmon in 20th century

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This report examines statistics connecting atmospheric processes with the fluctuations in abundance of Asian chum salmon (*Oncorhynchus keta*) and pink salmon (*Oncorhynchus gorbusha*).

The most critical period for the salmon reproduction is winter. There was a statistical link between atmospheric pressure in January and catches of *O. gorbusha* the following year, and catches of *O. keta* three years later. The abundance of *O. keta* and *O. gorbusha* that grew up in the spawning regions is influenced by atmospheric processes over the continent. However in such areas as Sakhalin, Kurils islands and Eastern Kamchatka climate conditions and therefore salmon abundance are determined mostly by atmospheric processes over the Pacific Ocean. These relationships are examined for Amur River basin salmon.

Interannual response of fish growth to the 3-D global NEMURO output with realistic atmospheric forcing. Part II: Pacific saury growth

Shin-ichi **Ito**[1], Kenneth A. Rose[2], Maki Noguchi-Aita[3], Bernard A. Megrey[4], Yasuhiro Yamanaka[5,3], Francisco E. Werner[6] and Michio J. Kishi[7,3]

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The bioenergetics model of Pacific saury, a part of NEMURO.FISH (North Pacific Ecosystem Model for Understanding Regional Oceanography for Including Saury and Herring), was driven by zooplankton densities and water temperature from 3-D global NEMURO. Since saury migrate from the Kuroshio area (KR) to the Oyashio area (OY) through the mixed water region (MW), three points were selected along 155 E from a 3-D global NEMURO run. Since the model zooplankton densities were smaller than the observed values, the saury's growth was underestimated by the model. To overcome this problem, an automatic calibration program PEST was applied. Using the calibrated parameters, the model was integrated from 1950 to 2002 and the wet weight of adult saury showed several distinctive shifts. To elucidate the key factors for wet weight change of saury, an additional 17 experiments were conducted. Two of the eight major shifts were controlled by temperature effects and the six others by zooplankton densities. The temperature effect was most important in OY. In MW, prey density was the controlling factor, with predatory zooplankton density playing the most important role. The direct temperature effect is closely related to the migration of saury. In the case of warmer conditions in OY, the saury's residence time in the OY is lengthened and, hence, the saury growth is accelerated. However, if the winter-time temperature in OY is high, the zooplankton density is decreased. In this sense, the large migration range of Pacific saury may be a strategy to stabilize their growth.

PICES XIV   S4-2612   Oral

Life history strategies: Applications to fisheries management

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Marine fish have evolved a wide range of life history strategies to deal with varying environmental conditions. In the Canadian Pacific region, fisheries target fish across all life history strategies, capturing migratory and other pelagics, anadromous species, demersal groundfish, and elasmobranchs. Biological traits of targetted species range from small sized, early maturing, short-lived species (less than 10 years) to large, late maturing, long-lived species (over 150 years). We used the life history trtaits of 42 marine fish to identify species groupings and life history strategies. We have linked life history strategies to generalized population dynamics, particularly long-term responses to climate and ocean changes. This allows us to build a conceptural framework of fisheries management options based on specific life history strategies and observed environmental conditions. Currently, over 400 species of fish are caught in Pacific commercial fisheries, however traditional stock assessments are undertaken for less than 50 species. One of the challenges facing fisheries management in the Pacific region, is the provision of management advice for species for which there is little or no abundance information. In such instances, fisheries scientists can use life history traits to identify a species' life history strategy and select appropriate management options from the conceptual framework.

PICES XIV   S4-2257   Oral

Appearance and rapid increase of the exotic copepod *Acartia tonsa* on the British Columbia continental margin

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The copepod *Acartia tonsa* is morphologically similar to, but slightly larger than its congener *Acartia longiremis*, which has been until now the dominant *Acartia* species on the British Columbia continental shelf. *Acartia tonsa* is endemic to the mid-latitude Atlantic and European marginal seas, but in the past several decades has established Pacific-resident populations in San Francisco Bay and in the Southern California Bight. It has also been observed off Oregon in low numbers during warm years with anomalously strong northward. In our British Columbia continental margin samples *A. tonsa* appeared for the first time (at very low abundance) in 1992 and 1993. It subsequently disappeared, but reappeared at higher abundance and more broadly in 2003. In 2004, it showed a rapid, and approximately exponential increase in abundance and biomass. By early autumn its abundance had surpassed that of *A. longiremis.* In spring 2005, *A. tonsa* abundance has remained high, and at many locations *A. longiremis* abundance now appears to be depressed. This is the first clear evidence in our region of successful invasion of a non-estuarine environment by an exotic zooplankton species.

PICES XIV   S4-2611   Poster

Contrast in life histories of commercially exploited marine fishes off the coasts of Canada and Korea and changes in ecosystem structure

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The history of commercial fisheries off the coasts of Canada and off of Korea are very different. These histories, in conjunction with different ecosystems, have resulted in disparate current species compositions. In Canadian waters, the dominant oceanographic domain is the coastal upwelling domain off of the west coast of Vancouver Island, the northernmost extent of the California Current System. This ecosystem is dominated by demersal species complexes, with an abundance of long-lived species such as flatfish, rockfish, sablefish, and halibut. During summer, migratory pelagics such as Pacific hake, Pacific salmon, and recently Pacific sardine, move into this area to feed. In the late 1970s, Canada declared jurisdiction for 200 miles from their coastline, and targeted major fisheries in Canada have been managed with a quota system. As such, fisheries off the west coast of Vancouver Island have been moderate. Off the Korean coast, a major oceanographic domain is the Tsushima

Warm Current Ecosystem in the East/Japan Sea. This ecosystem is currently dominated by short-lived pelagic and demersal fish. Historically, Korea has shared marine resources in this area with neighbouring countries, but stock assessment and quotas have only recently (since the late-1990s) been implemented for some major species. As such, fisheries can be described as intensive, and many stocks have been described as overfished. A joint Canada-Korea study has been initiated to compare these ecosystems as they relate to community composition and dominate fish species. Each ecosystem responded differently to climate impacts such as regime shifts under different exploitation histories. In the future, both countries will face the challenge of global climate warming, its impacts on ecosystems and both countries will need to develop adaptable fisheries and management of those fisheries. The challenges will be different for the two countries: Canada will need to conserve fish populations, while Korea will need to focus on rebuilding fish populations.

PICES XIV   S4-2277   Oral
Spatial dynamics of small pelagic-fish populations in the California Current system on seasonal and interannual scales during the last warming regime (1980-1997)

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Reports of long-term changes of sardine landings have suggested that when they are scarce, sardines are relatively sedentary in refuge areas but change behavior to highly migratory and colonize cooler areas when they are abundant. In contrast, anchovies expand around a fixed geographic center. The causes of such different geographical dynamics are unknown. To better understand such long-term, large-scale spatial processes may require understanding critical, smaller scales of variability. To identify and propose possible oceanographic processes related to spatial dynamics of the coupled sardine-anchovy populations, we analyzed the seasonal variability in distribution of relative abundances of northern anchovy (*Engraulis mordax*) and Pacific sardine (*Sardinops caeruleus*) (with emphasis on juveniles) along the California Current system (CCS), and their interannual variability caused by environmental changes during the warming period 1980-1997. Seasonal and interannual patterns of distribution suggest that fronts may be the oceanographic processes in the CCS that define aggregation and forage habitat for young pelagic fish. We suggest that the central stock of *E. mordax* is related to the Ensenada front, a geographically fixed feature. The southern stock is related to a geographically dynamic front, where the equatorward California Current (CalC) and the North Equatorial Current converge along the southwestern of the Baja California peninsula. During El Niño conditions the predominance of warmer water masses weaken these fronts, and upwelling caused by bathymetric or coastal-shape characteristics become important oceanographic processes as refuge areas. We further propose the *S. caeruleus* population is related to a geographically dynamic front, where the equatorward CalC and the inshore California Countercurrent (CcC) converge parallel to the shore off California and Baja California. Progressive poleward changes in the latitudinal position of higher relative abundances of young sardine along the front suggest a progressive interannual increase of the northward CcC advection after the 1976-1977 regime shift, whereas the CalC southward advection weakened.

PICES XIV   S4-2465   Oral
Long term variation of species and life stage composition of zooplankton in the western North Pacific: Introduction of the Odate project

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Since the 1950's, zooplankton have been routinely collected off north eastern Japan. Samples have been collected at fixed sampling lines, every month or periodically throughout the seasons, using a standard plankton net (0.33mm mesh size; 0.45m mouth diameter). More than 20000 of these plankton samples are located at the Tohoku National Research Institute. A report on the long term variation in wet weight of these samples was published by Dr. Kazuko Odate in 1994. This zooplankton biomass data set is known as the "Odate data". However, the wet weight data is not enough to reveal the relationship between zooplankton biomass and physical oceanographic data. Since information on interspecific relationships of zooplankton is necessary to analyze long-term variation of ocean ecosystems in relation to climate change, the species composition of the zooplankton samples used for Odate data were reinvestigated. A distinctive feature of this new data-set is the

study of dominant species life stages (instar of copepodite; *Neocalanus, Eucalanus, Calanus* and *Metridia* species). Using this new data-set, an interdisciplinary study on the long term variation of oceanic ecosystems, called Odate project, is being conducted. 1527 zooplankton samples have been examined and 206 species of copepods detected. During the 1970s in the Oyashio area, a high abundance of copepods was observed, with *Neocalanus* species especially dominant.

PICES XIV   S4-2267   Oral
Adaptive significance of spatial distribution patterns as reflection of life history strategy and density dependence in populations of some pelagic fish, squid and jellyfish species in Russian EEZ of North Pacific

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Based on pelagic trawl surveys, analysis of spatial distribution patterns are examined for pelagic fish, squid and jellyfish species throughout Russian EEZ (Bering, Okhotsk and Japan Seas) and adjacent waters of the North Pacific. Both CPUEs and biological parameters' spatial allocation are analyzed in relation to interannual and seasonal dynamics of overall species abundance. We show that spatial distribution patterns are of adaptive significance, depend significantly on type of life history strategy, and can serve as a measure of degree of density dependence. Increased species abundance results in better defined and more gradient spatial allocation of CPUEs, as well as in higher heterogeneity of species biological parameters throughout the area of its presence. During periods of lower abundance species seem to move towards "simplified" spatial structure and lower variability of biological parameters. We used different methods of spatial analysis (variogram, correlogram, SADIE analysis, *etc.*) in order to illustrate our conclusions.

PICES XIV   S4-2502   Oral
East/West comparative responses of a piscivorous marine bird to oceanographic variability in the North Pacific Ocean: California versus Tsushima current systems

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We studied spatial and temporal variation in diet composition and reproductive ecology of a piscivorous seabird, Rhinoceros Auklet *Cerorhinca monocerata*, in relation to ocean climate variability in two different marine current systems. The California Current (CCS) is a seasonally upwelling-driven system, while productivity in the Tsushima Current System (TCS) is driven by seasonal warm water advection. Southeast Farallon Island and Año Nuevo Island in the central California Current (37° N) support populations of approximately 1500 and 300 birds and time series span from 1987–2005 and 1993–2005, respectively. Rhinoceros Auklets on Teuri Island (44° N) in the TCS number roughly 400,000-600,000 breeding birds and diet and reproductive data exist for 1984–1985, 1987, and 1992–2005. Anchovy are important prey in both systems, although influence of other prey species differs, with rockfish being more important in the CCS, while sandlance play a secondary role in diet in the TCS. Parallel trends in various parameters of reproductive performance (fledging success, *etc.*) are evident between colonies in the CCS and TCS, yet while linkages between diet, growth and fledging success are strong in the TCS, there is a disconnect between growth and fledging success in the CCS, indicating complex effects of food on reproduction. Relationships between diet, reproduction and marine climate at different spatial scales are compared between systems.

Interdecadal variability in body size of *Neocalanus* copepods in the Oyashio waters from 1960 to 2002 - A study of the Odate Project

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Interdecadal variability in the body size (prosoma length of copepodite V stage) of *Neocalanus* copepods were investigated by using Odate Collection in the Oyashio waters for 1960-2002. We investigate body size of *N. flemingeri* for May and the *N. cristatus* and *N. plumchrus* for July, because the former species and latter groups mainly appeared in surface layer in spring and summer, respectively. Body size of *N. flemingeri* had high value in mid 1960s and early-mid 1990s. *N. cristatus* and *N. plumchrus* also had high value in their body size in the 1960s and 1990s. It is known the body size of copepods has a negative relationship with ambient temperature. However temperatures in surface layers increased from the 1960s to the mid 1970s and in 1990s. The pattern of interannual variations in biomass of *Neocalanus* copepods corresponded with their body size except for *N. flemingeri* in 1960s. It was reported that the body size of copepod had positive relationship with food availability. If the variations in biomass are related to the food availability then the variation in body sizes may be related to the variations in their food availability. We discuss the interdecadal variations in body size of *Neocalanus* copepods by using more information of environmental variables such as hydrography and nutrient conditions.

Differing response patterns of pelagic and demersal fish assemblages to the late-1980s regime shift in the Japan Sea

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The fish community in the Japan Sea is characterized by diverse fishes from warm water pelagic species to cold water demersal species. Both fish community structure and biomass in the Japan Sea are largely affected by the Tsushima Warm Current (TWC) and the Liman Current. In the late 1980s, an oceanic regime shift indicated by an abrupt change from cold to warm water in the TWC occurred. Using various environmental and biological time series, and principal component analysis (PCA), we investigated the response patterns of fish assemblages corresponding to this regime shift.

The first two principal components (PC1-2) from the PCA of catch time series (invertebrates to large predatory fishes) from 1958-2003 show decadal variation patterns with evident changes around the mid-1970s and late-1980s. In the TWC, the PC1-2 show a significant correlation to water temperatures at depths of 50m (50mWT). This suggests the decadal variation in the fish community is forced to the oceanic regime shift in TWC. Pelagic indicator species such as yellowtail and horse mackerel are positively correlated to the 50mWT, while most demersal species show a negative correlation. This indicates different responses to the oceanic regime shift. Japanese offshore bottom trawl catch data from 1979-2003 showed a northward shift in the distribution of cold water demersal species such as Pacific cod with the late 1980s regime shift. Results suggest that the late-1980s oceanic regime shift in TWC had varying impacts on fish assemblages.

Diagnosis and prognosis of extreme natural phenomena in the Russian Far East

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The probable mechanism of atmospheric circulation forcing to abundance of *O. keta* in Avvakumovka river (South Primorye) is presented. The mechanism is associated with the localization of large anomalies in the baric fields immediately above the spawning area.

Interval recognition is used to forecast these phenomena, in particular, anomalous ice cover in the Tatar Straits (Japan Sea). The coefficient magnitudes of interval identification (n=r/(r+m)) within $30\text{-}55^{\circ}$ N and $120\text{-}160^{\circ}$ E (30 features) during the months prior to the extreme years of ice cover in the Tatar straits were estimated. Analysis of maximal and minimal ice cover showed that the most coefficients of identification were observed in summer and autumn. These results support previous studies that suggest that inter-annual fluctuations in water temperature and ice cover of Tatar straits were determined by advectional constituents. Our data indicates the usefulness of the method of interval identification for forecasting ice cover.

Annual changes of areas of trade of pollock in the Sea of Okhotsk and Bering Sea for the last thirty years

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Pollock (*Theragra chalcogramma*) is a major commercial fish in the North Pacific Ocean particularly in Sea of Okhotsk and Bering Sea. The pollock roe fishery in Sea of Okhotsk is very valuable. In this area, pollock is fished from December to April and in the western Bering Sea from May to December. Pollock undergo significant annual fluctuation in biomass in Russian waters. Annual fishing areas are related to the amount of sea ice, the number of storms and stock abundance. Recently stocks have dramatically declined as a result of ocean conditions and fishing.

In this study, we examine logbook data from Russian fishing vessels from 1970 on 2000. Using these data the spatial - temporal movement of pollock between the Sea of Okhotsk and the Bering Sea was determined. We constructed a fishing catch grid for the Sea of Okhotsk and the western Bering Sea based on average monthly catches (on a decadal scale). Use of this catch by grid matrix allows increased fishing efficiency with minimum cost.

Changes in abundance and fish species composition of the Aniva Bay and La Perouse Strait (Sea of Okhotsk) in connection with climate

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The retrospective observations in the 20th and early 21st centuries show that climate influence on ichtiofauna of the Aniva Bay and La Perouse Strait manifested itself in two trends: fluctuations in the abundance of different fish and changes in species composition. For example, from 1924-1934, herring catches reached 400.0 thousand tons, but declined in the 1950s, to 130.0 thousand tons. By the end of the 1980s commercial fishing of herring was closed. Biomass of spawning pink salmon in the 1960s was about 3.0 thousand tons, however during 1998-2002, the annual catches of this fish reached 33.0 thousand tons. There were abundant schools of Japanese anchovy in 1950s, which appeared again in the Aniva Bay after a 30-year interval. In the 1980s, an intensive commercial fishery for Far East sardine periodically took place. Annual catches of walleye pollock reached 60.0 thousand tons in 1960s, and catches of sand lance in 1970s were at the level of 100.0 – 165.0 thousand tons.

By the beginning of the 21st century, the abundance of these two species declined to very low levels. Trawl surveys conducted from 2000-2004 indicate that capelin, herring, arabesque greenling (young) among pelagic fishes, and saffron cod, flounders and sculpins, among bottom fishes were the most abundant species. During the last five years, such south latitude species as Scomber japonica, *Coryphaena hippurus, Takifugu porphyreus, Sebastes wakiyai* and some new coldwater species were observed to appear in the study area.

PICES XIV   S4-2504   Oral

Interannual response of fish growth to the 3-D global NEMURO output with realistic atmospheric forcing. Part I: Latitudinal differences in Pacific herring growth

Kenneth A. Rose[1], Bernard A. Megrey[2], Francisco E. **Werner**[3], Yasuhiro Yamanaka[5,4], Maki Noguchi-Aita[4], Shin-ichi Ito[6] and Michio J. Kishi[7,4]

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Understanding ecosystem impacts of climate change at basin scales and across more than one species is one of the most important sampling and modeling challenges facing the ocean research community. A lower trophic level model (NEMURO) was embedded into a 3-D circulation model (3-D NEMURO) and used to simulate the daily dynamics of two groups of phytoplankton, three groups of zooplankton, and representations of nitrogen and silicate fluxes on a 3-D spatial grid for the Northern Pacific Ocean for 1948 through 2002. We used predicted water temperature and zooplankton densities from 3-D NEMURO for three locations (West Coast Vancouver Island, Prince William Sound, and Bering Sea) as inputs to a Pacific herring (*Clupea pallasii*) bioenergetics model to simulate predicted mean weight-at-age. Weight-at-age at the three locations showed shifts during the late 1970's that were also reflected in the 3-D NEMURO-predicted water temperature and zooplankton densities. The relative contribution of water temperature versus zooplankton densities to predicted herring growth response varied by location. Zooplankton were the major cause of predicted herring growth response for West Coast Vancouver Island, temperature dominated the response for the Bering Sea, and the Prince William Sound response was mix of temperature and zooplankton. Use of 3-D NEMURO output, computed in a consistent manner across broad geographic scales, allowed us to more rigorously compare predicted herring growth responses between locations. In a companion paper, the same methodology was applied to Pacific saury (*Cololabis saira*), allowing a cross-species comparison.

PICES XIV   S4-2425   Invited

Responses of opportunistic, periodic, and equilibrium life history strategies to climate-induced environmental regime shifts

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The triangular model of life history strategies (Winemiller and Rose, 1992) predicts the manner in which different species respond to environmental variation. Opportunistic life history strategists respond with comparatively rapid demographic responses (high resiliency) and rapid evolution. Estuarine taxa may have limited vagility, and marine pelagic species may have considerable dispersal capabilities both in immature and adult stages. Periodic strategists often reveal episodic, pulse-like demographic responses to spatial and temporal variation expressed over relatively large spatial scales. High spatiotemporal recruitment variation is manifested in dominant annual cohorts or recruitment hot spots, such as larval retention areas and coastal nursery habitats. The periodic strategy also should be associated with slower rates of evolution and reductions in effective population size due to high fitness variance (Hedgecock effect). Most periodic strategists have high dispersal capabilities, especially for pelagic eggs and larvae, but also for vagile adults in some cases. Equilibrium strategists should have significant density-dependent recruitment and relatively low demographic resilience (*e.g.* many elasmobranchs). Both immature and adult life stages should be particularly sensitive to changes in ecosystem properties, including community structure. In these taxa, vagility of immature life stages is low, and adults of some taxa may have limited vagility and often are dependent on particular habitats.

Climate change and regime shifts in ecosystem dynamics are expected to affect all species, but spatial dynamics and speeds of response would differ. Opportunistic strategist should adjust rapidly to changes in environmental conditions at small spatial scales via demographic and evolutionary change, but these taxa may be vulnerable to rapid, large-scale shifts. Periodic strategists should have rapid demographic responses expressed over large spatial scales, and these may result in genetic bottlenecks, local extirpations, and range shifts. Equilibrium strategists with relatively low vagility and demographic resilience would be highly impacted by major regime shifts. Reductions in these populations would further change food web dynamics and reduce regional biodiversity. These theoretical predictions are supported by findings from several recent studies.

PICES XIV   S4-2580   *Oral*

Distribution and population dynamics of Japanese sardine, anchovy and chub mackerel in the Kuroshio/Oyashio system: Seeking for mechanistic responses to regime shifts

Akihiko **Yatsu**[1], Hiroshi Kubota[1], Akinori Takasuka[1], Motomitsu Takahashi[2], Norio Yamashita[1], Hiroshi Nishida[1], Chikako Watanabe[1] and Yoshioki Oozeki[1]

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Decadal-scale species replacement or alternation of dominant species is evident among Japanese sardine (*Sardinops melanostictus*), anchovy (*Engraulis japonicus*), and chub mackerel (*Scomber japonicus*) in the Kuroshio/Oyashio System. Although they are short-lived (< 4 years for anchovy and < 8 years for sardine and mackerel) and basically zooplankton feeders, their life histories are different. For example, chub mackerel feed on anchovy larvae and adults. In general, sardine and mackerel spawn in the Kuroshio area during winter. Anchovy spawn from spring to autumn mainly in the Kuroshio but their spawning grounds extend to the Transition Zone when the stock is abundant. In order to determine mechanistic responses to regime shifts, we examined the historical data of distribution and abundance of eggs, larvae, juveniles and adults, and growth of juveniles in relation to environmental factors. Water temperature and prey density are responsible for early growth for these species. Abundance and spatial overlap with their common predators - skipjack tunas and common squids - may also play a role.

S5

CCCC/MODEL Topic Session
Modeling climate and fishing impacts on fish recruitment

Co-Convenors: Jacob Schweigert (Canada) and Yury I. Zuenko (Russia)

To model the state of fish populations, both individual growth and the population number are necessary. Recently the PICES MODEL Task Team has generalized ecosystem models for the North Pacific, and applied the prototype model of lower trophic models (NEMURO) for the growth of individual fish, at present Pacific saury and herring. However, the same developments were not implemented at the fish population level. Clearly, the abundance depends strongly on reproductive success and fish survival during early life stages, and these are, in turn, affected by the environment. This session will review existing models and related scientific knowledge on fish recruitment under varying environmental conditions, and create a foundation for their incorporation in the ecosystem model for the North Pacific and its regions.

Wednesday, October 5, 2005   08:30-12:30

08:30-08:40	**Introduction by Convenors**

08:40-09:20   **Franz J. Mueter**   (Invited)
Detecting and modeling environmental effects on recruitment: Strategies and pitfalls (S5-2480)

09:20-10:00   **Chiyuki Sassa, Youichi Tsukamoto, Yoshinobu Konishi, Songguang Xie, Yoshiro Watanabe and Hideaki Nakata**   (Invited)
Recruitment processes of jack mackerel (*Trachurus japonicus*) in the East China Sea (ECS) in relation to environmental conditions (S5-2400)

10:00-10:20   **Coffee Break**

10:20-10:40   **Alexander I. Abakumov and Irina V. Ishmukova**
Using the model approach to understand functioning of the Okhotsk Sea ecosystem (S5-2332)

10:40-11:00   **R. Ian Perry and Jake Schweigert**
Concepts of marine ecosystem carrying capacity, and their application to NE Pacific herring populations (S5-2369)

11:00-11:20   **Melissa A. Haltuch and Andre E. Punt**
Life history, climate forcing, and fish stock assessment – Evaluating statistical power (S5-2213)

11:20-11:40   **Yury I. Zuenko and Svetlana V. Davidova**
In situ experiments to investigate the japanese anchovy eggs development (S5-2448)

11:40-12:00   **Haruka Nishiakwa and Ichiro Yasuda**
Population decline of Japanese sardine and variation of mixed layer depth in the Kuroshio Extension (S5-2488)

12:00-12:20   **Michael J. Schirripa and J.J. Colbert**
Incorporating environmental effects in the assessment of sablefish (*Anoplopoma fimbria*) off the continental U.S. Pacific coast (S5-2500)

12:20-12:30   **Summary by Convenors**

Posters

Jae Bong <u>Lee</u>, Chang-Ik Zhang, Anne Hollowed, James Ingraham, Dong Woo Lee and Young Seop Kim
Stock assessment of jack mackerel around Korean marine ecosystems using environmental factors (S5-2346)

Kosei Komatsu, Akihide Kasai and Tomowo <u>Watanabe</u>
Modeling transport of eggs and larvae of jack mackerel in the East China Sea (S5-2490)

Life history, climate forcing, and fish stock assessment – Evaluating statistical power

Melissa A. **Haltuch** and Andre E. Punt

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Inter-annual atmosphere-ocean climate variability in the Pacific, *e.g.* the Pacific Decadal Oscillation and the El Niño Southern Oscillation, has been well documented along with concurrent variability in both pelagic and demersal species. However, changes in population abundance of fish stocks are largely attributed to fishing impacts, rather than environmental variability. High variability around stock-recruitment curves indicate that climate, in addition to stock size, probably affects early life history survival and subsequent recruitment to fisheries. Thus, management advice that ignores inter-annual climate forcing of productivity and / or carrying capacity may cause stocks to be over- or under-harvested. The efficacy of including environmental impacts on recruitment in management models needs to be evaluated to take account of environmental considerations within the single-species stock assessment paradigm. Therefore, simulation testing is used to determine the statistical power of currently-used stock assessment methods to correctly identify whether climate is forcing either carrying capacity or stock productivity. Specifically, climate may impact productivity via the steepness of the stock-recruitment curve (h) or via the unfished average stock size. Simulation results provide guidance for including climate as a forcing function in single-species stock assessments for three generalized life history types: a short lived pelagic schooling species, a moderately long-lived flatfish, and a long-lived rockfish.

Using the model approach to understand functioning of the Okhotsk Sea ecosystem

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The study of the marine ecosystem functioning is important for describing quantitatively the processes, which occur there. Development of this theory assumes extended studies of quantitative regularities in metabolism, rations, growth, species and population production. Knowledge of organic substance production both for populations and for ecosystem/subecosystem (pelagic and bottom) has scientific and applied importance. When quantitative characteristics (biomass, production, ration, mortality) are determined it is possible to compare ecosystem states corresponding to different climate regimes.

Biologists usually implement models in the form of block-schemes of mass flows between trophic blocks. Those mass flows present average values for a certain period of time. A method for assessing informal biological models is proposed. This method includes several steps:
1. Implementation of formal models in the form of differential equations;
2. Parametric identification according to a chosen scenario and under assumptions of stability;
3. Numerical simulations and predictions for various characteristics of the system for different periods of time.

Two scenarios of the Okhotsk Sea ecosystem model are used for parameter identification. In the first scenario, the natural mortality coefficients are calculated when biomass, ration and assimilative growth coefficients of trophic blocks are known. Results suggest that the natural mortality coefficients for every trophic block (except phytoplankton block) are greater than experimental data. In the second scenario, the assimilative growth coefficients are determined when biomass, ration and natural mortality are known. The model values of the assimilative growth coefficients for every block (except non-predatory zoobenthos block) are less than those known from literature. The equilibrium points are determined during parameter estimation. Deviations of equilibrium points were analyzed and the results show the motions close to the equilibrium points.

Stock assessment of jack mackerel around Korean marine ecosystems using environmental factors

Jae Bong **Lee**[1], Chang-Ik Zhang[2], Anne Hollowed[3], James Ingraham[3], Dong Woo Lee[1] and Young Seop Kim[1]

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Successful recruitment was dependent on the abundance and distribution of spawning biomass in the previous year, food availability and temperature in the major habitat of jack mackerel around Korean waters. Using a sequential data processing technique, a regime shift, or discontinuity, was tested in ocean environmental time series relative to the catch, recruitment and biomass at age of jack mackerel for 1968-2004. The spawning biomass and recruitment relationship of jack mackerel shifted in 1976 and 1987, and the estimated recruitment considering three regimes was highly significantly correlated with observed recruitment of jack mackerel ($P<0.001$). The optimal harvest rate of jack mackerel was estimated to be within the range of 30-35% of the unfished level of spawning biomass per recruit (SPR) that provides a yield near MSY for any probable spawner-recruit relationship (SRR). The SPR harvest rate required for establishing an F_{MSY} proxy for jack mackerel was also examined. Based on the optimal harvest rate, a maximum fishing mortality threshold (MFMT) was defined, which prevents overfishing while still achieving an optimal yield from the major jack mackerel fishery. For potential refinement of the present management system, a revised five tier system was developed that included an overfishing level (OFL) as well as acceptable biological catch (ABC) of jack mackerel around Korea waters.

Detecting and modeling environmental effects on recruitment: Strategies and pitfalls

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Research into the effects of environmental variability on recruitment has increased our general understanding of recruitment dynamics and has informed fisheries management decisions both qualitatively and quantitatively. However, there are few examples where environmental effects have been successfully incorporated into stock assessment or ecosystem models for predicting future recruitment. I will discuss general strategies for successfully quantifying and modeling environmental effects while minimizing the risks of identifying yet more spurious relationships. Strategies include (1) developing models based on biologically meaningful relationships (rather than inferring relationships from statistical models), (2) carefully selecting appropriate temporal and spatial scales of averaging for explanatory variables based on independent analyses, (3) accounting for effects of spawner abundance on recruitment and allowing for different environmental effects at low and high spawner abundances, and (4) modeling effects across multiple stocks of a species or across similar species. Examples from the Northeast Pacific will be provided to illustrate these strategies.

Population decline of Japanese sardine and variation of mixed layer depth in the Kuroshio Extension

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Japanese sardine, *Sardinops melanostictus*, is known to fluctuate drastically on inter-decadal time scales. There have been many previous studies about the population decline of Japanese sardine. Watanabe *et al.* (1995) attributed the cause to high larval mortality between the end of the first-feeding stage and age 1 and Noto and Yasuda (1999) reported the positive correlation between the winter sea surface temperature (SST) in the Kuroshio Extension (KE) and the sardine mortality. We found a significant negative correlation between the mortality coefficient from the postlarval stage to age 1 and March MLD in the KE. From late 1970's to 1987, March MLD was deep and the mortality coefficient was low. Since 1988 March MLD had been shallower and

the mortality was high. We use the NEMURO model to estimate interannual variation of bait-plankton. This model is forced by observed MLD, SST, short wave radiation and by monthly climatology of vertical nutrient profile. The estimated spring zooplankton biomass showed a positive correlation with March MLD. Because shallow winter MLD hastens the spring bloom in years of high mortality and shallow MLD, the plankton bloom didn't occur in spring but in winter and the spring biomass was low. Nutrients were consumed in the earlier bloom. This study suggested the following hypothesis: since the late 1980's, winter SST was high and MLD was shallow in the KE, the environmental change could lead to the decrease of spring zooplankton biomass and juvenile sardine coming into the KE couldn't survive due to the low food density.

PICES XIV S5-2369 Oral
Concepts of marine ecosystem carrying capacity, and their application to NE Pacific herring populations

R. Ian **Perry** and Jake Schweigert

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The mean level of abundance of a species in a particular area was included by Michael Sinclair (Marine Populations, 1988) as one of the four key factors in the regulation of marine populations. However, this concept has received relatively little attention in recent years in contrast to the problem of population (recruitment). Although these concepts are closely linked the mean level of abundance is a more direct reflection of the concept of "carrying capacity", *i.e.* the number of individuals in a population that can be supported by the resources of that ecosystem over the long term. The carrying capacity of a population in an area has important implications for long-term sustainable harvest as well as considerations for species viability and reference points for rebuilding strategies. We explore concepts of carrying capacity of marine ecosystems, beginning with (what have been called) long-term levels of (sustainable?) commercial catch and population productivity, and then examine the spatial and temporal variability of estimated carrying capacity in greater detail for herring populations in the NE Pacific. Our goal is to identify the carrying capacity for herring in these regions and to better understand the factors determining these levels and their variability.

PICES XIV S5-2400 Invited
Recruitment processes of jack mackerel (*Trachurus japonicus*) in the East China Sea (ECS) in relation to environmental conditions

Chiyuki **Sassa**[1], Youichi Tsukamoto[1], Yoshinobu Konishi[1], Songguang Xie[2], Yoshiro Watanabe[2] and Hideaki Nakata[3]

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Jack mackerel is an important fishery resource in southern Japan, Korea, and Taiwan, but information of their recruitment processes is limited. Ichthyoplankton surveys during 2001–2004 revealed that the primary spawning ground of jack mackerel is formed in the shelf break region of the southern ECS south of 28°N during late winter to spring. By the Kuroshio and its branch currents, a large proportion of larvae and juveniles originating from the spawning ground were transported to the northern ECS, Pacific coast of Japan, and western Japan Sea to recruit into the fishing grounds off Japan. Relationships among the abundance of larvae and juveniles, and age-0 recruitment of jack mackerel suggested that (1) survival during postlarval and juvenile stages was important for determining their year-class strength and (2) the survival rate was very high in 2001 during our study period. The otolith increment analysis suggested that early growth is one of the important factors determining recruitment success of jack mackerel. We discuss the relationship between the fluctuation of survival during postlarval and juvenile stages and the environmental conditions, such as habitat temperature, currents, and prey condition during 2001–2004. The copepod egg production rate in 2001 was much higher than in 2002–2004 in our study area, corresponding well with the jack mackerel survival. Importance of scyphozoan medusae for jack mackerel survival is also discussed, since jack mackerel juveniles associate with them and annual variations in medusae abundance and jack mackerel survival corresponded well in ECS.

Incorporating environmental effects in the assessment of sablefish (*Anoplopoma fimbria*) off the continental U.S. Pacific coast

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The status of the sablefish (*Anoplopoma fimbria*) resource off the continental U.S. west coast was assessed by explicitly accounting for variation is recruitment due to changes in environmental conditions along the coast. We modeled annual recruitment deviations by integrating a sea level time series into a more traditional stock-recruitment function within a statistical catch-at-age model. In this way, the standard deviation term of the stock-recruitment function, the term which allows recruitments estimates to depart from the curve, was partitioned into two sources of variation: the variation accountable for by environmental effects, and "other" variation due to unknown sources of error. The effect of accounting for environmental variation was examined by comparing the statistical catch-at-age model fits both with and without consideration of the environmental data time series. The model with explicit accounting of environmental effects resulted in a log likelihood that was sufficiently less than the model without environmental effects so as to conclude that the additional parameter significantly improved the fit.   Consequently, annual recruitment deviations were found to be significantly related to annual changes in sea level during critical times during the life cycle of larval sablefish. Furthermore, the consideration of the environmental effects made it possible to hind-cast recruitment deviations and additional fifty years as well as forecast deviations for the year of the assessment.

Modeling transport of eggs and larvae of jack mackerel in the East China Sea

Kosei Komatsu[1], Akihide Kasai[2] and Tomowo **Watanabe**[1]

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Recent larval sampling and drifter buoy observations indicate that eggs of jack mackerel (*Trachurus japonicus*) are spawned primarily around Taiwan in the southern East China Sea (ECS) and transported through survival/growth processes into three regions: the Pacific, the Japan Sea and the coastal region off Kyushu, Japan. However, the reason for annual variation in their recruitment is unclear, partly due to the complex current system in ECS, where the Kuroshio flows on the shelf break and partly separates northward linking up the Taiwan Warm Current on the continental shelf. To clarify the transport mechanism of eggs and larvae of jack mackerel, we conducted tracer experiments under realistic forcing, using an eddy-resolving OGCM assimilating satellite SSH/SST based on the adjoint ocean primitive equation model, C-HOPE, developed by the Max-Planck-Institute.   The model accurately reproduced transport of the drifter buoys after additional modifications: eliminating tidal noise in SSH-assimilation on the shelf and superimposing wind/wind-wave drift on currents. Pseudo-particles were released at 20m depth around the Taiwan in February from 2000 to 2004 and transported for 90 days, incorporating survival functions parameterized by modeled temperature and SeaWiFS chlorophyll concentration. Most of the particles, released northeast off Taiwan, were transported to the Pacific along the Kuroshio, however, those that survived were more abundant in the Japan Sea. These were originally detached from the Kuroshio and transported northward on the shelf to the Japan Sea. These experiments provided good estimates of the annual change of 0-age catches, clarifying the sensitivity of particle recruitment to temporal-spatial variations of oceanic conditions.

In situ experiments to investigate the japanese anchovy eggs development

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Egg development of japanese anchovy was investigated on several one-day or two-day surveys of stations in Peter the Great Bay (Japan Sea) in June-July of 2000 and 2004. The samples were collected using an

ichthyoplankton net in the sea surface layer every 4 hours. Dead eggs dominated in the samples (averaging 90.5%). Any significant trend in the total number of eggs was not evident within a day, but large fluctuations were observed, apparently the result of patchiness in the egg spatial distribution.

The egg development was partitioned into 5 stages. Abundance of the early stages (0-I) increased towards midnight suggesting this as the time of mass spawning. Later the proportion of the early stage eggs decreased gradually as the eggs matured. The total quantity of living eggs also had a tendency to decrease after the midnight maximum. The rate of mortality depended on the stage and was higher for the early stages (2-20% per hour) than for the late (II-IV) stages (0-14% per hour).

To determine the total duration of egg development and relative length of the early stages, the "age" distribution of eggs was approximated by a Gaussian curve. In this case, the proportion of any stage could be calculated by a Fourier integral. Actually, the observed proportion was formed by several generations of eggs spawned in successive nights, with the survival for each generation a function of its age. The parameters of the Gaussian distribution as σ, T_{0-I} (relative duration of the early stages) and T (total duration of the eggs development to larvae) were estimated by least squares to closely approximate to the observed values at all times within a day. They had the following values: $\sigma = 0,06-0,07$; $T_{0-I} = 0,12-0,18$; and T fluctuated from 56 to 77 hours. The eggs survival during the early stages was estimated as 13-79% (mean 47%), and final egg survival – was 0-79% (mean 31%). These estimates can be used for modeling the early ontogenesis of this species.

S6

FIS/CCCC Topic Session
Evidence of distributional shifts in demersal fish in relation to short/long-term changes in oceanographic conditions

Co-Convenors: Gordon A. McFarlane (Canada), Michael J. Schirripa (U.S.A.) and Mikhail Stepanenko (Russia)

Demersal fish, either on the continental shelves, slopes or seamounts, support major fisheries in both the eastern and western Pacific. These include such fish as the rockfishes (genus Sebastes), thornyheads (genus Sebastolobus) and many flounders (family Pleuronectidae). These species are known to exhibit periodic shifts in their distribution either latitudinally (moving north-south) or longitudinally (moving east-west). While these shifts can at times be attributed to such things as life history characteristics, often they are due to changes in the fish's environment. Changes in the fish's environment can be the result of short-term phenomena, such as seasonal depletions in oxygen levels, or long-term phenomena, such as decadal climate shifts. Shifts in the spatial distribution of these species due to changes in the fish's environment can cause these populations to move into and out of the areas traditionally covered by the fisheries they support, as well as the surveys that seek to assess their abundance. Consequently, resource surveys designed to develop annual indices of abundance for these species can produce erroneous trends, and as a result, the stock assessments that depend on these surveys will be inaccurate. If the causes of these distributional changes were known, indices of abundance could be modeled so as to account for these changes in ways other than changes in overall stock abundance. This session invites papers that describe the changes in demersal fishes distributions with specific emphasis on those changes due to changes in climate, either short- or long-term. The goal of the session will be to provide sound evidence for ecosystem-based distributional shifts that can be used to account for some of the year-to-year variability in survey trends of demersal fish that may currently be attributed to changes in overall abundance.

Wednesday, October 5, 2005   08:30-12:25

08:30-08:40   **Introduction by Convenors**

08:40-09:20   **George A. Rose**   (Invited)
Demersal fish distribution dynamics in Boreal and Sub-Arctic marine ecosystems (S6-2246)

09:20-09:45   **Jin-Yeong Kim, Yang-Jae Im, Seok-Gwan Choi, Soon-Song Kim, Joo-Il Kim and Young-Yull Chun**
Spatial limitation of demersal fish and ecosystem characteristics during wintering season in the southern waters of Korea (S6-2555)

09:45-10:00   **Review of posters**

10:00-10:20   **Coffee Break**

10:20-10:45   **Alexander I. Glubokov**
Pollock in ichthyocoenoses of the outer shelf and upper slope of the North and West Bering Sea (S6-2217)

10:45-11:10   **Alexei M. Orlov**
Long-term and seasonal shifts of distribution of commercially important flat- and rockfishes in the Pacific off the northern Kuril Islands and southeastern Kamchatka: Probable affecting of changes in climatic and temperature conditions? (S6-2235)

11:10-11:35   **Aleksey Yu. Merzlyakov**
Modern state and annual dynamics of demersal fish communities in the Okhotsk Sea (S6-2320)

11:35-12:00   **Paul D. Spencer and Tom W. Wilderbuer**
                Geographic distributions of eastern Bering Sea flatfish: Effects of environmental variability
                and population abundance (S6-2263)

12:00-12:25   **Franz J. Mueter and Bernard A. Megrey**
                Geographical shifts in the spatial distribution of Northeast Pacific groundfish populations in
                relation to water temperatures (S6-2481)

Posters

Leonid S. Kodolov and Maxim A. Ocheretyanniy
Distributional pattern and population structure of Greenland turbot *Rheinchardtius hippoglossoides* in the
Bering Sea (S6-2589)

Leonid S. Kodolov and Vladimir N. Tuponogov
Impact of some biological features and environmental factors on distributional patterns of North Pacific deep-
water fishes (S6-2324)

Larisa P. Nikolenko
Influence of environmental factors on year-class abundance of the Greenland turbot (*Reinhardtius
hippoglossoides*) in the Sea of Okhotsk (S6-2575)

Larisa P. Nikolenko
Seasonal migrations of the black turbot (*Reinhardtius hippoglossoides*) in the Okhotsk Sea (S6-2327)

Andrei A. Smirnov, Alexei M. Orlov and Yuri K. Semenov
Distribution of Greenland halibut, broadbanded thornyhead, skates, and eelpout in the eastern Sea of Okhotsk in
relation to changes of water temperatures within the layers of their inhabitation (S6-2608)

Vladimir N. Tuponogov
Vertical and spatial distribution of longfin grenadier off Japanese and Kuril Islands and in the Okhotsk Sea
(S6-2590)

Oleg G. Zolotov
Long-term changes in Atka mackerel, *Pleurogrammus monopterygius*, distribution and abundance in waters off
the northern Kurile Islands and southeastern Kamchatka (S6-2216)

Pollock in ichthyocoenoses of the outer shelf and upper slope of the North and West Bering Sea

Alexander I. **Glubokov**

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The Northwest Bering Sea represents one of the most productive water areas of the global oceans. The composition of hydrobiont communities is subjected to considerable interannual and seasonal changes caused by both climatic and oceanological restructuring of ecosystems and man-induced factors. The rise in fishing pressure on the key items of bottom and pelagic communities observed in recent decades entails transformation of the entire ecosystem. It would be impossible to understand the biocoenosis functioning pattern under the new conditions, and the confidence limits of their forecast succession estimates, without monitoring the status of the populations which comprise the biocoenosis, and of the species as a whole. This study involves the material collected pursuant to the joint scientific program conducted by KamchatNIRO, TINRO-Center and VNIRO in 1995 – 2004 in the format of 27 cruises (total of 1517 vessel days). We studied the status, qualitative and quantitative composition, spatial and temporal dynamics of the structure of ichthyocoenoses in the North and West Bering Sea. We analyzed the frequency of occurrence and distribution density of 62 fish species from Olutor Bay, 43 from over the Koryak seamount (underwater upland), and 67 from Navarin region, interannually and seasonally. The importance of pollock in the present day ichtyocoenoces is discussed in relation to the period of the last 10 years marked by an acute decline in the species' abundance in the North Bering Sea at the end of the second millennium, and a rapid recovery during the initial years of the third millennium. For the first time in the entire record of observations the trawl surveys were made three times a year. Their results made it possible to track down the ichthyocoenosis structure dynamics during the postspawning, feeding and prewintering life periods of pollock. It was found out that the elasmobranches, clupeids, gadoids and righteyed, sculpins, fatheads sculpins and eelpouts are predominant in the ichthyocenes.

Spatial limitation of demersal fish and ecosystem characteristics during wintering season in the southern waters of Korea

Jin Yeong **Kim**[1], Yang Jae Im[3], Seok Gwan Choi[2], Soon song Kim[2], Joo Il Kim[1] and Young Yull Chun[2]

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The Fisheries resources have been distributed spatially in the limited area during wintering season according to the effect from the seasonal and yearly variation of the environment and ecosystem characteristics. Management changes would be required to halt the current declining biomass trends through the spatial-based system of fisheries management incorporating ecosystem considerations in the policy. Therefore, we estimated spatial limitation of demersal fish and ecosystem characteristics during wintering season based on the data recently collected by trawling and acoustic surveys, and environmental factors in the southern waters of Korea. Additionally, spatial limitations of major fish species were analyzed by MDS (multi-dimensional scaling) and cluster analysis based on Bray-Curtis similarities. Sea surface temperature and salinity ranged from 7~16°C, 32.5~34.7, respectively, in the southern area of the Yellow Sea and western area of the southern coastal waters of Korea. Diversity showed mostly high values in the coastal area of Jeju Islands with high densities of major species. Major fish assemblages were distributed in the front area below 10 degrees sea surface temperature. Species composition of the whole fish assemblages were compared with the occurrence of demersal fish species as the role of predator for the potential prey fish. The evaluation of new management measures at the ecosystem level based on the bio-energetic point of view and habitat-specific effects were discussed by the results of spatial limitation of major fish species.

Distributional pattern and population structure of Greenland turbot *Rheinchardtius hippoglossoides* in the Bering Sea

Leonid S. **Kodolov** and Maxim A. Ocheretyanniy

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The Greenland turbot is distributed in the Okhotsk and Bering Seas, off the Kuril and Aleutian Islands. A separate independent population inhabits the Bering Sea. Most stocks of adult turbot are located at the continental slope, at depths of 300 - 1300 m, to the east of the Olutorsky Cape. About 60 - 70 % of turbot are found at the American continental slope, 5-10 % - off the Asian coast and about 30 % off the Aleutian Islands. In summer some of turbot migrates from the east into the Asian continental slope for feeding. Greenland turbot spawns over the entire Bering Sea continental slope, but most fish spawn in the southeastern part of the Sea. Eggs are carried out by currents into the northern Bering Sea. The turbot larvae inhabit midwater depths during some months. Larvae of body length 70 - 80 mm settle on the bottom. Juveniles and immature fish (until age 2 + years) are distributed in the northern Bering Sea, in the Anadyr Bay. Immature fish at age 3-6 years migrate along the northern shelf, including Russian waters. Mature turbot then move into the continental slope region. In the 1980s, turbot stocks in the Bering Sea were low, mainly due to overfishing of immature fish as bycatch. At present, there are some signs of turbot recovery in the Bering Sea.

Impact of some biological features and environmental factors on distributional patterns of North Pacific deep-water fishes

Leonid S. **Kodolov** and Wladimir N. Tuponogov

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Ichthyofauna of the continental slope (bathyal zone) includes specialized oceanic- (or ancient-) deep-water species adjusted to life in depths (Andriyashev, 1953; Rass, 1967). Adult fishes of the near-bottom pelagic communities (rockfishes, grenadiers, deep-sea cods, halibuts) live in the bathyal zone. Larvae and juveniles are either distributed in the open waters adjacent to the continental slopes (grenadiers and deep-sea cods), or live in the upper layers, while young fishes forage on the shelf. Species of the bathyal bottom community live in the bathyal zone during the entire life cycle (Zoarcidae, Liparidae, Cottidae, sharks, skates), and rarely have pelagic and shelf (elittoral) ontogenetic stages (flounder). Distribution of elittoral stages of flounder and sculpin overlap in the upper slope. Relief, systems of the currents, eddies, vertical water turbulence influence bathyal fishes distribution. The wide East Bering Sea shelf starving a surviving of eggs, immature fishes with shelf stages (rockfishes, halibut, arrowtooth flounders, sablefish). Prevailing sinking of waters in the northwestern Pacific and Bering Sea continental slope results in transport of eggs and juveniles of deep-water fishes beyond the shelf zone. Fishes having bottom spawning without the pelagic stage (Cottidae, Zoarcidae) dominate here. Grenadiers and deepsea cods are plentiful only in areas of increased vertical water turbulence, in zones of water sinking (northwestern boreal Pacific and western Gulf of Alaska). In such zones, vertical structure of waters collapses. It promotes an increase in abundance of inter-zonal plankton, the basic food for oceanic deep-water fishes.

Modern state and annual dynamics of demersal fish communities in the Okhotsk Sea

Aleksey Yu. **Merzlyakov**

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Biomass of demersal fishes in the Okhotsk Sea was estimated using data collected from 9 trawls surveys from 1986 through 2002. Today, spatial distribution density of demersal fishes is assessed at 2.6 metric tons per square km. It is smaller compared to the assessments made in the 1980s and 1990s, which reached 6.2 and 6.5 tons per square km, respectively. Demersal fishes were found in higher concentrations on the shelf than in the deep-sea regions. The highest fish concentrations were observed on the western Kamchatka shelf, where the

total biomass of demersal fish has changed from 10.7 to 32.6 tons per square km during the research period. The smallest biomass was observed in 2000. The most rapid decrease in abundance of demersal fish was observed in 1998. It happened, presumably, as the result of low intensity of the West Kamchatka Current, which was observed in the early 1990s. These changes must have affected the effectiveness of spawning and larvae survival of the most abundant species, and first of all those of the family Pleuronectidae, due to low stability of planktonic communities. The observed changes in stock abundance of various demersal fishes were accompanied by changes in the species composition of bottom fish communities. Species of the family Pleuronectidae were a predominant group during the research period. However, the proportion of this family in the total biomass of demersal fishes decreased from 72.1% in the mid-1990s to 41% in the last few years. This was due to a decrease in abundance of *Limanda aspera* and *Pleuronectes qudrituberculatus*, and due to a rapid increase in the overall biomass of species that belong to the families Cottidae, Zoarcidae and Stichaeidae.

PICES XIV   S6-2481   Oral
Geographical shifts in the spatial distribution of Northeast Pacific groundfish populations in relation to water temperatures

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The spatial distribution of many marine populations shifts seasonally, inter-annually, and at longer time scales. At decadal scales there is increasing evidence that the distributions of both terrestrial and marine populations shift in response to climate changes. We used trawl survey data from the U.S. West Coast, Gulf of Alaska, and eastern Bering Sea to investigate shifts in the distribution of numerous fish and invertebrate populations. We fit spatial models of the catch-per-unit-effort and presence/absence of individual taxa by region with depth and alongshore distance as covariates. We tested for significant changes in the average depth gradient and in the average alongshore gradient (primarily North-South) over the past 20 to 25 years. Observed changes in these gradients across numerous species were related to interannual and decadal-scale changes in ocean temperatures. Results will be summarized and discussed in the context of global climate changes.

PICES XIV   S6-2575   Poster
Influence of environmental factors on year-class abundance of the Greenland turbot (*Reinhardtius hippoglossoides*) in the Sea of Okhotsk

Larisa P. **Nikolenko**

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The paper deals with the variations in the productivity of the Greenland turbot (*Reinhardtius hippoglossoides*) generations in the Sea of Okhotsk in 1958-1990 and relationship between productivity and thermal sea regime. It was revealed that the productive generations of the Greenland turbot are predominantly observed in "temperate" or "warm" (based on hydrologic regime) years when a weak zonal atmosphere circulation takes place. Changes in productivity are probably the consequences of changes in the currents' pattern in different (based on thermal regime) years. In warm years, when a weak zonal circulation of atmosphere is observed, wide flow of the West Kamchatka Current carries out larvae of the Greenland turbot to the northeast of the Sea of Okhotsk, where major aggregations of young Greenland turbot occur. In cold years, when zonal transfer of air masses is intensified, the West Kamchatka Current forms a number of local gyres preventing carrying out of larvae to the northeast of the Sea of Okhotsk. Population yield may affect the formation of the Greenland turbot generations. In years of high abundance, even under favorable conditions, productive generations of the Greenland turbot were not found.

Seasonal migrations of the black turbot (*Reinhardtius hippoglossoides*) in the Okhotsk Sea

Larisa P. **Nikolenko**

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Long-term observations conducted in the eastern Okhotsk Sea (east of 150º00' E) in summer and autumn revealed that most individuals of the black turbot migrate to the main spawning grounds located generally to the north of 53º00'N in the TINRO Basin and Lebed Trench, and also in areas to the south and southwest of this trench. After spawning, most individuals of the black turbot migrate southward and concentrate off the southwestern coast of Kamchatka, where fish density reaches its maximum from March through May. Normally, turbot do not form dense aggregations off the Sakhalin Island in winter, and occur there sporadically. In spring, the fish concentrate mainly between 51º00' and 52º00'N. Mature individuals start moving northward in summer and by autumn, most of them gather in the northern Okhotsk Sea to spawn.

Distribution of Greenland halibut, broadbanded thornyhead, skates, and eelpout in the eastern Sea of Okhotsk in relation to changes of water temperatures within the layers of their inhabitation

Andrei A. Smirnov[1], Alexei M. **Orlov**[2] and Yuri K. Semenov[1]

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Recently in the eastern Sea of Okhotsk an active longline and gill net fisheries on Greenland halibut *Reinhardtius hippoglossoides matsuurae* are conducted. Longline catches reflect the distribution of feeding Greenland halibut, while gill net catches show species distribution during prespawning, spawning and postspawning periods. In Greenland halibut fisheries the bycatch of other fishes exists. The main species of bycatch in longline fishery are Pacific cod *Gadus macrocephalus*, skates Rajidae, eelpouts Zoarcidae, grenadiers Macrouridae, and broadbanded thornyhead *Sebastolobus macrohir*. Gill net bycatch comprises mostly broadbanded thornyhead, skates and eelpouts. Distribution of above species is poorly studied, especially its seasonal changes depending on oceanological conditions. Spatial distributions of above mentioned species based on studies conducted during September-November 2002-2004 aboard Russian research vessels "Kuril'sky", "Viliga", "Izumrud" and "Rubinovy" are considered. The results obtained are compared with multi-annual data on water temperatures at bottom in different months. The analysis showed the existence of relationship between variability of oceanological characters (water temperature) and distribution patterns of species under study. More detailed study of this relationship is planed in the future with further direct measurements of oceanological parameters (salinity and water temperature) during commercial fishing operations and fisheries research that is conducted by MagadanNIRO on annual basis.

Long-term and seasonal shifts of distribution of commercially important flat- and rockfishes in the Pacific off the northern Kuril Islands and southeastern Kamchatka: Probable affecting of changes in climatic and temperature conditions?

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The most commercially important flatfish and rockfish species in the Pacific waters off the northern Kuril Islands and southeastern Kamchatka are Greenland halibut *Reinhardtius hippoglossoides*, Kamchatka flounder *Atheresthes evermanni*, Pacific halibut *Hippoglossus stenolepis*, northern rock sole *Lepidopsetta polyxystra*, Pacific ocean perch *Sebastes alutus*, shortraker rockfish *S. borealis*, shortspine thornyhead *Sebastolobus alascanus*, and broadbanded thornyhead *S. macrochir*. These species comprised about 10% of total catch in the area only (according to multi-annual data of bottom trawl surveys, 1993-2000). However, they are in great

demand and have high market price that makes their fishery very profitable. One of the little-studied life history aspects of species in question are long-term and seasonal changes of their distribution and factors affecting such changes. Survey data showed that the majority of species exhibited significant changes in relative abundance (judged by CPUE indices and proportion in catch) and occurrence during 1996-98's, which may be associated with recent climate shift. On the other hand species considered also exhibited considerable changes in relative abundance and occurrence during different seasons (summer and autumn) that probably caused by seasonal changes of oceanologic factors. For all eight species in question maps of spatial distribution for 1993-1996's and 1997-2000's are drawn and compared both with each other and with respective maps of bottom temperature distribution. Maps of species spatial distribution are drawn for different seasons (summer and autumn) as well, which are also compared with corresponding maps of distribution of bottom temperature.

PICES XIV S6-2246 *Invited*
Demersal fish distribution dynamics in Boreal and Sub-Arctic marine ecosystems

George A. **Rose**

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Demersal and semi-demersal fish species exhibit dynamic distribution patterns at several temporal and spatial scales. Stability is probably rare. The longest time and largest space scales are geological in scope. Most recently, the Ice Ages of the past million years have shaped evolution and distribution most strongly. Examples of the redfishes (*Sebastes* spp.) moving from Pacific to Atlantic, and the gadoids moving from Atlantic to Pacific, are highlighted. Spatial dynamics also occur at decadal, annual, seasonal and diel time scales. Spatial scales tend to correlate in magnitude with temporal scales. Decadal shift "events" related to ocean climate have been observed in the North Atlantic; for example around Iceland-Greenland in the 1920s, the North Sea over the past few decades, and on the Labrador shelf in the 1990s. Annual changes in distribution through changing migration patterns are also known, and seasonal changes in repeatedly used routes and spawning sites are evident in Atlantic cod (*Gadus morhua*). Diel changes occur regularly in *Sebastes* on the Grand Bank, and other species. Distribution dynamics at the four smaller scales can influence fisheries surveys used in stock assessments. Using southern Newfoundland cod as an example, the influence of changing distribution patterns is examined.

PICES XIV S6-2263 *Oral*
Geographic distributions of eastern Bering Sea flatfish: Effects of environmental variability and population abundance

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Variability in environmental conditions and flatfish abundances in the eastern Bering Sea (EBS) since the early 1980s motivate an examination of how these factors relate to flatfish distributions. For example, 1999 was one of the coldest years observed despite occurring during a period of general warming, and the abundances of several flatfish species peaked from the late 1980s to the mid-1990s and have declined in recent years. For rock sole (*Lepidopsetta polyxystra*), the proportion of the distribution occurring in the southeastern EBS shelf is related to the proportion of the cold pool (a bottom layer of water less than 2° C) in the southeastern shelf. Randomization tests indicate that the temperatures occupied by flathead sole (*Hippoglossoides ellassodon*) during some warm years are not statistically different from the available temperatures on the EBS shelf, but during some cold years flathead sole select habitats with warmer than average temperatures. Greenland turbot (*Reinhardtius hippoglossoides*) are located near the northern edge of the survey area, and thus even subtle distribution shifts may result in a portion of the population moving out of the survey area. Additionally, the distribution of rock sole is also related to abundance, and multivariate models examining the relative influence of abundance and environmental variability will be explored. The effect of temperature upon survey catchability is incorporated into current assessment models for rock sole, yellowfin sole (*Limanda aspera*), and flathead sole, but potential shifts of species out of the survey area presents an additional challenge.

Vertical and spatial distribution of longfin grenadier off Japanese and Kuril Islands and in the Okhotsk Sea

Vladimir N. **Tuponogov**

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The longfin grenadier - *Coryphaenoides longifilis* (Gunther, 1877) has been known to occupy deep water for almost a hundred years. It was considered as a rare deep-water species. Its distribution and life history remained unknown for a long time. The first high concentrations were found near the Honshu Islands in 1974 at depths of 900-1300 m by the R/V *Shantar* (Kodolov, Kulikov, 1980). The TINRO conducted some bottom trawl surveys in 1980-1990 at the continental slope in the Okhotsk Sea, off Kamchatka, the Kuril Islands and Japan. The longfin grenadier was distributed at the continental slope of the Japanese and Kuril Islands, the Bering and Okhotsk Seas, and seamounts of the North Pacific Ocean. It occupies fourth place in catch occurrence among grenadier species just after the giant grenadier, the popeye grenadier and the roughscale grenadier. The longfin grenadier comprises 1-5 % of total catch and is relatively abundant just off the Pacific coast of Japan, Honshu Island where it makes up70-80 % of the catch. The longfin grenadier is distributed at depths between 550-2025 m. Density increases in waters deeper than 800 m and is maximum at depths of 1000-1400 m off Honshu Island. The CPUE in trawl fisheries varies from 2,5 т to 5-10 т. Turbot concentrations shift 100-200 deeper during the winter period. Seasonal migrations are related to feeding (spring-summer) and spawning (autumn-winter) periods. Longfin grenadier make also daily vertical migrations.

Long-term changes in Atka mackerel, *Pleurogrammus monopterygius*, distribution and abundance in waters off the northern Kurile Islands and southeastern Kamchatka

Oleg G. **Zolotov**

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Atka mackerel are one of the most numerous semi-demersal fish species along the Pacific coast off Kamchatka and North Kuriles. Despite of wide distribution and high abundance the species became an object of directed commercial fishing relatively late, since 1968. Ecological and morphological studies suggested that there was no evidence of reproductive isolation and that Atka mackerel form a single population from the central part of Kurile Chain throughout the Kamchatka to southwestern Bering Sea. The general pattern of seasonal distribution consists of pre-spawning migration from winter habitats mainly in the southern part of their range (outer shelf of the Central Kuriles and underwater plateau at 48°10′ - 48°30′ N) northwards to shallow coastal waters off the Paramushir Island and Kamchatka, and a return migration in late autumn. Thus, the reproductive habitats are widely extended in the form of discrete spawning grounds throughout all the range of population, whereas the winter habitats are localized primarily in the south. Multi-annual statistics of the near-shore fishery in Kamchatka waters demonstrate long-term periodicity in the number of pre-spawning and spawning Atka mackerel. High levels of abundance occurred during 1950's, in 1968-1976, and since the middle of 1990's; during other periods the spawning shoals were rarely found in the vicinity of Kamchatka coast, and all reproduction of the population was restricted with Kurile waters. Results of the study show that cyclic shifts in Atka mackerel's northward distribution depend on two factors: the stock condition and the oceanographic regime in the area.

S7

MEQ/FIS Topic Session
Current and emerging issues of marine and estuarine aquaculture in the Pacific region: Carrying capacity, ecosystem function and socioeconomics

Co-Convenors: Ik-Kyo Chung (Korea), Jian-Guang Fang (China), Carolyn Friedman (U.S.A.) and Galina S. Gavrilova (Russia)

It is well recognized that for successful and long-term utilization of waters for aquaculture and other uses, we must consider the allocation of resources and trophic structure of the system. Ecosystem-based management of resources requires ways to monitor current conditions and predict future states, particularly in response to known human activities that impact the marine environment. Mariculture is an important expanding industry in all PICES countries, and this session will consider mariculture as a case study on how the ecosystem impacts of a particular human activity can be managed. Indicators and predictive models are being used to evaluate and hypothesize the responses of an ecosystem to environmental impact and resulting management actions. This session will bring experts together to identify criteria for suitable indicators and the utilities of predictive models relevant to the impacts of mariculture, to assess the sensitivities of indicators, and to highlight gaps in current knowledge.

Tuesday, October 4, 2003   08:30-12:30

08:30-08:40   **Introduction by Convenors**

08:40-09:10   **Michael Rust and Colin Nash**   (Invited)
International efforts to apply environmental risk assessment to marine aquaculture (S7-2587)

09:10-09:30   **Galina S. Gavrilova**
The current status of research and problems of invertebrate mariculture in the Russian Far East (S7-2258)

09:30-09:50   **Yongsik Sin**
Use of ecosystem models for study and management of coastal estuarine ecosystems in Korea (S7-2493)

09:50-10:10   **Hisashi Yokoyama**
Proposal of site selection guidelines for fish farming in Japanese coastal waters (S7-2297)

10:10-10:30   **Coffee Break**

10:30-10:50   **Xuelei Zhang, M.Y. Zhu, L.H. Zhang and D. Zhang**
A first exploration on differential impacts of bivalve mollusc on the two phytoplankton groups, diatom and dinoflagellate (S7-2212)

10:50-11:10   **Dinabandhu Sahoo**
Integrating seaweed cultivation into brackish water aquaculture - Chilika Model (S7-2356)

11:10-11:30   **Ik Kyo Chung, Yun He Kang and Yu-Feng Yang**
Seasonal assembly of seaweed species in the sustainable seaweed integrated aquaculture system in Korea (S7-2378)

11:30-11:50   **Richard J. Beamish, Chrys-Ellen M. Neville and Ruston M. Sweeting**
Regimes and the relationship between farmed and wild salmon in British Columbia (S7-2610)

11:50-12:10   **Igor Khovansky and Anastassia Mednikova**
Perspectives of salmon sea ranching in the coast of the Okhotsk Sea and in estuaries of rivers (S7-2219)

12:10-12:30   **Larissa A. Gayko**
Influence of environmental factors to forecast the yield of mollusks on marine farms (Sea of Japan) (S7-2397)

Posters

Li-sheng Cai, Jianguang Fang, Zengfu Song, Xingming Liang and Tianxing Wu
Natural sedimentation in large-scale aquaculture areas of Sungo Bay (S7-2618)

Marianna V. Kalinina and Elena G. Semenkova
Use of a visual method of estimation of Japanese mitten crab ovaries by maturity stages (S7-2298)

Nikolina P. Kovatcheva
Crustacean cultivation in artificial conditions: Promising trends in aqua- and mariculture in Russia (S7-2239)

Nikolai I. Krupjanko and Aleksei V. Lysenko
Reproduction of chum (*Oncorhynchus keta*) and masu (*O. masu*) salmon at salmon hatcheries in Primorye (Peter the Great Bay) (S7-2560)

Dmitry S. Pavlov, George G. Novikov and Andrei N. Stroganov
On some ways of preservation of local fish populations (S7-2280)

Nadezhda E. Struppul and Olga N. Lukyanova
Selenium content in marine organisms from the Russian coast of the Sea of Japan (S7-2540)

Galina I. Victorovskaya, Anatoly S. Socolov and Igor J. Suhin
Increasing sea urchin settlement productivity using various forms of melioration (S7-2259)

Yong-Jian Xu and Wei Wei
Principle of ecologically environmental capacity and its application to planning and management of coastal aquaculture in China (S7-2339)

PICES XIV   S7-2610   Oral

Regimes and the relationship between farmed and wild salmon in British Columbia

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Salmon farming in British Columbia produces an average amount of salmon in an area of the ocean about the size of the Vancouver Airport that is more than double the total wild catch. About 4000 people have full time jobs in areas of the Province where these jobs are needed. Salmon farming is also controversial because there is uncertainty about the long-term effects on wild Pacific salmon. We show that some of these potential effects are related to decadal scale regime shifts that affect freshwater discharge and surface salinities in the spring.

PICES XIV   S7-2618   Poster

Natural sedimentation in large-scale aquaculture areas of Sungo Bay

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Sungo Bay is located east of Shandong Peninsula where scallops, oysters and kelp have been cultured in large scale. The experiment on natural sedimentation in aquaculture areas of Sungo Bay was made with sediment traps in 5 periods of one year. Scallop, oyster and kelp culture areas were chosen for the experiment, and the concentrations of TN, TP and POM in the particulate matter, both from the trap and from the sediment of the experimental areas, were measured. The result showed that the sedimentation rate of particulate matter was 278.8 g m^{-2}.d^{-1} in these areas. One gram of sediment settling to the bottom could carry 190.4μg of TN, 472.5μg of TP, and 0.103g of POM. The peak value of the TN content in the sediment appeared in May, and the minimal value appeared in December. But the value of TP content was higher in the cold season than in the warm season. The N/P ratio of the sinking sediment was in the range of 0.67~2.0, but that on the bottom was in the range of 0.025~2.0. These experiment data can be served as a basis for the studies of the nutrient flux and the carrying capacity of a shallow sea for aquaculture.

PICES XIV   S7-2378   Oral

Seasonal assembly of seaweed species in the sustainable seaweed integrated aquaculture system in Korea

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Seaweeds are reappraised as a key biofilter and production component in the sustainable seaweed integrated aquaculture system (SSIAS) in Korea. The local seaweed cultivar species such as *Porphyra* sp., *Laminaria* sp., *Undaria* sp., *Enteromorpha* sp. and *Gracilaria* sp. have proven to be good candidate biofilters in lower temperature season and wild *Codium* sp. and *Ulva* sp. have been chosen in higher temperature season. The year around operation of SSISA in a closed inland tank culture is feasible with seasonally assembled seaweed species. The subsistence-scale finfish-shellfish-seaweed polyculture in net pen cultures has been popular in Korea. This integration and balancing of the extractive (seaweed) and feed (finfish) cultures could mitigate eutrophication and the self-pollution of aquaculture in the coastal area. The emerging need of balanced ecosystem approaches to mariculture would be incorporated and managed under the 'Ecosystem Based Management'. Therefore, the immediate application of the SSIAS is recommended.

The current status of research and problems of invertebrate mariculture in the Russian Far East

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Research covering the field of mariculture and environment interaction is in its initial stage in Russia. Determination of potential carrying capacity of bays is one of the main concerns, and its solution is critical to the development of mollusk mariculture. The method of determining carrying capacity for seabed and suspended bivalve cultivation was developed for Posjet Bay by Soviet researchers in 1980s. Potential load on the bays was calculated by including the size of the cultivation areas, water exchange intensity, concentration of seston, quantity of the mollusks cultivated and filtration rate. This method may be used while research of other sea areas is being conducted. It will help in estimating the carrying capacity of Peter the Great Bay – the most suitable sea area for the development of mariculture in Primorye. Research on mariculture and environment interactions will result in studies of the bays' trophic resources and of mollusk's biosediment quantity during their cultivation. The experiments proved that changes in hydrobiont fermentative activity can serve as a diagnostic characteristic of environmental conditions changes. Economic aspects are highlighted in up-to-date mariculture projects in Russia. However, results of long-term research in various fields of study are essential to elaborate the biological basis for invertebrate cultivation. So, the duration of experimental work (*i.e.* project cost) depends to great extent on the scientific research available.

Influence of environmental factors to forecast the yield of mollusks on marine farms (Sea of Japan)

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To develop scientific methods for the long-term prediction of mollusk productivity, the first stage is to study the effects of hydrological parameters on the Japanese scallop and the technology of its cultivation. This work is in the first stage of research. All operations, from obtaining spat on artificial substrata (collectors) until commercial harvests are performed under natural conditions in a semi-closed Minonosok Bay on floating industrial installations. This work is based on the following materials: average daily air temperatures for many years, seawater temperature and salinity data provided by the Possyet hydrometeorological station (1930-2004), and the state hydrometeorological service. In addition, data were also included from many-years of observations (1970-1990) on the scallop *Mizuhopecten yessoensis* cultured under natural conditions in semi-enclosed Minonosok Bay (Possyet Bay) on floating installations (one near-shore and three seaward systems of ropes), in which scallop spat that settled onto the collectors was counted (specimens/collector). This study describes the results of statistical analysis of thermohaline characteristics during four periods of the annual developmental cycle of the Japanese scallop. The departures from mean values of duration of biological periods and their thermohaline characteristics, were calculated. To analyze the interconnection of periods, correlation matrices of mean period durations and seawater temperature and salinity mean values have been analyzed for each period. The yield of the Japanese scallop, *i.e.* the amount of spat settled on collectors, expressed in specimen/m^2 provided a criterion to estimate the effect of thermohaline conditions. Good-harvest and low-harvest years were recognized on the basis of an analysis of the distribution of harvest deviation from the trend. Based on analysis of the results, all parameters undergo considerable interannual variability. One can trace a downward trend in the duration of the larval period. The duration of the larval settling period was corroborated by the lowest variability. A close positive link was recorded between neighbouring periods for thermohaline characteristics of the periods. Comparison of the durations of all four periods in development of Japanese scallop did not change between 1970-1990 and 1999-2003, although it could be remarked that the max and min duration decreased.

Use of a visual method of estimation of Japanese mitten crab ovaries by maturity stages

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Characteristics of Japanese mitten crab *Eriocheir japonicus* (Crustacea: Decapoda, Grapsidae) ovaries color at different maturity stages were determined according to the Munsell Book of Color (1976). Mature females collected in a branch of the Artemovka River (Primorsky Krai) at 5 kms from the mouth in September 2003 were the target of our research. Ovary maturity stages were determined using standard histological preparations. It was established that during the research period, mature female gonads were at the 1-5th stages of development. For visualization of the received data they were transferred into (R, G, B) system by Munsell Conversion programme. As a result, it was possible to identify ovary color from the beginning of development up to mature gonads, including the following colors: light-yellow, yellow, beige, bright-violet, light-brown, brown, dark-violet and dark-brown. It is marked that the greatest variety of colors is observed at the 4th stage. The received data can be used in aquaculture for visual differentiation of *E. japonicus* ovaries by maturity stages.

Perspectives of salmon sea ranching in the coast of the Okhotsk Sea and in estuaries of rivers

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The role of sea ranching in estuarine and coastal waters is very important for the artificial reproduction of salmon. The efficacy of artificial propagation depends on the ecological rate of estuarine and marine ranching. For example, the potential of hatcheries on the Taujskaya Guba of the Okhotsk Sea depends on the efficacy of marine ranching. The objective of ranching is to provide abundant returns of adult salmon to the coast and to increase hatchery efficacy. For example, the return rates of chum and coho salmon released as smolts from open net-cages was higher than those recorded from the wild stock along the North Okhotsk Sea coast. This difference can be explained by the additional feeding of juveniles as the food base of the coastal areas is poor and areas for favorable foraging in nature can be reached only by the bigger smolts, and by their physiologies, *i.e.* the quality and survival rate of ranched smolts are higher than those of wild individuals. However, having a big smolt is not always profitable as poor quality feed can result in a weak and defective animal. Improving spawner quality may develop as the key biological technology as the ability to maintain spawners in cages set on the sea coast develops. First results of chum salmon spawning were encouraging. In salt water, fish are not infected by saprolegniosis and, therefore muscle fibers retain their red coloration. This technology allows populations to avoid the effects of overfishing in spawning rivers. Analysis of salmon ranching reveals that although there are positive examples and good results, returns of hatchery-reared salmon are not always stable and at several hatcheries, the run of the farmed population is insignificant compared with the wild population. The most promising way to improve artificial propagation is to use the technology of keeping spawners in sea water for spawning and to develop cage ranching of salmon in estuaries of small rivers.

Crustacean cultivation in artificial conditions: Promising trends in aqua- and mariculture in Russia

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In recent years, there has been a trend in Russia toward a revival of mariculture, resulting from the newly emergent and great demand for delicatessen foods, and a sharp decline in the abundance of certain hydrobionts (red king crab). The items for which new culturing techniques are being developed include both – freshwater and marine species. Farmed animals may include the freshwater crayfishes (Decapoda, Astacinae) – *Astacus leptodactylus and A. astacus,* and the freshwater giant shrimp (*Macrobrachium rosenbergii).* The red king crab (*Paralithodes camtschaticus)* is the main cultured marine species. Culturing of this species in Russia is being

done with two objectives in mind: (1) reproduction aimed at natural population recovery, and (2) additional rearing of pre-recruits to attain marketable size. The scientific research is conducted along such directions as the biological basis for raising the cultivation effects, feeds and production of feeds, disease and prevention, and equipment. In addition to the restoration of natural stocks, and to securing supplies for the delicacy product markets, this generation of culturing technology and the establishment of aquaculture facilities for crustaceans in Russia may ensure quite a number of jobs and raise the living standards in small communities.

PICES XIV   S7-2560   Poster
Reproduction of chum (*Oncorhynchus keta*) and masu (*O. masu*) salmon at salmon hatcheries in Primorye (Peter the Great Bay)

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Chum and masu are major Pacific salmon species in the rivers of southern Primorye. Human management became the reason of reduction of chum and masu salmon abundance. Two salmon hatcheries were established in the middle of the 1980s on the Barabashevka and Rjazanovka rivers. Chum salmon is the basic object of hatchery reproduction. About 20 million eggs are cultivated and about 18 million fry were released in recent years. Returns of adult fishes varied from 0.07-1.2 %, averaging 0.25-0.35 %. About 90% of the chum salmon returning to the rivers of Peter the Great Bay are the result of hatchery cultivation. Masu salmon cultivation in hatcheries has a short history. The first experiments were conducted by TINRO scientists in the Rjazanovka experimental hatchery from 1988-1990. By the end of 1990s, both hatcheries started to cultivate this species commercially. Fry cultivation and release occurred according to the following plan: 1) recruitment of natural populations due to release fishes in average weight, 0.4-0.9 g to the rivers; 2) release of one-year-old fishes (smolts) with an average weight of 18-20 g. The quantity of fry released by the two hatcheries gradually increased from 0.25 million up to 3.5 million, and during last 4 years, it has been about 1.5 million, on average. Smolts are released less, on average about 30 thousand per year.

PICES XIV   S7-2587   Invited
International efforts to apply environmental risk assessment to marine aquaculture

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The ecological risk assessment framework developed by the World Health Organization of the United Nations is widely used in other industries that impact the environment and the analytical techniques have been internationally accepted. Two international workshops, one held in Canada sponsored by ICES, and a second held in the United States sponsored by FAO, have attempted to apply the WHO framework to ecological risk assessment for marine net-pens and have independently developed similar guidelines. A third international conference sponsored by NOAA on the role of aquaculture in the marine ecosystem held in Hawaii, has also endorsed a scientific risk assessment approach but did not develop details about how to do this. This NOAA sponsored meeting did recommend the use of models for decision support as marine aquaculture industries grow and data becomes available. The FAO sponsored meeting called for countries to develop case studies for the major aquaculture industries in their marine waters with a potential follow-up meeting to present these case studies. This approach may also be appropriate for PICES research on aquaculture as it may impact carrying capacity, ecosystem function and socioeconomics.

PICES XIV   S7-2356   Oral
Integrating seaweed cultivation into brackish water aquaculture - Chilika Model

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Chilika, one of the largest brackish water wetland ecosystems in Asia, is situated on the east coast of India. Over the years, Chilika Lagoon has been threatened by siltation, eutrophication, changes in salinity regimes, fresh water weed proliferation, decrease in fish productivity, increased aquaculture, changes in species

composition and excessive removal of bioresources. Most of the agriculture fields around the lake were turned into aquaculture ponds and subsequently abandoned. More recently, it has been found that the income level of family members has gone down substantially due to various problems associated with intensive aquaculture. Because of these problems many people have become jobless. People from different parts of the Chilika region started migrating to the cities due to lack of any other job opportunity. Therefore, seaweed cultivation and processing was examined as an alternate source of livelihood. During the investigations, a strain of *Gracilaria verrucosa* was isolated which produces high quality agar. Various methods of culture and cultivation of *G. verrucosa* were investigated as well as the culture of *Paenus monodon*. It has been found that seaweed cultivation is slowly gaining acceptance among various communities, although this industry provides a lower return. Thus we have initiated large-scale cultivation of *G. verrucosa* at different locations with community participation. A model has been developed and successfully implemented in and around Chilika Lake where a person can earn $80-90 per month through seaweeds cultivation. A large number of NGOs and villagers have developed keen interests in this programme.

PICES XIV S7-2493 Oral
Use of ecosystem models for study and management of coastal estuarine ecosystems in Korea

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An ecosystem model was developed to describe the estuarine plankton of western coastal systems in Korea. The model is composed of 12 state variables including picophytoplankton, nanophytoplankton, microphytoplankton, heterotrophic bacteria, protozoa, microzooplankton, mesozooplankton, POC, DOC and nutrients such as ammonium, nitrite+nitrate, orthophosphate. Allometric relationships and density-dependent feedback control terms were used and forcing variables such as solar radiation and water temperature was included in the model. The ecosystem model was developed in Fortran using differential mass balance equations that were solved numerically using the fourth-order Runge-Kutta (explicit) technique. The model was calibrated by adjusting the parameters that were not identified from literature. After calibrating the ecosystem model, forcing and state variables were validated using historical data and field data collected from 2001 to 2004. Comparison of model predictions and field data for the principal forcing variables and state variables of primary producers showed generally good agreement. Using the validated model, environmental factors controlling the phytoplankton dynamics and responses of the plankton to the environmental changes were investigated.

PICES XIV S7-2280 Poster
On some ways of preservation of local fish populations

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In modern times, the cost of fishery production is increasing, but so are the costs of preservation and restoration of local fish populations with low abundance. That is why the development of economical biotechnology and equipment becomes more and more important now. At the Ichthyology Department of Moscow State University, some methods of fish growth control and modular equipment for fish farming have been developed. By manipulating such powerful factors as temperature and salinity, for instance, gives many possibilities to optimize traditional technologies and to construct new technologies to stimulate growth and development processes, with the aim to get high-quality fish fry. The equipment provides a possibility to regulate ambient conditions. Modules could be produced and equipped at work, delivered by any type of transport, installed and adjusted to start usage within several days. Using a principle of modularity, it is possible to quickly establish inexpensive fish farms for cultivation of different freshwater or marine fishes. Considering biodiversity preservation principles, these modular mini-enterprises will help to save the genetic structure of populations and the gene pool of rear species of fish and support the intra-specific biodiversity of commercially important fishes.

Selenium content in marine organisms from the Russian coast of the Sea of Japan

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Selenium content was analyzed in 10 species of algae and sea grasses, 18 species of molluscs, three species of echinoderms and 14 species of fish from the coastal zone of Primorye, the Sea of Japan. The determination of selenium fluorescence method conducted on analyzer of the liquids "Flyuorat-02-3M" ("Lyumeks", Russia). Primary colour filter UFS-2 (the wavelength = 366 nm); secondary colour filterZHS-17 (the wavelength to fluorescences F = 520 nm). The Reagent - 2,3-diaminonaphtaline. Selenium concentration in the common species of sea algae and sea grasses does not exceed 0.8 μg/g dry weight. The maximum content was revealed in *Sargassum (S. myabei)* – 1.06 μg Se/g. The analysis of selenium accumulation in organs of shellfish has shown that selenium concentration was higher in shellfish than in algae and sea grasses, and reaches 10.8 μg /g in the gills of *Mercenaria stimpsoni*. On average, this value was within the range of concentration 2-3 μg/g in muscle and 4-6 μg/g in hepatopancreas and gills. Selenium concentration was determined in three species of *Echinodermata*. The average level of selenium corresponds to its level in shellfish. Selenium concentration in fish caught in Sivuchiey Bay and Posyet Bay varied in the range 1-6 mkg/g. The maximum amount of the selenium, 6.2 mkg/g, was discovered in the liver of herring, *Clupea pallasi*, and the minimum, 1.1 μg /g, in the muscle of striped plaice, *Pleuronectes pinnifasciatus*. Results have shown that Primorye seaside is a selenium-deficient province. The average content of selenium in organs of investigated species is sufficiently low. Seafood is considered as an important source of necessary micronutrients in the daily human diet. So, it is necessary to develop the technology of marine organisms cultivation in selenium-rich environment.

Increasing sea urchin settlement productivity using various forms of melioration

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As sea urchin stocks are reduced by exploitation in all places, alternative measures are required to provide the market as well as to support its natural populations. Evidently, in order to preserve and maintain many sea urchin populations in good condition it is necessary to conduct various meliorative actions. A scheme for such actions has been worked out in FSUE at "TINRO-centre". It involves: transplantation of juvenile and mature animals from sites lacking macroalgae to sites with abundant kelp where gray sea urchins are intensively fished; making near-bottom substrate for kelp cultivation for sea urchins additional feeding; collection of juveniles at artificial collectors; settling of natural and artificially cultivated juveniles at specially prepared sites for growing up to commercial size. Transplantation of juvenile and mature sea urchins to sites with abundant kelp and as well as their additional feeding using artificially cultured kelps make possible to improve marketable quality of gonads and to increase sea urchins reproduction. These actions will maintain high productivity of traditional fishing sites and increase the quantity and biomass of gray sea urchins at sites with unfavorable conditions for its reproduction and growth.

Principle of ecologically environmental capacity and its application to planning and management of coastal aquaculture in China

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China's aquaculture production exceeds its fish capture landings. Fisheries (aquaculture) were playing an important role in food supply and became one of the most vital support industries and economic activities in rural development during the past 20 years. Expansion of coastal aquaculture and sea-farming stimulated a rapid increase in production, and also created much rural employment. The goal is to increase aquaculture to improve the welfare of farmers and develop the rural economy. However, an urgent problem is the adverse

environmental impacts accompanying the accelerated development of the industry. This article offers a new viewpoint to illustrate coastal aquaculture planning and management. Based on a division of different functional areas, the concept and principle of ecologically environmental capacity (EEC) are applied to guide the industry in aquaculture area. EEC is an integrated concept: within a special area, biological production of unit water bodies does not jeopardize environment, keep relative ecosystem stabilization, maximize economical benefit, accord with qualification of sustainable development, and attain maximum yield. EEC expresses that biological totality increases under environment conditions available, does not disturb the coastal environment, does develop sustainable biology production industry which is the long-range aim and standard of aquaculture development. Concerning polluted environments (aquaculture reduced) in coastal China, restoration is needed using "aquaculture does remedy aquaculture" as our guideline. According to the principle of environmental ecology, the pollutants from animal production will be transferred or recycled by food chains, *e.g.* adding costly plants to animal production system, both animal and plant benefit from each other. This can develop an ecological production model.

PICES XIV   S7-2297   Oral
Proposal of site selection guidelines for fish farming in Japanese coastal waters

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Environmental deterioration around fish farms has been widespread in Japanese coastal areas. A lot of effort has been paid to improve farm environments and various kinds of measures have been proposed. However, only a few measures have been put to use. The most practical way for environmental management of fish farms is to locate fish farms within the range of assimilative capacity and to control the stocking density of cultured fish. In this context, we proposed two indices for site selection guidelines. An 'ED' (Embayment Degree) index is calculated from the distance from the mouth of a bay to a fish-farm site, the width of a bay, the water depth of a site and the maximum depth at the bay mouth. Another index, 'ISL' (Index of Suitable Location) is calculated from the water depth and current velocity under a fish cage. Current velocities can be estimated using plaster balls easily and simultaneously at many stations. Biotic and abiotic factors at the fish farms were found to change along gradients of fish production and ED or ISL, suggesting that these indices are effective for estimating the assimilative capacity. ED can be used as a simple indicator for the site selection. ISL can be of a wider application to assess the assimilative capacity under a variety of topography.

PICES XIV   S7-2212   Oral
A first exploration on differential impacts of bivalve mollusc on the two phytoplankton groups, diatom and dinoflagellate

Xuelei **Zhang**, M.Y. Zhu, L.H. Zhang and D. Zhang

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Last year, we reported on preferential control by cultured bivalve molluscs on dinoflagellate biomass during field surveys in a coastal bayment where diatoms and dinoflagellates were dominant phytoplankton. Here we present novel findings from indoor controlled experiments on differential impacts of the scallop, *Chlamys farreri*, on the diatom, *Skeletonema costatum*, and the dinoflagellate, *Prorocentrum* sp. Feeding experiments indicated that *Prorocentrum* sp. was more efficiently grazed from the algal mixture by the scallops than *S. costatum*, regardless of the changes of algal cell density density ($0.5\text{-}20 \times 10^6$ cell/L) and changes of species contribution to the algal mixture (*Prorocentrum* sp. to *S. costatum* cell number ratio 1:8 - 8:1). Digestion efficiency for the ingested algal cells was high (>99%) and was similar for both algal species at a feeding rate up to 5 mm^3 d^{-1} ind.$^{-1}$, but decreased slightly (to 96%) at a feeding rate of 5-15 mm^3 d^{-1} ind.$^{-1}$. Concentrations of nutrients (dissolved inorganic nitrogen, phosphate and silicate) were higher in scallop-occupied seawater than in natural seawater. When inoculated together in scallop-occupied seawater, *S. costatum* outcompeted *Prorocentrum* sp. both in quantity and growth rate. These results indicate that scallops preferentially feed on *Prorocentrum* sp. compared to *S. costatum*, and decrease the competitive capacity of *Prorocentrum* sp. in scallop-occupied seawater. These effects might contribute to the preferential control by cultured bivalve molluscs on dinoflagellate biomass in the field.

S8
MEQ/FIS Topic Session
Ecosystem indicators and models

Co-Convenors: Glen Jamieson (Canada), Xian-Shi Jin (China), Patricia Livingston (U.S.A.), Tokio Wada (Japan), Vladimir I. Radchenko (Russia) and Chang-Ik Zhang (Korea)

Ecosystem-based management (EBM) of resources will require ways to monitor current conditions and predict future states. Ecosystem indicators are single variables that reflect the status of broad suites of management activities or environmental conditions, and their assessment is key to monitoring the achievement of EBM. Predictive ecosystem models can be used to hypothesize the responses of an ecosystem to management actions, to assess the sensitivities of indicators, and to highlight gaps in current knowledge. This session will bring experts together to identify criteria for suitable indicators and the utilities of predictive models, and to present candidates of indicators and models that are actively in use in PICES areas.

Thursday, October 6, 2005   08:30-17:00

08:30-08:40 **Introduction by Convenors**

08:40-09:40 **Elizabeth A. Fulton, Michael Fuller and Anthony D.M. Smith** (Invited)
Management strategy evaluation and indicators for ecosystem-based fisheries management (S8-2573)

09:40-10:00 **Gordon H. Kruse, Patricia A. Livingston and Glen S. Jamieson**
Evolution of ecosystem-based fishery management (S8-2614)

10:00-10:20 **Coffee Break**

10:20-10:40 **Sang Cheol Yoon and Chang Ik Zhang**
A comprehensive ecosystem-based approach to management of fisheries resources in Korea (S8-2354)

10:40-11:00 **Xianshi Jin**
Restocking changed ecosystem of the Yellow Sea and Bohai Sea (S8-2494)

11:00-11:20 **James E. Overland, J. Boldt, J. Grebmeier, J. Helle, P.J. Stabeno and M. Wang**
Multiple indicators track major ecosystem shifts in the Bering Sea (S8-2588)

11:20-11:40 **Michio J. Kishi, Ippo Nakajima and Yasuko Kamezawa**
Fish growth comparisons around Japan using NEMURO.FISH (S8-2262)

11:40-12:00 **Vladimir I. Zvalinsky**
Ecosystem parameters and stability: Theoretical considerations (S8-2576)

12:00-12:20 **Eleuterio Yáñez, Samuel Hormazabal, Claudio Silva, Aldo Montecinos, Alejandra Ordenes and Luis Cubillos**
Ecosystem indicators and integrated conceptual model: Fisheries managements perspective in the South-East Pacific (S8-2433)

12:20-14:00 **Lunch**

14:00-14:20 **Glen Jamieson and Cathryn Clarke**
Identification of ecologically and biologically significant areas in Pacific Canada (S8-2430)

14:20-14:40 **Chuan-Lin Huo, Geng-Chen Han, Ju-Ying Wang and Dao-Ming Guan**
EROD as bioindicator for monitoring of marine contaminants along the Dalian coast (S8-2252)

14:40-15:00 **Sun-Kil Lee, Jae Bong Lee, Chang-Ik Zhang and Dong Woo Lee**
Comparisons in ecosystem effects of fishing in Korean waters (S8-2350)

15:00-15:20 **Zhenyong Wang, Hao Wei and Zuowei Zhang**
Application of modified NEMURO Model to Jiaozhou Bay (S8-2377)

15:20-15:40 **Thomas C. Wainwright, James J. Ruzicka and William T. Peterson**
A biological production index for the northern California Current (S8-2598)

15:40-16:00 **Jie Li, Zengmao Wu and Xiaofang Wan**
Modelling study of the new production and the microbial food loop impact in the Yellow Sea Cold Water Mass (S8-2215)

16:00-16:20 **Coffee Break**

16:20-16:40 **Chris J. Harvey, Isaac C. Kaplan, Emily J. Brand, Elizabeth A. Fulton, Anthony D.M. Smith, Albert J. Hermann, M. Elizabeth Clarke and Phillip S. Levin**
A spatially-explicit ecosystem model to examine the effects of fisheries management alternatives in the California Current (S8-2499)

16:40-17:00 **Summary by Convenors**

Posters

Young-Min Choi, Kwang-Ho Choi, Yeong-Seop Kim, Jung Hwa Choi and Jong-Bin Kim
Ecosystem structure and fisheries resources status in the southern part of Korean waters (S8-2402)

German Novomodny, Igor Khovansky, Tatiana Ebergardt and Anastassia Mednikova
Main human threats to water ecosystems and commercial ichthyofauna of Russian Far East (Khabarovsk Territory) (S8-2218)

Jae Bong Lee, Chang-Ik Zhang and Dong Woo Lee
Ecosystem indicators for the recruitment of pelagic fish around Korean waters (S8-2347)

PICES XIV   S8-2402   Poster

Ecosystem structure and fisheries resources status in the southern part of Korean waters

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We investigated the ecosystem structure of the southern part of Korean waters, using Ecopath and Ecosim software, to evaluate interactions between biomass and food web in 2004 (spring and autumn). The food web was based on the stomach content of dominant species. Ecopath input parameters describe the 32 groups according to morphological feature, habitat and food web. Biomass was calculated to apply the ecosystem model with each level density. A total of 202 species occurred in spring and 113 species occurred in autumn, respectively. Species composition of catch data showed fish 58.6%, cephalopoda 6.0%, and crustacea 35.4% among the total. Euphausiacea occupied more than half of total stomach occurrence.

PICES XIV   S8-2573   Invited

Management strategy evaluation and indicators for ecosystem-based fisheries management

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Large numbers of indicators have been proposed for describing that state of marine ecosystems and detecting the impacts of human activities (such as fisheries) on such systems. Recently simulation testing and empirical (field-data based) applications have shown that there is a short list of indicators that could be used as the seed for ecosystem-based management. The list includes such things as relative biomass (or biomass ratios) of key groups, proportional habitat cover, simple diversity indices, size and trophic spectra, maximum (or mean) length of the catch (across species), size at maturity of key species types and physical system characteristics that define the system context. While this list is a mix of single value and two-dimensional indicators all are simple indices that require little processing post-collection and all consistently provide strong signals regarding system state and dynamics. Moreover, they are relatively easy to calculate, interpret, and generalise (across systems and through time); and are robust to noise, data gaps and assumptions. These features mean that it is feasible to imagine a system of robust ecosystem-based fisheries management that included indicators as a key advisory component. Key aspects of such a management scheme will also be discussed here.

PICES XIV   S8-2499   Oral

A spatially-explicit ecosystem model to examine the effects of fisheries management alternatives in the California Current

Chris J. **Harvey**[1], Isaac C. Kaplan[1], Emily J. Brand[1], Elizabeth A. Fulton[2], Anthony D.M. Smith[2], Albert J. Hermann[3], M. Elizabeth Clarke[1] and Phillip S. Levin[1]

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Fisheries managers off the west coast of the US increasingly must balance tradeoffs between complicated management issues. They also must build management plans that account for the dynamic oceanography and productivity of the region. Management tools such as spatial closures or climate-triggered fishing policies could address these issues, but a modeling framework is needed to test such potential policies. To address this need, we built an ecosystem model of the California Current System, extending from the US/Canada Border to Point Conception, California, and out to the 1200-m isobath. The model structure (Atlantis) includes the trophic dynamics of 44 functional groups in the food web, using nitrogen as a common currency between groups. Functional groups include habitat-forming species like kelp, cold-water corals and sponges, as well as vertebrates, cephalopods, benthos, zooplankton, phytoplankton, and detritus. The model is divided into 62 spatial zones, each with seven depth layers. This allows us to explicitly test hypotheses regarding migrations, movement behavior, and spatial management options such as marine protected areas. The model is forced with hydrodynamic flows, salinity, and temperature outputs from a high-resolution ROMS oceanographic model, allowing us to test the impacts that changes in upwelling or coastal currents have on nutrients and primary productivity. Separate

sub-modules simulate the dynamics of 29 fishing fleets, as well as fisheries data collection, assessment, and management decisions. Model outputs reproduce observed time series of primary productivity and the abundance of commercial groundfish stocks and other species sampled in trawl surveys.

PICES XIV   S8-2252   Oral
EROD as bioindicator for monitoring of marine contaminants along the Dalian coast

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There have been many efforts to find suitable biological parameters for pollution monitoring programmes in the past 20 to 30 years. The monooxygenase (MO)-activity of fish has been shown to be useful as an 'early warning' system for environmental contamination caused by polycyclic aromatic hydrocarbons (PAH), polychlorinated dibenzodioxins (PCDD) and certain polychlorobiphenyl (PCB). Ethoxyresorufin-O-deethylase (EROD) is one of the model reactions of the cytochrome P-450-1A1 mediated monooxygenase system. In this paper, EROD activity, measured by kinetics fluorescence spectrophotometry, was selected as an indicator of PAHs and PCBs effects in benthic fishes. EROD induction in fish liver exposed to organic contamination demonstrated the ability of this technique to be an available and efficient marker of exposure to specific pollutants. After it was determined that there existed a dose/effect relationship between EROD activities and specific pollutant concentrations, an initial assessment of biological effects on the fish *Hexagrammos otakii* was carried out in well-chosen stations of the coasts along Dalian. It was proved feasible that EROD activity could be used to assess specific contamination through combination with other analysis data of PCBs. It has to be noted that factors that have effect on EROD activities in organisms are various. Therefore, a regular biological effects monitoring had been carried out for three years along Changhai area of Dalian by measurement of EROD activities in fish, to find out the feasibility of studying such parameters in the field. The optimal conditions for analysis of EROD activity were further discussed. Moreover, a much faster and simpler method for the hepatic EROD activities measurement of fish, using a fluorescence plate-reader, is introduced, studied and discussed in this paper.

PICES XIV   S8-2430   Oral
Identification of ecologically and biologically significant areas in Pacific Canada

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As part of its national Oceans program, Canada is in the process of assessing ecologically and biologically significant areas (EBSAs) so that effective marine conservation can be achieved. EBSAs are identified as those areas worthy of enhanced management action, and are expected to be areas where monitoring of ecosystem health indicators will be focused. Criteria for EBSA identification in Canada include consideration of the spatial extent of species aggregation(s); the presence of and relative abundance of unique species, ecosystem features, and non-indigenous species; the relative importance of areas in determining the reproductive and survival fitness of individuals and populations; and the resilience of populations or ecosystems features to human impacts. While there is presently a noticeable lack of coincidence between EBSAs and current mpas, it is expected that identification of EBSAs will lead to establishment of priority areas in the development of a regional marine protected area network.

PICES XIV   S8-2494   Oral
Restocking changed ecosystem of the Yellow Sea and Bohai Sea

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At present, many commercially high-valued, large-sized species have been depleted or replaced by low-valued, small-sized species in the Yellow Sea and Bohai Sea. Changes in species composition have been observed in the Yellow Sea, Bohai Sea. The ecosystem indicators varied with time and with different trophic levels. In the Yellow Sea ecosystem, anchovy (*Engraulis japonicus*) might be an indicator species. It has been the most abundant stock

and major prey for most piscivorous fish in the Yellow Sea for the last two decades and stock variations may affect ecosystem structure. At a lower trophic level, *Euphausia pacifica* and *Calanus sinicus*, are important food to many species. The diet variations of major predators may indicate the changes in food availability of the ecosystem. However, the decline of many traditionally important species indicates a need for restocking. Many methods have been used to rebuild such depleted stocks, including different fisheries management measures, such as input and output control of fishing wild stocks, closed area and season, minimum landing size and mesh size, *etc.*, and enhancement by releasing, transplanting and mariculture of introduced species, *etc*. Restocking of depleted fishes need more input by both manpower and financing, and ecosystem based management is required.

PICES XIV   S8-2218   Poster
Main human threats to water ecosystems and commercial ichthyofauna of Russian Far East (Khabarovsk Territory)

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Sustainable status of ecosystems is needed for the productivity and long-term exploitation of ecosystems. Human activities produce ecosystem changes with great economic deprivation. Changes of natural and climate factors are mainly gradual and can be forecast. Anthropogenic effects are mostly drastic, spontaneous and hard to estimate their damage. Productivity of ecosystems can suffer from different pollutants (industrial and domestic sewerage, mining and cutting, introduction of exotic species, genetic pollution of native populations) and from the inadvisable management of ecosystems and unequal distribution of fishing efforts.

Pollution of ecosystems has focused public attention, but resource management is not considered enough. The glaring example of the underexploitation influence on Far East marine ecosystem is the cessation of marine mammals catch in the early of 1990's leading to negative consequences. The presently abundant pinnipeds and white whale are serious competitors with humans, consuming such valuable commercial species as salmon. In addition, now resources of coastal waters are very poorly exploited.

Exploitation of freshwater biological resources is adversely effected by the ecological pollution of rivers and lakes (for example, "phenolic" problem of the Amur River) and also by poaching preventing from conservation and restoration of commercial species (for example, sturgeons on the Amur River).   In winter when the self-purification of the Amur River is low, the pollution of waters by different substances results in changes of fish meat quality, weakening of immunity, and low food base for fry that effects the fish productivity of the Amur River.

Poaching is one of the main ecosystem impacts. People believe that administrative and prohibitive measures are not effective to resolve this problem but there is an international experience of such methods (for example, CITES). Economic measures against poaching are gradually developing.

PICES XIV   S8-2262   Oral
Fish growth comparisons around Japan using NEMURO.FISH

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NEMURO.FISH is a lower trophic level model of nutrients and zooplankton coupled with a bioenergetics model of fish consumption and growth. It has previously been applied to saury and herring. We applied the same kind of bioenergetics model, coupled with NEMURO, to common squid and chum salmon. Model squid and chum salmon migrate from spawning areas to nursery areas and graze on zooplankton, the concentration of which was calculated by 3-D NEMURO. The results show good agreement with body weights of fish/squid, and can explain the role of temperature and food density on their growth.

PICES XIV   S8-2614   Oral
Evolution of ecosystem-based fishery management

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Worldwide declines in marine fisheries have prompted calls for a paradigm shift from single-species management to ecosystem approaches to fisheries. Despite garnering much attention in the media and scientific conferences, confusion persists among many fishery scientists, managers, and public about terminology, as well as practical implications. Ecosystem-based management is set into the evolutionary context of traditional single-species management approaches by tracing the history of recent international fishery agreements, such as the FAO Code of Conduct for Responsible Fisheries and the Precautionary Principle and Precautionary Approach. The view is advanced that ecosystem-based management is a process, not an endpoint. An important feature of ecosystem-based management is an open public regulatory process that explicitly solicits and respects active involvement of diverse participants with different perspectives, including fishery and other marine scientists, resource economists, fishery managers, enforcement officials, all segments of the fishing industry, environmental representatives, residents of coastal communities, and other stakeholders. Identification and formal adoption of ecosystem-based management objectives are also important. For practical reasons, the unwieldy complexity of real-world ecosystems has prompted the development of models to examine ecosystem dynamics. Model outputs, combined with a multitude of other ecosystem considerations, are now being used to identify numerically and spatially appropriate ecosystem indicators for monitoring with available resources. The examples of the Alaska framework for evaluating ecosystem impacts of fishing using indicators and models and the Canadian process for moving from broad conceptual to specific operational EBM objectives will be summarized.

PICES XIV   S8-2347   Poster
Ecosystem indicators for the recruitment of pelagic fish around Korean waters

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Stocks of pelagic fish species showed long-term variability during the four decades around Korean marine ecosystems, owing to fishing impacts and changes in their environments. In this study, environmental effects were investigated to develop ecosystem indicators for the recruitment of major pelagic fish around Korean waters. Based on the hypothesis of advection-based recruitment, successful recruitment of pelagic fish species were dependent on the abundance and distribution of spawning biomass in the previous year, food availability and temperature in the major habitat of the pelagic fish around Korean marine ecosystems. Using a sequential data processing technique, a regime shift, or discontinuity, was tested in ocean environmental time series relative to the catch, recruitment and biomass at age of major pelagic species for 1968-2004. Based on the regime shift years, generalized additive models (GAM) were developed to explore relationships between recruitment, spawning biomass and environmental variables in the major habitat area of pelagic fish around Korean marine ecosystems. Surface current transportation, zooplankton biomass and temperature were selected as candidates of ecosystem indicators for pelagic fish species, such as jack mackerel, around Korean marine ecosystems.

PICES XIV   S8-2350   Oral
Comparisons in ecosystem effects of fishing in Korean waters

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To investigate characteristics of Korean fisheries resources, and to compare effects of fisheries on marine ecosystems in Korean waters, a self-organizing mapping technique was applied to classify groups with 86 marine species in Korean waters, based on six ecological variables. Trophic levels of catches in three marine ecosystems,

i.e., the East/Japan Sea (EJS), Yellow Sea (YS), and East China Sea (ECS) were estimated, and the structure and composition of species groups for the ecosystems were analyzed. The piscivorous demersal fishes at high trophic levels decreased, whereas planktivorous pelagic fishes and crustaceans at low trophic levels increased in all the ecosystems. When fishing intensities in terms of F/Z ratio and fishing mortality (F) were compared by the ANOVA test, no significant differences were found among the decadal F/Z ratios, and among the ratios and Fs in the three ecosystems during the three decades (P>0.05). However, when we assessed whether Korean fisheries were balanced in ecological terms as a function of annual catches and mean trophic levels, the decadal means of FIB ("Fishery is balanced") index in the YS ecosystem decreased from -0.02 in the 1970's to -0.43 in the 2000's (P<0.001). The decadal means of the index declined from 0.14 to -0.03 in the EJS ecosystem, and from 0.01 to -0.01 in the ECS ecosystem during the same periods (P<0.001). There were also significant differences of FIB indices in three ecosystems during the four decades in Korean waters (P<0.001). Therefore, fishing activity incorporating ecological terms such as trophic level was a good indicator to assess the effects of fisheries on Korean marine ecosystems.

PICES XIV   *S8-2215*   *Oral*
Modelling study of the new production and the microbial food loop impact in the Yellow Sea Cold Water Mass

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The Yellow Sea Cold Water Mass (YSCWM), as an important oceanic phenomenon in the marginal sea of China, is always an interesting issue in the study of this region, and the research achievements of the bioactive elements have been acquired in recent years (Diao *et al.*, 1985; Wang, 2000). It is verified that the YSCWM brings significant influence to the geochemical and biological processes in the Yellow Sea. The YSCWM begins to appear in April, reaches its maximum in May or June, and disappears at November or December. During the period of its existence, the seasonal thermocline hampers the upwards nutrients translation from bottom layer (Wang, 2000).

A coupled pelagic-benthic three-box model was developed by Wan *et al.* (2003b) based on the Jiaozhou Bay model (Wu *et al.*, 2001), and is applied to study the ecosystem of the YSCWM, and includes the important impact of the microbial loop and nutrient effects from both atmospheric deposition and sediment ecudation. Initialized by the *in situ* dataset from the project of "*Ecosystem Dynamics and Sustainable Utilization of Living Resources in the East Sea and the Yellow Sea*", the model simulates the seasonal variability of the vertical structure of the ecosystem of the YSCWM. The investigation "*Ecosystem Dynamics and Sustainable Utilization of Living Resources in the East Sea and the Yellow Sea*" covers most of the region in the Yellow Sea and East China Sea. Seven cruises are carried out in June, November 2000 and January, April, May, June, July 2001, respectively. The simulation region is from 34.2ºN to 36.6ºN in the south-north direction, 121.6ºE to 124.4ºE in the west-east direction and the mean depth is about 69m, with all together 11 observation stations included. The model is run from June 16, 2000 to June 15, 2001 initialized by in situ observations on June 16, 2000. Due to limitation of available data, part of the initial values such as Bbac, Det, Btin and Btip are obtained by diagnostic method according to the observed pelagic and benthic data in the East China Sea (Song, 1997), the northern of South China Sea (Liu *et al.*, 2000) and Ebenhoh *et al.* (1995).

The modeling results estimate that the annual production in the YSCWM is 83.2 gC m^{-2} yr^{-1} and annual mean daily production is 228.47 mgC m^{-2} d^{-1}. Zhu *et al.* (1993) estimated the mean primary production ranged from 200 to 500 mgC m^{-2} d^{-1} in most area of the Yellow Sea, and the annual mean value is 425 mgC m^{-2} d^{-1}. By the comparison between the results of Zhu *et al.* (1993) and our simulated results, it is concluded that the primary production in the YSCWM is low and the annual mean production is also lower than the mean value in the whole Yellow Sea.

The phytoplankton production sustained by N comes from river, atmosphere and bottom ecudation, *etc.* and is called new production and the other sustained by regeneration N is called regeneration production. In this paper, the new N for the YSCWM is considered to come from two sources: the atmospheric deposition and sediment ecudation. Based on analysis of the inorganic nitrogen sources, it is concluded by our model system that the *f* ratio, the percentage of new production to total primary production, is 33.0%, the simulated annual total new production is 27.4 gC m^{-2} yr^{-1} in the YSCWM, and belongs to the lower value in the coastal sea. Yang *et al.* (1999) found that the regeneration production occupied more than 60% of the primary production from the investigation in the

Yellow Sea, which means that the *f* ratio is no more than 40% in the Yellow Sea. Tian *et al.* (2003) also found that the *f* ratio is about 30% in the Yellow Sea by using a three-dimensional pelagic ecosystem dynamic model. The ratio of phytoplankton biomass to zooplankton biomass ranges from 0.36 to 1.53 calculated by using *in situ* observation data. So a conclusion can be drawn that the microbial food loop plays an important role in the zooplankton growth in the YSCWM.

The analysis of simulated microbial loop shows the influence of annual variation. During the spring bloom, there is more phytoplankton in the upper water layer and the contribution of microbial loop to zooplankton growth just accounts for 20 percent. The contribution of the microbial loop in the whole water volume is 40.43% in spring and increases with the decrease of primary production in summer and autumn. In these two seasons, an interesting phenomenon emerges that the impact of the microbial loop in the middle water layer is a little lower than in the upper water layer, which is in good agreement with the observation that a chlorophyll *a* maximum emerges in subsurface layer (20~30m) during the same period (Xia *et al.* 2001; Wang *et al.* 2002). The winter primary production maintains a low level even with rich nutrients in upper water layer, and the impact of microbial loop is higher relatively in the whole layer during the same time.

The modeling quantitative analysis indicates that the annual mean contribution of the microbial loop to zooplankton growth in the whole YSCWM water volume is 60.4%, which is similar to that in Taiwan Strait (Huang *et al.*, 2002). This result addresses the crucial role of the microbial loop in the cycle of the ecosystem energy and matter in the YSCWM, especially in autumn and bottom layer. But the ratio of the zooplankton biomass to primary production stays at an abnormally high value in the YSCWM most of the year. Although the effect of the microbial loop on the growth of zooplankton is very important, it is difficult to explain the high ratio. This problem will be studied in future work.

PICES XIV   S8-2598   Oral
A biological production index for the northern California Current

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Predicting effects of changing ocean climate on living marine resources can improve resource management. Here, we consider the predictability of zooplankton production in the Northern California Current as an index of food supply for juvenile salmon and other pelagic fishes. Our approach uses a simple NPZ-type biological production model coupled to a simple model of wind-driven upwelling and mixing to reconstruct biological production for seven years with observed nutrients, phytoplankton, and zooplankton. Key parameters were adjusted to provide a "best fit" to the observations. The model was then used to hindcast production for years without plankton observations, resulting in a longer index of seasonal zooplankton production. This index shows promise as an indicator of food supply for juvenile salmon, although its utility in resource management has not yet been evaluated.

PICES XIV   S8-2588   Oral
Multiple indicators track major ecosystem shifts in the Bering Sea

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Observations over the previous five years show persistent warm and ice-free conditions in the southeastern Bering Sea compared to the mid-1990s, despite large variability in climate indices. These conditions follow a major climate transformation around 1977 accompanied by a major reorganization of the marine ecosystem. Over the last decade annual fisheries surveys in the south indicate a continued decline in recruitment to cold water stocks such as Greenland turbot and snow crab. However, walleye pollock is characterized by a large, rather stable population. We find multiple indicators since the mid-1990s that the sea-ice driven, benthic-dominated, shelf ecosystem of the northern Bering Sea is giving way to a more pelagic subarctic ecosystem as well. There is decreased benthic productivity south-southwest of St. Lawrence Island, northward expansion of the foraging

range of gray whales, and Yupik observations of changes in behavior of walrus in response to changes in sea-ice cover. There is a substantial increase in pelagic fish species in recent years, *i.e.* juvenile pollock and pink and chum salmon. Although a large shift to cold climate conditions is a possibility due to large climate variability in high latitudes, that the Bering Sea is part of larger climate changes in the Arctic and that it is difficult to remove the heat already gained by the ocean in recent years from diminished sea ice areas, supports the continuation of the trend toward subarctic ecosystems in the Bering Sea, with profound impacts on marine mammals, and commercial and subsistence fisheries.

PICES XIV   *S8-2377*   *Oral*
Application of modified NEMURO Model to Jiaozhou Bay

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Anthropogenic activities and oscillation in climatic conditions have important impacts on marginal sea ecosystems. Jiaozhou Bay is a semi-enclosed bay at the westside of the Yellow Sea and is strongly influenced by human activities. Knowledge of its nutrient composition, biological structure, and evolvement mechanism is needed urgently for marine ecosystem based management (EBM). Ecosystem modeling is scientific and effective method to deal with them.

NEMURO Model is a simple but mature ecosystem model which is designed and promoted by North Pacific Marine Science Organization (PICES). Eleven nutrients and plankton variables, except for phosphorous, are considered in this box model. The Jiaozhou Bay ecosystem is reported to be controlled mainly by phosphorous and silicate, so a Modified NEMURO Model was designed and applied in our work.

Modeling results and analysis show that: 1. Total Phytoplankton Biomass (TPB) has an obvious annual cycle with one summer peak. The TPB maintains at a stable low level (0.3~0.4 µmolN/L) during the whole January and February until March when it goes higher, and then peaks at 2.65 µmolN/L in mid June. The TPB goes down after June until it returns to the same stable low level the next January. 2. Silicate concentration in deep layer (Tsio3d) and half saturation constant of it (Ksi) are of much importance in this ecosystem compared with those of nitrate. TPB is more sensitive to those of silicate according to sensitivity analysis. What is interesting, the concentration of silicate in the deep layer is crucial to the composition of phytoplankton. The ratio of small phytoplankton (PS) to large phytoplankton (PL) becomes less than 1.0/1.0 when Tno3d is reduced by 20%, while it becomes higher when Tsio3d is raised. That means there may be a trend of community succession from PL-domain to PS -domain when concentration of silicate decreases, just as it is observed in Jiaozhou Bay. 3. The cycle of phosphorous is our innovation in this work. HPO4, DOP and POP were added as new variables. The results show that consideration of phosphorous limits primary production of PS and effects the composition of phytoplankton. Further research on verifying the biological process parameters regarding phosphorous is needed.

PICES XIV   *S8-2433*   *Oral*
Ecosystem indicators and integrated conceptual model: Fisheries managements perspective in the South-East Pacific

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The Chile-Peru Eastern Boundary ecosystem is one of the most productive systems of the planet. This richness takes place mainly by coastal upwelling induced by winds blowing predominantly towards the Equator and by advection towards the Pole of nutrient-rich water. In this ecosystem, El Niño events are the most important in determining interannual variability. Nevertheless, after the El Niño of 1972-73, a regime shift was observed, and associated with it was a clear decrease in the anchovy fishery after the mid 80's. From the mid 70's, a remarkable increase of sardine landings and in lesser quantity of jack mackerel and horse mackerel landings was observed. A second regime shift was observed after 1985, associated mainly with anchovy recovery and sardine decrease.

We developed an integrated conceptual model of different local and large scale phenomena that affects the marine environment and the distribution and abundance of the main pelagic resources of northern Chile. This model is

based on the analyses at different scales of environmental, biological and fishery data. The model describes the inter-decadal (associated with regime shifts) and interannual (associated with El Niño events) fluctuations in the Equatorial Pacific Ocean, South-East Pacific and northern Chile spatial scales, and the effects in the annual cycle, planetary waves dynamics and coastal upwelling. In this framework, the interdecadal fluctuations play an important role in the sequence of alternating anchovy-sardine-anchovy regimes. An identification and development of ecosystem indicators and proxies is also proposed, in order to support the fisheries management decision making process.

PICES XIV   S8-2354   *Oral*
A comprehensive ecosystem-based approach to management of fisheries resources in Korea

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Most fish stocks in Korean waters are known to be overexploited, and some stocks have been depleted due to the increase in fishing intensity and over-capitalization of fishing fleet. In addition coastal fishing grounds have deteriorated due to coastal pollution and land reclamation in Korea. Traditional management tools in Korea fisheries are mostly indirect control devices, such as mesh size restriction, minimum size of fish limits, closed areas/seasons, boat licenses, and gear limitation. After extending its fisheries jurisdiction in 1994, a TAC-based management system has been adopted for a few selected fish stocks. A number of difficulties are associated with the practical management by indirect control devices and by the TAC-based management system. The biological and economic effects of these management approaches have not been verified yet. The necessity of the ecosystem-based management considering habitat, environment, and ecological interactions of species is recently stressed worldwide. In this study, a comprehensive ecosystem-based integrated management program is developed to accomplish sustainable exploitation and efficient management of fisheries resources at the ecosystem level in Korea. The program has three management systems: 1) the offshore large ecosystem management system, 2) the inshore self-regulatory ecosystem management system, and 3) the marine ranching ecosystem management system. We suggest specific management plans that include detailed management objectives and associated indicators and reference points for the three management systems, based on the geographical and ecological characteristics of each management system considering the current state of fisheries management in Korea.

PICES XIV   S8-2576   *Oral*
Ecosystem parameters and stability: Theoretical considerations

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An earlier developed approach to modelling of biological processes and ecological systems has established that any ecosystem may be described by equations using three types of dimensionless parameters: relative concentration of limiting element, the generalized kinetic parameter (relative resistance) of any trophic link and substance flux (relative rates of processes) between various ecosystem components. This approach reveals ecosystem-level parameters or indicators. Such parameters are: the maximal rate of photosynthetic production and the general contents of limiting element in all ecosystem components. The ecosystem parameters (but not the parameters of actually trophic links) also are substrate constants (analogues of Michaelis constant) and relative resistance of trophic ecosystem links.

The analysis shows that stability of an ecosystem is defined by a ratio of the total concentration of limiting element and its substrate constants for different trophic links. The ecosystem stability is less than the difference in rates of processes (relaxation times) of various trophic links. It is also established that the choice of the function describing the dependence of process rate of a trophic link on substrate (food) concentration essentially influences on ecosystem stability and relaxation time of a system to a steady state.

S9
MEQ Topic Session
Ecological effects of offshore oil and gas development and oil spills

Co-sponsored by the Northwest Pacific Action Plan (NOWPAP) of UNEP

Co-Convenors: Tatiana Belan (Russia) and Kazuichi Hayakawa (Japan)

In recent years, offshore oil and gas production expanded to new areas of the world ocean. Unfortunately, oil and gas exploration and extraction can be associated with negative ecological consequences. For example, seismic surveys may interfere with commercial fishing, installation of platforms disturb habitats of marine fish and invertebrates, and the discharge of drilling muds introduce a number of contaminants into the surrounding waters. Oil spills associated with offshore operations or with tanker accidents also threaten the marine environment. Recent spills have demonstrated vulnerability of coastal communities. Oil slicks at sea can kill or otherwise adversely affect marine birds and mammals, zooplankton, as well as the eggs and larvae of fish and invertebrates. The goal of this session is to bring together marine scientists working on these issues and to discuss what steps can be taken to minimize adverse ecological effects of offshore oil and gas production.

Wednesday, October 5, 2005   08:30-13:00

08:30-09:00	**Chang-Gu <u>Kang</u>, Seong-Gil Kang and Jeong-Hwan Oh** (Invited) Oil spills - Risk, preparedness and response in the Northwest Pacific (S9-2245)
09:00-09:20	**Kazuichi <u>Hayakawa</u>, Maki Nomura, Takuya Nakagawa, Seiji Oguri, Takuya Kawanishi, Akira Toriba and Ryoichi Kizu** Study on damage and recovery of coastlines for three years after the Nakhodka oil spill (S9-2300)
09:20-09:40	**Valentina V. Andreeva, Tatyana V. Konovalova, Paul G. <u>Mowatt</u> and Olga V. Samoilyuk** Review of monitoring results in the area of Moliqpak platform (north-eastern shelf of Sakhalin) (S9-2271)
09:40-10:00	**Review by A.V. <u>Moshchenko</u> based on the following abstracts:** **Tatyana V. Konovalova, Alexander V. Moshchenko, Tatyana A. Belan and Nadezhda K. Khristoforova** Alterations of biotopical conditions and variations of benthos distribution near Molikpaq platform (North-East Sakhalin Island shelf) (S9-2250) **Alexander V. Moshchenko, Tatyana V. Konovalova and Nadezhda K. Khristoforova** Changes of granulometric composition of bottom sediments near Molikpaq platform (North-East Sakhalin Island shelf) (S9-2260) **Evgeniyi V. Karasev, Tatyana S. Lishavskaya, Tatyana. A. Belan, Alexander V. Tkalin, Alexander V. Moshchenko and Anastasia S. Chernova** Ecological investigations on the Sakhalin Island shelf, including Molikpaq platform monitoring: A review of FERHRI studies (S9-2294) **Tatyana V. Konovalova, Alexander V. Moshchenko, Tatyana S. Lishavskaya and Nadezhda K. Khristoforova** Interrelation of the contents of petroleum hydrocarbons, metals and granulometric composition of sediments near Molikpaq platform (North-East Sakhalin Island shelf) (S9- 2253)
10:00-10:20	**Coffee Break**

10:20-10:40	**Takuya Kawanishi, Masayuki Kunugi and Kazuichi Hayakawa** Monitoring chemical substances in surface sea water in North Pacific Area (S9-2552)

10:40-11:00   **Review by G. Moyseychenko based on the following abstracts:**

                Galina Borisenko and Galina Moyseychenko
The quantification of natural radioactive background levels of radioactivity in offshore bottom sediments of northeastern part of Sakhalin Island (S9-2437)

                Inna Nemirovskaya, Galina Moyseychenko and Yury Blinov
Concentrations and compositions of aliphatic and polycyclic hydrocarbons in bottom sediments off Sakhalin Island (S9-2388)

11:00-11:20   **Valentin I. Sergienko, Valeriy I. Petukhov, Irina G. Lisitskaya and Igor A. Vagenik**
Geo-chemical monitoring of oil and gas complex at Sakhalin shelf (S9-2548)

11:20-11:40   **Xuelei Zhang, R.J. Wu, Z.H. Zhang and Z.F. Dong**
Benzene toxicity to the scallop, *Chlamys farreri*, and the shrimp, *Penaeus japonicus* (S9-2211)

11:40-12:00   **Galina Moyseychenko and Alla Ogorodnikova**
Possible influence of accidental oil spills on the Far Eastern Sea shelf biota (S9-2379)

12:00-12:20   **Svetlana V. Davydova and Sergey A. Cherkashin**
Ichthyoplankton as an indicator of the state of coastal ecosystems in the areas of oil and gas deposits on Sakhalin shelf (S9-2287)

12:20-12:40   **Alexander Bogdanovsky, John Wardrop, Igor Kochergin, Sergei Pokrashenko, Igor Arshinov and Sergey Rybalko**
Progress in oil spill risk assessment for Sakhalin shelf conditions (S9-2620)

12:40-13:00   **Discussion**

Posters

Valentin L. Andreev and Valeriy I. Petukhov
Informational system for "Marine ecological monitoring" (S9-2558)

Andrey P. Chernyaev
Petroleum hydrocarbon pollution of Ussuriyskiy Bay (Japan Sea) in 2003 – 2004 (S9-2469)

Sam Geun Lee and Eun Seob Cho
Effects of oils and chemical dispersants on the growth of the phytoplankton, *Cochlodinium polykrikoides* (S9-2569)

Olga N. Lukyanova, Andrey P. Chernyaev, Sergey A. Cherkashin and Svetlana A. Aleshko
The distribution of petroleum hydrocarbons and biota assessment in Amursky Bay (Japan Sea) (S9-2237)

Galina Moyseychenko and Alla Ogorodnikova
The assessment of acoustic measurements' impact upon animal plankton of far eastern seas (S9-2538)

Oleg V. Kusailo, Yuri Y. Nikonov and Gennady A. Kantakov
Determining bottom sediments distribution by hydroacoustic monitoring (S9-2511)

Valeriy I. Petukhov, Irina G. Lisitskaya and Alexandra V. Romanchenko
Research of the composition of petroleum products to identify petroleum contamination (S9-2557)

Sergey Rybalko, Igor Kochergin, Victor Putov and Tatyana Belan
Complex environmental impact assessment within marine seismic surveys (S9-2619)

PICES XIV   S9-2558   Poster
Informational system for "Marine ecological monitoring"

Valentin L. **Andreev** and Valeriy I. Petukhov

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Obtaining essential, true and up-to-date data is the key to making accurate decisions in our "information age". The obligatory stage of processing and analysis of the information lies between the stages of obtaining the data and ultimately making decisions. The Informational System (IS) under discussion is based on the theses stated above. It is intended for data reliability check, as well as for the analysis with the use of traditional and non-traditional (heuristic) methods. It has functionality which is a feature of the DBMS (data base management software): data does not depend on the processing programs, data is stored safely, access to data is centralized and sanctioned, duplication and inconsistence of data is excluded. IS contains a customizable interrogator system; the interface is user-friendly, it helps to actualize the data, *etc*. This work has a goal to bring into focus the fact that systems of independent files (which by no means are provided with these features) are still used in the existing processing of marine expeditionary data. A peculiar feature of IS is the support of COM technology, which makes it possible to apply the power of models of spatial data (discrete and continuous) that are used in well-known geo-informational systems. The spatial component is important in hydro-biological research, as well as in granulometric, chemical and hydrological research. Some subsystems of IS can be used as automatization servers. The other peculiarity of IS is that it includes mathematical methods for simultaneous processing of all data, independent of their nature and type. It can increase the effectiveness of monitoring because in this case, the decisions are made not concerning each separate factor (biological, chemical *etc.*), but according to synergy effect – in combined accounting to all data obtained to date.

PICES XIV   S9-2620   Oral
Progress in oil spill risk assessment for Sakhalin shelf conditions

Alexander **Bogdanovsky**[1], John Wardrop[2], Igor Kochergin[1], Sergei Pokrashenko[2], Igor Arshinov[1] and Sergey Rybalko[1]

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The complex study of oil spill risk and stochastic oil spill simulation allows estimates of potential environmental hazards that should be taken into account when deciding upon safe allocation of oil processing facilities and planning oil spill response measures. This technology has been developed based on VOS 4.0/REA model and applied to estimate oil spill risks for various Sakhalin shelf oil and gas exploration projects. This technology takes into account availability of sensitive shoreline (mouths of lagoons and rivers) and offshore (grey whale feeding areas and marine mammal gathering sites) areas. Statistical oil simulations that accommodate variable seasonal hydrometeorological conditions allows the determination of a comparative hazard index for different project options and deciding upon the most reasonable allocation of hazardous facilities and/or the most efficient oil spill response measures. Study results cover southern Sakhalin including probabilities of Sakhalin and Hokkaido Islands shoreline pollution. For the northeastern Sakhalin shelf it has been shown how oil spill risks and modeling have been used in research for choosing environmentally sound offshore pipeline routes. The study also describes application of oil simulation results in oil spill response planning.

PICES XIV   S9-2437   Oral
The quantification of natural radioactive background levels of radioactivity in offshore bottom sediments of northeastern part of Sakhalin Island

Galina **Borisenko** and Galina Moyseychenko

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The aim of our work was the estimation of natural radioactivity of bottom sediments that is defined with natural radioactivity (NRN) of uranium and thorium series and K^{40}. The investigation was conducted in areas with gas and oil deposits, where the drilling operations had started during the *Sakhalin-2* project. The reason for the investigation was the initiation of the drilling process. The analysis of the data received showed that the average content of Ra_{226} and Th_{232} in bottom sediments, that consist of fine-grained sands, was $7.9 \pm 3,3$ and 5.6 ± 3.0

Bk/kg respectively. An admixture of ooze increased the activity of NRN by 1.5-2 times and reached 11.3±4.0 Bk/kg for both radionuclides. The content of K^{40} varied from 470 ± 90 Bk/kg for sand up to 650 ± 120 Bk/kg for mixture of mud and sand. The comparison of this data with that of background studies that were conducted before the initiation of oil and gas development, showed that the level of NRN in bottom sediments associated with the *Sakhalin-2* project remained on the same level as in 1997. Thus the gas and oil development has not had a negative influence on the radiation situation in the area to date.

PICES XIV   S9-2469   Poster
Petroleum hydrocarbon pollution of Ussuriyskiy Bay (Japan Sea) in 2003 – 2004

Andrey P. **Chernyaev**

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Development of the oil and gas industry in the Russian Far East has had a negative influence on the state of marine ecosystems. It is connected not only with direct mining, but also with transportation of oil and products associated with its processing. There is a tendency toward increasing concentrations of petroleum hydrocarbons (PH) in Ussuriysky Bay water (up to 70 μg/l) for last decade. PH determination in sea water and sediments was carried out by IR-spectroscopy. In the autumn of 2003, high heterogeneity in the distribution of PH in seawater was observed. The lowest concentration was observed in the inner part of the bay (65 μg/l) and the highest levels in Sukhodol Bay (1120 μg/l). The presence of high PH concentrations in some areas, for example, near Cape Telyakovskogo (120 μg/l), is possibly explained by the local input. PH concentrations in the sediments of this area were low – about 90 mg/kg. However, in Sukhodol Bay, high PH concentrations have been found out in sediments (1230 mg/kg) as well as the seawater, that testifies to chronically pollution here. In the autumn of 2004, the situation did not change. The average PH concentration in seawater in inner part of Ussuriysky Bay was 77 μg/l, in the central part - 53 μg/l, and in the area of Cape Telyakovskogo - 108 μg/l. The highest concentration (248 μg/l) was found out in the area of salt barriers where there is a sharp change of physical and chemical properties of seawater.

PICES XIV   S9-2287   Oral
Ichthyoplankton as an indicator of the state of coastal ecosystems in the areas of oil and gas deposits on Sakhalin shelf

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The state of ichthyoplankton on the eastern Sakhalin Island shelf was investigated in summer 2002. Eggs of walleye pollock *Theragra chalcogramma* and yellow-fin sole *Limanda aspera* were selected as bioindicators for estimation of coastal ecosystem quality because the eggs of these species were characterized as widely distribution and having a high number in samples. The minimum number of normally developing eggs of pollock and yellow-fin sole was observed over the oil and gas deposits in coastal zone of the northeastern Sakhalin shelf. The coincidence of stations (83%) with a high proportion of the dead eggs of both species testifies on similar unfavorable influence of environmental factors on the embryogenesis in deposits areas. The share of normally developing eggs caught in these areas was 2.8% for pollock and 3.7% for flounder whereas on the average these values for the whole surveyed region were about 10 times higher (29 and 30.2% accordingly). Evidently, pollutants acting together with other environmental changes caused the observed eggs mortality.

PICES XIV   S9-2300   Oral
Study on damage and recovery of coastlines for three years after the Nakhodka oil spill

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The damage and recovery of the Japanese coastline from Suzu, Ishikawa Prefecture to Mikuni, Fukui Prefecture was investigated visually over three years after a C-heavy oil spill from the Russian tanker "Nakhodka" in the

Sea of Japan on January 2, 1997. The beached C-heavy oil tended to remain for a long time on coasts of bedrock and boulder/cobble/pebble but it was removed rapidly from coasts of gravel/sand and man-made structures. On the coasts of the latter type, wave energy appeared to be the main force for removing the oil. One year after the spill, C-heavy oil tended to remain strongly on the sheltered coasts of bedrock and boulder/cobble/pebble. Even on the coasts of this type, the contamination was remarkably removed by 2 years after the oil spill. The concentration levels of polycyclic aromatic hydrocarbons (PAHs) in oil lumps, sand and seawater were monitored over 3 years after the oil spill. The concentrations of PAHs having 2 or 3 rings decreased more quickly than did those of PAHs having 4 or more rings, suggesting volatilization as the main factor for the decrease. On the other hand, the concentrations of PAHs having 4 to 6 rings did not start to decrease until 7 months after the spill. The main factor for the decrease seemed to be photolysis. The concentration of benzo[a]pyrene (BaP) in seawater off the polluted coasts was high 1 month after the spill and then decreased. Three years after the spill, the level fell to the sub ng/L level, which was as low as those in seawater at unpolluted clean coasts in Japan. The concentration of BaP in greenling was higher than the normal level only during the first 2 months after the spill. These results suggest that the coastlines in Ishikawa and Fukui Prefectures that were polluted with C-heavy oil recovered in 3 years.

PICES XIV   S9-2245   Invited
Oil spills - Risk, preparedness and response in the Northwest Pacific

Chang-Gu **Kang**, Seong-Gil Kang and Jeong-Hwan Oh

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In today's world, oil spills are a major environmental problem. In total, millions of tonnes of oil have been spilled into the world's oceans, resulting in enormous impacts on fisheries, wildlife and their habitats, coastal industries and tourism, and even on political and social aspects, etc. The sea area of the far-eastern Asian countries was regarded as the area facing the highest risk of oil spill in the world. In fact, 16 major oil spills (greater than 1,000 tons), 115 intermediate spills (50 ~ 1,000 tons), and innumerable small spills (less than 50 tons) have been occurred in the area from 1990-2002. The four countries bordering the Northwest Pacific have developed effective measures for regional cooperation in marine pollution preparedness and response within the framework of the Northwest Pacific Action Plan (NOWPAP), agreed in 1994 by the governments of China, Japan, R. Korea and Russia. They have developed the NOWPAP Regional Oil Spill Contingency Plan and its Memorandum of Understanding, which will be a firm foundation in our strong partnership among NOWPAP Members in the relevant field. The present paper also introduces current activities of MERRAC as a new regional initiative on marine pollution preparedness and response in the NOWPAP region, together with analysis of oil spill risk in the region and regional preparedness and response system to oil spill.

PICES XIV   S9-2294   Oral
Ecological investigations on the Sakhalin Island shelf, including Molikpaq platform monitoring: A review of FERHRI studies

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Complex ecological investigations on the Sakhalin Island shelf were expanded at the end of the last century. In the 1990s, experts of FERHRI executed a number of expeditions at the Piltun-Astokh and Lunskoe oil and gas fields. The monitoring studies of the Molikpaq platform (Piltun-Astokh field) in 1998-2003, and the investigations along the prospective lines of underwater pipeline and at some other regions of the Sakhalin-2 project infrastructure development in 2001 were made. Background characteristics of the granulometric composition of bottom sediments, of the contents and distributions of various classes of contaminants in sea water and sediments (petroleum, alkanes, and polycyclic aromatic hydrocarbons, metals, phenols, detergents), of the status of pelagic and benthic communities, and also of birds and sea mammals were obtained. Results of the monitoring studies at Piltun-Astokh field showed the absence of significant influence of the oil and gas extraction works on the ecosystem of this area.

Monitoring chemical substances in surface sea water in North Pacific Area

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Pollutants are brought to sea from various paths: atmospheric deposition, discharge from rivers, and ships. Various substances such as heavy metals, nutrients, organic chemicals including PAHs, POPs, oil spillage, are considered to be threats to marine environment. The sea is the final sink of anthropogenic and natural pollutants and thus monitoring of surface seawater is essential for the preservation of the marine environment. We are developing a seawater monitoring system using commercial and scientific vessels. Concentrating sampling systems, together with several automated sensors were loaded onto vessels and chemical substances and water quality data were collected during the voyages. Poly-urethane and activated carbon fiber (ACF) adsorbents were used as the concentrating media for chemical substances. About 200 litters of seawater was pumped and brought to the adsorbents at a constant flow rate. Concentrating media was frozen at minus 20 degrees centigrade, brought to laboratory, and then chemical substances were extracted by the Soxlet method and served for chemical analysis. It turned out that this system for useful for monitoring organic substances including POPs. In this report, we will present some results of seasurface water monitoring and also a plan for investigation of concentration of organic chemicals in Northwest Pacific Region Sea.

Effects of oils and chemical dispersants on the growth of the phytoplankton,
Cochlodinium polykrikoides

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This study was conducted to understand the effects of oil spill accidents and the use of dispersants on the growth of *Cochlodinium polykrikoides*. Kuwait oil, United Arab Emirates oil, Bunker-C, kerosene and diesel oil, and two types of oil spill dispersants, Hi-Clean and Seagreen 805A were added with a series of 10 ppb to 300 ppm in the f/2-Si medium at 20 deg C under a photon flux from cool white fluorescent tubes of 100 μmol m^{-2} s^{-1} in a 14: 10 h L:D cycle for the culture of *C. polykrikoides*. In low concentrations of $\leq$1 ppm of examined oils no impact on the growth of *C. polykrikoides* was recorded, while in high concentration of $\geq$10 ppm cell density, it was significantly decreased with the range of 10 to 80% in comparison with the control. The growth of *C. polykrikoides* after the addition of the dispersants $\geq$10 ppm appeared to decrease by 70% in comparison with the control after 14 days, whereas the growth of *C. polykrikoides* exposed to $\leq$5,000 ppb showed little serious impact. The toxicity of a mixture of three types of oils and two types of dispersants appeared to have similar variations with dispersants. However, almost all the *C. polykrikoides* cells died regardless of types of dispersants and combined mixtures within a few days after the addition of high concentrations.

The distribution of petroleum hydrocarbons and biota assessment in Amursky Bay (Japan Sea)

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The distribution of petroleum hydrocarbon (PH) was determined in Amursky Bay (Japan Sea) near Vladivostok in summer, 2004. Samples of seawater and bottom sediments were collected at 45 stations. The total content of PH was analyzed with an IR spectrometer. Concentrations of PH in seawater varied from 0.03 to 0.92 mg dm^{-3}, and in bottom sediments – from 5.3 to 441 mg kg^{-1}. The areas with maximal and minimal levels of oil pollution were marked. There was no correlation between the total biomass of macrozoobenthos and the concentration of PH in bottom sediments, but biological effects were determined by the impact on organismal and molecular levels. The use of bioindicators has shown the influence of pollution by decreasing species numbers and also

displayed by changes in the population structure of mysids *(Crustacea).* The distribution and abundance of indicator species were the most informative indexes of coastal ecosystems. Activity of glutathione-S-transpherase (the key enzyme of biotransformation) was higher in mussels *Crenomytilus grayanus* in sites with increased PH level in bottom sediments. Glutathione concentration was higher in mussels from the sites with moderate levels of pollution and depressed in mollusks from the chronically polluted site. The results showed us that the ecological situation in the inner areas of Amursky Bay is unfavorable.

PICES XIV   S9-2250   *Oral*
Alterations of biotopical conditions and variations of benthos distribution near Molikpaq platform (North-East Sakhalin Island shelf)

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Effects of sediment grain size, petroleum hydrocarbons and metal contents in bottom sediments on composition and structure of benthos were investigated near Molikpaq platform from 1998-2001. Factor analysis showed that alterations of the fraction composition explain the notable part of the variations of benthos abundance and diversity characteristics. Increased species diversity and richness of benthos accompanied a decrease of sediment sorting and, accordingly, the growth of biotope diversity. Partial replacement of sediments after the platform installation, when gravel grounds were exchanged for sandy ones, resulted in a spatial re-distribution of the associations of benthic animals. Any negative effects of the contents of petroleum hydrocarbons and metals on the composition and abundance of benthic communities were not found.

PICES XIV   S9-2260   *Oral*
Changes of granulometric composition of bottom sediments near Molikpaq platform (North-East Sakhalin Island shelf)

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Grain-size composition of the sediments near Molikpaq oil-extracting platform (Piltun-Astokh field) was studied before and after its installation in 1998-2001. Application of factor analysis to the data obtained revealed two kinds of consequences of technology sediment replacement. First, the relatively short-term effects, which affected a significant part of the area and were expressed as the growth of the content of fine particle association (<0.25 mm). Evidence of these effects almost completely disappeared by October 1999, a year after the platform installation. Second, the longer-term local effects, basically within a 250-m radius of the platform, were reflected in a reduction of the area occupied by the psephitic particle association (>1 mm). Traces of these effects remained until September-October 2001. Only within 125 m from the platform were the consequences of sediment replacement not statistically significant. These two kinds of effects occurred against a background of high natural spatial and temporal variability in deposits almost over the whole area and were expressed, first of all, in variations of sand fraction content. On the whole, high hydro- and lithodynamics do not make conditions for contaminant accumulation.

Interrelation of the contents of petroleum hydrocarbons, metals and granulometric composition of sediments near Molikpaq platform (North-East Sakhalin Island shelf)

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The content of petroleum hydrocarbons (PHCs), metals, and grain-size composition of bottom sediments were studied near Molikpaq oil-extracting platform (Piltun-Astokh field) in 1998-2001. During the whole period of investigation, the concentrations of PHCs and trace metals in sediments of the study area were low and matched those of non-polluted areas of World Ocean. Application of factor analysis showed that PHCs and metals deposited in the area occurred from different sources. Factor analysis did not detect the accumulation of PHCs in the sediment fine particle association. As a whole during studied period, a stable decrease of average content of PHCs was observed. The total metals concentrations were 1.5-2 times below the minimum threshold concentrations causing negative biological effects.

Review of monitoring results in the area of Moliqpak platform (north-eastern shelf of Sakhalin)

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Sakhalin Energy has carried out annual monitoring of the marine environment and benthic communities since 1998 when the platform was installed. The programme includes the collection of water samples in close vicinity of the platform and sediment samples in the area of 3-5 km around the platform. Reference zone stations are located 10 km south of the platform. Industrial environmental monitoring revealed the changes in content and volume of waste waters.

A high level of hydrodynamic activity in this area results in water mixing and soil grading diversity, thus providing a low level of water layer and bottom sediment pollution. The research of 1998 – 2004 prove that all controllable features of soil and water (oil hydrocarbons, metals, phenols, synthetic surfactants, biological oxygen demand, nitrites, nitrates, ammonia nitrogen, phosphates, silicates, suspended matter) complied with background levels for the Sakhalin's northeastern shelf. Neither the environment nor the biota have proven to have clearly defined tendencies in variability caused by industrial impact, including variability of the plankton and benthic community features (season and annual variability, rearrangements of soils due to hydrodynamic activity in the platform area).

Concentrations and compositions of aliphatic and polycyclic hydrocarbons in bottom sediments off Sakhalin Island

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Concentrations and compositions of the aliphatic hydrocarbons (AHC) and polycyclic aromatic hydrocarbons (PAH) in surface sediments of the Sakhalin Island shelf were studied in 1994 and 2002. Higher AHC and PAH concentration found in offshore sediments in 2002, as compared with those in 1994, are most likely related to the different lithological types of analyzed sediments. The presence of transformed anthropogenic petroleum alkanes, which were not detected previously, implies the increased pollution related to the intensified economic activity in the area of the oil and gas development. The composition of hydrocarbons in bottom sediments reflects their differentiation during sedimentation, *i.e.*, sorption and biotransformation rather than genesis of

initial organic matter. Therefore, the composition of alkanes in bottom sediments and that of the spilled oil differ from each other. In conclusion, it should be noted that the lithological type of sediments and natural geochemical background of hydrocarbons (concentration of hydrocarbons and their composition) should be taken into consideration when interpreting data on oil pollution in bottom sediments. This is of principal importance when estimating the results of ecological monitoring in areas of marine oil and gas deposits where petroleum hydrocarbons of both natural and anthropogenic origin can occur.

PICES XIV   S9-2379   Oral
Possible influence of accidental oil spills on the Far Eastern Sea shelf biota

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Industrial activity intensification increases the probability of an accidental oil spill in the coastal area. Accidents happen mostly while vessels are approaching ports in sea shelf areas. Accidental spills affect the most productive marine areas, zones of active fisheries, hatcheries and recreation. Oil spills account for a total of 6% of all hydrocarbon intake, causing major damage to sea ecosystems. We examined accidental oil spill influence on biota in the littoral and sublittoral area. Oil products have a toxic influence on phytoplankton and animal plankton in pelagic layer. Emulsified oil causes ichthyoplankton and meroplankton mortality in the surface layer. Affected regions during coastal oil spills can spread up to 5.5 km of beach length and 10m wide. Oil spills coming in contact with the coastline have considerable negative influence on macrophytes at depths up to 10 m depth and more, and on slow-moving species living on bottom, algae, echinoderms, bivalves and other inhabitants. According to model estimates, damage to commercial bioresources from accidents in the littoral zone can exceed that in the pelagic zone of different seas by 100 times. Direct loss due to macrophyte mortality totals 99.4 % of the whole damage, and 0.14% due to commercial littoral benthos mortality. Indirect loss totals 0.18% of phytoplankton and animal plankton mortality, 5×10^{-5} % of ichthyoplankton mortality, and 0.24 % of food benthos.

PICES XIV   S9-2538   Poster
The assessment of acoustic measurements' impact upon animal plankton of far eastern seas

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The impact on marine organisms and ecosystems starts with the geological exploration of the sea bottom. It continues after discovering potential oil and gas geological structures with the further estimation of the quantity of the hydrocarbons they may contain. The assessments of damage to zooplankton from acoustic measurements took place in the Japan Sea offshore, in Peter the Great Bay, in the Samarginsky area, and on the Magadan offshore areas in the Okhotsk Sea. We used mathematical models to calculate the coefficient of death-rate for different groups of zooplankton, typical for the investigated area, within the range of the influence of the acoustic transducer. Our damage estimates used coefficients that were based on the attributes and quantitative characteristics of an ecosystem's functioning and productivity rate, determined from long-term complex studies. We also provide a specific analysis of the peculiarities of the impact upon biota in the Magadan offshore and Peter the Great Bay regions. The acoustic measurements are an necessary stage of oil and gas exploration in the sea, and thus it will be used in all parts of the Far Eastern offshore. Therefore, it is seen to be essential to have a sufficient assessment of the damage to the sea organisms.

PICES XIV   S9-2511   *Poster*
Determining bottom sediments distribution by hydroacoustic monitoring

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A new technology of determining bottom sediments distribution using a hydroacoustic method is presented. During 2003-2005, shellfish inhabitation and influence of dumping on the bottom sediments distribution were observed by QTC technology. The results demonstrate that it is an effective tool for monitoring, decision-making, and for research of the ecological effects of offshore oil and gas developments arising from ongoing and future projects off Sakhalin Island

PICES XIV   S9-2548   *Oral*
Geo-chemical monitoring of oil and gas complex at Sakhalin shelf

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Expeditionary surveys were carried out on the eastern part of Sakhalin shelf (in water areas of Piltun-Astokhskoye and Lunskoye oil fields) and in Aniva Bay onboard the R/V *Akademic M.A. Lavrentiev* in June-July 2003 and from the R/V *Professor Gagarinskiy* in June-July and October 2004. The surveys carried out as part of a program of ecological monitoring by "Sakhalin Energy Investment Company Ltd" with the goal to maintain an unbiased control over influence upon environment caused by construction and use of the objects of marine oil and gas complex. The level and character of anthropogenic influence upon marine environment was rated according to the results of the research of chemical composition of upper layer of marine bottom deposits, as bottom deposits are the final stage of migration of contaminants. The ecological condition of a water area was rated according to indices under control which are common indicators in assessment of anthropogenic influence upon the condition of marine environment. These indices characterize the basic processes of contamination and autoregulation of the hydro-ecosystem. Bottom deposit samples were analyzed for metal content, total petroleum, and polyaromatic hydrocarbons. A feature of the areas under study is the high heterogeneity of the distribution of physical-chemical characteristics of bottom deposits. That is why information obtained for each area under study and for each index under control was presented as statistical rating of a sequence of data which contained the results of chemical analyses. This approach makes it possible to compare the areas under study according to background characteristics and to reveal patterns of areal and temporal changes.

PICES XIV   S9-2557   *Poster*
Research of the composition of petroleum products to identify petroleum contamination

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Petroleum products which got into the marine environment near the town of Holmsk (Sakhalin Island) in September 2004 as a result of the wreck of the Belgian oil tanker Christopher Colombo are the objects of the research conducted. Samples of oil film taken at the wreck site were examined by the following methods: chromato-mass-spectrometry (GS-MS); isotope mass-spectrometry (IRMS); mass-spectrometry with induction-coupled plasma (ICP-MS); infrared Fourier-spectrometry (IRS). The IRS method was used for preliminary identification of petroleum products. Data which makes it possible to identify the origin of petroleum with a high level of reliability and determine petroleum contamination was obtained with mass-spectrometry methods. The whole body of the results obtained will allow determination of the initiator of contamination (connection or absence of connection of the tanker wreck to possible petroleum contamination) in disputable (arbitral) cases. It allows a well-defined expert conclusion in a wide range of climate conditions and in a long time interval after the incident. The experience gained by the surveys conducted showed that carrying out expert analysis at such a level is possible and that there is a necessity for serious work aimed at development and mastering of methods, and their certification.

Complex environmental impact assessment within marine seismic surveys

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One of the priorities of geological exploration of the oil and gas deposits is an estimation of the potential within the exploratory zone. There are two methods to obtain seismic data – two-dimensional and three-dimensional. A two-dimensional seismic survey is a simpler method that provides seismic data along survey transects. Two-dimensional surveys are mainly applied at the very beginning of subsoil exploration works. Three-dimensional seismic surveys registers the third dimension and produces seismic data by surfaces. The additional data provide a 3D chart of geological structures and ensures higher accuracy. Three-dimensional seismic surveys are characterized with higher densities of impulse points as compared to two-dimensional surveys, but the same energy level per impulse is used. Impulse sources have an adverse impact on the marine environment. We describe various seismic energy sources like dynamite, gas mixture, sparker, marine vibrator, and compressed air. We studied in detail the environmental impact that might be produced by the most widely used compressed air sources (airguns).

Benzene toxicity to the scallop, *Chlamys farreri*, and the shrimp, *Penaeus japonicus*

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Oil spills are a serious problem in world ocean shipping. Among the dissolved fractions of spilled petroleum and gasoline, benzene and its alkyl homologues that are collectedly referred to as BTEX, are most toxic to aquatic species. However, we lack information on BTEX's toxic effects on marine animals in particular. Here we present the results of a preliminary study on benzene's toxic effect on two marine invertebrates that are cultured widely in China: the scallop, *Chlamys farreri*, and the shrimp, *Penaeus japonicus*. The results indicated that benzene was more toxic to the shrimp than to the scallop. Benzene was lethal to the shrimp (body length 88.6±4.8 mm) only when administrated at doses above 20 mg/L and mortality occurred only within the first hour of the 24 hour exposure. Mortality of the shrimps was 40%, 70% and 100% to nominal concentration of benzene at 100 mg/L (dissolved 5.9 mg/L), 500 mg/L (dissolved 27.1 mg/L) and ≥1000 mg/L (dissolved ≥63.0 mg/L), respectively. Benzene was toxic to the scallops (shell height 30.4±1.7 mm) at nominal concentrations above 100 mg/L, but mortality (75%) occurred only in scallops exposed to 1000 mg/L nominal benzene concentration (dissolved <3.9 mg/L after 6 hr exposure) between 12 and 24 hr of exposure and all scallops died within 1 hr exposure to 2000 mg/L nominal concentration (dissolved 121.5 mg/L). The estimated 1-hr-LC50 of benzene was 13 and 40 mg/L for the shrimp *P. japonicus* and scallop *C. farreri*, respectively, and 24-hr-LC50 of benzene was 4 mg/L for the scallop, *C. farreri*. These values are lower than or similar to the predicted and empirical LC50 of benzene toxicity to marine organisms.

S10

TCODE Topic Session
Marine data management and delivery systems to support ecosystem monitoring

Co-Convenors: S. Allen Macklin, Bernard A. Megrey (U.S.A.) and Igor I. Shevchenko (Russia)

A stated objective of PICES is to provide data in exchangeable formats to better enable the evaluation of North Pacific ecosystems status and trends, and to support other strategic pursuits. PICES scientists face challenges in managing and delivering data in a shareable way. Furthermore, a growing number of ocean observing systems require data management and communication methodologies that conform to rigid standards and protocols. For the most part, traditional science education of the past century offered little training in data management. Today's typical scientist, although supportive of data exchange, lacks the background to understand techniques to facilitate it. This session will acquaint PICES scientists with state-of-the-art information about metadata description, data delivery and data browsing techniques, with emphasis on existing standards and web services recommended for ocean observing systems. Basic to advanced methods will be presented in a graduated format. Presenters and participants will describe and explore existing successful systems. Participants will learn ways to map existing data structures into conformant, exchangeable formats using no-cost, open-source applications.

Tuesday, October 4, 2005   14:00-18:10

14:00-14:30   **Anthony W. Isenor**   (Invited)
Data exchanges, XML, and why the exchange problem is still unsolved (S10-2426)

14:30-14:50   **Deng-Wen Xia**
Marine data exchange prototype based on XML (S10-2539)

14:50-15:10   **Dmitry. D. Kaplunenko, Vyacheslav B. Lobanov, Young Jae Ro and Mikhail Danchenkov**
Merging Argo data and ship CTD observations to study mesoscale patterns in the Japan/East Sea (S10-2477)

15:10-15:30   **Natalia I. Rudykh, Elena V. Dmitrieva and Vladimir I. Ponomarev**
Use of diverse database aggregation for the study of variability in oceanographic parameters of the Japan/East Sea (S10-2317)

15:30-15:50   **Shin-ichi Ito, Shigeho Kakehi, Motohiko Kashima, Yoshioki Oozeki and Kazuyuki Uehara**
A system development for near-realtime data exchange between ship and shore-based analysts in Japan's Fisheries Research Agency (FRA) (S10-2410)

15:50-16:10   **Benoît Pirenne and Robin Brown**
NEPTUNE and VENUS: Data management and archival system for cabled ocean observatories (S10-2622)

16:10-16:30   **Coffee Break**

16:30-16:50   **Kimberly Bahl, Hee Dong Jeong, Kyu Kui Jung, Hae Seok Kang, S. Allen Macklin and Bernard A. Megrey**
Federated metadata of PICES member nations: Information sharing across international boundaries (S10-2505)

16:50-17:10   **Alex Kozyr and Misha Krassovski**
The Mercury Metadata Search System and Web-Accessible Visualization and Extraction System (WAVES) for oceanographic data (S10-2561)

17:10-17:30	**Igor D. <u>Rostov</u>, Vladimir I. Rostov, Natalia I. Rudykh, Elena V. Dmitrieva and Alexander A. Pan**
	Oceanographic data base applications for the Far Eastern Region of Russia (S10-2286)

17:30-17:50	**Sei-Ichi <u>Saitoh</u>, Hidetada Kiyofuji, Daichi Tachikawa, Mihoko Abe, Kazuhiko Tateyama and Motoki Hiraki**
	Research and development of ubiquitous information services for integrated fisheries activities in the offshore around Japan (S10-2420)

17:50-18:10	**Anatoly I. Alexanin, Marina G. <u>Alexanina</u>, Pavel V. Babyak and Michail V. Kruglov**
	Problems of satellite data delivery and their solution by the FEB RAS Centre for Regional Satellite Environment Monitoring (S10-2525)

Posters

Stepan A. <u>Antushev</u>, Vitaliy K. Fischenko and Andrey V. Golik
About the scope of Grid technologies for support of complex oceanographic research in the northern Pacific (S10-2416)

Sergey A. Fedorov, Vitaliy K. Fischenko and Andrey V. <u>Golik</u>
Web-based technology of CTD data visualization in FEB RAS corporate oceanographic GIS (S10-2415)

Sergey M. <u>Krasnopeyev</u> and Alexander O. Teregulov
Metadata catalogue service based on the preliminary national standard (S10-2564)

Alexander A. <u>Pan</u> and Vladimir I. Rostov
Tools for the visualization of gridded oceanographic data (S10-2390)

Tomowo <u>Watanabe</u> and Yukimasa Ishida
Oceanographic data in the Japan Fisheries Oceanography DataBase (JFODB) (S10-2521)

PICES XIV   S10-2525   Oral

Problems of satellite data delivery and their solution by the FEB RAS Centre for Regional Satellite Environment Monitoring

Anatoly I. **Alexanin**, Marina G. Alexanina, Pavel V. Babyak and Michail V. Kruglov

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Delivery of satellite information (data and metadata) is actual and difficult problem. Decisions realized by Global Earth Observation Information Systems such as INFEO/EOPortal (ESA) and EOSDIS (NASA) provide a reasonable solution for terminal users. It is necessary to adopt existing software for integration in these systems and to generate data and metadata according to formats needed. It is also necessary to develop new methods for satellite data processing and to expand GIS technologies. FEB RAS Centre has abilities to receive and to process high-resolution data from polar-orbiting satellites NOAA, FY-1C, FY-1D, and SeaStar/SeaWiFS, as well as geostationary satellites FY-2B, FY-2C and MTSAT-1R, for satellite monitoring of ocean and atmosphere. The methods used permit realization of image navigation with sub-pixel accuracy, creation of time–spatially averaged sea surface temperature, and estimation of sea surface current velocity and sea surface temperature structures. The site was constructed *(*www.satellite.dvo.ru*)* for access to satellite data of the FEB RAS Centre. The user interface has been developed, as well as a request registration and user notification facility. The interface allows a remote user to make a request for satellite data processing. The interface has features both interactive and automatic access to metadata.

PICES XIV   S10-2416   Poster

About the scope of Grid technologies for support of complex oceanographic research in the northern Pacific

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During recent years, the world scientific community's interest to Grid technologies essentially has increased. Grid is a system that integrates and provides its users with common informational, computational, analytic and telecommunication resources. Today, there are successful applications of Grid technologies in some scientific disciplines – high-energy physics, biology, chemistry, bio-medicine. We should note that practically all Grid-projects are being developed using common standards proposed by the Grid community – OGSA (Open Grid Services Architecture). Grid standardization should ensure the possibility of subsequent integration of separate small projects into larger ones up to the project level of world-wide scientific Grid application. Taking into account these circumstances, we consider expedient deployment of the regional oceanographic Grid-project for the northern Pacific. Participants will get effective access to distributed oceanographic data, a wide spectrum of techniques for analytical processing and common computational resources. For this purpose, obviously, pre-created technologies for shared access to oceanographic data should be adapted to OGSA standards, and all subsequent development should be done according to these standards. In POI, FEB RAS started work on a prototype of the regional oceanographic Grid-project. It's based on a pre-existing corporate oceanographic GIS of FEB RAS. Development of the prototype is being done using the Globus Toolkit, which is recommended as a main tool for development of OGSA-compatible Grid projects. In particular, we've developed and are now testing technology providing remote access to distributed oceanographic resources of the FEB RAS corporate network and technology providing users with distributed computational resources of the network including supercomputers for execution of several difficult computing tasks.

NEPTUNE and VENUS: Data management and archival system for cabled ocean observatories

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NEPTUNE and VENUS are cabled ocean observatory projects in coastal (VENUS) and offshore (NEPTUNE) waters. These cabled observatories offer the capability for high bandwidth (100 Mb/s) bi-directional data transmission using the same fibre-optic cable technologies used in the commercial telecommunications industry. These observatories depend on advanced data managing and archiving systems that provide interfaces to a diverse set of instruments and their data. These systems must enable control of and collect data from instruments, store data securely, perform preliminary quality control, generate processed data products and deliver useful data to end users. To operate effectively within the growing community of ocean observatories, it is imperative that these systems conform to standards for ocean observing systems (*e.g.*, for data exchange, data cataloguing and web services) and support both expert and non-expert users.

Web-based technology of CTD data visualization in FEB RAS corporate oceanographic GIS

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Oceanographic GIS at the Far Eastern Branch of the Russian Academy of Sciences (FEB RAS) provides more than 30 kinds of oceanographic data pertaining to the northwestern Pacific. One of the most important kinds of data in GIS is CTD data. The CTD database now includes information from more than 1.6 million oceanographic stations. It is regularly updated with data from new FEB RAS marine expeditions and data from open oceanographic sources available through the internet, in particular, from sites of the NEAR-GOOS project (http://near-goos1.jodc.go.jp/) and the US National Oceanographic Data Center (http://www.nodc.noaa.gov/). The web-based technology that allows GIS users to select necessary CTD data and build visual images useful for data interpretation is described. The main advantage of this technique, in comparison with desktop visualization programs, for example, Ocean Data View, is that it makes possible simultaneous work by many users accessing a common data archive using a simple and intuitively understandable web interface. Another advantage of this technology *versus* other web-based visualization systems, for example, the well-known system Java OceanAtlas (http://odf.ucsd.edu/joa/jsindex.html), is that CTD data can be displayed and analyzed together with other kinds of oceanographic data, for example, with the climatic or satellite data in GIS. It expands the scientific possibilities for doing substantial interpretation of oceanographic information.   Though this visualization technology of CTD data is intended for scientists of FEB RAS now, potentially it can be used by other internet users.

Data exchanges, XML, and why the exchange problem is still unsolved

Anthony W. **Isenor**

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The exchange of data between systems continues to provide obstacles to many collaborative programs. The introduction of XML and efforts in metadata standardization, have helped with many issues. However, obtaining successful and unambiguous data exchange is still a difficult process. This presentation will explore exchange models, the role of XML and efforts underway to address current exchange problems.   The presentation will begin with descriptions of models that support combining data from multiple sources. A model supported by a data structure, as well as one supported by a full database, will be described. The marine community efforts thus far have involved data structures and as such, data structure examples will be given.

These will include the efforts of the ICES/IOC Study Group on XML (SGXML) development of the Keeley Bricks, Geography Markup Language (GML), and the efforts of the JCOMM Expert Team on Data Management Practices (ETDMP). The XML implementation of these data structures allows easy transfer, but this shifts the problem to an issue of 'data understanding' or semantics. Typical semantic problems include parameter code issues, units and metadata standards. Focusing on the parameter code issue, the Marine Metadata Interoperability (MMI) Project is attempting to provide interoperability between data terms by mapping and harmonizing parameter usage and parameter discovery vocabularies. This effort is utilizing Web Services to provide users with access to mapped vocabularies.

PICES XIV   S10-2410   Oral
A system development for near-realtime data exchange between ship and shore-based analysts in Japan's Fisheries Research Agency (FRA)

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In this decade, more than half of FRA's research vessels (R/Vs) are intranet equipped at a time when the internet system has changed the world with its utility. Despite FRA R/V's intranet capabilities, connections linking them to shore-based analysts have been limited because of low-speed and high-cost communications. A system to enable near-realtime and inexpensive data exchange between R/Vs and shore-based laboratories was developed. Now, PC-type servers on R/Vs 1) produce TESAC/BATHY messages from CTD (conductivity, temperature, depth sensor) data and send them to the Japan Meteorological Agency, 2) archive CTD data to the database (IBM-DB2), and 3) synchronize the database with a counterpart in an on-land server. The database synchronism is controlled by http protocol, and only the updated data are exchanged through high data compression. The data transfer is performed by IMMARSAT-B with HSD (High Speed Data Service), 64 kbps, communication. There are automated and manual modes for the database synchronism. For the automated mode with 8 hours interval synchronism, the cost for communication is less than 80 thousand yen per month. From the synchronized database, both the on-R/V and on-land server are able to provide temperature, temperature gradient, and temperature front maps on several depths through the web. This system will enable common data sharing, not only between R/V and land, but also between R/Vs. Therefore, this system enables efficient multi-ship surveys. Also, this system will help provide initial conditions for prediction models.

PICES XIV   S10-2477   Oral
Merging Argo data and ship CTD observations to study mesoscale patterns in the Japan/East Sea

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The growing activity in the development of the Global Ocean Observing System (GOOS) and its components Argo and GODAE is causing huge amounts of information on the state of the ocean-atmosphere system on global and regional scales. The rapidly growing Argo profiling float array is now the largest source of CTD profile data from the open ocean. Over the last 5 years (1999-2004), a large amount of profiling floats was released in the Japan/East Sea region under national and international programs, and the number of ship hydrographic observations has been essentially increased. Much hydrographic data became easily available through the internet under the NEAR-GOOS project. Thus, it becomes possible to use the Argo drifters data array for merging and augmentation of *in situ* observations obtained from specific and regular cruises in the mentioned region. Information from ship observations is available from various sources provided by different countries and agencies. Exploiting this information requires an adequate tool that allows users to acquire, merge and process available data.

The goal of this work is to show an example of such a tool for integrating information to study mesoscale features within the area of the Japan/East Sea. For this purpose, we use the Virtual Database (VDB) technology implemented through the World Wide Web network. Thus, we merge available hydrographic data obtained by ships and Argo drifters in the Japan/East Sea during 1999-2004. Obtained fields represent quite well the basin-scale and, in some cases, mesoscale features and allow tracing of the features' seasonal variability and evolution of mesoscale eddies structure. However, our implementation of VDB-technology has some limitations owing to the data exchange problems still remaining in the region, network conditions and principles of data storing at the national oceanographic data centers. In that regard, the future development of such system of merging information is the subject for discussion.

PICES XIV S10-2561 *Oral*
The Mercury Metadata Search System and Web-Accessible Visualization and Extraction System (WAVES) for oceanographic data

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Mercury (a.k.a. Beija-flor) is a Web-based system to search for metadata and retrieve associated data. Developed at Oak Ridge National Laboratory, Mercury incorporates a number of important features. Mercury invokes a new paradigm for managing dynamic distributed scientific data and metadata; puts control in the hands of investigators or other data providers; is inexpensive to implement; is implemented using Internet standards, including XML; supports international metadata standards, including FGDC; is compatible with Internet search engines; is based on COTS software, including Blue Angel Technologies' MetaStar® products and Hummingbird's Fulcrum SearchServer®; and adds value to the COTS software. Mercury is based on Internet standards; its core software works with these non-proprietary Internet standards. Mercury supports the following protocols and markup languages: HTTP (hypertext transfer protocol), Z39.50, FTP (file transfer protocol), HTML (hypertext markup language), and XML (extensible markup language).

WAVES is an Internet-based, data delivery mechanism that automates the process of delivering oceanographic data to the Carbon Dioxide Information Analysis Center (CDIAC) user community. The Web-Accessible Visualization System (WAVES) provides a system whereby users can view a graphical summary of data collection points (cruise paths), and *via* provided metadata viewing tools and graphing options, identify and download data sets of interest. WAVES automates the distribution of oceanographic data *via* the Internet by satisfying the following objectives. The web interface consists of a search function allowing the user to perform a sub-setting search by any combination of metadata parameters. WAVES provides users with a graphic depicting the world's oceans and all cruise paths, and it provides users with the ability to zoom on particular geographic extents containing selected data, cruises, or geographic areas of interest. It also provides users with a dynamic on-screen display of summary metadata elements associated with each sampling location along the zoomed geographic extent. The on-screen display will automatically be updated as the user moves her mouse over different points on the cruise path graphic. Summary metadata elements for underway measurements and discrete measurements are a subset of the full metadata. WAVES provides users with links from the full metadata to the data set containing the selected data point of interest. It contains a seamless, on-the-fly method for creating scatter plots, single station plots for property *versus* depth, and property versus property plots. In addition, the graph contents are available to save to an image file in .jpg, .gif, and .ps formats for use in other applications. Additionally, WAVES provides users with the ability to download the current data and metadata selection as ASCII, CSV, and NetCDF formatted files.

PICES XIV S10-2564 *Poster*
Metadata catalogue service based on the preliminary national standard

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Our ability to access, integrate and use spatial data from disparate sources (across jurisdictions) in guiding decision making is dependent on the implementation of Spatial Data Infrastructures (SDI). The key components of SDI are: geospatial data catalogues and geomatics standards (data exchange standards).

The Pacific Institute of Geography (Vladivostok, Russia) has completed implementation of Catalogue Service-Web with restricted capabilities. A client software for metadata creation is based on the Russian profile of ISO 19115 standard as designed. This software program is used to assist entry of information. Specifically, it checks the syntactical structure of the file; modifies the arrangement of information, and repeats this process until the syntactical structure is correct. Finally, it verifies that the information describes the subject data completely and correctly. Metadata are exchanged in Extensible Markup Language (XML).

PICES XIV   S10-2505   *Oral*
Federated metadata of PICES member nations: Information sharing across international boundaries

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PICES metadata federation will provide tools for multi-national sharing of information on marine ecosystems. The tools are based on the proven ANSI Z39.50-1995 (ISO 10163-1995) protocol for delivery and sharing of information in a common format. The Z39.50 protocol includes client and server software modules that establish a connection, pass a formatted query, return query results, and present identified documents to the client in one of several formats. Using XML-coded metadata (conforming to the Federal Geographic Data Committee standard) with easily obtained, no-cost, open-source iSite software, and a publicly accessible web server, any data center can join in a federated system. A good example of such a system is the National Spatial Data Infrastructure clearinghouse that presently has nearly 400 nodes. Ultimately, this PICES partnership will include all member countries (Canada, Peoples Republic of China, Indonesia, Japan, Republic of Korea, Russian Federation and the U.S.A.) that will share with the world the wealth of marine ecosystem information available from eastern Asia and western North America. In progress now is a proof-of-concept data sharing collaboration between the North Pacific Ecosystem Metadatabase and the metadata archives of the Korea Oceanographic Data Center; the project has also opened discussions with the Japan Oceanographic Data Center.

PICES XIV   S10-2390   *Poster*
Tools for the visualization of gridded oceanographic data

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Special software for different kinds of oceanographic data visualization has been created. It is used for development of new on-line products of POI data bases (DB) applications. The first versions of POI information products were created as static systems and electronic atlases. Evolution of information and development technologies (World Wide Web, programming languages and relational DB management systems) provide effective methods to develop tools for data processing in dynamic mode and data presentation in comfortable electronic format. These tools are web-based applications and released on PHP-technology with support of the DB management system MySQL. The tools allow users to query and to search data rationally, and to select different variables such as time and location. All of these actions can be executed in interactive mode within the Internet browser.

Oceanographic data base applications for the Far Eastern Region of Russia

Igor D. **Rostov**, Vladimir I. Rostov, Natalia I. Rudykh, Elena V. Dmitrieva and Alexander A. Pan

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For many years POI has provided development of technologies for the collection, accumulation, processing and long-time storage of data on the ocean environment to maintain POI studies in the western Pacific. With the help of the relational DB management system several problem-oriented oceanographic data bases have been created.   Using modern information technologies ensures the efficient creation of capacious electronic oceanographic information-reference systems, thematic data bases, atlases and their delivery to users through computer networks and on CD-ROM.

The several versions of POI information products on CD-ROM are partly presented on the site <http://www.pacificinfo.ru>. The most recent products are "Atlas of the hydrophysical characteristics of a region off the southeastern part of the Kamchatka Peninsula", "Guide to identifying marine mammal species of Pacific waters of Russia" and "Ice conditions of the Bering Sea".

The systems provide quick access to raw data, gridded data and information specially selected and stored on CD-ROMs, as well as to other on-line or general reference information disseminated among different sources.

Use of diverse database aggregation for the study of variability in oceanographic parameters of the Japan/East Sea

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Using diverse databases from multiple sources represents a powerful and synergistic approach for oceanographic study. However, data can be voluminous, and can be difficult to provide prompt access to various data groups. The basis of our approach is the idea of uniting all required data into a database of the relational type and with a unified system.

Here is a review of the information resources. There are multi-source oceanographic databases of temperature and salinity (MODB) for the Japan/East Sea from POI, daily sea surface temperature (SST) on a 15-min grid, daily data of some meteorological parameters from several coastal meteorological stations, and monthly SST on a 1-deg grid. Considered are technologies for projecting and realizing the automated oceanographic database. We present analysis of logical models for arranging the marine data and discuss their relational structure that allows adequate presentation of the initial data from all used sources.

Aggregated data bases allow study of a marine area using a united information field, making it easy to compare the very different data to reveal relationships or independent behavior of oceanographic parameters and forces in a region. Such concatenated databases enable analyses of variability of SST, thermohaline structure, and geostrophic currents in the Japan/East Sea, and meteorological characteristics over the sea and adjacent area. Large-scale oceanographic features are generally found in all datasets.

Research and development of ubiquitous information services for integrated fisheries activities in the offshore around Japan

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This paper presents an overview of a newly developed ubiquitous fisheries information system using satellite remote sensing and geographical information system (RS/GIS). The system was developed to aim for providing high value-added fisheries oceanographic information in anytime and at anywhere. We also made this system for a wide range of users, especially fishermen and managers in fisheries cooperation or fisheries experimental stations. This system consists of four subsystems; a MODIS (Moderate Resolution Imaging Spectroradiometer) receiving subsystem, a database subsystem, an analysis subsystem, and a GIS subsystem (WebGIS and onboard-GIS).   The MODIS system provides sea surface temperature, chlorophyll-a concentration and sea ice distribution. The database manages all products under Oracle software. The analysis subsystem produces level 1 to level 5 products, which include fishing ground forecasts of Japanese common squid, Pacific saury and Albacore tuna. These procedures run automatically, so that fishermen can receive information in near real time through communications satellites (maritime satellite internet services). The GIS subsystem contains two parts, one is WebGIS (ArcGIS) on land, and the other is GIS offshore using GEOBASE. All users can operate all products dynamically such as overlaying, measuring distance from the nearest port or fishing grounds on the GIS. This system can help to support effective fishing activities such as determining the quickest route to a fishing ground destination or the nearest landing port.

Oceanographic data in the Japan Fisheries Oceanography DataBase (JFODB)

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Fisheries research in Japan stands on a history of more than one hundred years. A large number of oceanographic and marine biological data were obtained and archived during this long history. Most of the data face many difficulties for preservation, as they were printed or handwritten on paper. The request for long-term data to support global warming research and marine-resources change research is getting strong year by year. Therefore, the plan for database construction for oceanographic and marine biological data was accelerated. By getting a three-year budget from the Japan Science and Technology Agency (JST), the National Research Institute of Fisheries Science (NRIFS) started the Japan Fisheries Oceanography DataBase (JFODB) project in the autumn of 2001. An organized suite of oceanographic observations by research institutions for fisheries science was initiated in the 1910s. About 70 repeated observation lines in the adjacent seas of Japan and about 100 coastal stations existed already before World War II. However, most of the data from these observations were not used effectively for a long time. In the project, we newly digitized oceanographic data for the period from the 1910s to the 1950s and merged them into the existing digital dataset for the period after the 1960s. Though we are still tackling some problems in order to complete the data set, the JFODB will provide useful data for investigation of long-term variability in oceanographic conditions of the western North Pacific in the near future.

Marine data exchange prototype based on XML

Deng-Wen **Xia**

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Argo floats are a kind of measuring device for the special purpose of building the global ocean observation net. In this paper, a prototype system for Argo data exchange is discussed. The system was designed based on XML technology, taking the internet as the data exchange platform and XML as the data medium. This system is a key technological development for marine data integration and exchange.

FIS Paper Session

Co-Convenors: Yukimasa Ishida (Japan) and Gordon H. Kruse (U.S.A.)

Papers on all aspects of fishery oceanography in the North Pacific and its marginal seas are invited.

Wednesday, October 5, 2005 14:00-18:00

14:00-14:20   **Gennady A. Kantakov and Sergey D. <u>Bukin</u>**   (Oral)
Oceanographical conditions changing and *Pandalus borealis* redistribution in the northern part Sea of Japan (FIS_Paper-2517)

14:20-14:40   **Yuri Yu. <u>Nikonov</u>, Andrey S. Krasnenko and Valeriy N. Chastikov**   (Oral)
Numerical analysis of the *Paralithodes brevipes* larvae migration in the Southern-Kurile strait's region (FIS_Paper-2305)

14:40-15:00   **John R. <u>Bower</u>**   (Oral)
Paralarval distribution patterns of the gonatid squid *Berryteuthis anonychus* in the North Pacific (FIS_Paper-2476)

15:00-15:20   **Yeong <u>Gong</u>**   (Oral)
Productivity of common squid, *Todarodes pacificus* in Korean waters and its adjacent regions (FIS_Paper-2591)

15:20-15:40   **Hyoung-Chul <u>Shin</u>, Don Hyug Kang and Yoon-Seon Yang**   (Oral)
Fate of the common squid population in Korean waters; a natural oceanographic experiment over various time scales (FIS_Paper-2495)

15:40-16:00   **Eun Jung <u>Kim</u>, Suam Kim, Dae-Yeon Moon and Jeong-Rack Koh**   (Oral)
The vertical and horizontal distribution of bigeye (*Thunnus obesus*) and yellowfin tuna (*Thunnus albacares*) related to ocean structure (FIS_Paper-2518)

16:00-16:20   **Coffee Break**

16:20-16:40   **Toshiyuki <u>Konishi</u>, Hidetada Kiyofuji and Sei-Ichi Saitoh**   (Oral)
Predictability of Pacific saury fishing grounds in the Northwestern North Pacific using satellite remote sensing data (FIS_Paper-2282)

16:40-17:00   **Oleg <u>Bulatov</u>**   (Oral)
The Bering Sea pollock and regime shifts (FIS_Paper-2272)

17:00-17:20   **Alexei M. Orlov and Andrei N. <u>Stroganov</u>**   (Oral)
Prerequisite of the study of Pacific cod population structure (FIS_Paper-2231)

17:20-17:40   **George <u>Shevchenko</u> and Olga Shershneva**   (Oral)
Monitoring of SST in the areas adjacent to the river mouths of Sakhalin applied to the problem of fry salmon release (FIS_Paper-2269)

17:40-18:00   **Hyunju <u>Seo</u>, Suam Kim, Sukyung Kang and Kibeik Seong**   (Oral)
A new estimation of salmon return rate and its use in environmental studies (FIS_Paper-2519)

14:00-14:20   **Vladimir A. Rakov, Valentina V. Goncharova and Yulia V. Zavertanova**   (Oral)
Monitoring of macrobenthos and larvae of fish at the Vrangel Bay (Sea of Japan) (FIS_Paper-2413)

14:20-14:40   **Hyejin Song, Gun Wook Baeck and Suam Kim**   (Oral)
Food and feeding of the common squid *Todarodes pacificus* (Cephalopoda: Ommastrephidae) off Busan, Korea (FIS_Paper-2355)

14:40-15:00   **Vadim F. Savinykh, Natalya S. Kosenok and Mikhail A. Zuev**   (Oral)
Distribution and feeding of Japanese flying squid in the subarctic boundary zone (FIS_Paper-2615)

15:00-15:20   **Hiroshi Kubota, Yoshioki Oozeki and Ryo Kimura**   (Oral)
Feeding ecology of larval and juvenile black snake mackerel (*Nealotus tripes*, Gempylidae) and their roles in the fish communities of the Kuroshio Extension Region (FIS_Paper-2449)

15:20-15:40   **Dongwha Sohn, Sukyung Kang and Suam Kim**   (Oral)
Comparison of otolith microchemistry between chum salmon (*Oncorhynchus keta*) and cherry salmon (*Oncorhynchus masou*) in Korean waters (FIS_Paper-2345)

15:40-16:00   **Jong-Hun Na, Zang Geun Kim, Hawsun Sohn and Chang Ik Zhang**   (Oral)
Age and growth of minke whale *Balaenoptera acutorostrata*, studied from bycatches in Korean waters (FIS_Paper-2601)

16:00-16:20   **Coffee Break**

16:20-16:40   **David Welch, Peggy Tsang, Jayson Semmens, Sonia Batten and R. Scott McKinley** (Oral)
Performance of the POST (Pacific Ocean Shelf Tracking) array in 2004-05, and plans for the future (FIS_Paper-2421)

16:40-17:00   **Konstantin A. Karyakin**   (Oral)
The use of the "Orca Sphere" device in bottom longline fishery in the Okhotsk Sea (FIS_Paper-2602)

Posters

K.I. Afanasiev, G.A. Rubtsova, T.V. Malinina, E.A. Salmenkova, V.T. Omelchenko and L.A. Zhivotovsky
Monitoring of Pacific salmon *Oncorhynchus keta* W. in the Sakhalin-Kuril Islands region using DNA markers (FIS_Paper-2256)

Nadezhda L. Aseeva
Change of Myxozoa life strategy in the Japan/East Sea in XX Century (FIS_Paper-2568)

Nadezhda L. Aseeva
Myxozoa parasites in the fishes of the Japan Sea (FIS_Paper-2577)

Alexander A. Bonk
The loss of herring developing eggs in spawning grounds in the western Bering Sea (FIS_Paper-2311)

Oleg Bulatov and Georgiy Moiseenko
The Bering Sea pollock stock assessment using GIS "Fishery" (FIS_Paper-2291)

Svetlana V. Davydova
Interadecadal variations of the masses subtropical fishes reproduction and their influence on ichthyoplankton community of northwestern Japan/East Sea (FIS_Paper-2365)

Elena E. Andreeva, Svetlana V. Davydova and Marina A. Shebanova
Species composition, distribution and food habits of ichthyoplankton in the Okhotsk Sea in summer-autumn, 2003-2004 (FIS_Paper-2333)

Yeong Gong and Young-Sang Suh
Effect of the environmental conditions on the structure and distribution of Pacific saury in the Tsushima Warm Current region (FIS_Paper-2593)

Elena V. Gritsay
The northern Bering Sea pollock fishery in 2004 (FIS_Paper-2318)

Soto-o Ito and Yukimasa Ishida
Species identification and age determination of Pacific salmon (*Oncorhynchus* spp.) by scale patterns (FIS_Paper-2380)

Victor A. Nazarov, Boris I. Ivanov and Nikolay A. Chernykh
Changes of fish communities in estuaries of the Peter the Great Bay during the 20-21st centuries (FIS_Paper-2527)

Yeong Hye Kim, Dong Woo Lee, Jae Bong Lee, Kwang Ho Choi, Young Seop Kim, In Ja Yeon, Byung Kyu Hong and Soon Song Kim
Age and growth of the yellow croaker, *Larimichthys polyactis* in the East China Sea (FIS_Paper-2323)

Nikolai V. Kolpakov
Interannual variability of species composition and structure of circumlittoral fish community of Russkaya Bay (northern Primorye, Sea of Japan) (FIS_Paper-2392)

Svetlana Davydova, A. Zhigalin and N. Kuznetsova
About species composition and distribution of ichthyoplankton in the northwestern part of Pacific Ocean (FIS_Paper-2364)

You Jung Kwon, Dae Yeon Moon and Chang Ik Zhang
Stock assessment of bigeye tuna (*Thunnus obesus*) in the Pacific using the AD model builder (FIS_Paper-2444)

Victor A. Nazarov
Composition and proliferation of mullets in far-eastern seas of Russia during the XX-XXI centuries (FIS_Paper-2549)

G.V. Avdeev and E.E. Ovsyannikov
The northern Okhotsk Sea pollock year-classes abundance (FIS_Paper-2313)

S.L. Ovsyannikova
Walleye pollock distribution and migrations in the south Kuril region in 1999-2004 (FIS_Paper-2315)

Andrew B. Savin
Seasonal migrations of Pacific cod (*Gadus macrocephalus*, Gadidae) nearshore of Kamchatka peninsula (FIS_Paper-2304)

Victor A. Nazarov, Eugene I. Barabanshchikov, Nikolay A. Chernykh, Alexander A. Goryainov, Boris I. Ivanov, Nikolay I. Krupyanko, Anatoly Yu. Semenchenko, Vladimir I. Tarazanov and Sergey F. Zolotukhin
Characteristics of salmon association in the Sea of Japan's EEZ of Russia on boundary of the 20-21st centuries (FIS_Paper-2528)

Alisa V. Semina, Neonila E. Polyakova and Vladimir A. Brykov
Genetic divergence in daces of the *Tribolodon* genus (Teleostei: Cyprinidae) from Far Eastern seas (FIS_Paper-2308)

Young Il <u>Seo</u>, Jin Yeong Kim, Joo Il Kim, Sung Tae Kim, Chang Ik Zhang and Jae Bong Lee
Assessing the impact of yellow goosefish predation on small yellow croaker in the East China Sea of Korea (FIS_Paper-2399)

E.I. Barabanshchikov, N.V. Kolpakov and M.E. <u>Shapovalov</u>
Appraisal of striped mullet (*Mugil cephalus*) stock near-shore of Primorye (FIS_Paper-2524)

Marina A. <u>Shebanova</u>
Feeding of juvenile *Cololabis saira* in waters of Peter the Great Bay (Sea of Japan) (FIS_Paper-2334)

Hirofumi <u>Shimizu</u>, Kiyoshi Fujita and Yoshioki Oozeki
Bone abnormality of pacific saury larvae *Cololabis saira* (FIS_Paper-2329)

M.A. <u>Stepanenko</u> and E.V. Gritsay
Effects of 2000 year class for recruitment Pollock in the eastern Bering Sea (FIS_Paper-2314)

Katsuya <u>Suzuki</u>, Tsutomu Takagi, Shinsuke Torisawa, Hiromu Fukuda, Osamu Murata, Shinji Yamamoto and Kazushi Miyashita
Evaluating the roles of vision and the lateral line in the schooling behavior of chub mackerel (*Scomber japonicus*) using a mathematical model (FIS_Paper-2417)

Inja <u>Yeon</u>, Yangjae Im, Hakjin Hwang and Myoungho Sohn
Current status of the Yellow Sea fisheries resources and management in Korea (FIS_Paper-2545)

Hakjin Hwang, Inja <u>Yeon</u>, Yangjae Im and Myoungho Sohn
Current stock conditions of yellow croaker, *Pseudosciaena manchurica*, in the Yellow and East China seas (FIS_Paper-2586)

Inja <u>Yeon</u>, Yangjae Im, Myoungho Sohn, Hakjin Hwang and Manwoo Lee
Morphological identification of subpopulations of the blue crab, *Portunus trituberculatus*, in the western sea of Korea (FIS_Paper-2585)

PICES XIV   FIS_Paper-2256   Poster
Monitoring of Pacific salmon *Oncorhynchus keta* W. in the Sakhalin-Kuril Islands region using DNA markers

K.I. **Afanasiev**[1], G.A. Rubtsova[1], T.V. Malinina[1], E.A. Salmenkova[1], V.T. Omelchenko[2] and L.A. Zhivotovsky[1]

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Chum salmon, *Oncorhinchus keta*, is one of the most economically important species of Pacific salmon in the Russian Far East. This species is reproduced in the rivers of both Asian and American coast and is the aim of artificial reproduction in hatcheries. In the Russian Far East, it is mainly represented in the Sakhalin-Kuril Islands region. Although chum salmon populations have already been investigated with use of classic genetic markers, such as protein polymorphisms, the level of genetic variation at these loci was not high enough to reveal fine population structure. Also, the distribution of chum samples analyzed so far was not sufficient to cover various levels of stratification, including different regions and wild versus farm reared stocks. We developed microsatellite markers (or STRs, short tandem repeats) specially designed for this species, based on the primers from the database of "Molecular Ecology", and studied samples from both wild and hatchery populations in southern and eastern Sakhalin Island and western Iturup Island. Additionally we began to monitor the dynamics of the artificial stock at the Taranai hatchery (Aniva Bay, southern Sakhalin) which has been recently formed of fertilized eggs introduced from different Sakhalin Island chum populations; our analysis includes the return from the first artificially reproduced generation released in 1999. We found statistically significant within- and between-island differentiation in chum STR variation. The Taranai population showed signatures of genetic disequilibrium, which indicates the very beginning of the genetic process of population formation.

PICES XIV   FIS_Paper-2568   Poster
Change of Myxozoa life strategy in the Japan Sea in XX Century

Nadezhda L. **Aseeva**

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Myxozoa are parasites of marine and freshwater fishes. Some species develop a r-strategy (large vegetative forms, great number of small-size spores), but others develop a K-strategy (few spores with complex structure). Unlike other animals, the r-strategists infected mainly single species, but K-strategists are usually able to infect multiple fish species. In total, 130 Myxozoa species have been found in the Japan Sea. In the early 20th Century, Fujita (1923) described 22 species, primarily r-strategists. Dogel (1948) found mostly the same species in the waters of Primorye, but added 14 new species to the Japan Sea, again predominately r-strategists. Shulman (1966) found a similar species composition of Myxozoa plus a few new species. Since early 1980s, Myxozoa species changed rapidly (Aseeva 1986, 2000, 2002). The number of r-strategists changed insignificantly, but new K-strategist species appeared. Now there are 90 K-strategist species in the Japan Sea, belonging to 15 genera. Among them, the genera *Palliatus, Davisia, Alataspora, Pseudoalataspora* were found only in 1990-2000s. Typically, myxozoans with a K-strategy are parasites of gull bladder. New Myxozoa species for the Japan Sea were either undescribed or were described from southern fish species. So, the increasing number of species is possibly connected to an increase in host species diversity and tropical fish appearance caused by climate change. On the other hand, strong variability of the spore structure exists, possibly caused by mutation. So, we cannot exclude a possibility of speciogenesis. The r-strategy is more pervasive in stable environments, and the K-strategy predominates in changing environments.

PICES XIV   FIS_Paper-2577   Poster
Myxozoa parasites in the fishes of the Japan Sea

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Recently, 132 species of Myxozoa parasites have been documented from fishes of the Japan Sea, which belong to 17 families and 21 genera. Most of them (112) are of marine origin, but 20 species are of freshwater origin. The highest species diversity has parasitofauna of Pleuronectiformes, which are infected by 46 species of

Myxozoa. Four genera of Myxozoa (*Alataspora, Palliatus, Pseudoalataspora,* and *Parvicapsula*) are observed in flounders only, but the genus *Sphaeromyxa* has never been observed in fish of this order. The Myxozoa parasites of flounders have various shapes of their spores and vegetative forms. The fishes from the order Scorpaeniformes are infected by 32 Myxozoa species with predominance of the genera *Sphaeromyxa, Myxidium,* and *Ceratomyxa.* The Gadiformes fishes are infected by three species of these parasites belonging to the genera *Zschokkella, Myxidium* and *Sphaeromyxa* (the *Sphaeromyxa* were found in *Eleginus gracilis* only). The Clupeiformes fishes have another three species of Myxozoa belonging to the genera *Ceratomyxa* and *Ortholinea.* Anadromous and semi-anadromous fishes of the orders Mugiliformes, Salmonifomes, and Perciformes are infected by 12 species of Myxozoa belonging to the genera *Myxidium, Myxosoma, Myxobolus, Sphaerospora,* and *Chloromyxum.* All of them, with inclusion of *Myxidium,* have a freshwater origin, but are adapted to marine life. The fishes from the orders Squaliformes, Rajiformes, Beloniformes, Perciformes, and Tetraodontiformes are infected insignificantly and have no more than a single species of Myxozoa for each host.

PICES XIV   FIS_Paper-2311   Poster
The loss of herring developing eggs in spawning grounds in the western Bering Sea

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In spawning grounds of herring in the western Bering Sea (the population of Korf and Karaginski Bays) the number of eggs spawned has been reduced significantly. In 2004 results of special observations indicated that the reduced number of herring eggs in the spawning grounds is related to ecological conditions. In herring spawning ground periodically exposed to draining, although protected from negative influence of waves (*i.e.* the spawning ground of lagoon type), the number of eggs was reduced by 52.6% on average, whereas in the spawning ground influenced less by the tides and ebbs, while much more by the waves (locked coastal spawning ground), the loss of eggs for the same period of observation was 71.3%. In the lagoon spawning grounds the loss of eggs takes place mostly due to the feeding by seabirds, fishes and invertebrates on. For example, reduction of eggs due to seabird feeding varied from 65.1% at daily tide to 91.4% at a neap tide. On average the percent egg reduction due to seabird feeding reached 86.8% in this spawning ground. In the locked coastal spawning ground until neap tide the loss of eggs due to seabird feeding was about 8% for the first 24 hours and varied from 45.9 to 51.4% for next days, with a maximum loss of 94% at neap tide (49.8% in average). For this spawning ground the main cause of egg losses is waves.

PICES XIV   FIS_Paper-2476   Oral
Paralarval distribution patterns of the gonatid squid *Berryteuthis anonychus* in the North Pacific

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Berryteuthis anonychus is a small (mantle length, ML, to 150 mm) oceanic squid distributed mainly in the northeast Pacific, where it is an important prey for salmonids, Pacific pomfret, and red flying squid. Despite its importance in the food web of the subarctic North Pacific, little is known about its life history. This study examines the paralarval distribution patterns of *B. anonychus* in the North Pacific to determine where it spawns and better understand its migration. Paralarvae were collected during six summer cruises (1999-2004) in the North Pacific aboard the Hokkaido University training ship *Oshoro Maru*. A total of 552 bongo-net tows were conducted between 0- and 100-m depth. Parlarvae occurred north of the Subarctic Boundary from the Subarctic Current to the Alaska Stream. In the North Pacific, MLs of juveniles and adults increase from south to north, suggesting *B. anonychus* migrates northward during spring. Based on these data, possible migration scenarios will be proposed.

Oceanographical conditions changing and *Pandalus borealis* redistribution in the northern part Sea of Japan

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Redistribution of shrimp (*Pandalus borealis*) in the Sea of Japan is analyzed based on routine oceanographic observations along three lines in Tartar Strait, CTDs, plankton surveys, and shrimp catch data. Possible oceanographic causes of the *Pandalus borealis* redistribution in the northern part Sea of Japan are discussed.

The Bering Sea pollock and regime shifts

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The walleye pollock, *Theragra chalcogramma,* is the most important species in the world fisheries. The main fishing grounds are located in Bering and Okhotsk Seas. The maximum Bering Sea catch has exceeded 4 million tons, the minimum level was about 1,6 million tons. In all areas (western, northern, eastern, Aleutian Basin, Aleutian Islands) stock biomass peaked in middle 1980's and extremely low level at the end of 1990's were observed. Despite of spawning grounds being temporally and spatially isolated, strong year-classes of walleye pollock appeared in the eastern (western) Bering Sea in 1966, 1967, 1977, 1978 (1978, 1979), 1982 (1982), 1984 (1986), 1989 (1988), 1992 (1992), 1996, 2000. The maximum numbers of eggs in the eastern and western Bering Sea was observed in 1990, larvae and yearlings - in 1987. The appearance of those strong year-classes are not a result of high abundance of spawning females: the strong 3 and 5 year classes appeared mainly in the first and in the late years of the solar activity cycle. The extremely high year classes are registered in 1977-1978 years. After extremely cold winter 1976/1977 the mean summer temperature of water sharply increased in 1977/1978 up to 4,0-4,8 C (Khen, TINRO-centre). Chlorophyll-a concentration increased from 1,1 to 4,1 mg/m cub in 1977-1980 (Tadakoro, 2002). Therefore, the regime shift occurred in 1977, which may change water temperature, primary production, zooplankton productivity, was proposed as the main reasons of walleye pollock stock biomass dynamics in the Bering Sea.

The Bering Sea pollock stock assessment using GIS "Fishery"

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The new approach for stock assessment biomass of walleye pollock was based on using the information system "Fishery". The data was obtained from vessels fishing pollock in the Navarin area (59-64 N, 176 E-175 W) in 1998-2004. Biomass of walleye pollock was calculated on information about large Russian vessels tows duration, type of trawls, horizontal opening and catch per one hour. In each quadrangle Pollock biomass was estimated for each month. We found that biomass widely changed in this region. The minimum season recorded in cold period – March-April, when the ice edge has extremely south position. The maximum seasonally biomass was observed in July-November. Obtained data showed that the lowest level of biomass recorded was in 2000, after this year biomass increased only until 2004.

Interadecadal variations of the masses subtropical fishes reproduction and their influence on ichthyoplankton community of northwestern Japan/East Sea

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The fish community of northwest part of the Japan/East Sea is comprised of boreal and subtropical representatives from the south for feeding and spawning as water temperature warms in spring. Subtropical species (sardine *Sardinops melanostictus*, mackerel *Scomber japonicus*, anchovy *Engraulis japonicus*, saury *Cololabis saira*) dominated the fish community of the Japan/East Sea in part of 20th Century. From 1988 to 2003 ichthyoplankton surveys revealed marked changes in species composition and biomass of fish eggs and larvae. After 1990 the number of sardine eggs and larvae decreased gradually in the northwest part of the sea. Then, in 1997, sardine eggs and larvae disappeared as the stock decreased sharply. During the last decade, mackerel abundance has been low. At the end of 1990s, a short-term increase in mackerel catches near the coast of Korean Peninsula and an appearance of eggs in northwest part of Sea (south of Primorie) was associated with a strong 1995 year class. The leading role of anchovy in the ichthyoplankton community is determined by a high stock level and active spawning in northwest part of sea. However, significant interannual variability in spawning intensity and recruitment exist. The intensity of spawning depends on development of the coastal branch of the subarctic front. Currently, saury is the second numerous species. Young were widely distributed in summer and autumn in the northwest part of sea. Analyses of biological and environmental factors revealed that conditions favorable to successful reproduction of anchovy and saury in the Japan/East Sea occurred during the last decade.

Species composition, distribution and food habits of ichthyoplankton in the Okhotsk Sea in summer-autumn, 2003-2004

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Ichthyoplankton was sampled in summer and autumn, 2003-2004, along the shelf of the Okhotsk Sea (352 stations). Ichthyoplankton was represented by eggs and larvae of 37 fish species, belonging to 18 families. Boreal ichthyofauna dominated, but warm-water species were collected, as well, including Pacific saury *(Cololabis saira)*, Japanese anchovy *(Engraulis japonicus)*, and Japanese gisu *(Pterothrissus gissu)*. Flounders (family *Pleuronectidae*) were represented by the greatest number of species (7). Among them, larvae of Sakhalin flounder *Limanda sakhalinensis* were the most abundant and widely distributed in both years. Larvae of banded Irish lord *Hemilepidotus gilberti* predominated, accounting for 63% of the total catch. In ichthyoplankton of the Okhotsk Sea eggs of 4 species fish were present – yellowfin sole *(Limanda aspera)*, Korean sole *(Glyptocephalus stelleri)*, walleye pollock *(Theragra chalcogramma)* and Japanese anchovy. The spatial distribution of fish larvae is conditioned by the hydrological features of the Okhotsk Sea. The largest numbers of larvae were caught at the northeastern coast of Sakhalin and at the northwestern shelf of the Okhotsk Sea in subarctic waters. Representatives of a subtropical complex (*e.g.*, Japanese anchovy, Pacific saury), as well as flounder eggs, were caught at the southeastern Sakhalin and Kuriles in waters of the Japan Sea. The diet of fish larvae in the Okhotsk Sea included more than 20 plankton species of different sizes. The dominant food items for all fish larvae were the copepods, *Pseudocalanus minutus* and *Oithona similis*. *Paracalanus parvus,* and copepod eggs, and nauplii were secondary prey. Fish larvae began actively consuming zooplankton after reaching 6 mm in length.

Effect of the environmental conditions on the structure and distribution of Pacific saury in the Tsushima Warm Current region

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Interannual and decadal scale changes in body size of Pacific saury, catch and catch per unit effort were examined to investigate the environmental effects on the stock structure and abundance in the Tsushima Warm Current region. Interannual changes in thermal conditions are responsible for the different occurrence (catch) rates of sized group of the fish. Changes in body size due to environmental variables lead the stock to be homogeneous during the period of high abundance, while one of the reminder cohorts supports the stock during the period of low level of abundance. Migration circuits of two cohorts of saury stock are hypothesized on the basis of short life span and spatio-temporal changes of the stock structure in normal environmental conditions. Changes in upper ocean structure and production cycles by the decadal scale climate changes lead changes in stock structure and recruitment, resulting in the fluctuation of saury abundance. Hypothesized mechanism of the effects of climate changes on stock structure and abundance is illustrated on the basis of changes in thermal regime and production cycle.

Productivity of common squid, *Todarodes pacificus* in Korean waters and its adjacent regions

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Fishery and some biological data of common squid, *Todarodes pacificus*, were used to describe changes in population structure and abundance in relation to oceanic climate factors. At present, it has possible to consider them as a single population to conserve. Areas of abundance of the population shifted from the Kuroshio-Oyashio Current region to the Tshushima Warm Current region in the early 1970s. Decadal ocean climate shifts between the cool and warm regimes in the last century appear to be associated with the productivity of the squid. Possible changes in distribution, life history traits and abundance are explained on the basis of the changes in current-mediated migration circuits.

The northern Bering Sea pollock fishery in 2004

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The biomass of Eastern Bering Sea pollock varied significantly during the 1990s and 2000s. Although biomass of the Bogoslof spawning stock was very low by the end of the 1990s and early 2000s, catch-per-unit-effort (CPUE) of factory trawlers fishing over the continental slope in the Pribilof canyon (depth 580-620 m) in February increased since 2000, possibly reflecting a broad-scale of migration of first maturing (age 5-6) fish from the shelf to the continental slope in addition to recruitment to the Bogoslof stock. Direct observations onboard factory trawlers revealed that some prespawning 5-6 year old fish migrate from outer shelf to the adjacent continental slope inside the Pribilof and Zhemchug canyons by the end of February and early March. Five year olds accounted for 15-17% of these prespawning fish in 2003 and 75-80% in 2005, the latter representing the abundant 2000 year class. Big concentrations of prespawning pollock occurred at depths of 400-500 m in the Bering canyon north of Akutan Island between mid February and early March. In the Zhemchug canyon, the proportion of females with hydrated eggs increased from 0.27 to 58.2% during mid February to early March 2005. At the same time, pollock CPUE, reflecting number of fish in the canyons, decreased from 91.5 t to 31.1 t. These data demonstrate that prespawning pollock began active migration to southeast in last ten days of February. This all suggests that the biomass of the Bogoslof spawning stock may have been underestimated as recruitment increased in the 2000s.

Species identification and age determination of Pacific salmon (*Oncorhynchus* spp.) by scale patterns

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This paper summarizes methods used to determine the species and age of Pacific salmon (*Oncorhynchus* spp.) by visual interpretation of characters on the scales of fish caught in the North Pacific Ocean and adjacent seas. Scale characters, such as freshwater growth, radial striations, and shape and number of circuli, are used to identify the Pacific salmon species. Several illustrated keys are included to determine the freshwater and ocean ages.

Changes of fish communities in estuaries of the Peter the Great Bay during the 20-21st centuries

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Estuarine communities of the Peter the Great Bay basin are including the fishes of three extensive groups: marine (sthenohaline, mesohaline and euryhaline), anadromous and freshwater (sthenohaline, mesohaline and euryhaline) with more than 130 species as a whole. Special researches of estuarine ichthyofauna here were begun at 1910-Th years and then were continued regularly to the present days activating especially since 1992. Qualitative fish species composition during the last hundred years is characterized the stability of freshwater and anadromous association's components. In other side substantial changes of marine fish species body were took place. At the second and fourth quarters of XX century and the first pentade of XXI century the number of warm-liked species was increased under the influence of climate factors mainly. Last years some rare species were occurred such as striped puffer, triple-tail and others.

Quantitative parameters of communities were varied very dynamically according the climate changes and human activities. First of its promoted to increasing or decreasing of warm-liked or cold-liked species, for example, far-eastern sardine-iwashi, Japanese anchovy, herrings, salmons, green gar, striped mullet and others. The second factor's group promoted to changes of all fish stock quantity. Pollutions and fishery were the unselective decrease causes of the common fish resource abundance. Fishery was the selective decrease reason of abundance of the commercial species. Pisciculture which was started in the Bay since 1980 is influence on stocks of pacific salmons preferably. Both of pollutions and fishery were promoted to degradation of several species natural stocks in the Peter the Great Bay estuaries such as pacific herring, smelt, haarder, wachna cod and others during last thirty years period especially.

The use of the "Orca Sphere" device in bottom longline fishery in the Okhotsk Sea

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The problem of killer whale predation on demersal fishes during longline fisheries has recently attracted attention of fishermen in many fishing areas, particularly in the Okhotsk Sea. Fishermen lose catches and fishing time because killer whales regularly prey on fish caught by longliners. Killer whales may cause damage to bottom nets and sometimes significantly reduce the amount of catch. The "Orca Sphere" is a device specially designed for keeping killer whales away from fishing boats. It was manufactured by the "SaveWave" company in cooperation with "Mustad." By generating ultrasonic signals, "Orca Sphere" restricts the ability of killer whales to echolocate thus preventing them from approaching fishing gear. In April-May 2005, the longliner "Yuliya Star" used "Orca Sphere" five times. Three times killer whales moved away from the vessel after the device was deployed. Once, killer whales were present within approximately 5 miles off the vessel, but did not approach the fishing gear and did not prey on the longline catch during the entire period of signal emission. In

one case, "Orca Sphere" generated a signal too weak to keep killer whales away from the vessel. In this latter case, catches of turbot were attacked by killer whales.

PICES XIV   FIS_Paper-2518   Oral
The vertical and horizontal distribution of bigeye (*Thunnus obesus*) and yellowfin tuna (*Thunnus albacares*) related to ocean structure

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To delineate the relationship between tuna populations and their ecological characteristics in the tropical and subtropical ocean, Korean longline fishing data on bigeye (*Thunnus obesus*) and yellowfin (*Thunnus albacares*) tuna were analysed. The National Fisheries Research and Development Institute of Korea collected totals of 211 sets in the Central East Pacific Ocean during August 1999 – October 2000, and TAO array information was used to understand vertical structure of water properties in surface layer. The depths of hooks in longlines indicated that the vertical catch rates of bigeye and yellowfin tuna were different, and the thermocline seemed to be important factor to determine the vertical habitat of two species: High densities of bigeye tuna were found between 9°C-13°C, just below the thermocline (>290 m), while yellowfin tuna resided in broad range (10°-20°C) of temperature above the thermocline (150 – 300 m). There was no strong seasonal difference in vertical distribution, but different depths of the mixed layer in eastern and western Pacific caused different vertical location of tuna species. The bait was also analysed for selectivity. Five kinds of main baits are used in this tuna fishing – mackerel, horse mackerel, squid, sardine and herring. Among the baits, sardine and horse mackerel were more frequently chosen by both species. Understanding the relationship between bait animals and physical environments is important for better fishing efficiency.

PICES XIV   FIS_Paper-2323   Poster
Age and growth of the yellow croaker, *Larimichthys polyactis* in the East China Sea

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The yellow croaker, *Larimichthys polyactis* is distributed in the Yellow Sea and the East China Sea. Stocks of this species have been decreasing, due to changes in the environment and to overfishing. Further decreases in thie abundance of this species are expected. Therefore, we need more effective management of this fishery. The purpose of this study is to update information on its age and growth, and to suggest management strategies for this resource.

Age and growth of *L. polyactis* were estimated from the right sagittal otoliths of 501 fish specimens from March 2002 to February 2003 in the East China Sea. The examination, on the outer margins of the otolith, showed that the opaque zone was formed once a year. The marginal increment of the otolith was formed as annual rings between May and June at the beginning of the spawning season. The growth of fish, expressed by the von Bertalanffy growth equation, was $L_t = 389.01 (1-e^{-0.1465(t+1.501)})$ for females, and $L_t = 311.75 (1-e^{-0.2143(t+1.5122)})$ for males, where L_t is total length in mm and t is age in years. The growth of males and females were different. Most examined fish were 1, 2, and 3 year old specimens, and the oldest fish was 7 years old (males) and 8 years old (females).

Interannual variability of species composition and structure of circumlittoral fish community of Russkaya Bay (northern Primorye, Sea of Japan)

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The species composition and structure of the circumlittoral fish community of Russkaya Bay were investigated in 2000-2004 by sampling with small-cell set nets (125 catches at the depths up to 10 m). Dynamics of the integrated characteristics of community (species diversity, domination, abundance) is analyzed. During these years, there was an increase of species diversity at the expense of some subtropical species (*Hexagrammos otakii, Lateolabrax japonicus*, *Takifugu rubripes, etc.*). During 2001-2002, the community had more than one dominant species. From 2000 to 2004 there was the change in dominance from Japanese surf smelt, *Hypomesus japonicus* (52.6% on weight) to Japanese dace, *Tribolodon hakuensis* (52.3 %). The increase in numbers of Pacific capelin, *Mallotus villosus catervarius*, arabesque greenling, *Pleurogrammus azonus*, and Pacific herring, *Clupea pallasii,* is striking. The relative density of fish biomass in coastal waters of northern Primorye varied insignificantly during 2000-2004; CPUE varied within just 4.2-4.6 kg per 100 m^2 of net per day. Observed dynamics in the characteristics of the circumlittoral fish community off northern Primorye seem to be connected to the influence of a warmer Sea of Japan in 2000-2004. Given a probable impending cooling cycle in 2005-2006, in next 2-3 years we expect an expansion of the scales of migrations of the Japanese anchovy, *Engraulis japonicus,* in a northwest part of the Sea of Japan, and also an increase in numbers of saffron cod, *Eleginus gracilis* and some others species.

Predictability of Pacific saury fishing grounds in the Northwestern North Pacific using satellite remote sensing data

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Pacific saury, *Cololabis saria*, is one of the most important commercial fishes exploited in the Northwest North Pacific Ocean. This study investigated the temporal and spatial variability of sea surface temperature (SST) and chlorophyll-*a* concentration (Chl-*a*) on the formation of saury fishing grounds, and the influence of the thermal front on saury fishing grounds, and we estimated daily saury fishing grounds based on these result. Saury fishing grounds were defined as the distributions of fishing fleet lights detected using DMSP (Defense Meteorological Satellite Program) /OLS (Operational Linescan System) nighttime image. We employed NOAA/AVHRR SST data and Orbview2/SeaWiFS Chl-*a* data to examine the range of the SST and Chl-*a* in the area where the fishing grounds were formed. Then we estimated the fishing grounds using these range from the SST and Chl-*a* data. The SST gradient was determined by the analysis of SST histogram within 11*11 pixel window. Pacific saury fishing grounds during the last ten days of October 2001 was formed on the range of 10.5°C-12.0°C and 1.0-2.0mg/m^3 in the southeastern Hokkaido water, 15.0°C-17.4°C and 0.3-0.5mg/m^3 in Sanriku water and 16.5°C-17.5°C and 0.5-1.0mg/m^3 in Jyoban water. The estimated fishing grounds were distributed on the northern or the northeastern areas of the strong SST gradient. This results show a relatively good agreement with the daily saury fishing grounds detected by DMSP/OLS. These results would help us develop new and powerful way to estimate fishing ground for effective saury fishery.

Feeding ecology of larval and juvenile black snake mackerel (*Nealotus tripes*, Gempylidae) and their roles in the fish communities of the Kuroshio Extension Region

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Black snake mackerel (*Nealotus tripes*) are distributed from tropical to sub-tropical areas of the Indo-Pacific Ocean. They also occur in the Kuroshio Extension Region off Japan, and they sometimes dominate second only to pelagic fish (mainly Japanese anchovy *Engraulis japonicus* in recent years) in the larval and juvenile fish communities at surface. To clarify their roles in these communities, we investigated feeding habit and daily ration of *N. tripes* from specimens caught by a frame trawl (mouth opening: 5 m^2; mesh size: 1.59 mm; towing speed: 4 kt) in May 2001. Diets mainly consisted of copepods (especially *Paracalanus* spp.) in the early stage (<10 mm standard length (SL)) and diet composition was similar to that of larval anchovy (15–30 mm SL). The diet composition changed with size; diets of juveniles larger than 20 mm SL mostly consisted of fish larvae and euphausiid (72% and 21% in number, respectively). Among identified fish larvae from the stomachs, most of them (N=54, 92%) were Japanese anchovy, and the others (N=5) were *Myctopum asperum* (Myctophidae). Daily ration of *N. tripes* was estimated as 19.6% in dry weight, according to the method of Elliott and Persson (1978). Total daily consumption by *N. tripes* was estimated to be 7.7% of larval anchovy (<15 mm SL) biomass in a studied area. We concluded that *N. tripes* had two important ecological roles from the viewpoint of the interaction with larval anchovy, competitors during early stages and predators during later stages.

About species composition and distribution of ichthyoplankton in the northwestern part of Pacific Ocean

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The northwestern part of Pacific Ocean is one of the most productive zones of world's oceans. Kuroshio (warm) and Oyashio (cold) currents interact in this area. Intensive passive migration of larvae from the main reproduction area (coastal water of Japanese islands) to ocean zone determines survival of young fish as recruitment. Fish eggs and larvae were collected with a nekton net in November 2001 and July 2002 in an area between 41º21´- 45º20´S and 150º01´-157º30´E. The ichthyoplankton community was formed by 38 species, 18 families and 29 genera. Eggs of *Sardinops melanostictus, Leuroglossus schmidti* and *Laemonema longipes,* and larvae *Cololabis saira* and *Engraulis japonicus* were the most numerous in ichthyoplankton samples. Representatives of Myctophidae family were more diverse *(Diaphus* genus prevailed) in Kuroshio zone. Water of the Subarctic Front showed the lowest species diversity; boreal species (families - Gonostomatidae, Myctophidae, Hexagrammidae) dominated in this area. The number of tropical and subtropical species increased in Kuroshio water. The zone of transition water had the highest diversity of fishes. Species of the subtropical and subarctic complex were present, but larvae of boreal fishes dominated this water. Ichthyoplankton was basically concentrated in the coastal water of Japanese islands in the autumn 2001. In the summer of 2002 eggs and larvae were widely scattered throughout the entire studied area.

Stock assessment of bigeye tuna (*Thunnus obesus*) in the Pacific using the AD model builder

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The bigeye tuna (*Thunnus obesus*) inhabit warm, temperate, and very deep waters throughout the world. Most bigeye tuna are caught in the Pacific Ocean, but they are also found in the Indian and Atlantic Oceans. In 2003

total annual catch of bigeye tuna was 51,600 mt, and the catch by Korea was 14,400 mt, accounting for 28% of the total catch. The annual catch of bigeye tuna tends to increase recently, but the stock condition is still unknown at this stage. In spite of the increasing demand for conservation and rational management for this species, stock assessment has not been attempted yet in Korea. In this study, we conducted a preliminary stock assessment of bigeye tuna in the Pacific using the AD model builder. A strong management action for the bigeye tuna is urgently needed for the conservation and sustainable use of this species, based on the result of stock assessment.

PICES XIV   FIS_Paper-2601   Oral
Age and growth of minke whale *Balaenoptera acutorostrata*, studied from bycatches in Korean waters

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Population dynamics of minke whale are important for fisheries management, because minke whales have the largest biomass of all cetaceans of marine ecosystems. In this study, we sampled North Pacific minke whales, *Balaenoptera acutorostrata*, that were bycaught in Korean waters from April 2002 to May 2004. Age determination was carried out using baleen plates. One hundred twenty-six baleen plates and eleven earplugs were analyzed for age. There was a 2-year difference between growth layer groups of baleen plates and those of earplugs. Maximum age was estimated at 12 years with 810 cm from baleen plates, and maximum age estimated from an earplug was 7 years with a length of 740 cm. Mean length by age was estimated at 408.8 cm for age 0 and 810 cm for age 12. The von Bertalanffy growth parameters estimated from a non-linear regression were $L_\infty = 878.25$ cm, $K = 0.1774$/yr and $t_0 = -3.36$. For females, the von Bertalanffy growth parameters were estimated as $L_\infty = 946.02$ cm, $K = 0.137$/yr and $t_0 = -3.93$. For males, those were estimated as $L_\infty = 842.3$ cm, $K = 0.21$/yr and $t_0 = -3.05$.

PICES XIV   FIS_Paper-2549   Poster
Composition and proliferation of mullets in far-eastern seas of Russia during the XX-XXI centuries

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According the opinion of various researchers in far-eastern seas of Russia four mullet species are habitat. They are *Mugil cephalus* (striped mullet), *Liza (Chelon) soiuy* (haarder), *Liza (Chelon) haematocheila* (red-lip mullet) and *Crenimugil crenilabis* (beard mullet). Last hundred years surveys analysis is assure that two mullets listing above were founded and live here only – striped mullet and haarder. Formerly (1910-1970), it was convinced that more abundant mullet in far-eastern seas was a haarder opposite a striped mullet which was scarce. Conclusions were based on results of fishing statistics usually without special research despite the fact of all mullets as "pilengas" (folk name of haarder) were called. Since 1975 (since 1985 particularly) when the complex researches were started the correlation between the numbers and biomass of different mullet species was founding out. Present days the striped mullet biomass at some mathematics ranks above than haarder ones. With a comparison of climate, abiotical, biological and fishing situation between the second and fourth quarters of XX century including first years of XXI ones we suppose that the haarder rich catches information at the northern part of the Sea of Japan or southern part of the Sea of Okhotsk, for example in 1929, 1931, 1932 was erroneous. That was a striped mullet abounding this areas since 1980 again.

Our and other research demonstrate that the striped mullet is distribute at the Sea of Japan along the shore of Primorsky, Khabarovsky Territories and Sakhalin Island; also at the Sea of Okhotsk along the shore of Khabarovsky Territory and Magadansky Region, Sakhalin Island excepting zone from Elizaveta Cape to Terpeniya Bay, and South Kuril Islands. The striped mullet is habitats in Russian Far East seas as season migrant (May-November) and it's fishing almost 1.0 thousand tons per year. Haarder lives at the Sea of Japan only with most abundance along the shore, in estuaries and rivers of South Primorye. It is fishing less than 100 tons per year.

Numerical analysis of the *Paralithodes brevipes* larvae migration in the Southern-Kurile strait's region

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An analysis of *Paralithodes brevipes* larvae spacial distribution is one way of understanding processes of crab reproduction. In this paper we present a study of changes in concentration of *Paralithodes brevipes* larvae in the Southern-Kurile strait's region using numerical methods. We used the three-dimensional numerical Princeton ocean model (POM) for this study. Initial data in our calculation was the result of research sone in the year 1998. A biological model was developed for modeling migration of *Paralithodes brevipes* larvae in the zooplankton stage. The algorithm of ecological POM was based on the algorithm of an ecologic-physic model for the PAPA-KKYS station. Zooplankton concentration was calculated with using hydrodynamic (temperature, salinity, radiation, water circulation and speed of currents and others) and biological (ammonium, phosphorus, DON, PON, DOP, POP, phytoplankton and others) characteristics. Probabilistic space of zooplankton accumulation was calculated in the Southern-Kurile strait's region.

The northern Okhotsk Sea pollock year-classes abundance

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High spawning activity of pollock was observed just in the eastern part of Okhotsk Sea in early 2000. Significant spawning concentration of pollock was not observed in area placed to the west from 149°E. This was caused by hydrological conditions of the sea.

Relatively cold years have been observed in the Okhotsk Sea since 1998 especially in the western areas of the sea. The eastern part of the sea was warmer because of Pacific waters carried with the Western-Kamchatka Current. Environment conditions there were potentially favorable for reproduction of pollock. Therefore year-classes of pollock in the western part of the sea, were weak, but in the eastern part strong year-classes appeared in 2000 and 2002.

Spatial distribution of 2000 and 2002 year-classes in first years of life were similar. A large number of immature fish was observed along coast of the western Kamchatka, in essential quantities in a Shelikhov Bay and to the south from P'jagina Peninsula. Displacement of young pollock year-classes into a feeding-zone at northern slopes of TINRO Basin was observed only from Shelikhov Bay. The pollock originally from the western Kamchatka, basically habited close to spawning ground.

The period of cold years was finished in 2002. Warming up of waters has proceeded and extended to the western and northwest parts of the sea. As a result of it in the western areas of the sea, environment conditions changed to those that are favorable of pollock reproduction. It has resulted in strong year-class in 2004, appearing both western area and in Shelikhov Bay. High concentration of 2004 year-class pollock were observed in the Shelikhov Bay and along northern coast of Okhotsk Sea at depths of 100-300 m in 2005. Abundance of 1 year old pollock in 2005 is highest it has been for the last 7 years.

Walleye pollock distribution and migrations in the south Kuril region in 1999-2004

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Features of pollock interannual and seasonal distribution for 1999-2004 are submitted. The basic spawning grounds of pollock are located off the Okhotsk side of the Islands. Prespawning fishes are distributed in

December-January in the Nemuro strait by two concentrations. Proportion of prespawning pollock is higher in the southern concentration, compared to the northern part, and egg concentrations are observed by the end of December there. Thus, pollock migrate from the northern part of the Nemuro strait into the southern part for spawning. Pollock spawning in the Okhotsk sea waters of Iturup Island begins in February, and prespawning concentrations appeared in December. The eggs are distributed in the South-Kuril strait and off northeast coast Iturup Island in spring 2004. However the prespawning and spawning pollock were not observed in the catch in the strait nor the Little Kuril Ridge. Hence,this concentration was formed due by eggs which were carried from other spawning ground. Immature fishes dominated at the northeast coast Iturup Island. Proportion of spawning and postspawning pollock was not more as 2,1 %. Obviously, spawning was conducted basically in the Okhotsk Sea waters, and eggs were carried out in Pacific ocean waters by currents. 0+ year old pollock are distributed in South-Kuril strait and Prostor Bay in summer-autumn. Immature pollock migrates into waters of the Iturup Island at age 1 and inhabit its feeding area at age 2 +. Seasonal distribution of immature pollock does not change essentially.

PICES XIV   FIS_Paper-2413   Oral
Monitoring of macrobenthos and larvae of fish at the Vrangel Bay (Sea of Japan)

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The benthos and fish larvae of Vrangel bay was monitored in 2004 and 2005 in connection with construction and operation of dry dock in the port of "Vostochny". Monitoring of the biota in Vrangel Bay was prompted by dredging, disassembly of the crosspiece of the dry dock, and construction of two concrete bases for oil platforms in the Sea of Japan. Escavation led to major changes in species structure and a decrease in density and biomass of individual species of the benthic community. The overall biomass of the benthos and phytobenthos was reduced by ten to a hundred fold. In the impacted areas, the biomass of the benthos did not exceed 100 g/m^2. On soft bottom sediments of Vrangel Bay more than 30 species of animals from 5 types and 7 classes were collected and identified. The most numerous were bivalve mollusks, polychaetes and gastropods. The majority of bivalve mollusks were small with ages that did not exceed 2-3 years. In April - June 2005 the most frequently encountered fish larvae were *Hypomesus japonicus* and *Stichaeus nasavae*, and those encountered less often included *Clupea pallasi* and *Hemilepidotus gilberti*.

PICES XIV   FIS_Paper-2304   Poster
Seasonal migrations of Pacific cod (*Gadus macrocephalus,* Gadidae) nearshore of Kamchatka peninsula

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Investigated area covers the waters nearshore of Kamchatka from 50°50′ N to 60°35′ N. Materials of nine bottom trawl surveys, conducted in 1976 - 1992 as well as daily database of fishing information for 1995 – 2004 making 24509 vessel-days of catch available for use in this paper.

Monthly dynamics of cod bathymetrical commercial distribution was revealed. Its weighted mean decreases to minimum depths (113 m) in August, but increases to maximum depths (228 m) in February.

Essential seasonal variability of cod distribution density is revealed in different regions of its inhabitation. So, in north bays - Karaginsky and Olyutorsky, density of cod distribution was the highest since May till October. On the contrary, in south Bays - Kronotsky and Avachinsky the top density occurs since September till April. This information, as well as that published earlier (Savin, 2004) allowed its seasonal migration along the eastern Kamchatka to be revealed. Foraging period occurs in Karaginsky and Olutorsky Bays, as well as in the western Bering eastward from Cape Olyutorskiy, but wintering in Kronotsky, Avachinskiy Bays, at the south-eastern coast of Kamchatka, and also in the Okhotsk Sea.

The main reason of cod migration from the Bering Sea to the south-eastern coast of Kamchatka, probably, is a seasonal glaciation of the water area part, where cod was foraging in summer. It causes the significant reduction

of the areas with favourable wintering conditions. At the sometime the forming conditions allows a great number of cod to winter near the shore of the south of Kamchatka.

PICES XIV   FIS_Paper-2615   Oral
Distribution and feeding of Japanese flying squid in the subarctic boundary zone

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Japanese flying squid *Todarodes pacificus* spawns in subtropical waters and migrates passively with the Kuroshio Current in a northeastern direction. The subarctic boundary zone is a feeding region for this species. The biomass of this squid was estimated as 520 thousand tons in July-August 2002. Maximal density (2.3 tons/km^2) occurred in the Oyashio current, and minimal density (0.3 tons/km^2) occurred in the transformed subarctic waters. Squids (51%), fishes (44.1%) and euphausiids predominated the stomach contents of Japanese flying squid. Minimal stomachs fullness occurred in daytime from noon till 4 pm. Fishes (mostly Pacific saury) dominated in their food at night, whereas squids dominated during the day. Euphausiids were observed only twice in the evening. Daily ration of Japanese flying squid was estimated as 7.8% of body weight. Each day this species consumed about 40,000 tons, including about 15,000 tons Pacific saury. Japanese flying squid is one of the main predators of Subarctic boundary region.

PICES XIV   FIS_Paper-2528   Poster
Characteristics of salmon association in the Sea of Japan's EEZ of Russia on boundary of the 20-21st centuries

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Research of salmon association and stocks in the Sea of Japan was conducted during the May-July period of anadromous migrations through the EEZ of Russia, 1995-2002. Salmon migrations were started always from the south part of EEZ in central part of the sea (Kita-Yamato Plateau) and it was followed to north-west and north with the 8^0C-12^0C increasing of water temperature (0-10 m layer). At the second half of June – first half of July salmons (pink and cherry chiefly) were entered into the Russian territorial sea and rivers of Primorsky Territory, Khabarovsky Territory and Sakhalinsky Region. The salmon species were presented by *Oncorhynchus gorbusha* (pink), *O. masou* (cherry), *O. keta* (chum), *O. tschawytscha* (chinook), *O. mykiss* and *Salvelinus malma krascheninnikovi* (red-spotted trout). The basis of salmon mass on quantity and species composition was consisted of pink (population of Primorye Region) which since 1998 was got more abundant in even years than odd one. At the different years it was fluctuated from 98.9% to 99.7% (number of individuals and biomass) and from 20% to 50% (number of species) accordingly. The second abundant species of all surveyed always was the cherry. During 1995-2002 years it quantity was varied from 0.25% to 1.1% (numbers and biomass) and from 20% to 50% (number of species). The third species on abundance was the chum. Sometimes it was absent, but sometimes the chum's quantity in EEZ was comparable with the cherry ones reaching to 0.05% of number individuals and biomass. The fourth species was the red-spotted trout which was caught out every year scarcely. The chinook (1995) and *O. mykiss* (2000) both were occurred lonely.

Genetic divergence in daces of the *Tribolodon* genus (Teleostei: Cyprinidae) from Far Eastern seas

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Daces are numerous in Far Eastern ichthyofauna and play an important role in the fisheries and aquaculture of the Primorsky region, Sakhalin, and Japan. Since this is the only group of cyprinid fishes adapted to ocean salinity, their biology is interesting and attractive for investigations from the point of view of both basic and applied sciences. Using PCR-RFLP-analysis of mitochondrial DNA fragments, genetic divergence of three species of the genus *Tribolodon: T. hakonensis* (Gunther), *T. brandti* (Dybowski), and *T. ezoe* (Okada et Ikeda), inhabiting estuaries of the Sea of Japan and the Sea of Okhotsk was studied. The amount of mtDNA divergence between these species is estimated to be approximately 10% of nucleotide substitutions. The time of their independent divergence is estimated at about 5 million years, which corresponds with the period between Miocene and Pliocene. On the eastern coast of Sakhalin Island a form of dace was found that is morphologically similar to *T. hakonensis* of the Sea of Japan, but essentially differs from it by the mtDNA. Data on biological and genetic characteristics of *T. hakonensis* from Primorye and *T. hakonensis* from Sakhalin and Japan waters suggest that these two forms may be different cryptic species.

A new estimation of salmon return rate and its use in environmental studies

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A new method of estimation of return rate in salmon species is proposed, and some possible factors determining homing success of chum salmon were investigated based on this new estimation. Data sets used in this study were the total fry release at the Namdae River, the age composition of returns, zooplankton biomass, and seawater temperature in coastal areas during the 1980s. Return rate of Korean chum salmon was calculated considering the proportion of the sum of homing salmon over ages 2-5 to the total release in a specific year. Return rates of 1983 and 1986 brood stocks were high, while those of 1985 and 1988 were low. In general, the trend of return rate was similar to that of zooplankton biomass except in 1986. Sea surface temperature was extremely low (mean = 3.4°C in April) in 1986 and high (mean = 13.7°C in April) in 1989, which might have resulted in a low return rate for 1985 and 1988 brood stocks. Further, in spring 1989, low zooplankton biomass could be another reason for a low return rate. The new estimation method resulted in different return rates than those using traditional methods. For example, the return rate of chum salmon in 1992 estimated in the traditional way (*i.e.*, return in 1992 divided by the release in spring 1990) was relatively high compared to other years, but the return rate of the 1989 brood stock with out method was extremely low. Therefore, the use of new approach seems to be reasonable for investigating the relationship between salmon populations and their environments.

Assessing the impact of yellow goosefish predation on small yellow croaker in the East China Sea of Korea

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The Yellow goosefish (*Lophius litulon*) is widely distributed in the East China Sea including the southern coast of Korea. This fish is a typical top predator with a large mouth, consuming small yellow croaker (*Larimichthys polyactis*), which account for more than 50% of its total prey in Korean marine ecosystems. While small yellow croaker is one of the most important species ecologically and economically in Korean waters, the fish stock has been decreasing due to overfishing and ecological impacts, such as predation mortality. Therefore, it is necessary

to establish a rebuilding program for the stock. Based on the prey-predator hypothesis, we assessed the impact of yellow goosefish predation on small yellow croaker and developed a multi-species virtual population analysis (MSVPA) model for the small yellow croaker stock accounting for the predation mortality by yellow goosefish in the East China Sea ecosystem. This study showed that the abundance of small yellow croaker stock was influenced by the predation of yellow goosefish as well as human fishing activity. Finally, considering the foraging ecology of yellow goosefish and commercial fishing intensity, a rebuilding plan for small yellow croaker was suggested and discussed.

PICES XIV   FIS_Paper-2524   Poster
Appraisal of striped mullet (*Mugil cephalus*) stock near-shore of Primorye

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Striped mullet from the Japan Sea forms its stock in waters off South Korea. In Primorye waters, striped mullet only forage, forming an ephemeral stock, most of which do not come back and die. In samples it is represented by immature and first-time mature (95-100%) individuals. It is difficult to estimate the biomass of the striped mullet stock, because of a lack of a fishery. We utilized data from seine fishing and visual assessments of striped mullet biomass nearshore and from winter and summer kills in estuarine coastal systems of Primorye. About 60,000 (60 t) of striped mullet were assessed visually in the north of Primorye (Samarga-Venyukovka Rivers) in the coastal zone (<200 m in width) in the surface layer in July 2000. In 1997-2002, striped mullet average density in coastal Russkaya Bay was 0.2 t/km^2 based on seine fishing (if fishing efficiency is equal of 1, but our observations indicate it was 0.02-0.5). It is estimated that the stock of foraging striped mullet in Primorye waters was 1,000-10,000 t in different years. In recent years the northward expansion of striped mullet has increased to the Okhotsk Sea. Annually in summer about 200 t of migrating striped mullet die from diseases. All fishes wintering in Primorye waters are lost. By preliminary data 500-1,000 t or more of striped mullet die in rivers from the Povorotny to Zolotoy Cape in winter in different years.

PICES XIV   FIS_Paper-2334   Poster
Feeding of juvenile *Cololabis saira* in waters of Peter the Great Bay (Sea of Japan)

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Samples were collected in waters of Peter the Great Bay (Sea of Japan) in summer 2003. One hundred and forty four stomachs of larvae and fry of Pacific saury *(Cololabis saira)* of different sizes were examined. *Cololabis saira* are considered to be plankton-feeding fishes, as they feed mainly on Copepoda and Amphipoda (Kuznetsova, Chuchucalo, 1991). The diet of larval saury in waters of Peter the Great Bay included more than 20 planktonic organisms of different sizes. As larvae increased in size, prey size increased. Within larvae of size 0.6-10.5 cm, length of prey varied from 0.2-0.3 (Copepod nauplii) to 3.5 mm *(Metridia pacifica)* to 6 mm *(Themisto japonica)*. Prey composition varies with ontogenetic stage and reflects zooplankton composition in the surrounding environment. Copepod nauplii dominated the prey of larval saury of size 0.6-1.0 cm. Larvae of size 1.0-1.2 cm feed mainly on *Oithona similis*, *Paracalanus parvus*, and *Acartia* sp. Saury fry of size 2.5-10.5 cm consumed *Metridia pacifica*, *Calanus pacificus*, and *Themisto japonica*. The average repleteness of larvae and fry of saury varied from 1.5 to 38.3%. Consistent with published research (Kuznetsova, Chuchucalo 1991; Kuznetsova *et al.* 1994), juvenile *Cololabis saira* had had two peaks of feeding activity, one in morning and the other in evening.

Monitoring of SST in the areas adjacent to the river mouths of Sakhalin applied to the problem of fry salmon release

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Formation period of favorable conditions for salmon fry (water temperature 7°C or more) in the areas adjacent to the river mouths is very important problem for Sakhalin salmon hatcheries because of strong water temperature variability in the near-shore zones of Sakhalin Island in spring. SakhNIRO has been carrying out SST monitoring on the shelf of Sakhalin and Kuril Islands using TeraScan station. Satellite SST data for the areas adjacent to the river mouths of Sakhalin were collected during 1997-2005. The average period for water temperature reaching 7°C and more was determined. For the southwestern coasts of Sakhalin Island and the northwestern part of Aniva Bay the average period for water temperature to reach 7°C or more way 15 of May. In the eastern part of Aniva Bay this period is about 20-22 of May. On the southeastern shelf of Sakhalin Island, the water warming-up occurs later - in the early June. In the spring of 2005, strong negative water temperature anomalies were observed on the southern Sakhalin shelf. In the first half of May their values reached -3°C in the Aniva Bay and near the southeastern coast. Along the southwestern Sakhalin coast, anomalies were about -2°C. In the second half of May water temperature was close to the norm in the southern part of Tartar Strait, however negative anomalies were observed in the northern part of the Strait. Negative anomalies occurred in Aniva Bay and near southeastern Sakhalin coast as before. Having based on these results, we recommended delaying the release of fry from salmon hatcheries.

Bone abnormality of pacific saury larvae *Cololabis saira*

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Many bone abnormalities were observed in pacific saury larvae during a spawning investigation in 1988. Larvae were sampled by the R/V Soyomaru of the Tokai Regional Fisheries Research Laboratory. This study is aiming to examine the frequency and symptoms of bone abnormalities found in pacific saury larvae.

Samples were collected with 'Maruchi A net' towed from the Soyomaru at a speed of 2 knots for 5 minutes at the sea surface. The net was towed at 146 sites within the offshore waters between Shionomisaki and Boso, from 24th February to 20th March 1988. Each sample was fixed with 5% formalin. The length of each larva was measured, and then its cartilage and bone were stained according to the method of Dingerkus and Uhler (1977). Abnormal parts and symptoms were microscopically observed to obtain the appearance rate of abnormalities.

Pacific saury larvae (684 individuals ranging from 5.4mm to 65.2mm TL) were primarily collected inside the Kuroshio Current, and bone abnormalities were found in 180 individuals (26.3%). Details of abnormalities are: fused centrum (PU3+4), 129 (71.7%); short centrum, 3 (1.7%); abnormal neural spine, 40 (22.2%); abnormal haemal spine, 8 (4.4%); abnormal branchiostegal, 5 (2.8%); abnormal rib, 4 (2.2%); others, 2 (1.1%). In many cases each abnormality was observed individually; 11 (6.1%) had two different abnormalities at the same time. In addition, no samples having more than three kinds of abnormalities were found. Although abundance decreased as size increased, the percentage of abnormalities increases in larvae up to 20mm in length and decreases afterwards.

Fate of the common squid population in Korean waters; a natural oceanographic experiment over various time scales

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Fluctuation in recruitment and biomass of the common squid (*Todarodes pacificus*), a short-lived species, is closely linked to the oceanographic variability. Squid catches in Korean waters exhibited a marked increase since the end of 1980s. The area of elevated temperature widened during winter in southern waters of Korea, but no such trend is obvious during autumn. So, the increase in catches is apparently associated with the expansion of the warmer waters during winter. Warmer winters may have resulted in extended spawning in both in time and space, and hence contributed to a basis for more successful recruitment. With years of higher catch, peak spawning tended to shift to October from September. This indicates that more squids were hatched later in the season in those years. The effects of more extensive spawning may have been further reinforced by enhanced spring zooplankton biomass in southeastern waters of Korea, which was also prominent during 1990s. Consistently warmer winters observed in southern waters of Korea since the end of 1980s may signify a change on a large scale that accompanies an altered behavior of warm currents into Korean waters. Spatially divided squid catch within a year demonstrated that varying local hydrographic conditions might modify the squid distribution. Seasonal hydrography and temporal/spatial distribution of the catch varied between good and poor years of squid catch. The fate of the squid population, indicated by catch statistics, may represent a series of oceanographic experiments repeated over various time scales, from seasonal to decadal.

Comparison of otolith microchemistry between chum salmon (*Oncorhynchus keta*) and cherry salmon (*Oncorhynchus masou*) in Korean waters

Dongwha **Sohn**[1], Sukyung Kang[2] and Suam Kim[1]

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[2] Fisheries Research and Development Institute, Republic of Korea

A chemical analysis on trace elements was conducted to reveal the depository relationship between fish otolith and rearing water. Around 1200 fry and 2 juvenile (age 1+) chum salmon (*Oncorhynchus keta*), and 38 juvenile (age 1+) cherry salmon (*O. masou*) were collected from three major hatcheries (Yangyang, Samchuk and Uljin of Korea) on the eastern coast of the Korean Peninsula in March 2002. For chemical analysis, otoliths were removed, and rearing water was filtered through a 0.45 μm membrane filter using a vacuum pump. We measured fork length and body weight of each salmon. Trace elements in the otoliths and water were analyzed using inductively coupled plasma mass spectrometry (ICP-MS) at the Korea Basic Science Institute. Elemental signatures indicated that the chemical compositions of rearing water were distinctly different from each other, and this difference resulted in the difference in chemical composition of fish otoliths. Especially, some trace elements, such as Sr/Ca and Ba/Ca, in the rearing waters seemed to be well reflected in the otoliths of fry and juvenile chum salmon and juvenile cherry salmon. Comparison of Sr/Ca in otoliths of fry and juvenile chum salmon indicated that salmon fry otoliths showed higher Sr/Ca ratio than juvenile salmon. Further, otoliths of juvenile salmon showed higher Sr/Ca concentration than otoliths of the cherry salmon. The Zn/Ca ratio of fry and juvenile salmon revealed a higher ratio in the earlier stage. Species-specific accumulation of trace elements was found in both juvenile chum and cherry salmon.

PICES XIV   FIS_Paper-2355   Oral

Food and feeding of the common squid *Todarodes pacificus* (Cephalopoda: Ommastrephidae) off Busan, Korea

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Diets of common squid *(Todarodes pacificus)* were examined to reveal changes in feeding habits in association with their growth schedule. From a total of 701 stomachs of subadults and adults caught off Busan from September 2004 to March 2005, prey organisms in stomachs were identified and dry weight of each prey species was recorded. The size range of squid specimens was 85-328 mm mantle length (ML), and 275 stomachs (39.2%) were empty. From entire specimens, stomach contents consisted of fishes, cephalopods, and crustaceans, and the dry-weight of each group was 73%, 21% and 5%, respectively. Though cannibalism was common at all size groups, examination of diets by size squid categories revealed ontogenetic variation in the prey. As common squid become larger, the percentage of cephalopods consumed increases, and consequently there is a concurrent decrease in the proportion of fishes consumed. The mean Stomach Content Index (SCI), the proportion of stomach weight to body weight, decreased as common squid grew. During the main spawning period in winter, higher gonad index and condition factor appeared in both sexes, while the SCIs were much reduced compared to pre-spawning period.

PICES XIV   FIS_Paper-2314   Poster

Effects of 2000 year class for recruitment pollock in the eastern Bering Sea

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The Eastern Bering Sea pollock biomass varied significantly in 1990-2000s and the latest series of biomass estimated by EI MWT and bottom trawl surveys and its variation has been reflected by CPUE data. The eastern Bering Sea pollock may spawn over a wide geographical area therefore recruitment have great spatial differences. The Bogoslof pollock spawning stock had very low biomass by the end of the 1990s and early 2000s. At the same time CPUE data from factory trawlers, which traditionally fish for pollock over the continental slope in the Pribilof canyon in February and early March, shows CPUE increasing since 2000, which could reflect an increasing scale of migration in first maturing fish from shelf into the continental slope as well as deepwater Bogoslof pollock stock recruitment. Significant increases in CPUE in 2005 was further evidence of the increased abundance of 2000 year class of pollock. The age of first maturing Bogoslof pollock is 5-6 years. Some prespawning 5-6 years old fish migrate annually from outer shelf into the adjacent continental slope (depth 580-620 m) inside the Pribilof and Zhemchug canyons by the end of winter and early March. Most solid concentrations of prespawning fish are observed in the Pribilof and Zhemchug canyons in first part of the February each year in 1990-2000s. The 5-years old mature pollock consisted of about 15-17% prespawning fish in the canyons and adjacent continental slope in 2003 and about 75-80% in 2005. The recruits of 2005 represent abundance of the 2000 year class.

PICES XIV   FIS_Paper-2231   Oral

Prerequisite of the study of Pacific cod population structure

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Pacific cod *Gadus macrocephalus* is one of the most commercially important fish of the North Pacific that appear in the first ten of valuable fishery targets. World demand on Pacific cod and products of their processing gradually increases due to low fat and high protein content. The Pacific cod fishery had developed especially intensively during the second half of the XX century. Thus, their annual harvest from 1950 to 1992 has increased from 45.7 to 493.8 thousands tones. After slightly decreasing, the annual catches in the beginning of current millennium had stabilized at the level of about 330 thousands tones and now comprises about 1.2% of total capture production in the North Pacific Ocean by all countries. The fishery on Pacific cod is traditionally

conducted by Canada, Japan, Republic of Korea, USA and Russia/USSR. In the past Poland and Germany were involved in this fishery as well. Currently leading position in Pacific cod annual catches belongs to USA (69.9%) following by Russia (18.2%) and Japan (8.7%). The abundance of Pacific cod in the long-term aspect fluctuates considerably. However, species population structure, stock size in many major areas, and causes that affect abundance changes are still poorly understood. Therefore studies of population structure of Pacific cod with the use of modern ichthyologic, biochemical and genetic methods based on approaches and existing experience obtained during recent genetic studies of Atlantic cod population structure seem very actual and promising. These studies will promote increased security and effectiveness of commercial exploitation of species resources. It is proposed to conduct large-scale total surveys within the entire Pacific cod area from Korean waters to west coast of the North America with involvement of scientists from different countries and institutions that will allow to strengthen and to coordinate studies on species considered and to obtain a clear idea of their population structure and to characterize the conditions of individual stocks.

PICES XIV FIS_Paper-2417 Poster
Evaluating the roles of vision and the lateral line in the schooling behavior of chub mackerel (*Scomber japonicus*) using a mathematical model

Katsuya **Suzuki**[1], Tsutomu Takagi[2], Shinsuke Torisawa[2], Hiromu Fukuda[2], Osamu Murata[3], Shinji Yamamoto[3] and Kazushi Miyashita[4]

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The schooling behavior of captive chub mackerel (*Scomber japonicus*) was observed under light (300 lx) and dark (< 0.01 lx) conditions. To investigate the role of the lateral line for schooling, the fish were divided into an experimental group in which the lateral line sensory system of each fish was disabled and a control group in which the lateral lines were intact. The two-dimensional motion of individuals during 3-min observations periods was digitized and processed, and forces dominating the schooling behavior were quantified using a mathematical model. The force making the swimming speed and direction of each fish uniform dominated the behaviors in both groups in the light and in the dark control group. The force keeping a proper distance between neighboring fishes did not dominate any behaviors. Results suggest that chub mackerel form schools by synchronizing their swimming speed and direction, and that they can form schools using either vision or lateral lines. The behavior of synchronizing the swimming speed and direction in the experimental group in the light was affected by other individuals swimming in a wide area to the front and side of the fish. This behavior in the control group in both the light and dark, however, was affected strongly by other individuals swimming in a narrow area directly in front of the fish. This suggests that chub mackerel use their lateral lines when they form schools in parallel orientation to other fishes. Chub mackerel may be able to form similar schools under both light and dark conditions, because light has no effect on the area of other fish sensed by the lateral line.

PICES XIV FIS_Paper-2421 Oral
Performance of the POST (Pacific Ocean Shelf Tracking) array in 2004-05, and plans for the future

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During 2004 and 2005, POST deployed a demonstration array consisting of 120 km of acoustic listening lines, stretching over 1,500 km north to south. POST's twin objectives were to (a) establish that it is feasible to develop an essentially complete census of even small fish (salmon smolts) over the continental shelf and (b) demonstrate that the results provide useful scientific insight that can improve both fisheries management and marine science. In 2004, a total of 1,050 salmon smolts were surgically implanted with individually identifiable acoustic tags. In 2005, with the increase in participation by other individuals and organizations, a total of 2,673

animals were surgically implanted. Detection rates for 20 km long listening lines were ≥91%. The 2005 trials of a modified technical system should now allow the deployment of a permanent array, and the resulting seabed grid of listening lines will form a continental-scale telecommunications network unlike anything previously conceived with unique capabilities. As well as forming an array capable of measuring direction, speed of movement, depth, and survival for fish, the establishment of an array for fish tracking will also provide the data transmission and power supply backbone needed to host other ocean sensors, yielding detailed fields of the changes in bottom temperature, salinity, and currents over time. It is now possible to conceive of doing direct experimental studies on fish in the ocean, measuring how survival or behaviour changes in different treatment groups, and to establish how survival varies in El-Niño years.

PICES XIV   FIS_Paper-2545   Poster
Current status of the Yellow Sea fisheries resources and management in Korea

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The Yellow Sea is bordered by the Korean Peninsula and China. Its benthic substrate is largely sand and mud, with an average depth of about 40 m. Coastal currents and a branch of the Kuroshio Current bring in nutrients, allowing it to have a high species richness, with about 450 large species, of which about 50 are commercially targeted by Korean and Chinese fisheries. Most fished species overwinter in deeper water in the southern Yellow Sea, and migrate to coastal areas for spawning and feeding from spring through autumn. Most commercially valuable demersal fish stocks have been overexploited due to both a continuous increase in fishing capacity in adjacent coastal states and nearshore fish habitat deterioration because of large land reclamations and municipal and industrial waste discharges. While traditional fishery landings have generally decreased, catches of more recently exploited small pelagic fishes have on average increased. However, a reduction in fish size in the catches suggests at least some of these stocks may also now be becoming overexploited. The Korean government has reduced fishing fleet sizes, established new fishing regulations and is strengthening implementation of other conservation measures, such as restoration of fishing habitats. Adoption of a TAC-based quota management system and increased release of hatchery-produced fish are both part of the resource restoration effort. However, since many of the heavily exploited or overexploited species are transboundary stocks, achievement of successful conservation will require collaboration with China to ensure that species are adequately managed throughout their geographical distribution.

PICES XIV   FIS_Paper-2586   Poster
Current stock conditions of yellow croaker, *Pseudosciaena manchurica*, in the Yellow and East China seas

Hakjin Hwang, Inja **Yeon**, Yangjae Im and Myoungho Sohn

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Landings of yellow croaker, *Pseudosciaena manchurica,* in the Yellow and East China Seas have decreased significantly since the mid 1970s. Several management measures have been introduced to conserve them, but population size remains low. To rebuild this population, it is now necessary to consider more effective management methods. To determine the current stock conditions based on the long term changes in the population, fishery and biological data collected over 36 years (1969-2004) were analysed. Yearly fish length compositions were analysed by cohort for the time periods 1968 through 1970, 1978 through 1982, and 1993 through 2004. Catch data were available from 1969 to 2004. Annual population sizes were calculated based on length composition, the relationship between total length and body weight, and total landings. The distribution of fish densities from trawl surveys conducted between 2000 and 2004 were also considered. Analysis showed that, since the 1970s, average size of harvested fish has decreased; the proportion mature fish smaller than the 50% maturity length in catches has increased and the estimated biomass has decreased significantly. In the mean time, slight signs of recovery are recently observed in the Yellow Sea. Consequently, the main management recommendation is that juvenile fish need to be better protected to allow the rebuilding of resources to a more sustainable population level. This will require modification of existing fish size limit, permissible mesh size, and closed area and season regulations.

Morphological identification of subpopulations of the blue crab, *Portunus trituberculatus*, in the western sea of Korea

Inja **Yeon**, Yangjae Im, Myoungho Sohn, Hakjin Hwang and Manwoo Lee

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Landings of blue crab, *Portunus trituberculatus,* in Korean waters have declined from 32,000 t in 1988 to 5000 t in 2004, with an increasing rate of decline due to overfishing by Korean and Chinese competitive fishing activities and habitat deteriorations because of land reclamations and waste discharges from the two countries. Therefore, additional stronger management measures are now necessary to conserve and rebuild the stocks. The first step pertinent to fisheries management for each stock unit is identification of subpopulations. To analyze the stock units based on the morphological characters, samples of about 40 crabs each were collected from five coastal areas (Incheon, Taean, Buan, Yeonggwang and Yeosu coasts). Eleven morphological characters, including carapace length and width, chela length and width, *etc.*, were measured. Differences were examined between sexes within a region and between regions for each sex. The analysis indicated there were significant differences not only between the opposite sexes but also among the regional samples at 5% level. Finally, it was revealed there are two blue crab subpopulations in the Korean western sea, one in the mid part and the other in the southern part. For more definitive conclusions, additional studies are planned to consider genetic, elemental composition, and tag-recapture methods. Pending final results, more effective management should be considered to recover the stocks.

POC Paper Session

Convenor: Michael G. Foreman (Canada)

Papers are invited on all aspects of physical oceanography and climate in the North Pacific and its marginal seas, particularly those related to the impacts of future climate change.

Wednesday, October 5, 2005 14:00-18:10

14:00-14:10 **Michael G. Foreman**   (Introduction by POC Chairman)
Evaluation of climate change projections: A new Working Group under the PICES Physical Oceanography and Climate Committee

14:10-14:40 **Hiroyasu Hasumi, Tatsuo Suzuki, Takashi T. Sakamoto, Seita Emori, Masahide Kimoto and Akimasa Sumi**   (Invited)
Present and future of the North Pacific simulated by a high resolution coupled atmosphere-ocean general circulation model (POC_Paper-2221)

14:40-15:10 **Muyin Wang and James E. Overland**   (Invited)
A first look at the new IPCC AR4 climate model simulations over the North Pacific (POC_Paper-2503)

15:10-15:30 **Yasuhiro Yamanaka, Taketo Hoshioka, Maki N. Aita and Michio J. Kishi**   (Oral)
Changes in ecosystem in the western North Pacific associated with global warming (POC_Paper-2255)

15:30-15:50 **Larissa A. Gayko**   (Oral)
The analysis of temperature regimes in coastal areas of the north-west Japan/East Sea by climatic periods (POC_Paper-2283)

15:50-16:10 **Ichiro Yasuda, Satoshi Osafune and Hiroaki Tatebe**   (Oral)
Possible mechanism of bi-decadal North Pacific ocean/climate variability in relation to the 18.6-year period nodal cycle (POC_Paper-2487)

16:10-16:30 **Coffee Break**

16:30-16:50 **Skip McKinnell**   (Oral)
Detecting the 1972/73 El Niño in the Northeast Pacific with an improved tropical teleconnection index (POC_Paper-2310)

16:50-17:10 **Victor I. Kuzin, Aleksandr S. Lobanov and Valery M. Moiseev**   (Oral)
Analysis and modeling of north and tropical Pacific SST variability (POC_Paper-2358)

17:10-17:30 **Yulia N. Tananaeva and Marat A. Bogdanov**   (Oral)
Interannual variability of cold and warm seasons and their duration in the North West Pacific (POC_Paper-2431)

17:30-17:50 **Satoshi Osafune and Ichiro Yasuda**   (Oral)
Bidecadal variability in the intermediate waters of the northwestern subarctic Pacific and the Okhotsk Sea in relation to the 18.6-year nodal tidal cycle (POC_Paper-2485)

17:50-18:10 **Fangli Qiao, Changshui Xia, Zhenya Song, Yongzeng Yang and Yeli Yuan**   (Oral)
Ocean surface waves play an essential role in air-sea interaction from an atmosphere-wave-ocean coupled model (POC_Paper-2319)

08:30-08:50   **Shin-ichi Ito, Shigeho Kakehi, Motohiko Kashima, Kosei Komatsu, Takashi Setou and Yasumasa Miyazawa**   (Oral)
Predictability of location of the Kuroshio Extension and the Oyashio First Branch by JCOPE (POC_Paper-2407)

08:50-09:10   **Michael Foreman, Wendy Wiggins, Angelica Peña, Emanuele Di Lorenzo, Barbara Hickey, Amy MacFadyen and Vera Trainer**   (Oral)
Modelling and observational studies of the Juan de Fuca Eddy (POC_Paper-2293)

09:10-09:30   **Gennady A. Platov, Elena N. Golubeva, Young Jae Ro and John F. Middleton**   (Oral)
Numerical study of the general circulation in the Japan/East Sea with simple assimilation of temperature and salinity data (POC_Paper-2344)

09:30-09:50   **Olga O. Trusenkova, Vyacheslav B. Lobanov and Aleksandr A. Nikitin**   (Oral)
Seasonal and interannual variation of currents in the western Japan/East Sea: Numerical simulation in comparison with infrared satellite imagery (POC_Paper-2273)

09:50-10:10   **Gongke Tan, Binghua Guo, Kyung-Tae Jung and Hyoun-Woo Kang**   (Oral)
A review of the investigation and study on Yellow Sea circulation (POC_Paper-2361)

10:10-10:30   **Coffee Break**

10:30-10:50   **Hao Wei, Yunchang He, Qingji Li and Zhiyu Liu**   (Oral)
Seasonal hypoxic zone adjacent to the Changjiang Estuary (POC_Paper-2254)

10:50-11:10   **Young Jae Ro and Kwang Young Jung**   (Oral)
Realtime monitoring of oceanic state variables in Kangjin Bay, South Sea, Korea (POC_Paper-2386)

11:10-11:30   **Yuri Yu. Nikonov, Valeriy N. Chastikov and Ludmila Yu. Gavrina**   (Oral)
Water and chlorophyll circulation modeling of Aniva Gulf according to oceanographic data from the year 2002 (POC_Paper-2302)

11:30-11:50   **Anatoly Obzhirov, Anatoly Salyuk, Renat Shakirov, Olga Vereschagina, Natalia Pestrikova, Artem Ageev, Anna Venikova, Olesia Yanovskaja and Elena Korovitskaja** (Oral)
Flux of methane to the atmosphere from the Okhotsk Sea (POC_Paper-2459)

11:50-12:10   **Vladimir I. Matveev**   (Oral)
Interannual changes of dissolved oxygen in an active layer of the Okhotsk Sea (POC_Paper-2582)

12:10-12:30   **Nafanail V. Bulatov and Natalya G. Obukhova**   (Oral)
One type of eddy development in the north-eastern Kuroshio branch (POC_Paper-2484)

12:30-14:00   **Lunch**

14:00-14:20   **Yugo Shimizu, Lynne D. Talley, Shin-ichi Ito and Miyuki Tatesawa**   (Oral)
Distribution and transport variations of source waters for North Pacific Intermediate Water formation revealed by multiple tracer analysis (POC_Paper-2411)

14:20-14:40   **Yury V. Novikov and Vadim M. Petruk**   (Oral)
On the problem of bottom water formation on the shelf of Peter the Great Bay (Japan/East Sea) in spring (POC_Paper-2228)

14:40-15:00   **George Shevchenko and Valery Chastikov**   (Oral)
Seasonal variability of oceanological conditions in the southern part of the Okhotsk Sea from CTD surveying on standard section Cape Aniva – Cape Dokuchaev (POC_Paper-2268)

15:00-15:20   **Andrey G. Andreev and Victoria I. Baturina**   (Oral)
Impacts of the tides and atmospheric forcing variability on salinity and dissolved oxygen in the western subarctic Pacific (POC_Paper-2270)

15:20-15:40   **Young-Gyu Park, Kyung-Hee Oh and Moon-Sik Suk**   (Oral)
Meridional mass and heat transport across the 38-40°N line in the East/Japan Sea (POC_Paper-2432)

15:40-16:00   **Denis V. Darkin, Leonid M. Mitnik and Maia L. Mitnik**   (Oral)
Evolution of sea ice in the Okhotsk Sea in January-April 2003: Analysis with the use of multisensor satellite and auxiliary data (POC_Paper-2321)

16:00-16:20   **Coffee Break**

16:20-16:40   **Hiroki Takemura and Sei-Ichi Saitoh**   (Oral)
Spatial phytoplankton distributions affected by eddy dynamics in the Eastern Kamchatka Current and Oyashio regions during the spring between 1998-2004 (POC_Paper-2460)

16:40-17:00   **Vladimir A. Luchin and Igor A. Zhigalov**   (Oral)
Typical distribution of interannual variations of water temperature in the active layer of the Okhotsk Sea and their possible prediction (POC_Paper-2322)

Posters

Tatyana V. Belonenko
Oceanographic field variability in the North Pacific by temperature circulation indices (POC_Paper-2483)

Tatyana Bogdanovskaya
Comparative analysis of parameters of Pacific subtropical anticyclones (POC_Paper-2461)

Valentina D. Budaeva, Georgi V. Shevchenko, Vajcheslav Makarov and Valery N. Chastikov
Intraannual thermohaline dynamics in Aniva Bay (POC_Paper-2382)

Manchun Chen, Hui Wang and Hengyi Weng
Interannual-interdecadal variability of the mean sea level along the China Coast during 1968-2002 (POC_Paper-2617)

Maochang Cui, Lingjuan Wu and Fan Wang
Principle of partial similitude for tsunami waves (POC_Paper-2226)

Boris S. Dyakov
Spatial and temporal variability in circulation and hydrophysical fields in Tatar Strait (POC_Paper-2440)

Victor R. Foux
Altimetry estimation of divergence and convergence area dispositions in streams for exchange application (POC_Paper-2531)

Lyudmila Yu. Gavrina, L.N. Propp and V.N. Chastikov
Factors of the environment and production characteristics in Aniva Bay, Sea of Okhotsk and bordering straits (Laperuz, Tatarsky) in 1996-2002 (POC_Paper-2530)

Shigeho Kakehi, Shin-ichi Ito, Motohiko Kashima, Kosei Komatsu, Takashi Setou and Yasumasa Miyazawa
The comparisons between JCOPE and observed data in Tohoku regions (POC_Paper-2409)

Kosei Komatsu, Takashi Setou, Yasumasa Miyazawa, Akira Kusaka, Shin-ichi Ito, Shigeho Kakehi, Motohiko Kashima, Manabu Shimizu, Hideki Akiyama, Kazuyuki Uehara and Mitsuyuki Hirai
Verification of JCOPE ocean forecast system using *in situ* data of Japanese fisheries research institutions (POC_Paper-2456)

Takashi Setou, Kosei Komatsu, Yasumasa Miyazawa, Shin-ichi Ito, Kazuyuki Uehara, Manabu Shimizu, Akira Kusaka, Shigeho Kakehi, Motohiko Kashima, Hideki Akiyama and Mitsuyuki Hirai
Incorporating *in situ* data obtained by Japanese fisheries research institutions into the JCOPE ocean forecast system (POC_Paper-2457)

Young Jae Ro and Kwang Young Jung
Hydrographic and hydrodynamic variability in Kangjin Bay, South Sea, Korea (POC_Paper-2446)

Gennady A. Kantakov
Low salinity signal propagation in the western part of the Sea of Okhotsk (POC_Paper-2512)

Yun-Bae Kim, Kyung-Il Chang, JongJin Park, Kuh Kim, Jae Hak Lee and Jae-Chul Lee
Flow through the Ulleung Interplain Gap in the southwestern East/Japan Sea (POC_Paper-2543)

Yu-Fei Lin, Su-Mei Liu, Lei Ji, Guo-Sen Zhang, Yan-Feng Bi and Jing Zhang
Multivariate statistical study on the chemical composition of rainwater at Zhoushan Archipelago (POC_Paper-2491)

Zhiyu Liu, Haitang Wang and Hao Wei
Bottom drag coefficient estimates in the tidal bottom boundary layer from acoustic Doppler velocimeter data (POC_Paper-2247)

Vasiliy F. Mishukov, Alexander N. Medvedev and Andrey S. Neroda
Natural and anthropogenic sources of chemical elements in aerosols over Vladivostok (POC_Paper-2222)

Valentina V. Moroz and Konstantin T. Bogdanov
Water structure and circulation variability in the Kuril Straits area (POC_Paper-2244)

Hanna Na and Kuh Kim
Temporal variation of the estimated volume transport through the Korea and Tsugaru Straits (POC_Paper-2389)

Aleksander A. Nikitin
Thermal features of water structure of the Japan/East Sea on satellite and ship observations (POC_Paper-2248)

Aleksander A. Nikitin, Yury Novikov and Vadim Petruk
Monitoring of Peter the Great Bay (Japan/East Sea) on IK-images and hydrological data in April-May of 2005 (POC_Paper-2249)

Alexander A. Nikitin, Larissa S. Shkoldina, Ekaterina N. Selivanova and Lyana D. Kulichkova
The phenomenon of warm water allochthonts in the north-western Japan/East Sea during winter-spring 2003-2004 and peculiarities of the thermal regime (POC_Paper-2359)

Eugene V. Samko and Vadim M. Petruk
Research on Bering Sea geostrophic circulation from satellite altimetry data: Two approaches to solving the problem (POC_Paper-2296)

Antonina M. Polyakova
Especially dangerous wave heights and safety of the fishing fleet in the Northern Pacific (POC_Paper-2381)

Antonina M. Polyakova
Ice formation is especially dangerous for fishing boats in the Northern Pacific and for the safety of the fishing fleet (POC_Paper-2383)

Eung Kim and Young Jae <u>Ro</u>
Structure of seawater properties profiled by the Argo floats in the Ulleung-do area (East/Japan Sea), 2003-2004 (POC_Paper-2452)

Eugene V. <u>Samko</u>, Nafanail V. Bulatov and Eugene O. Basyuk
Structure of an anticyclonic eddy in the southern Kuril Islands region and its influence on water dynamics and the saury fishery (POC_Paper-2470)

Renat B. <u>Shakirov</u>, Anatoly I. Obzhirov, Anatoly N. Salyuk and Nicole Biebow
Methane anomalies in the Okhotsk Sea (POC_Paper-2523)

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Monitoring of baroclinic circulation conditions and ice cover by GIS methods in the Far Eastern Seas (POC_Paper-2583)

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Daily variation of abnormal ocean conditions in the northwestern Pacific Ocean using NGSST satellite data (POC_Paper-2592)

Svetlana N. <u>Taranova</u> and Igor A. Zhabin
Water mass transformation in the Japan/East Sea (POC_Paper-2225)

Galina A. <u>Vlasova</u> and Vladimir I. Rostov
Analysis of seasonal variability of hydrodynamic structures in the Sea of Okhotsk and their dependence on baric systems in the atmosphere (POC_Paper-2284)

PICES XIV   POC_Paper-2270   Oral
Impacts of the tides and atmospheric forcing variability on salinity and dissolved oxygen in the western subarctic Pacific

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The impacts of the variation in the wind forcing and the 18.6-year tidal (K_1) cycle on surface salinity and the concentration of dissolved oxygen (DO) in the intermediate waters of the subarctic North Pacific were analyzed. Our results demonstrate that the interannual changes of surface salinity and DO on isopycnals in the intermediate waters of the western subarctic Pacific can be described very accurately by a linear combination of the intensity of the Aleutian Low pressure system (North Pacific index) and zonal momentum flux (45°N-52°N, 165°E-170°W) in winter, and an annually averaged cubic of tidal amplitude for the central Aleutian and northern Kuril regions. The residual signal for dissolved oxygen (DO) shows a good correlation with the temporal variations of DO in the Alaskan Gyre.

PICES XIV   POC_Paper-2483   Poster
Oceanographic field variability in the North Pacific by temperature circulation indices

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Changes in the quantity of commercial fishes are known to strongly depend on oceanographic conditions. There is conclusive proof of a statistical connection between the indices of the Pacific Decadal Oscillation (PDO) as well ENSO (El Niño/La Niña + Southern Oscillation) and fishery areas in the Northwest Pacific (Koldunov A.V., Staritsin D.K., 2005). Thus PDO and ENSO are becoming good predictors for quantifying the estimation of commercial fishes. The PDO and ENSO characterize the temperature modes of a region. A wavelet-analysis of monthly averaged PDO and ENSO results revealed some basic energy areas of the PDO and ENSO variability for various scales and time intervals. The periods 22 years (double the cycle of solar activity), 19 years (period of the Moon and the Sun tidal force action), 11 years (period of solar activity), 7 years (the component nutational period), 14 months (period of the speed of Earth's rotational change – nutational tidal), annual and semi-annual cycles are allocated as characteristic scales of the variability. The fluctuation in amplitudes of these characteristic periods is estimated as nonlinear effects that are determining the energy flows in the field of high and low frequencies. The comparative analysis of PDO and ENSO results leads to a conclusion about a phase delay of a PDO rather ENSO.

PICES XIV   POC_Paper-2461   Poster
Comparative analysis of parameters of Pacific subtropical anticyclones

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This paper provides a comparative analysis of long-term variability of two Pacific subtropical anticyclones (North Pacific High and South Pacific High) over the period from 1948 to 2003. Among the parameters subject to comparison are long-term variability of pressure in the centre, as well as latitude, longitude and area under the anticyclone. Having analysed over a 56-year period, it can be said with confidence that there are individual periods characterized by a synchronous tendency of the centres' behaviour. These periods are strongly marked in winter and spring (winter and spring in the northern hemisphere), while in autumn they are much weaker. The seventies and the nineties are particular years. Since the mid nineties there has been a tendency towards a synchronous pressure rise, a movement of anticyclones towards each other and an increase of regions being under the centres. The best correlation is between the pressure in anticyclones and their dimensions (correlation coefficients are 0.5-0.6, dependences are positive). In summer weak tendencies observed during the analysis of long-term variability of the parameters are typical of northern and southern centres.

Intraannual thermohaline dynamics in Aniva Bay

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Intraannual change of water temperature, salinity and density might be traced almost through the whole water column in Aniva Bay with water dynamics being the main influencing factor. Large-scale reconstruction of thermohaline conditions in the bay is dependent on the combined action of the East Sakhalin Current (ESC), river discharge, precipitation and intrusion inflows of the Japan/East Sea waters. In October-December it is the East Sakhalin Current that transports a lot of fresh and vertically homogeneous transformed Amur River water along the shelf and Eastern Sakhalin slope. This conclusion is well supported by Itoh and Ohshima (2000) who believe the ESC transport to La Perouse Strait increases in autumn and may cause considerable water freshening at the Okhotsk side of Hokkaido Island. The position of the near-bottom isohaline of 32.5 psu (isopycnal of 26.5) and the area bounded by these isolines might serve as an integral index of water freshening in Aniva Bay. Near-bottom intrusions of the Japan/East Sea waters in autumn and winter (October-January) are determined to cause a transformation (*i.e.* annual considerable renewal) of the last-year cold intermediate layer (CIL) in the southern deep-water part of the bay. Near-bottom water temperature within the CIL in January might go above zero up to 1-2C°, thus being considerably higher than in summer (-0.5 to -1.5C°). Water temperature rise near the bottom serves like a "thermal oasis" that is favorable for the development of sea hydrobionts. The CIL registered in Aniva Bay is mainly of local genesis and dependent on convective cooling of waters at the northern periphery of anticyclonic eddy A_1.

Interannual-interdecadal variability of the mean sea level along the China Coast during 1968-2002

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The interannual-interdecadal variability of the mean sea level (MSL) at 23 tide-gauge stations along the China coast and its relationship with global SST during 1968-2002 is studied by empirical othogonal functions (EOF) and linear regression analyses. The first four MSL EOF modes account for almost 80% of the variance on timescales longer than one year. The MSL EOF1 (45.4%) represents the simultaneously same-signed variation of the MSL near the 23 stations. The linear regression of the annual SST anomaly at each grid against the principal component of the MSL EOF1 is similar with the spatial pattern of the SST EOF2, which shows a pronounced east-west seesaw along the equator between the SST anomalies in the central-eastern Pacific and that in the western Pacific/Indian Ocean. This relationship indicates that the rising of the MSL along China coast since late 1977 is mainly due to the rising SST in the Chinese coastal areas, which is teleconnected with the pronounced cooling trend in the equatorial central-eastern Pacific area. The weak interannual variability in this dominant mode shows that most of the MSL variance off the China coast has no apparent relationship with the El Niño phenomenon. The spatial pattern of the MSL EOF2 (17.6%) shows a north-south seesaw, which changes sign near the station Pingtan (119.8ºE, 25.5ºN). This mode corresponds to a basin-wide variation in both the Pacific and Indian Oceans to the north of 20ºS, which is basically in phase (out-of-phase) with the SSH variation at the northern (southern) stations. It exhibits apparent interdecadal variability, *i.e.*, near the northern stations, the MSL was decreasing in the 1970s, rising in the 1980s, and decreasing again in the 1990s, beside some weak interannual variability, while the opposite may appear for the southern stations. Superimposed on this interdecadal variation is mainly a quasi-biennial timescale. The third and the fourth modes basically represent the MSL variability at the stations Tanggu (117.7ºE, 39.0ºN) in the north, near the estuary of Haihe River, and Gaoqiao (121.6ºE, 31.4ºN) in the south, near the estuary of the Yangtze River, respectively. Both principal components show apparent interannual variability. The MSL at Gaoqiao seems to be influenced more by El Niño activity than in Tanggu, suggested by the similarity between the fourth linear regression SST pattern and the SST EOF1. It is also consistent with the timing of the major floods events in the Yangtze River valley studied in earlier research.

Principle of partial similitude for tsunami waves

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Tsunamis (generally referring to earthquake tsunamis) are the most serious oceanic disasters in coastal countries and one of the most important natural disasters as confirmed by the United Nation's International Decade for Natural Disaster Reduction (IDNDR). The frequency of occurrence of tsunami waves is very low, but they are not easy to dissipate once they take place. Tsunami waves are oceanic small-amplitude gravity waves that transport energy extensively in deep water and break forth vastly in shallow water. The theoretical basis for the principle of wave partial similitude (PWPS) is simply proposed by two ways of studying the mechanism of tsunami occurrence and catastrophic development. Firstly, the PWPS is deduced by formally putting the small-amplitude gravity waves on one-dimensional vertical and two-dimensional horizontal subspaces, respectively, and using the principle of flow similitude (PFS) twice. Secondly, it is demonstrated by directly using harmonic solutions of classical linear small-amplitude wave theory with constant water depth for two-dimensional incompressible non-rotational gravity waves. Its significance lies in the fact that a bridge is built between the familiar surface gravity waves produced by a thrown stone and infrequent tsunami waves, and between the classical linear small-amplitude wave theory and the most serious oceanic natural disaster occurring all over the world. We present a new powerful experimental research method resulting from dynamic theoretical analysis and numerical computation methods to compensate for the lack of detailed observations.

Evolution of sea ice in the Okhotsk Sea in January-April 2003: Analysis with the use of multisensor satellite and auxiliary data

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During the 2003 winter season multichannel polarized microwave measurements of the ice cover of the Okhotsk Sea were carried out by AMSR and AMSR-E scanning radiometers from ADEOS-II and Aqua satellites, correspondingly. Passive microwave data as well as several acquisitions of Envisat and ERS-2 Synthetic Aperture Radar (SAR) images coupled with QuikSCAT SeaWinds scatterometer, NOAA AVHRR radiometer and other remotely sensed data and surface analysis maps have allowed us to trace the evolution of the Okhotsk Sea ice cover induced by both atmospheric and oceanic processes. Estimation of the atmospheric contribution to the brightness temperatures $T_B(\nu)$ measured over the ice cover was done on the basis of modeling microwave radiative transfer in the atmosphere-underlying surface system at all AMSR frequencies ν. The fields of the $T_B(\nu)$ at higher frequencies (89.0 and 36.5 GHz) and collocated SAR imagery were used to study the mesoscale and small scale features of the ice cover and their changes. The ice floe drift along the east Sakhalin coast and the coastal polynias off the north-west coast of the Sea of Okhotsk, near the eastern Sakhalin coast and other places, were investigated by joint analysis of datasets formed not only by the corrected $T_B(\nu)$ but by NOAA AVHRR, Terra and Aqua MODIS images, Quickscat-retrieved ice fields, *etc*. The seasonal changes of radiative and backscatter characteristic of sea ice resulting from the appearance of free water in the uppermost layer of snow-ice cover were compared with the visible/infrared satellite images, weather maps and coastal stations reports. The features of sea ice distribution and forms around Kashevarov Bank were revealed by joint analysis passive microwave, SAR and visible/infrared data.

Spatial and temporal variability in circulation and hydrophysical fields in Tatar Strait

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The present work is devoted to research on the variability of circulation and thermohline fields in Tatar Strait. Data from hydrological surveys on research vessels of the TINRO-CENTRE are used as the basis of an article on Tatar Strait for the period 1985-1995. Geostrophic currents are estimated using a dynamic method. The choice of sampling locations was determined by the depth of hydrological stations: 200-500 m. Capacity of currents on dynamic sections was estimated on depth izotahi 1 cm/sec. The 51°45' N latitude was considered to be the northern border of Tatar Strait (Cape Sushev-Cape Tyk), and the southern boundary was determined at approximately 46° N (Cape Belkin-Cape Kuznetsov). In a year with warm waters, the intensity of branches of the Tsusima current in Tatar Strait is high, and this resulted in the generation of the Shrenk and Primorye currents. In thermally cold years, the intensity of branches of the Tsusima current is less, and the probability of generation of the Sakhalin current is more. The circulation is subject to greater variability in the northern half of Tatar Strait than in the southern. In this part of the passage there could be a two-layer structure of currents. Irrespective of the type of a thermal mode, constant components of the circulation in Tatar Strait were branches of the Tsusima, a southern part of the Primorye current and a southern part of the Sakhalin current – the Western Sakhalin. The Shrenk current and the northern part of the Sakhalin current are attributed to variable components of circulation in the passage. Development of the Shrenk and Primorye or Sakhalin currents assumed low temperatures accordingly in western and eastern parts of Tatar Strait. The probability is great that the Shrenk and Primorye currents will be traced in thermally warm years, and the Sakhalin – in cold years at accordingly high or low intensity of the Tsusima current. From spring through summer, disbursements of branches of the Tsusima current which are included in Tatar strait, increased. Thus there were more disbursements of one of the currents - Primorye or Sakhalin.

Modelling and observational studies of the Juan de Fuca Eddy

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The Juan de Fuca (or Tully) Eddy is a summer upwelling feature located off southwest Vancouver Island at the entrance of Juan de Fuca Strait. Recent studies indicate that the eddy is an initiation site for the toxigenic phytoplankton *Pseudo-nitzschia* that impact shellfish along the Washington coast. As part of ECOHAB PNW (Pacific Northwest), a project funded by the Ecology and Oceanography of Harmful Algal Blooms program, field programs have been combined with bio-physical models to better understand the ecology and dynamics of these blooms. Though the eddy is comprised of nutrient-rich California Undercurrent Water which has been upwelled onto the Vancouver Island shelf via the Juan de Fuca Canyon, the dynamics of its generation remain speculative. Recent simulations with the Regional Ocean Modeling System (ROMS) suggest that eddy formation and its subsequent magnitude are governed by an interaction of winds, estuarine flow, and tides. Model and ECOHAB field survey results will be shown and the eddy's role as an initiation site for harmful algal blooms will be briefly described.

Altimetry estimation of divergence and convergence area dispositions in streams for exchange application

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Areas of intensive biological and exchange efficiencies in the seas are known to be closely related to frontal zones as well as to the divergence and convergence area dispositions in streams, upwelling/downwelling areas, and synoptical eddies. However, it was very difficult to use this knowledge in operative research because of poor oceanographic information. The situation has changed with the occurrence of satellite altimetry. The change speed is formed through a complete flow divergence which is determined by the β-effect and a rotor tangential wind pressure for synoptic time scales. The complete flow is composed from geostrophic flow, pressure gradient flow and drift flow.

Now it is possible to proceed from exchange experiences and general representations about distribution of commercial fish congregations during feeding migrations to trade recommendations based on altimetry information. Fish congregations are formed in convergence areas of flow (positive level anomalies) causing a feeding plankton concentration in stationary convergence areas (for example, a frontal zone or a stationary anticyclonic eddy) where plankton can be gradually eaten up and then the aggregations are passed to other convergence areas. Comparing altimetry information to temperatures, it is clear that the former is much more representative of thermodynamic peculiarities of the ocean fields.

Factors of the environment and production characteristics in Aniva Bay, Sea of Okhotsk and bordering straits (Laperuz, Tatarsky) in 1996-2002

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Data on the concentrations of dissolved oxygen, mineral and organic forms of nitrogen and phosphorus, silicon and chlorophyll *a* in the Aniva Bay, and the southern part of Tatarsky and Laperuz Straits in various seasons of 1996-2002 are presented.

The concentration of dissolved oxygen changed depending on photosynthesis intensity and the amount of organic matter in the water. For example, in bottom water layers (500m) in Tatarsky Strait low oxygen saturation (up to 47%) has been registered, while the nitrate nitrogen content has reached to 28 μM. In spring during phytoplankton bloom, the oxygen saturation of the water in Aniva Bay rose to 163% when the maximum concentration of chlorophyll *a* was 20,6 μg/dm^3. In some seasons, coastal water at a depth of 30-40 m were subject to an oxygen deficiency up to 67,5%, while in the Laperuz Strait down to a depth of 50m oxygen saturation was more than 80%.

It was noted that the water masses of Aniva Bay were characterized by a rather complicated composition because of agitation of three main water structures: north desalinated waters, entering the south-western part of the bay, more saline transformed waters of the Japan/East Sea, as well as waters transported by the Eastern-Sakhalin Stream of the Okhotsk Sea. Characteristics of these water structures change significantly during the year. In coastal waters of the areas studied, the terrigenous flow is evidently influenced by the qualitative composition of the water.

The analysis of temperature regimes in coastal areas of the north-west Japan/East Sea by climatic periods

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The tendencies of climate change–global warming are of great interest. To estimate the possible after effects of climatic changes and their impact on the environment and economy, investigations of climatic changes in some regions are of special interest. It is an urgent problem to define the most vulnerable areas of the coastal zone by data analyses of a series of instrumental observations. The long-term series of data from observations of sea water surface temperature and air temperature, conducted at four hydrometeorological stations (HMS) in Peter the Great Bay, the Japan/East Sea were investigated. Analysis was done on the variability of parameters calculated for each thirty-year normal series, determined by The World Meteorological Organization: 1901–1930 (I), 1931–1960 (II), 1961–1990 (III), and the rest following period 1991–2003, equal to 13 years (IV). Selective means of series of monthly averaged water and air temperature for each station accounted for each "normal" period, and then the anomalies (Δt) were calculated between each neighbour period. The general tendency for the rise of temperature in winter and in spring and fall of temperature in summer and autumn was observed between stations when comparing mean water temperature of periods II and III. At the present stage, when comparing periods III and IV, it was noted that there was both a rise in average monthly water temperature (excluding August at HMS Possyet) and average annual temperature (from 0,5ºC at HMS Possyet to 0,8ºC at HMS Vladivostok and Nakhodka).

When comparing average monthly air temperature of periods II and III between stations, the tendency is analogous: a rise of temperature in winter and spring, and fall of temperature in summer and autumn, excluding Nakhodka, where the total rise in air temperature is observed from period to period. Comparing periods III and IV revealed a rise in average air temperature through almost all months. Average annual air temperature under transition from period II to III increased from 0,3 to 0,6°C; from III to IV increased from –0,7 to 1,1ºC, that is, an almost double increase. Hence for the last 13 years increases in water and air temperature at all hydrometeorological stations in Peter the Great Bay have occurred.

Year-to-year fluctuations in both water and air temperatures are synchronous. The analysis of interannual variations of the temperature regime of coastal waters in the Peter the Great Bay allows us to single out and to assess climatic trends in the distribution of water and air temperatures, and in the distribution of water and air temperatures during the warm and cold seasons. The variations in the regime of the southeastern and southwestern parts of the Bay have been observed, but no differences in air mass temperatures have been registered.

The temperature regime of waters in Peter the Great Bay is influenced both by climatic and advective factors. The results obtained testify to the climatic regime variation in the northwestern Japan/East Sea.

Present and future of the North Pacific simulated by a high resolution coupled atmosphere-ocean general circulation model

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A high resolution coupled atmosphere-ocean general circulation model is used for future climate change projections. The model includes a T106 atmosphere and an eddy-permitting ocean, and has been run on the Earth Simulator. A control climate run under fixed preindustrial conditions, a twentieth century reproduction run under historical external forcing, two future projection runs based on Intergovernmental Panel on Climate Change (IPCC) emission scenarios, and an idealized global warming run under a 1% yr^{-1} increase of the atmospheric CO_2 concentration have been completed. We have also used a lower resolution version (a T42 atmosphere coupled with an ocean of ~1° horizontal resolution) of the same model, where the applied physical

parameterizations are the same as in the high resolution version. Here, projected changes of the North Pacific and associated changes in the climate over the North Pacific region are presented, with contrasting results of the two models. Model performance in simulating the present state of the North Pacific is also presented. Owing to the high ocean resolution, oceanic mean state and variability, such as those related to the Kuroshio and the equatorial currents system, are much more realistically simulated in the control and twentieth century runs of the higher resolution model. Differences in such features between the two models lead to different oceanic responses under global warming. For example, the Kuroshio and its extension are intensified in the higher resolution model, which is related to an El Niño-like atmospheric response to global warming. The atmosphere exhibits a similar response in the lower resolution model, as also seen in many other global warming projections, but the response of the Kuroshio is totally different because of its inability to properly simulate the Kuroshio separation. Some more conspicuous local and basin-scale features of the North Pacific under global warming will be presented.

PICES XIV   POC_Paper-2457   Poster
Incorporating *in situ* data obtained by Japanese fisheries research institutions into the JCOPE ocean forecast system

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Japanese local fisheries research institutions constitute a horizontally close-arranged monitoring system around the coastal region off Japan in the western North Pacific. Most of these *in situ* data (hereafter FRDATA), however, have not been distributed to the global network; consequently they were not used for operational ocean predictions. The Fisheries Research Agency (FRA) and Frontier Research Center for Global Change (FRCGC) cooperatively incorporated FRDATA into the JCOPE ocean forecast system developed by FRCGC, composed of an Ocean General Circulation Model (OGCM) assimilating satellite SSH/SST and hydrographic data of Global Temperature-Salinity Profile Program designed by NOAA. The incorporation of FRDATA allows better capturing of ocean structures. For example, hydrographic structures in the Kuroshio frontal region were finely depicted as opposed to structures mapped without FRDATA. As a result, initial values obtained by the data assimilation were improved. The hydrographic structures of the Kuroshio small meander event, which occasionally appears southeast of Kyushu of Japan and acts as a trigger of the Kuroshio large meander events, were correctly reproduced. This successful reproduction can improve the prediction accuracy of the system, and hindcast experiments with the assimilation to FRDATA have brought predictions closer to observations compared to hindcasts without FRDATA.

PICES XIV   POC_Paper-2407   Oral
Predictability of location of the Kuroshio Extension and the Oyashio First Branch by JCOPE

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The Frontier Research Center for Global Change (FRCGC) has conducted the Japan Coastal Ocean Predictability Experiment (JCOPE) and developed an ocean prediction system (JCOPE-system) with a POM based model. The JCOPE-system uses a data assimilation method to include data from satellites, Argo floats

and ships. However, most of the hydrographic data, observed by local fisheries institutions, have not been included because they were not reported by BATHY/TESAC messages. The Fisheries Research Agency (FRA) has started a joint program with FRCGC to develop a data transfer system to improve the predictability of the JCOPE-system. As a first step, we validated the predictability of the current JCOPE-system by comparing model results with observational data. In this study, we focused on the locations of the Kuroshio Extension (KE) and the Oyashio First Branch (OFB) on the east coast of Japan, since those two indices are the most important factors for determining the ocean conditions in the area. The data assimilation appropriately reproduced the position of KE, although OFB was not correctly reproduced. The predicted positions of KE and OFB were both separated from their observational values. However, the predictions had a tendency to follow the data assimilated reanalysis values rather than the purely simulated values (with no data assimilation and realistic forcing). These results showed that the predictability of KE and OFB depends greatly on the initial conditions. The initial conditions are derived by the data assimilation, therefore, the results imply that the model predictions will be improved if data from local fisheries institutions are added to the data assimilation.

PICES XIV   POC_Paper-2409   Poster
The comparisons between JCOPE and observed data in Tohoku regions

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An ocean circulation model assimilating satellite altimetry, SST and hydrographic observations has been constructed to investigate ocean predictability around Japanese coastal regions under the Japan Coastal Ocean Predictability Experiment (JCOPE) by the Frontier Research Center for Global Change. Monthly repeated hydrographic section data measured by prefectural fisheries research institutes located on the east coast of Tohoku (the northeastern area of Japan) are used in the comparisons against three model runs (without assimilation, with assimilation and for hindcast). The simulated temperature and salinity were improved by assimilation, though the hydrographic data used for comparisons was independent to the assimilation. The hindcast forced by climatological monthly wind stress and heat/salt fluxes showed increasing differences from observed data with the increase in the integration time. However the difference induced by the hindcast was smaller than that between initial conditions and observed data. These results indicate that appropriately assimilated initial conditions are important to predictions within about two months. For the improvement of initial conditions, we are also developing the system to collect and assimilate the near real time hydrographic data observed by prefectural fisheries research institutes, which are now not included in the assimilation.

PICES XIV   POC_Paper-2456   Poster
Verification of JCOPE ocean forecast system using *in situ* data of Japanese fisheries research institutions

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JCOPE, the ocean forecast system of the Frontier Research Center for Global Change (FRCGC), is an eddy-resolving Ocean General Circulation Model (OGCM) assimilating *in situ* temperature/salinity profiles and satellite SSH/SST which succeeded in forecasting information on the Kuroshio large meander last spring.

However, its reproducibility, especially for hydrographic structures, has not been verified adequately using *in situ* data. We verified the accuracy of the OGCM and data assimilation of JCOPE, comparing its hindcast and reanalysis data with hydrographic data in the western North Pacific observed by Japanese fisheries research institutions. The hindcast data indicated some systematic biases of the OGCM, representatively, faster propagation of the Kuroshio meander to downstream and frequent formation of large meanders accompanied by detached-eddies, although reproducibility increased remarkably in comparison with the no-assimilation case. The reanalysis data, as the initial condition, are calculated in sequential processes: gridding observational data with an optimal interpolation (OI), estimating T/S profiles with a multivariate OI (MOI), and noise elimination. Among these processes, the OI tended to make frontal structures looser in the Kuroshio and Mixed Water regions partly due to the constraint of the Nyquist time-space scale of 10 days and 50 km. In the MOI, discrepancies appeared in salinity profiles, especially in the subarctic region, which was attributed to a procrustean estimation of salinity profiles from SSH with weak signals. These are expected to be corrected by incorporating the horizontally close-arranged hydrographic data of Japanese fisheries research institutions into the data assimilation with revision of the assimilation parameters under the cooperative project between the Fisheries Research Agency and FRCGC.

PICES XIV   POC_Paper-2446   Poster
Hydrographic and hydrodynamic variability in Kangjin Bay, South Sea, Korea

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In a separate paper by Ro and Jung, a realtime monitoring system which has produced a time series of 16 oceanic state variables (such as temperature, salinity, currents, dissolved oxygen, air temperature, solar radiation, wind, *etc*.) since April, 2003 was described in detail. Time series analyses of these oceanic state variables were carried out in terms of harmonic, spectral and coherency analysis, multiple correlation analysis among variables, and heat budget decomposition. The annual temperature range was 27.5°C with the lowest, 1.9°C, occurring on January 26, 2004 and the highest, 29.4°C, occurring on July 31, 2004 The latter is regarded as extremely high compared to other neighboring water bodies. Salinity ranged from 10.63 psu in July to 33.35 in February, 2004. Tidal currents ranged from a maximum of 37.1 cm/sec at flood to 32.5 cm/sec at ebb. In the heat budget analysis, in summer, the average net heat gain was 127.2 watt/m^2 while in winter the average net heat loss was 132.7 watt/m^2. Latent heat during typhoon passage in summer increased remarkably by around 13 times to be 389.2 watt/m^2 compared to an average value of 29.0 watt/m^2. In winter, latent heat loss was 144.7 watt/m^2 compared to sensible heat loss of 56.8 watt/m^2.

PICES XIV   POC_Paper-2512   Poster
Low salinity signal propagation in the western part of the Sea of Okhotsk

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Based on numerous mooring observations and CTD surveys, the effect of the fall in peak propagation of the East Sakhalin Current is demonstrated. In Aniva Bay, it is shown how the dichothermal layer changes. The influence of Japan/East Sea water is overestimated as early investigations have noted. The main cause of the disappearance of the dichothermal layer in Aniva Bay is due to the seasonal propagation of the East Sakhalin Current.

Flow through the Ulleung Interplain Gap in the southwestern East/Japan Sea

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The Ulleung Interplain Gap (UIG) is about 90 km wide, and serves as a main passageway for the exchange of deep waters below 1500 m depth between the Ulleung Basin (UB) and the Japan Basin. A map of bottom potential temperature indicates that the densest flow into the UB, colder than 0.1°C (the East Sea Deep and Bottom Waters according to Kim *et al.*, 1996), must take place through the UIG (Chang *et al.*, 2002). Chang *et al.* (2002) conjectured a net inflow of about 0.5 Sv into the UB through the UIG using a single mooring at EC1 (Fig. 1). A high-resolution numerical model, however, predicts that the deep inflows occur in the western UIG and outflows occur in the eastern UIG (Hogan and Hurlburt, 2000), suggesting the necessity for measuring flows over the entire gap to estimate the deep water flux. An array of five current meter moorings, each of which was equipped with two current meters at around 1800 m depth and 20 m above the seabed, was deployed in November 2002 for reliable flux estimates of deep water through the UIG. Each mooring was successfully recovered in April 2004. The mean flow pattern is characterized by a strong and narrow outflow in the eastern UIG strengthening to the east near Dokdo, and a broad inflow in the western UIG, strong in the mid-UIG and weakening to the west near Ulleungdo. The results show that the deep flow near Dokdo has significant effects on the deep water exchange between Ulleung Basin and Japan Basin.

Analysis and modeling of north and tropical Pacific SST variability

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In the present paper, two methods are used to analyze the SST data of the ECMRF and NCEP/NCAR/NOAA datasets. The first is the classical empirical orthogonal function (EOF) analysis, which allows the reconstruction of the El Niño and La-Niña events with good accuracy by only the first few EOFs. However, the periods between these events need many more EOFs for their reconstruction. The variability in the midlatitude is also not separated because of a strong signal in the tropics. Therefore, for the separation of these signals the cluster method is used. The results obtained show that, except for signals in the tropics, there exists a well-marked signal in the subpolar gyre and the Kuroshio Extension with inter-decadal modulation. The modeling of the ocean response to atmospheric forcing during the 1981-1990 period shows reasonably good agreement in the phase and the amplitude of the simulation of the tropical (El Niño, LaNiña) events of the model during this period. The subtropical anomalies are described more poorly.

Multivariate statistical study on the chemical composition of rainwater at Zhoushan Archipelago

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The chemical characteristics of rainwater at stations located in the East/Japan Sea were studied for the period between January 2002 and December 2003. The stations are located in northeast of Zhejiang Province (latitude 29º32N to 31º04N and longitude 121º30′E to 123º25′E), where is the largest archipelago in China exists. Rainwater samples were collected and major species (F^-, Cl^-, NO_3^-, SO_4^{2-}, K^+, Na^+, Ca^{2+}, Mg^{2+}, NH_4^+, pH) were determined. Concentrations varying in range and character were depicted. On the basis of the data, principal component analysis (PCA) and factor analysis (FA), such as the kinds of multivariate statistical techniques, were used to acquire further knowledge on the characteristics of species analyzed. The distribution character of

samples was clearly depicted in the new PC1-PC2 ordinate generated by orthogonal projection and the reasons that caused the outliers in samples were discussed. In order to get the latent variables which most distinguishably effect the sample distribution, data profiles were investigated by factor analysis. Three latent variables were responsible for the sample distribution within sufficient analysis accuracy, NO_3^- -SO_4^{2-}- NH_4^+ factor (FA1) called an "anthropogenic factor", Na^+-Cl^-(FA2) called a "marine factor", and Mg^{2+} factor (FA3).

PICES XIV   POC_Paper-2247   Poster
Bottom drag coefficient estimates in the tidal bottom boundary layer from acoustic Doppler velocimeter data

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Bottom friction is very important to coastal hydrodynamics. Reliable bottom drag (*Cd*) depends on the bottom layer turbulence structure. Turbulence characteristics in the bottom boundary layer (BBL) of coastal water (the Yellow Sea, dominated by semi diurnal tides) were measured during the spring cruise of the R/V *Dongfanghong 2* in March, 2005. A 64-Hz Nortek Acoustic Doppler Velocimeter (ADV) and a RDI 600-kHz ADCP were anchored at station A1 (35.90°N, 121.58°E, at 40m depth). The sampling was carried out every 10 min to get 2048 samples of bottom 3D velocity and one profile of ensemble velocity each time within 24 hours.

Bottom stresses were estimated by two methods: COV (direct Covariance measurement) and TKE (Turbulent Kinetic Energy). These two methods yielded similar estimations of bottom stress based on ADV output. The mean calculated bottom drag coefficient *Cd* from estimated stress and the mean bottom velocity was 3.6×10^{-3}, which was obviously larger than the typically assumed value of 2.5×10^{-3}. The intense variation of *Cd* reached two orders of magnitudes ranging from 3.4×10^{-4} to 3.0×10^{-2} during the observation. Turbulent kinetic energy dissipation rate (ε) was estimated from a fit of the Kolmogorov –5/3 spectral slopes in the inertial range of the 1D frequency spectrum. Near the bed, vertical velocities are less contaminated by vibration than the horizontal velocities, and the fluctuations w′ are more likely to be due to turbulence (Stapleton and Huntley, 1995), so in this study, we systematically applied the method only to vertical velocities. Most of the calculated ε had an order of 10^{-6} m^2 s^{-3} with maximum and minimum values of 4.6×10^{-4} m^2 s^{-3} and 2.8×10^{-7} m^2 s^{-3} respectively. The comparison between time evolutions of ε and tide indicated a strong ebb-flood asymmetry of ε. The vertical velocity spectrum showed good agreement with the corresponding Nasmyth Universal Spectrum. Both *Cd* and ε have an obvious frequency 2 times that of tide.

PICES XIV   POC_Paper-2582   Oral
Interannual changes of dissolved oxygen in an active layer of the Okhotsk Sea

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For data obtained from 1930-2002, maps of monthly distributions of dissolved oxygen in the surface layer of the Okhotsk Sea are constructed and interannual variability is analyzed. The temporary variability of oxygen in the Okhotsk Sea is illustrated by the slowing down of the reorganization of the field of oxygen structure and in the small changes in the absolute size of its concentration. It is well traced in the surface layer which is most subject to the influence of external factors. Therefore, on the surface, the amplitude of interannual fluctuations reaches 1.5 ml /l, and in the 50 - 200 m layer it is 0,5 ml / l which demonstrates the fast attenuation with depth of seasonal changes.

The spatial distinctions due to geographical features in various areas of the sea, are most strongly determined by the dynamics of the waters, and by the beginning and end of the photosynthesis period. In June, in northeast part of sea, the oxygen content exceeds 12,0 ml / l, and in a northwest part of the sea it is reduced to 7,5-6,5 ml / l.

The structure of the oxygen field in the surface layer essentially changes within one year. In the summer in the top part of the layer (0-100 m), it is characterized by the general reduction in oxygen concentration from the central areas of the sea to the shelf. In the bottom part of the layer (100-200 m), conversely, there is an increase in concentration in the same direction. In the winter the structure of the dissolved oxygen field with depth does

not change and also it characterizes increase in concentration from the central areas of the sea to shelf. Changes in the structure of the field are caused by the seasonal reorganization of thermal structure of the surface layer, *i.e.* the formation of a seasonal thermocline in the summer, its destruction in the winter, and also by intensive mixing in the winter in coastal areas and at the beginning of photosynthesis in these areas. Changes in the distribution of dissolved oxygen at the beginning of late autumn occur at intermediate depths and are probably connected to the increased flow of Pacific water to the Okhotsk Sea.

PICES XIV   POC_Paper-2310   Oral
Detecting the 1972/73 El Niño in the Northeast Pacific with an improved tropical teleconnection index

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Our inability to detect a major El Niño in the extra-tropical North Pacific in 1972/73 was perhaps one of the major contributors to the view that all El Niños are different. A re-analysis of tropical forcing/extra-tropical SST response reveals that the 1972/73 El Niño went undetected because the background state of nature during the early 1970s was not given adequate consideration, particularly the concept of persistent states of nature in the climate system. As it turns out, coastal North American SSTs increased in 1972/73 as in all other major El Niños of the twentieth century, but because the initial state was significantly colder than average when the El Niño occurred, the increase did not stand out as a positive anomaly against the entire record. It appears that the 1972/73 El Niño was not the anomaly; the anomaly was the cold regime in the Northeast Pacific that lasted from 1968-1975, the most dominant feature in the 500 hPa height anomalies in the Gulf of Alaska. A new Western Tropical Pacific Index of the mid-latitude teleconnection shows this regime rather clearly and is sufficiently invariant that it may be useful as a forecast tool for Northeast Pacific ecosystem variability.

PICES XIV   POC_Paper-2222   Poster
Natural and anthropogenic sources of chemical elements in aerosols over Vladivostok

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A comparison of natural dust storms and anthropogenic effects of Vladivostok City on air quality was done on 2004 data set. At the beginning of sampling the highest concentrations of elements in aerosols were connected with strong dust storms in China. Concentrations then decreased sharply to background levels, with some oscillations. Local minimum data were observed when wind directions were mainly from west to north and element concentrations in aerosols were not influenced by the anthropogenic sources of Vladivostok's industry and transport.

To identify and account for the contributions of source elements in the content of aerosols, a Target Transformation Factor Analysis (TTFA) was applied, which has been thoroughly described in Hopke *et al.* (1976). For the total set of data in 2004, TTFA demonstrated that clay and slates, and sandstone and soil are the most important natural sources of elements (54,42% - Na; 43% - Fe; 59% - Mg; 47% - Mn; 31% - Cu; 1,96% - Zn; 41.8% - Co; 32% - Ni; 36.0% - Pb) while coal fly ash is the primary anthropogenic source (20,5% - Na; 39.9% - Fe; 25.9% - Mg; 48.1%- Mn; 57.9% - Cu; 26.9% - Zn; 45.8% - Co; 31.8% - Ni; 47.0%- Pb).

At the beginning of observations of dust storms coming from China to Vladivostok, the elements found in natural abundance were Na, Fe, and Mg with strong anthropogenic influence on concentrations of Zn, Pb, Co and Ni by coal fly ash. This is not unusual because coal is widely used in China for domestic heat and for coal-fired power plants. These results confirm our data about active transport of matter by atmospheric jet currents which can quickly and unexpectedly bring various substances to different regions of Russian Far East. After a change in meteorological conditions from 16-30 March 2004, we observed a sharp decrease in the content of atmospheric aerosols and only natural sources affected aerosol content. From 6 April 2004, the TTFA analysis revealed that coal fly ash appeared to be the main contributor of anthropogenic sources to the aerosol in Vladivostok.

Water structure and circulation variability in the Kuril Straits area

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This study was based on the resources of the Pacific Oceanological Institute Far Eastern Branch of the Russian Academy of Sciences (POI FEB RAS) data bank, including the archive materials of the national research cruises in the Kuril Islands area, the data of the modern field observations carried out by POI FEB RAS in 1977-1993, as well as the global array of average long-term hydrological data of the more than semi-centennial period covering the whole area of the NW Pacific. The role of the Kuril Island Straits in the formation of water characteristics of the Kuril-Oyashio current zone was analyzed. The dependence of water structure formation in the current zone on the variability of water exchange through the straits was revealed. New information about hydrological water characteristic variability was obtained. It was shown that the Kuril-Oyashio Current zone – supplied by transformed Sea of Okhotsk waters, takes place in the sub-strait zones of all relatively deep water straits. In summer, the Sea of Okhotsk water inflow through the straits is the most intense. The Bussol' Strait is the main supplier of the transformed Sea of Okhotsk waters but in the sub-strait zone of the Friz Strait, the current is replenished both by the warmest and saltiest waters, and the coldest and least saline Sea of Okhotsk waters. As a result of the variability of the water discharge to the ocean through the straits, there is a variation of water circulation in the sub-strait areas, and correspondingly, of the thermohaline and dynamic characteristics of the particular zones of the Kuril-Kamchatka Current-Oyashio system. Such variability has both seasonal and interannual character.

Temporal variation of the estimated volume transport through the Korea and Tsugaru Straits

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The volume transports (VT) of the Korea and Tsugaru Straits was estimated using sea level differences (SLD). The conversion equation from SLD to VT can be computed according to the linear correlation between the VT and the SLD. The sea level data along the Korean and Japanese coasts have been measured for several decades. Thus the VT of the Straits can be estimated by applying the conversion equation to the whole period that the sea level data are present. In the case of the Korea Strait, the SLD was calculated using the sea level data of Pusan and Moji. The transport data by submarine cable was used to get the conversion equation from the SLD to the VT (Lyu and Kim, 2003). The atmospheric pressure effect and the baroclinic part of SLD were removed before computing the conversion equation. In the case of the Tsugaru Strait, Tappi and Yoshioka were selected for the calculation of the SLD. The conversion equation from the SLD to the VT was obtained using the transport data by a vessel-mounted ADCP (Ito *et al.*, 2003). As a result, the mean value of the VT through the Korea Strait is 2.53 Sv and that through the Tsugaru Strait is 1.6 Sv since 1984. Approximately 63% of the VT of the Korea Strait flows out through the Tsugaru Strait.

Monitoring of Peter the Great Bay (Japan/East Sea) on IK-images and hydrological data in April-May of 2005

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Hydrological surveys in the Peter the Great Bay of the Japan/East Sea and in Ussuriyskiy Bay – part of the Peter the Great Bay - were conducted in April - May of 2005 as part of the TINRO-Centre program of investigations of the biological resources of the Far East seas. At the same time, monitoring of the thermal conditions of the bay was made using data from IK-images from the NOAA meteorological satellite of high resolution (1 km). Intrusion of the cold and salty surface coastal waters along the western coast of the bay and removal of the

warm and less salty near estuary waters along the east coast, were observed in the hydrological data at the end of April. It is necessary to note that a coastal water mass was traced in the north of the bay up to depth of 10-20 meters. In comparison with the first survey in May, the northern and western half of the bay was entirely occupied by near estuary waters, and southern and eastern parts were occupied by coastal masses. IK-images also showed that the coastal waters were superseded in northern and coastal parts of the bay. Downwelling was precisely traced, its border coincided with the frontal zone on the surface and passed on isobath 40-50 meters. This hydrological situation in Peter the Great Bay is a consequence of an abnormal early establishment of strong summer monsoon conditions. Thus, the joint analysis of the IK-images and hydrological data has demonstrated interesting spatial - temporary structure in the waters of Peter the Great Bay, which can be used to determine the hydrological condition of the bay for short-term and long-term forecasts.

PICES XIV   POC_Paper-2248   Poster
Thermal features of water structure of the Japan/East Sea on satellite and ship observations

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Investigation of thermal fronts and eddies in the Japan/East Sea is of scientific and practical interest. Modern investigations of fronts are practically impossible without use of satellite information. Knowledge of the basic features of the hydrological regime of the Japan Sea has been provided by Uda, (1934); Suda, (1938); Istoshin, (1960); Nikitin, Kharchenko, (1989); Isoda *et al.*, (1991); Isoda, (1994); Ostrovskii, Hiroe, (1994); Danchenkov *et al.*, (1997); Nikitin, Dyakov, (1998); and Zuenko, (1996, 1999, 2000).

In this work IK- and TV-images of high solution (1 km and 4 km) of the surface of Japan/East Sea for 1975-2002 were used. Data from ship observations on sections along 132 °E, (Sangarskiy, Antonovskiy) and oceanographic surveys of 1979-97 were used in addition. More than 900 maps of frontological analysis were constructed. Satellite data on sea surface properties is non-uniformly distributed. The greatest quantity of maps is constructed in March-May and October-November. Fewer maps are constructed in December-February. The greatest coverage fell to 1980-1982, 1985-1986, 1987 and 1992-1996. Hydrological seasons in the Japan/East Sea were based she classification of G. I. Yurasov (1977) in view of variability of vertical thermal structure of waters.

Results of the analysis of satellite images have allowed solution of several problems:
    To allocate areas where surface thermal fronts and eddies are observed.
    To define position of fronts and eddies in various years and seasons.
    To study seasonal variability of position of fronts and eddies in inneryear cycle (time of occurrence and disappearance, the period of existence).
    To investigate interannual variability of position of fronts.
    To study dependencies of distribution and migration of pelagic fishes and other fishery properties from the oceanic phenomena observed on IK-images.

As a result of the analysis of the satellite and hydrological information the following conclusions were reached:
    The satellite information adequately displays basic elements of the hydrological structure, and allows development of valuable qualitative and quantitative information on parameters, existential variability and small-scale structure of frontal zones.
    The basic elements of hydrological structure in the Japan/East Sea are quite stable in all seasons. Some exceptions were seen in the summer period.
    Migratory pathways and distributions of pelagic organisms like *Sardinops sagax melanosticta* and northern fur seals (*Callorhinus ursinus*) can be traced from the position of the Subarctic front along warm and cold streams especially in the spring and autumn periods.
    The generalized scheme of position of surface thermal fronts and eddies of Japan/East Sea is made and their interannual and seasonal variability is considered.

Classification of thermal structure in a northwest part of Japan/East Sea and some elements of its variability will be presented.

The phenomenon of warm water allochthonts in the north-western Japan/East Sea during winter-spring 2003-2004 and peculiarities of the thermal regime

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According to satellite information, an intensive transfer of subtropical waters to the north-western Japan/East Sea has been taking place since the middle of the summer 2003 and has caused a significant extension of the summer hydrological season. Field investigations have shown that, in general, the thermal conditions of the north-western Japan/East Sea were greatly above the standard during 2003. High temperatures (1-3 degrees above) were observed along the coast of Primorye (except for the zone between 44-45°N). The intensive penetration of warm waters into the north-western part during autumn led to the later intensification of the subarctic front. This process also took place in winter 2003-2004. As a result, patches and streams of water with temperatures above zero were recorded near the Middle Primorye's offshore in November 2003 and in Peter the Great Bay in February 2004.

These processes affected the structure of the plankton community: the presence of the warm water allochthonts (a ocean subtropical zooplankton species) was recorded in winter-spring period which is not their usual time. In the beginning of December 2003 in the Kievka Bight (Middle Primorye), calanoid copepods *Mesocalanus tenuicornis, Calanus pacificus, Paracalanus parvus, Clausocalanus* sp. and siphonophores *Halistemma rubra* were registered in plankton samples. In March 2004 in Vostok Bay (Peter the Great Bay, Southern Primorye), copepods *Mesocalanus tenuicornis, Microsetella rosea, Oncaea conifera, Sapphirina* sp. and *Stephos* sp. were registered in waters with temperatures below zero. So, the bioidication method of research has let us ascertain the facts of warm water coming to the north-western part of the Japan/East Sea during winter-spring period 2003-2004, and this is confirmed by instrumental methods (satellite and hydrological observations).

Water and chlorophyll circulation modeling of Aniva Gulf according to oceanographic data from the year 2002

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Aniva Gulf is located at the southern end of Sakhalin Island. Questions about the interaction between people and the gulf ecosystem are important, especially with the development of oil projects in gulf area. Calculation of contaminant distribution (oil, dredging and other) is one of the important tasks. Solution to this problem cannot proceed without making prognostications of water circulation in gulf. The gulf is also important as an area of biological productivity. In this paper we make an attempt to use data from oceanographic stations to make prognostications using numerical methods. Data were obtained from 15 oceanographic stations in 2002 (11-12 April, 20-21 June, 07-09 August, 30-31 October). Fields of water circulation, temperatures, salinity and chlorophyll concentration were analyzed. We used the three-dimensional numerical Princeton Ocean Model (POM) for the calculations.

One type of eddy development in the north-eastern Kuroshio branch

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The analysis of satellite infra-red images indicates that interactions of frontal zone eddies play a basic role in the formation of large eddies going to Southern Kuril region. Several anticyclonic eddies were observed in frontal Kuroshio zone in spring 2004. The first eddy was the large stationary anticyclone A24 (with a 130-mile diameter) and was observed south-east of Hokkaido. The second eddy was mesoscale anticyclone A25 (with a 50- to 60-mile diameter). It was observed at 40°N and probably was formed by the Tsugaru Current. The third eddy was a warm stationary Kuroshio ring A26 and was observed at 37-38°N. The last eddy was a large warm stationary Kuroshio ring A28 (with a 130-mile diameter) and was observed in the southern part of the frontal zone at 151-154°E.

The interaction of eddies A26 and A28 was considered. A26 eddy's centre moved quickly along the anticyclonic circulation path and arrived on the Honshu coast during 2004. From there it moved away from the Honshu coast in December 2004. This movement can be considered as a wave reflecting from an obstacle. A28 eddy moved quickly westward (1-2 miles/day) along the Kuroshio front. This movement can be considered as an opposite wave along the front. A28 eddy moved along anticyclonic circulation path between 146-148° E and reached 145° E at the end of November 2004.

The centre of A26 eddy was found at 143°E during this period. The distance between the centres of the eddies decreased to 90-100 miles and the edges of the eddies contracted. A new anticyclone (with a 100-mile diameter) was formed as result of this interaction. The new eddy was probably formed by the interactions of direct and reflecting waves from the Honshu coast. The new anticyclone was situated at 145° E in mid December 2004. Part of A26 eddy's water remained near the Honshu coast. The size of the formatted eddy did not exceed more than 40-50 miles. This new eddy was called A28 again. The eddy's centre moved quickly northward to 40° N and then occupied a stationary position. A28 eddy will probably define conditions in the southern Kuril region in summer 2005.

Flux of methane to the atmosphere from the Okhotsk Sea

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It is known that methane concentration is growing in the atmosphere by about 1% per year. Methane creates a greenhouse effect that contributes to Global Climate Change. What is the source of methane in the Okhotsk Sea? Previous investigations of methane distribution in water columns of the Okhotsk Sea (1984-2004) and the monitoring of methane have shown that the methane flux from the interior to the water column increases during a period of seismo-tectonic activity. In this case, fault zones open and gas hydrates destroy. Methane goes from the decomposition of gas hydrates to the water column and creates sound-scattering flares (acoustic anomalies) in an echogram. Methane flare concentrations in water columns are usually high, 10000-20000 nl/l or more. From oil-gas bearing layers, methane migrates via fault zones to the water column as well as seeping out of vents with and without acoustic anomalies, correspondingly. Methane anomalies (500-2500 nl/l) form in bottom water and upper layers of the water column. As a result of our investigations, we found the following:
1. Sources of methane are oil-gas bearing sediments, discharges of gas hydrates and modern bacteria-generating production. 2. Methane anomalies exceed background values by about 10-10000 times. 3. The flux of methane goes from sediments to the water column and to the surface and to the atmosphere mostly in the shelf area. More methane occurs in the spring and autumn seasons. Therefore, the methane flux from the Sea of Okhotsk will increase the methane concentration to the atmosphere which will add to the greenhouse effect and drive Global Climate Change. Methane will also increase during the period of seismo-tectonic activity this area.

Bidecadal variability in the intermediate waters of the northwestern subarctic Pacific and the Okhotsk Sea in relation to the 18.6-year nodal tidal cycle

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Using historical oceanographic data, we investigated the long-term variations of the intermediate waters in the four regions in the northwestern subarctic Pacific: Oyashio (OY), Okhotsk Sea Mode Water (OSMW), Upstream Oyashio (U-OY) and East Kamchatska Current (EKC). We found bidecadal oscillations in various water properties that are synchronized with the 18.6-year nodal cycle. In periods when the diurnal tide is strong, apparent oxygen utilization (AOU) and phosphate are low in OY and OSMW, and the thickness of the intermediate layers is large in OY, OSMW, and U-OY. Around the mesothermal (temperature maximum) water, potential temperatures are low in the areas on the Pacific side, and high in OSMW. The mixing ratio of OSMW in the U-OY water is high. These bidecadal oscillations can be explained by the vertical mixing around the Kuril Straits induced by the diurnal tide whose amplitude is modulated by the 18.6-year period nodal tidal cycle. Higher sea surface salinity (SSS) water around the Kuril Strait caused by stronger tidal mixing is transported northward along the cyclonic Okhotsk Sea Gyre, and possibly enhances the formation of the dense shelf water (DSW). This makes AOU, phosphate and potential vorticity lower in OSMW and OY.

Meridional mass and heat transport across the 38-40°N line in the East/Japan Sea

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By combining velocity estimates at 700m levels from Argo data, and geostrophic calculations from a CTD section made across the East/Japan Sea between 38-40°N in 1999, we were able to obtain a section of absolute zonal velocity. In general, barotropic components are dominant especially below the thermocline, since the vertical stratification is very low. The velocity section well reflects the meander of the flow along the polar front. The total volume and heat transports through the section are 1.6 Sv and 0.15 PW respectively. These numbers are smaller than those estimated in the Korea Strait by 30 to 40% because the CTD section does not capture the strong and narrow currents along the Korean and Japanese coasts. A meridional overturning stream function estimated from the velocity section shows that a meridional overturning circulation exists about 1 Sv below the thermocline.

On the problem of bottom water formation on the shelf of Peter the Great Bay (Japan/East Sea) in spring

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Variability of water structure on the shelf and at the continental slope is investigated using data from two surveys carried out in Peter the Great Bay in late April of 2004 and 2005. The basic water masses of the area were determined and their distribution was considered. The year 2004 was peculiar in the sense that water stratification remained rather strong for the spring period. The Surface Coastal water mass was observed down to a depth of 30-50 m. Intermediate and bottom layers on the shelf were occupied mostly by Deep Shelf water. Bottom Shelf water with a thickness of 5-20 m from the bottom and high density (temperature 0.0 to -0.6°C, salinity 34.00-34.12 psu), occupied a sufficiently large area in the center of the Bay between isobaths 40-90 m. This water was formed as the result of winter convection and, most likely, was slowly displaced downwards on the slope. The Japan/East Sea Proper water was observed near the continental slope below the 50 m horizon. In the spring of 2005 the conditions differed considerably. Water stratification was weak. Influx of subarctic waters to the central and southern parts of the Bay was traced in the surface layer. The Surface Coastal water was replaced to the northern part of the Bay. Water temperature at the surface of the Bay was 0.5-1.5°C below

that in the previous year. Strong downwelling was observed near the frontal zone between Surface Coastal and Surface Subarctic waters. The downstream caused fast destruction of the Bottom Shelf waters, which were observed in the western part of the Bay with the temperature only 0.1 to -0.8°C and salinity 33.96-34.04 psu. Water temperature near the bottom on the shelf was 0.5-1.0°C higher than in the previous year. The intensive advection of shelf waters to the continental slope area was noted. These waters were traced at a distance of 10-15 miles from the slope at the 80-350 m layer. Water temperature near the continental slope in this layer was 0.7-1.2°C lower than in the last year. The hydrological situation of 2005 was the consequence of an anomalous early establishment of a summer monsoon and its high intensity. In April the frequency of winds in the southern quarter was 74 %, and 48 % the wind rate was >10 m/s. In the same period of the previous year winds in the southern quarter were only 24 % and their rate and usually did not exceed 10 m/s. Thus, besides winter processes, spring processes are also concluded to be an important factor controlling deep water formation and ventilation. Slope convection can be cancelled by vertical mixing and downwelling in spring which limits deep layer ventilation. On the other hand, downwelling is an effective mechanism for the shelf bottom ventilation.

PICES XIV   POC_Paper-2296   Poster
Research on Bering Sea geostrophic circulation from satellite altimetry data: Two approaches to solving the problem

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In order to find the best way to analyze water dynamics in the Bering Sea using satellite altimetry data, two ways of calculating geostrophic currents are considered:
1. Calculation of geostrophic currents using the sea surface height from satellite altimetry data and the geoid model.
2. Calculation of geostrophic currents using the average climatic field of geostrophic currents constructed from Levitus climatology and from sea level anomalies calculated from satellite altimetry data.

A comparison of the results of current calculations using these methods with the survey data of the R/V *TINRO* (25 June – 27 September, 2002) was done. The results of the analysis showed that:
- from constructed charts of the currents using the ocean climatology, and from constructed charts of the currents constructed using the geoid model, all basic dynamic formations allocated on oceanologic survey data were observed;
- geostrophic currents estimated with the ocean climatology better correspond to the currents estimated according to oceanologic survey data;
- the greatest distinctions for the currents calculated from the ship data and currents calculated from the satellite altimetry data are observed in the shelf zone of the Bering Sea;
- on charts of the geostrophic currents constructed from the ship data, small-scale formations in some cases are not displayed owing to the large distance between oceanological stations.

PICES XIV   POC_Paper-2344   Oral
Numerical study of the general circulation in the Japan/East Sea with simple assimilation of temperature and salinity data

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The numerical model of the Japan/East Sea seasonal variation was performed by means of a regional ocean circulation model. The main objective was to get a better understanding of the Japan/East Sea dynamics and thermodynamics on the basis of the available Generalized Digital Environmental Model (GDEM) dataset of climatological temperature and salinity annual variations. The study focuses on the following issues: a) the analysis of seasonal variation associated with varying Tsushima Strait transport and annual variability of the wind stress; b) the salinity belt structure produced by reverse motion of the Tsushima warm and salty water, its origin and dynamics; c) the Japan/East Sea intermediate water dynamics and its dependence on the seasonal variation of the subpolar front strength. The model results show that seasonal factors like winter convection, strong monsoon and weakening subpolar frontal currents are responsible for the intermediate water spreading

from the region of their origin off Peter the Great Bay. The thermohaline property of this water is a result of a mixture of northern cold and less saline flow with salty and warm water intruded into the northern gyre system due to changing inflow-outflow balance among major straits.

PICES XIV   POC_Paper-2381   Poster
Especially dangerous wave heights and safety of the fishing fleet in the Northern Pacific

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Big waves are more often the cause of vessel and cargo loss in the Northern Pacific. Especially dangerous heights of 8 m and more dampen the success of the trade fishery in the Northern Pacific. For successful fishing, it is necessary to know the distribution and the time of appearance of especially dangerous wave heights. Dangerous wave heights are observed during the cold season, especially from November to February. Two zones of maximum frequency for especially dangerous heights occur in the West and East of the Northern Pacific. Understanding the peculiarities in distribution and frequency of dangerous wave heights will allow us to provide security to fishery ships in the Northern Pacific.

PICES XIV   POC_Paper-2383   Poster
Ice formation is especially dangerous for fishing boats in the Northern Pacific and for the safety of the fishing fleet

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Ice formation (or icing) is especially dangerous to fishing boats in the Northern Pacific. Dangerous icing of the boats occurs when intensive accretion of ice results in more than 4 t/hour and occurs when:
   a)   the speed of wind is higher than 15 m/s and the air temperature is lower -3° C.;
   b)   the wind speed is from 9 to 15 m/s and the air temperature is lower 8° C.
In the Northern Pacific especially dangerous icing is observed along the eastern seacoast of Kamchatka Peninsula, Kuril Islands and the extreme North East Pacific, and by the North American sea coast, mainly in winter. This ice formation (icing) on boats is the cause of boat loss, diminishes the effectiveness of Fishing Fleet activity, and decreases the fishery owing to the unfavourable conditions. The possible use of icing maps of the North Pacific by fishing boats to avoid dangerous zones is considered.

PICES XIV   POC_Paper-2319   Oral
Ocean surface waves play an essential role in air-sea interaction from an atmosphere-wave-ocean coupled model

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Previously, most ocean circulation models have overlooked the role of the surface waves, and thus have produced insufficient vertical mixing. As a result, nearly all the ocean circulation models face some common problems such as when the simulated summertime SST is overheated, the simulated mixed layer is too shallow and the strength of the thermocline is too weak due to insufficient mixing in the upper ocean compared with observations. As the ocean surface layer determines the lower boundary conditions of the atmosphere, this deficiency has severely limited the performance of the coupled ocean-atmospheric models and hence the numerical studies of climate. For example, the simulated cold tongue in the tropical Pacific is too cold for all atmosphere-ocean coupled numerical models. Recently we developed a 3-D wave-circulation coupled theoretical model, and set up a wave-circulation coupled numerical model and an atmosphere-wave-ocean coupled numerical model. With a third generation wave numerical model, the wave-induced vertical viscosity and diffusivity are calculated.

The wave-circulation coupled numerical model results indicate that the wave-induced vertical mixing can penetrate down to 100m depth. In boreal summer the wave-induced mixing is strong in the southern oceans

south of 30°S, and in boreal winter it is strong in the North Pacific and the North Atlantic north of 30°N, as well as in the southern oceans south of 40°S. The new scheme has enabled the mixing layer to deepen, the surface excessive heating to be corrected, and excellent agreement with observed global climatologic data has been achieved. For example, with the wave effect considered, the mean correlation coefficient between simulation and Levitus data in the upper 100m along a section of 35°N in the Pacific and Atlantic Oceans is raised to 0.93 from 0.68 without wave effect. In the southern hemisphere, similar results are achieved. The atmosphere-wave-ocean coupled numerical model results indicate that the too cold tongue in tropical Pacific is much improved, and the sub-arctic region may play a much more important role in climate change than previous understood.

All these results suggest that ocean surface waves can greatly improve the performance of numerical models in the upper ocean. Our study indicates that surface waves are essential for mixed layer formation, and that they are the primary drivers of upper ocean dynamics. Therefore, surface waves play a critical role in the climate studies.

PICES XIV   POC_Paper-2386   Oral
Realtime monitoring of oceanic state variables in Kangjin Bay, South Sea, Korea

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A realtime (RT) monitoring system for oceanic state variables was developed and has been operating since April, 2004 in Kangjin Bay, South Sea, Korea. The RT production of a data stream and display on an Internet web page is made possible in continuous functions of various system elements. Detailed technical information for the RT monitoring system is described in Ro *et al.* (2004). The water quality parameters, current and meteorological conditions are continuously monitored with very high sampling resolution (10 min) throughout the year and are being published on internet web pages (http://oceaninfo.co.kr/kangjin). This study focuses on the formation of the hypoxia in the shallow Kangjin Bay in the South Sea by understanding the oxygen supply and consumption processes in the water column and at the bottom sediment interface in connection to the pulse type Dam water discharge during the monsoon summer season. The occurrence of the hypoxia caused by water discharge in the Bay is suspected to cause the dramatic mass death of local shell-fish. This study will elucidate a series of physico-chemical processes and their implications for the local eco-system. We have found a very significant and striking mechanism for the formation of the hypoxia in Kangjin Bay which was driven by the abrupt dam water discharge with large volume. This has caused a strong halocline (pycnocline) which has then inhibited the supply of aerated surface water into bottom layer where consumption of oxygen is taking place by the organic sediment oxygen demand. The series of the physical processes were observed from field work records of vertical profiles of water quality, and tidal current and bottom sediment analysis.

PICES XIV   POC_Paper-2452   Poster
Structure of seawater properties profiled by the Argo floats in the Ulleung-do area (East/Japan Sea), 2003-2004

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This study analyzed the temperature-salinity structure around Ulleung-do Island (UI) waters by using all CTD profiles obtained by Argo floats in the period of 2003. 10. to 2004. 9. The raw CTD data were calibrated and tested for error contamination and quality controlled data were then compared to Korean Oceanographic Data Center (KODC) data obtained in the same period and to the climatology dataset, Generalized Digital Environmental Model (GDEM) published by the U.S. Navy. The comparison between Argo profile data and KODC shows good agreement, while that between Argo and GDEM shows a salinity discrepancy up to 0.15 psu. The waterbody in the upper 800 m around Ulleung-do Island turned out to be composed of three major water masses, which is in accordance with traditional water characteristics. In the upper layer, there exists a water mass of higher temperature and lower salinity in the western part of the UI which is under the influence of summer-time Tsushima warm water diluted by the river runoff. The salinity below 300 m appears very homogeneous in all salinity profiles and is less than 34.1 psu, while the temperature shows larger variance of up to 9.0°C. The behavior of three Argo floats released in the western part of UI shows striking differences in that their fates and trajectories diverged into three different paths depending on the water masses they rode. The

CTD profiles obtained with the high sampling rate by Argo floats provides us with more information to understand the spatial-temporal variability of seawater properties in the study area.

PICES XIV   POC_Paper-2470   Poster
Structure of an anticyclonic eddy in the southern Kuril Islands region and its influence on water dynamics and the saury fishery

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The evolution of an anticyclonic eddy in the southern Kuril Islands region during the year 2000 is considered from satellite (infrared) IR and altimetry data. The eddy started to form off Cape Inubo in 1997 and disappeared at the end of 2000. Within the period of observations (January-November, 2000), the eddy had passed 260 miles northeastward with an average velocity 0.75-0.80 miles/day. The maximal velocity of its movement was observed in late April and in May (1.3 miles/day). The spatial scales of the eddy were 90-130 miles. The rotating current inside the eddy had a velocity up to 70 cm/s, according to the satellite altimetry data.

Oceanographic data from the R/V *Boso-maru* (Japan) obtained from 2 sections crossing the eddy in August 3-5, 2000 were used for analysis of the eddy structure. The eddy features were observed in the whole 1000-meter water column. Maximal geostrophic velocity inside the eddy (23-38 cm/s) was observed in the 70-120 m layer. The thermohaline structure of the eddy is described in detail.

Under the influence of the anticyclonic eddy, water dynamics of the southern Kuril Islands region essentially changed: water transport by the first branch of Oyashio decreased considerably and sometimes this branch disappeared; the main Oyashio flow shifted to the second branch of the Oyashio. These changes in water circulation are the reason for saury fishing grounds formation on the ocean side of the region (on the Subarctic front to the east from 148-149°E) and for the Russian saury fleet moving to the ocean in October–November of 2000.

PICES XIV   POC_Paper-2523   Poster
Methane anomalies in the Okhotsk Sea

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Research is aimed to explore the features of fossil methane emission and distribution induced by modern regional and local variable geological settings in the Okhotsk Sea. Tectonically generated pathways related with hydrocarbon sources (oil-gas deposits, gas saturated sediments, gas hydrates, coal bearing sediment complexes and others) are considered to be the main structures of methane leaking to the water column. Three basic geological patterns controlling methane emission are pointed out: sporadic single local vents/flares within the intersections of the disjunctives, wide areas of methane steady seepage through the grids of local faults over oil-gas deposits and methane emission via the abrasion zones of folded structures. Methane anomalies (up to 30,000 nl/l) were found in all water masses of the sea but their spatial varieties have genetic relations with different hydrocarbon sources which suggests a high permeability of active fault zones and geodynamic, seismic and geochemical activity in some areas, especially along the western Okhotsk Sea.

PICES XIV   POC_Paper-2583   Poster
Monitoring of baroclinic circulation conditions and ice cover by GIS methods in the Far Eastern Seas

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Applying methods of modern GIS technology, complex maps of atmospheric pressure distributions above the earth and their anomalies in January-February, as well as the localization of the ice edge in Japan/East, Okhotsk,

Bering seas in March of 1997-2003, were compiled. An analysis of baroclinic circulation processes above the Asian-Pacific region (60^0 E – 160^0W, 20 – 80^0 N) was carried out and the spread of the ice is assumed to clear up these inter–annual differences. They appear generally in the position and intensity of the Siberian anticyclone and Aleutian Low. Especially evident distinctions were found in the above-earth fields and location of the Siberian anticyclone, as well the Aleutian Low centers in the years of extreme ice cover. It was determined that extreme low ice cover in the Okhotsk sea during 1997, when the area of ice cover was 53,7 % in March, originated in the weak intensity of the Siberian anticyclone and a shift of the Aleutian Low to the East. The main cause of extremely high ice cover in the Okhotsk Sea during 2001, when area of ice cover equaled 97,6 %, was a shift to the north and sharp drop in pressure of the Aleutian Low in February, when the anomalies in a small area reached minus 11 gPa. In the Bering Sea, the year 2001 was featured by extremely low ice cover, in which the ice cover area totaled only 31 %. This phenomenon was due to the Bering Sea being under the influence of the front part of cyclones that are forming the Aleutian depression.

PICES XIV   POC_Paper-2268   Oral
Seasonal variability of oceanological conditions in the southern part of the Okhotsk Sea from CTD surveying on standard section Cape Aniva – Cape Dokuchaev

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Regular observations on a standard oceanological section give us excellent data for investigating seasonal and interannual variations of fish and other types of marine biota habitat. The section Cape Aniva–Cape Dokuchaev (AD), which crosses the southern part of the Okhotsk Sea from the southeastern end of Sakhalin Island to the northeastern end of Kunashir Island, is the most informative among sections of the Sakhalin shelf. This section also crosses zones of the East Sakhalin Current and Soya Warm Current. Multiyear mean temperature and salinity distributions on the AD section in May were analyzed to describe oceanological conditions in spring. We have found that the influence of the Soya Warm Current in May is relatively weak. The cold intermediate layer is well-expressed. Low salinity waters were found in the upper 50-meter layer being formed as a result of sea ice melting. The influence of Soya Warm Current is very significant in the southeastern part of the AD section in summer; the Japan/East Sea warm waters were observed in the upper 200-meter layer on the shelf of Kunashir Island. At the same time, we have found the cold intermediate waters with temperature -1.3°C on the shelf of Sakhalin Island. The East Sakhalin Current transports relatively warm and fresh Amour River waters to the southern part of the Okhotsk Sea in the fall season. The cold intermediate layer is destroyed in November. At the same time, the influence of the Japan/East Sea warm waters is significant on the shelf of Kunashir Island. We have also analyzed ADCP current data that were measured near Cape Aniva and Cape Dokuchaev.

PICES XIV   POC_Paper-2411   Oral
Distribution and transport variations of source waters for North Pacific Intermediate Water formation revealed by multiple tracer analysis

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In order to reveal time and spatial variations in the distribution and transport of the source waters for the North Pacific Intermediate Water (NPIW) formation, we calculated the source water components by multiple tracer analysis and examined their transports off the east coast of Japan. In each season of 2001, hydrographic observations were made on a repeat section called the Oyashio intensive observation line off Cape Erimo (OICE), which extends southeastward from the Hokkaido coast. A least square multiple tracer analysis using temperature, salinity, oxygen and potential vorticity was applied to calculate isopycnal mixing ratios at densities 26.7 - 27.3 σ_θ among three source waters, which are defined as the Okhotsk, East Kamchatka (EK) and Kuroshio waters, respectively. Combining the mixing ratios with geostrophic currents referred to 1500 dbar, we calculated their transports across OICE. In the mixing ratio distribution, it is clearly seen in any season in the Oyashio area that the EK component increases with depth/density while the Okhotsk component is almost confined at 26.7-27.0, suggesting that they are mixed to form Oyashio water with a different mixing ratio at each density. In the transports contributing to NPIW formation, the Okhotsk and EK components commonly have a clear seasonal signal, with a maximum in winter and minimum in summer, whereas we cannot see any

significant seasonal signal in the Kuroshio component. In an annual average, the NPIW-contributing Okhotsk transport (3.5 Sv for 26.7 - 27.3 σ_θ) is larger than the EK transport (1.5 Sv).

PICES XIV   POC_Paper-2592   Poster
Daily variation of abnormal ocean conditions in the northwestern Pacific Ocean using NGSST satellite data

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The New Generation Sea Surface Temperature (NGSST) Development Group (Leader: Hiroshi Kawamura) has been working on a new satellite-based SST product, which utilizes benefits of the modern satellite/*in situ*-based ocean observing systems and overcomes weaknesses of the present operational SST products since 2000 (Guan and Kawamura, 2004). Real-time generation and distribution of the new SST products for open oceans have started.

The daily variations of SST in the northwestern Pacific Ocean were studied in this paper. Spatio-temporal variations which have global and short-term changes were captured by NGSST, in particular with respect to the abnormal phenomena such as cold water extension in the Yellow Sea, local heating in the East China Sea, cold and warm water patches caused by typhoons in the East/Japan Sea, and huge tidal fronts in the Kuril Islands. Local heating occurred on the surface layer in the East China Sea for 15 days (August 4-18, 2004). The surface cooling of cold water lower than 10m suddenly extended from the coast of Shanghai-Qingdao in China to the southeastern part in the East China Sea for 5 days (March 25-28, 2005). A huge cold water mass lower than 10m temporally variated in the Kuril Islands for 6 days (August 26-31, 2004). Abnormal cold and warm water caused by typhoon Megi occurred in the East/Japan Sea for 7 days (August 19-25, 2004). The occurrence of daily abnormal ocean conditions are caused by typhoons, monsoons, sea surface wind, low salinity and tidal currents in the northwestern Pacific Ocean.

PICES XIV   POC_Paper-2460   Oral
Spatial phytoplankton distributions affected by eddy dynamics in the Eastern Kamchatka Current and Oyashio regions during the spring between 1998-2004

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In this study, we use satellite multi-sensor remote sensing to investigate the relationship between the eddy field and the distribution of phytoplankton biomass in the Eastern Kamchatka Current (EKC) region during the spring between 1998-2004. We employed ocean color (Chlorophyll-*a* (Chl-*a*), SeaWiFS), photosynthesis active solar radiation (PAR, SeaWiFS), sea surface temperature (SST, AVHRR), and sea surface height anomaly (SSHA, AVISO) datasets. Primary production was calculated using the vertically generalized production model (VGPM) of Behrenfeld and Falkowski (1997). Phytoplankton biomass in the EKC region was the highest in the western sub-arctic gyre region during the spring. The distributions of phytoplankton biomass were different for each year. On the other hand, a number of mesoscale eddies propagated from the western Bering Sea or the Aleutian chain. The positions of eddies affecting surface flow also differed for each year. Our results indicate that high chl-*a* regions would be transported to offshore by the anticyclonic eddy which is located along the south-eastern Kamchatka Peninsula. While the anticyclonic eddy was identified near shore during spring in 1998-2002 and 2004, its location was offshore in 2003. Therefore high chl-*a* distributions show different spatial patterns reflected by the eddy field. These results suggest that the spatial eddy field should affect high chl-*a* regions. Further analysis may be achieved to clarify the spatial relationships between high chl-*a* regions and the eddy field.

A review of the investigation and study on Yellow Sea circulation

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The Yellow Sea is a shallow semi-closed shelf sea, which is adjacent to the East China Sea on the south and connected to the Bohai Sea on the north. The bottom topography of the Yellow Sea is characterized by the Yellow Sea trough stretching from southeast to north with a water depth of 70m to 100m, on both sides of which the isobaths are basically parallel to the coastline with quite a slope on the east side and a wide shallow water area on the west side. The Yellow Sea is affected little by the Korushio. In the Yellow Sea, the tidal current is dominant and the residual current is very weak with a speed of less than 5cm/s and quite unstable in direction. Thus, it provides difficulties for observing and studying the Yellow Sea circulation. As well, there are many fisher-boats and very active fishing activities all year round in this region and this brings lots of risks to long-term continuous observational moorings. Up to now, Yellow Sea circulation is not well understood due to limited of current-observing data. There are still serious controversies remaining on Yellow Sea circulation. In this paper, the investigation and study on Yellow Sea circulation are reviewed and some argued questions will be put forward.

Interannual variability of cold and warm seasons and their duration in the North West Pacific

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The important factors determining the development of production processes in the ocean are the beginning, duration and ending of the phenological seasons. These characteristics vary from year to year. The sea surface temperature (SST) is a well illustrated characteristic for them, as it is the parameter resulting from ocean-atmosphere interaction. The analysis of weekly SST maps for the North West Pacific (including the Okhotsk and the Bering Seas) allowed us to reveal some essential interannual differences in the character of winter cooling and summer warming. An important regularity was found: interannual variability of seasonal dates at the beginning is opposite in sign to the variability of their duration. Thus, the earlier a season begins, the longer it will stay (and *vice versa*). This regularity allows a rather early prediction of the end of the current season. The beginning of a season was considered as the crossing of a chosen latitude or longitude by a chosen isotherm. The persistent duration of this isotherm was chosen to estimate the seasonal duration. Variability of ice conditions in some regions of the above-mentioned seas follows the same regularity. Therefore, it can also be used to predict the time of ice edge retreat for such regions as the West Kamchatka and South Kuril Islands (Sea of Okhotsk), St. Mathew Island and 62°N (Bering Sea). For the Bering Sea a trend to shortened cold seasons was detected.

Water mass transformation in the Japan/East Sea

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The changing of climate influences the thermohaline structure and ecosystem of the Japan/East Sea. The idea for this study is that by calculating the vertical mass flux as a function of the density of the surface water rather than as a function of location, it is possible to deduce the amount of water mass formed or modified in any given density range by air-sea fluxes of heat (H) and fresh water (E-P). Our aim is to estimate the formation rate of water with density similar to intermediate water.

NCEP/NCAR reanalysis data are used to estimate the rate water mass transformation in the Japan/East Sea from 1948 to 2002. The amount of surface water that sinks and forms the intermediate mass is defined. We found

that the formation rate of water with the density of High Salinity Intermediate Water ($\sigma_\theta > 27,3$) decreased and the formation rate of water with density 26.9–27.3σ_θ increased. Some of this water sinks to form Low Salinity Intermediate Water. The total formation rate of intermediate water has not changed considerably from 1948 to 2002. Comparison of the formation rate with atmospheric indices shows that the formation of the High Salinity Intermediate Water is primarily influenced by the Siberian High, which is associated with the Arctic Oscillation, and, secondarily influenced by the Aleutian Low.

PICES XIV   POC_Paper-2273   Oral
Seasonal and interannual variation of currents in the western Japan/East Sea: Numerical simulation in comparison with infrared satellite imagery

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The Japan/East Sea is a mid-sized East Asia marginal sea, while its current system is similar to that of large-scale oceanic circulation. In particular, the Sea has its own system of western boundary currents (WBC), the northward East Korean Warm Current (EKWC) and southward cold Primorye (Liman) Current and its continuation, North Korean Cold Current. After the separation from the western coast, the WBCs converge, forming a zonal Subarctic Front. The circulation in the northwest Japan/East Sea, where the separation occurs, is highly variable both on seasonal and interannual timescales (Zuenko, 1996, 1999; Danchenkov *et al.*, 1997; Lobanov *et al.*, 2001; Nikitin and Kharchenko, 2002). In this study, the focus is on the seasonal variation of the separation latitude and Subarctic Front and on seasonal and interannual variation of currents off Vladivostok and North Korea (in the area north of the separation latitude). Numerical simulations are performed with the use of the Marine Hydrophysical Institute (MHI) oceanic model (Shapiro and Mikhaylova, 1992). Monthly buoyancy and 1998-2000 wind forcing is applied, based on data from NCEP Reanalysis and Global Precipitation Climatology Projects. The simulated EKWC intensifies in late summer–autumn when the increased non-linearity facilitates the onset of separation and the separation latitude shifts southward. Simulation results suggest that variations in currents off Vladivostok and North Korea can be associated, to a considerable extent, with the change of wind. The simulation results are confirmed by patterns derived from the A-Highers SST (Sakaida *et al.*, 2000) and New Generation SST (Kawamura *et al.*, 2005).

PICES XIV   POC_Paper-2284   Poster
Analysis of seasonal variability of hydrodynamic structures in the Sea of Okhotsk and their dependence on baric systems in the atmosphere

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In the given study an attempt has been made to analyze hydrodynamic structures in the Okhotsk Sea on the basis of numerical experiments using a quasistationary baroclinic model (Vasiliev, 2002) and a classification of the baric systems (Polyakova, 1999). In brief, the essence of the method is in the following: a prognostic model is created using the principles of self-similarity or vertical similarity, *i.e.* it is just a function of their stratification. The input information for the model is a global array of the monthly averaged climatic data of surface temperature and salinity in the nodes of a regular $1^0 \times 1^0$ grid, and average monthly fields of the atmospheric pressure, corresponding to certain types of the baric systems. Bottom topography, coast-line framework, water-exchange on the liquid margins, β-effect, coefficients of the vertical and horizontal turbulent exchange are also considered. This classification of synoptic processes is based on the dislocation of the main trajectories of cyclones over Far Eastern Seas and the North Pacific.

Analyses of charts for the transport streamfunctions have shown that the study areas are characterized by quasi-stationary hydrodynamic characteristics not dependent on atmospheric circulation, and specific hydrodynamic features dependent on atmospheric baric systems originating over the ocean surface. The common feature for all charts is the cyclonic activity in the Okhotsk Sea with a mosaic of anticyclonic whirls near the South Kuril Islands. The specified hydrodynamic regime creates optimum conditions for active fishery development in the investigated water area.

A first look at the new IPCC AR4 climate model simulations over the North Pacific

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The 20th century and future climate system are assessed based on 56 ensemble runs from 19 coupled atmosphere–ocean general circulation models (AOGCMs) and their corresponding control runs. All models simulated the late 20th century warming to various degrees and 60 % of the models produce about the right level of variance for wintertime surface temperature anomalies. Models with the best simulations generally have better resolution of surface land and sea ice processes. Spatial and temporal distributions of warm anomalies are different among the ensemble members, but similar to observed intrinsic variability. For future scenarios two approaches are taken. We first look at the large scale patterns of SST and climate indices such as the Pacific Decadal Oscillation, the Pacific North American pattern and the Aleutian Low relative to the background variability from their control runs. In the second approach we investigate upscaling of parameters important to the ecosystem for the Bering Sea; these include surface radiative, sensible and latent heat fluxes, wind speed cubed, sea ice parameters, north-south wind components and the curl of the wind stress.

Seasonal hypoxic zone adjacent to the Changjiang Estuary

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There is a large south-northward hypoxic zone adjacent to the Changjiang Estuary during the warm season, similar to other large runoffs in the world. Dramatic low dissolved oxygen (DO) concentrations, less than 0.8mg/l, were found during the cruise of September 2003. The hypoxic zone (DO<2mg/l) was about 2×10^4 km^2 along the 20-50m isobaths. SBE 911$^+$ CTD casts were carried out at 32 stations and Chl-*a*, turbidity, and DO concentrations were measured at the same time as temperature and salinity in order to examine the relationship between the hydrological environment and the hypoxia. There is a complex water mass system in this area: the Changjiang discharge plume, with high nitrate and ammonia concentrations, runs to the north-east of the estuary in a 5m surface layer. Water with salinity less than 30 can have an influence on Cheju Island. Under this water mass lies cold water (sal<32, temp<16^{0}C) from the Yellow Sea that intrudes to the inner shelf along the 50-m isobath. High salinity water (sal>34) from Taiwan Strait runs to the north along the coastal side of the 50-m isobath at the bottom. It returns to the south-east when it reaches the 32^{0}N latitude. A high Chl-*a* concentration band was found but did not match the hypoxic zone very well. Lowest turbidity is found in the isopycnocline and resuspended particulate material can almost not cross the isopycnocline. Particulates of dead algae in the upper layer were transported to other areas rather than being deposed and decomposing locally. The hypoxia occurred at the strong isopycnocline where the density difference is large due to the large salinity difference between Changjiang discharge (sal<24) and salty water from Taiwan Strait (sal>34). Strong stratification prohibits the mixing down of DO in the upper layer, that was obtained from the atmosphere or produced by algae growth. Particulate organic carbon (POC) in the lower water layer is advected by Taiwan Strait Water or decomposes in the sediment and consumes the DO to produce a hypoxia condition. It is so sensitive to meteorological conditions that no hypoxia was found after 3 days of the onset of north winds.

Changes in ecosystem in the western North Pacific associated with global warming

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To predict the effects of global warming on ecosystem dynamics and the effects of those changes on biogeochemical cycles, oceanic CO_2 uptake, and fishery resources, we need to develop 3-D global models which explicitly represent dynamics of oceanic circulation, ecosystems and fishes. We developed a global 3-D ecosystem model extended from NEMURO (North pacific Ecosystem Model Used for Regional Oceanography)

of PICES (North Pacific Marine Science Organization), which includes phytoplankton and zooplankton divided into two and three groups, respectively, and coupled with carbon and nutrients cycles. NEMURO has also been coupled with a fish bioenergetics and a population model for two species of pelagic fish. Using data sets of observed climatology and simulated fields (COA-GCM developed by CCSR/NIES) as boundary conditions for our ecosystem model, we conducted experiments for demonstrating the effects of global warming on ecosystems and pelagic fish. The model results show increased vertical stratification in the subtropic-subarctic transition zone associated with global warming. As a result, in the transition zone, primary production and diatoms as percentage of total phytoplankton drastically decrease at the end of the 21st century. In the biogeochemical cycles, rain ratio and e-ratio, a ratio of export production to primary production, are also drastically changed due to transition of plankton groups and warming. For Pacific saury, a popular fish in Japan, global warming leads to a decrease in its body length and change in its migration route.

PICES XIV   POC_Paper-2487   Oral
Possible mechanism of bi-decadal North Pacific ocean/climate variability in relation to the 18.6-year period nodal cycle

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Bi-decadal oscillation is known to be dominant in inter-decadal mid-latitude North Pacific climate variations, and influences the ocean as well as marine ecosystems. Osafune and Yasuda (2005) discovered bi-decadal oceanic fluctuations in the intermediate waters in the Oyashio and Okhotsk Sea around the Kuril Islands where strong diurnal tides enhance diapycnal mixing that could be modulated with the 18.6-year period tidal cycle. Sea-surface temperature and salinity around the Kuril Islands and the body lengths of the C5-stage *Neocalanus cristatus* and *N. flemingeri* in the Oyashio also change during the 18.6-year cycle. These bi-decadal oceanic signals precede the bi-decadal component of climate indices such as North Pacific, Pacific Decadal Oscillation and East-Asian Monsoon by a few years. A new hypothesis is here proposed, linking the 18.6-year tidal cycle with the North Pacific climate variability through the changes of North Pacific Intermediate Water circulation and poleward heat transport by the oceanic western boundary currents. Waters with higher salinity around the Kuril Islands during the time when the diurnal tide is stronger could be transported northward to enhance dense shelf water formation. This might change the oceanic heat transport and fronts along the Oyashio and the Kuroshio, and lead to bi-decadal climate variability.

PICES XIV   POC_Paper-2322   Oral
Typical distribution of interannual variations of water temperature in the active layer of the Okhotsk Sea and their possible prediction

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Fluctuations in oceanographic parameters can generate either favorable or adverse conditions for the living organisms. Knowing the features and regularities of the long-term variability of oceanographic conditions is the urgent topic of the sea ecosystem study. While studying interannual variability of the Okhotsk Sea thermal conditions and possibility of their prediction we used a hypothesis that water temperature anomalies in the active layer of the sea form in winter time. We also assumed water temperature anomalies (at subsurface horizons) to be traced for a long time within a year and spread over extended area. We used all available oceanographic data obtained by research institutes of Russia, Japan and USA (more than 95,000 oceanographic stations carried out from 1930 to 2004).

Based on the prior EOF decomposition of water temperature fields at a 50m horizon (Luchin, Zhigalov, Plotnikov, 2003), we estimated anomalous thermal conditions between 1950 and 2001. According to estimations, 1951, 1955, 1958, 1959, 1966, 1967, 1973, 1976-1978, 1999-2001 might be attributed to cold years; 1950, 1952-1954, 1957, 1960, 1962, 1965, 1969-1971, 1975, 1979, 1980, 1982, 1983, 1985, 1986, 1988-1990, 1992, 1993, 1995, 1996, 1998 – to normal years; and 1956, 1961, 1963, 1964, 1968, 1974, 1981, 1984, 1987, 1991, 1994, and 1997 might be attributed to warm years. Normal years are the ones that meet correlation

/ΔT/ < 0.674σ, where ΔT is the product of the first temporal and spatial functions of water temperature decomposition by EOF and σ is the standard deviation. Cold years are the ones that meet correlation ΔT < -0.674σ, while warm years shall meet 0.674σ < ΔT correlation.

Then we compiled files of cold, warm and normal years and drew charts of average multi-year water temperature typical for every type of thermal condition. We used indices of macro-scale climatic changes in the Northern Hemisphere atmosphere and hydrosphere, ten-day and monthly ice conditions in the Okhotsk Sea, surface water temperature near the northern and central straits of the Kuril Ridge as the factors that might influence interannual variability of the active layer thermal conditions. We also analyzed correlation between multi-year variability of the Okhotsk Sea thermal conditions and biological parameters that characterize fluctuations of some of the hydrobionts (pollock, herring, euphausiids).

BIO Poster Session

Convenor: Michael J. Dagg (U.S.A.)

Posters on various aspects of biological oceanography in the North Pacific and its marginal seas (excluding S2 & S3 topics) are welcome.

Wednesday, October 5, 2005 18:00-20:00

Denis A. Akmaykin and Pavel A. Salyuk
Statistical structure of biooptical parameters of the surface layer at the Japan and Okhotsk seas (BIO_Poster-2473)

Evgenyi I. Barabanshchikov
Zooplankton and marginal filters of estuarine systems of Primorye (BIO_Poster-2553)

Ludmila S. Belan
Distribution of macrozoobenthos at the North-East Sakhalin Island shelf in 2003-2004 (BIO_Poster-2391)

Irina Yu. Bragina, Valery N. Chastikov and Olga V. Shershneva
Influence of seasonal and interannual environmental changes on the structure of zooplankton community of Aniva Bay and adjacent deep-water area (1987-2005) (BIO_Poster-2554)

Gennadyi A. Shevtsov, Oleg N. Katugin and Mikhail A. Zuev
Distribution of the large-sized boreopacific gonatid squid (*Gonatopsis borealis*) in the northwestern Pacific Ocean and adjacent marine areas (BIO_Poster-2325)

Tatyana Krupnova, Vladimir Pavlyuchkov and Vera Agarkova
Adaptation mechanisms of gray sea urchins and *Laminaria* coexistence (BIO_Poster-2370)

Tatyana Krupnova
Phenomenon "Isoyake" along the Far Eastern coast and the methods of control (BIO_Poster-2371)

Hyun-Ju Oh, Seong-Yong Moon, Jin-Yeong Kim, Yong-Kyu Choi and Yong-Hwa Lee
Intra-annual characteristics of the copepod community related to the ecosystem in the southern waters of Korea (BIO_Poster-2544)

Hee Won Park and Chang Ik Zhang
A study on the self-regulatory ecosystem management system in Korea (BIO_Poster-2467)

Kyum Joon Park, Chang Ik Zhang and Jong Hun Na
Changes in diet compositions of finless porpoise (*Neophocaena phocaenoides*) by growth in the west coast of Korea (BIO_Poster-2468)

Vladimir Pavlyuchkov, Tatyana Krupnova, Oksana Mikhailova and Aleksandr Popov
Measures for sea urchin stock preservation under their active fishing (BIO_Poster-2372)

Nataliya V. Pecheneva and Vyacheslav S. Labay
Some features of the main macrozoobenthic groups on the Okhotsk Sea shelf along the northeastern Sakhalin Island (BIO_Poster-2621)

Pavel A. Salyuk, Oleg A. Bukin and Denis A. Akmaykin
Monitoring of processes of dissolved organic matter production by phytoplankton using optical spectroscopy methods (BIO_Poster-2418)

Yugo Shimizu, Kazutaka Takahashi, Shin-ichi Ito, Shigeho Kakehi and Tomoharu Nakayama
Southward biomass transport of major subarctic copepods by Oyashio current (BIO_Poster-2408)

Hyoung-Chul Shin, Kang Hyun Lee, Kyung Ho Chung and Sung-Ho Kang
Zooplankton distribution along a transect off Sakhalin Island during early summer 2005 (BIO_Poster-2496)

Olga O. Kalata and Larissa S. Shkoldina
Seasonal dynamics of species composition and community structure of neritic copepods in Amursky Bay (Peter the Great Bay, Sea of Japan) (BIO_Poster-2395)

Larissa S. Shkoldina and Artur G. Pogodin
Structure and distribution of zooplankton of Sakhalin Bay and Academy Bay (Sea of Okhotsk) (BIO_Poster-2360)

Elena A. Shtraikhert and Sergey P. Zakharkov
Variability of chlorophyll-a concentration caused by wind upwelling in Peter the Great Bay in the autumn of 2003 (BIO_Poster-2316)

Alla V. Silina and Natalia V. Zhukova
Influence of organically enriched river run-off on the symbiotic community of scallops and polychaete worms (BIO_Poster-2335)

Statistical structure of biooptical parameters of the surface layer at the Japan and Okhotsk seas

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Satellite ocean color data from Sea-viewing Wide Field-of-view Sensor (SeaWiFS) are used. Investigation area is the Japan Sea and the Sea of Okhotsk. SeaWiFS level 2 data were analyzed for 2000-2005 years. 2-dimensional correlation functions of normalized water-leaving radiances (nLw) at wavelength 412, 443, 490 nm were calculated in floating (step 100 km) spatial circle (radius 50 km) window. Values of the correlation function on level 0.7 of maximum were fitted by ellipse function (named as correlation ellipse). Obtained correlation ellipses were plotted on geographical map. Daily and monthly map with correlation ellipses were made. Ellipses orients along nLw's field anisotropy. Ellipses are closed to circle in the case of isotropic nLw fields. Ellipses orientation shows common direction of currents. The anisotropy is high at the shelf regions and longer axis of ellipse generally directed along coastline. The anisotropy is low at the open part of investigating seas due to absence of strong steady currents. Regions with similar statistical structure were selected using such ellipse parameters as angle of inclination, extinction coefficient and one of the axis. In these regions similar hydro physical processes takes place. With the help of obtained correlation ellipses it is possible to conduct fast optimal interpolation of satellite data.

Zooplankton and marginal filters of estuarine systems of Primorye

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Estuaries are transitive zones between fresh-water and oceanic systems. Also, hydrological data show they are marginal filters where large amounts of organic and inorganic substances settle.   The mechanism of sedimentation is a difficult physical and chemical process and is connected, mainly, with changes in salinity. However it also has a biological component, involving zooplankton.

The concentration and species composition of zooplankton are unequal along the whole length of estuarine systems. Two zones (external and internal) are identified by different parameters, and the last one – includes three parts of the estuary (upper, middle and lower). The extent of each site depends on riverbed structure.

In the upper part of the internal estuary, zooplankton community structure is dominated by rotifers, both by biomass and by number. The freshwater fauna of planktonic animals dominates. Closer to the middle part, the quantity of cladocera increases and copepods also become numerous. An abundance of brackish water zooplankton species appears.   The lower zone of the internal estuary is characterized by the highest concentration of copepods, mainly particle filtering organisms. In this region there is a mixture of brackish water species with a great variety of sea species. Outside of the internal estuary, the biomass and numbers of planktonic animals sharply declines by one - two orders of magnitude.

Thus, the estuarine system by itself is a marginal filter and most of its suspended particles are filtered by planktonic organisms and settled as fecal pellets.

Distribution of macrozoobenthos at the North-East Sakhalin Island shelf in 2003-2004

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399 benthic species were found at the North-East Sakhalin Island shelf and slope in 2003-2004. Average benthos biomass varied from 499.2 to 1035.0 g/m^2, average density varied from 2212.6 to 12691.0 ind/m^2. The

highest biomass was observed on fine and medium sands, at the depth range 28-94 meters. Six faunal groups had the highest quantitative parameters: Polychaeta, Bivalvia, Amphipoda, Echinoidea, Actiniaria, and Cumacea. Cluster analysis detected the following bottom communities: *E. parma*, Actiniaria, Amphipoda, *D. bidentata*+Amphipoda, Spongia+Ascidia+Hydrozoa. Communities of *E. parma* and Actiniaria were found on the fine and medium sands at 200 meters depth along the coast. Communities of Amphipoda and Cumacea were situated in the south part of study area on the silty sands, at a depth of 90 meters. Sessile suspended feeders were situated in gravel sediment in the north part of study area at depths of 100-200 meters. Benthos of the North-East Sakhalin Island shelf in 2003 and 2004, as in the past years, were characterized by high species composition and high quantitative abundance.

PICES XIV   BIO_Poster-2554
Influence of seasonal and interannual environmental changes on the structure of zooplankton community of Aniva Bay and adjacent deep-water area (1987-2005)

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The study region is the northern part of La Perouse Strait and the southern deep-water part of the Okhotsk Sea. During 1987-2005, 29 surveys were conducted by a standard scheme of stations. A total of 880 zooplankton samples were collected using Juday nets ($0,1$ м^2, 0.112 mm) in the layer 100-0 (bottom-0) m. A frontal zone between subtropical and subarctic water masses, seasonal upwellings and anticyclonic eddies occur in the study region. Significant species diversity and total biomass fluctuations are common for zooplankton of this region.

From the results of research in 1987-1995, Aniva Bay and the adjacent deep-water area were determined as the most productive subregions around Sakhalin Island. In Aniva Bay the cold-water euphausiid *Thysanoessa raschii* (*Th. inermis* in the extremely cold period) was found to be dominant in spring. The highest-density zone of euphausiid aggregations coincided with the northern periphery of the quasi-stationary anticyclonic eddy A1. In autumn, the cold-water (CW) medium-size copepods (*Pseudocalanus minutus*, *Ps.newmani*, *Acartia longiremis*) dominated as usual. However, during a significant positive SST anomaly, the moderately-cold-water neritic copepod *Centropages abdominalis* prevailed by biomass. On the whole, zooplankton biomass in autumn was significantly lower compared to the spring.

The cold-water copepod *Metridia okhotensis* prevailed by biomass in the deep-water area. The densest aggregations of this species occurred near the southern boundary of an anticyclonic eddy, which existed eastward of the southern Sakhalin coast. The cold-water plankters: euphausiid *Th. inermis*, copepod *Metridia okhotensis,* and chaetognath *Sagitta elegans* dominated (total biomass was about 1400 mg/m³) during the periods with low ice formation, a depressed state of the warm currents system and a deficit of atmospheric warm inflow. Higher zooplankton biomasses are common for periods with negative anomalies of water temperature in the layers of 50-100 and 100-200 m.

In autumn, minimum biomass of the cold-water group is common for periods with almost zero values of geostrophic transport, calculated by observations on the common transect between Cape Aniva – Cape Dokuchaev. A great percentage of the moderately-cold-water forms *Euphausia pacifica* and *Calanus plumchrus* is also common for these periods. The copepods *Pseudocalanus minutus* and *Ps. newmani* prevailed (22%) in the plankton along with the warm-water *Calanus pacificus* which constituted more than 7% of the total biomass. The relatively low biomass level (332 mg/m³) proves the relationship between productivity and reduced heat content of the water layers of 50-100 m ($r = 0.58$) and 100-200 m ($r = 0.86$) in the study area.

From the results obtained during 2001–2005 in Aniva Bay, it was concluded:
a) substitution of large cold-water euphausiids and chaetognaths for copepods of the same ecological group (*Pseudocalanus minutus, Ps. Newmani* and *Acartia longiremis)* in the Aniva Bay zooplankton community took place in the spring period, and total zooplankton biomass in spring decreased significantly;
b) along with the gradual rise of SST, there was an intense increase in development of the neritic copepod complex, which resulted in shifting the annual maximum of total biomass dynamics to the autumn period;
c) south - boreal, subtropical and tropical copepod species increased in biomass in Aniva Bay waters, and their distribution was observed up to the northern coast of the bay;
d) zones with high concentration of euphausiids *Thysanoessa raschii* and *Th. inermis* were observed to be formed in late autumn – winter.

By the results of recent observations in the deep-water part of the Okhotsk Sea, the following features have been noted:

a) both a spring and autumn decrease in total zooplankton biomass due to the euphausiid *Thysanoessa inermis*, the chaetognath *Sagitta elegans*, and the copepod *Metridia okhotensis*.

b) a portion of the warm-water species common for the Soya Current increased up to 14% of the total zooplankton structure in late autumn. (In November, the biomass of these species reached 65% of the total zooplankton biomass at some stations located in the southern Kuril waters).

According to the satellite data, there is a trend for SST to increase in spring, summer and autumn periods in the deep-water part of the Okhotsk Sea. Changes in zooplankton communities under the influence of oceanographic factors will be discussed.

PICES XIV   BIO_Poster-2325
Distribution of the large-sized boreopacific gonatid squid (*Gonatopsis borealis*) in the northwestern Pacific Ocean and adjacent marine areas

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The boreopacific, or northern gonatid squid (*Gonatopsis borealis*) is widely distributed in the North Pacific Ocean and its marginal seas and basins, including the Okhotsk and Bering seas, and the Gulf of Alaska. This muscular nektonic squid is an active pelagic predator, and is a major component in the North Pacific pelagic food webs due to its very high abundance. Two size groups, or cohorts of this squid have been distinguished based on size at maturity: small-sized and large-sized. Spatial and temporal distribution patterns of individuals classified as the large-sized cohort have been analyzed basing on the extensive data collected in multiple research expeditions of TINRO-Centre from 1984 through 2004 in the North Pacific Ocean and its marginal seas. In the offshore oceanic areas, the squid at various ontogenetic stages occurred almost all the year round, being highly abundant in summer and autumn, and being rare in winter and spring. Distribution of the large-sized *G. borealis* spanned vast oceanic region to the north of the Subarctic Boundary between approximately 145º-170ºE, and 36º-46ºN. Besides, the squid was occasionally captured in the southeastern Okhotsk Sea in spring. Two peaks of abundance of early ontogenetic stages and juveniles (mantle length (ML) ranging from 11-120 mm) were present, one large peak in June-July in the area of the West Wind Drift, and another smaller peak in October-November somewhat northerner. Larger individuals (ML>120 mm), including maturing and sexually mature (ML of about 250-300 mm), occurred from May to December mainly in the western part of the surveyed area. The occurrence of various ontogenetic stages of the large-sized *G. borealis* in the northwestern Pacific Ocean suggests that life cycle of this highly abundant pelagic cephalopod species is associated with subarctic oceanic waters.

PICES XIV   BIO_Poster-2370
Adaptation mechanisms of gray sea urchins and *Laminaria* coexistence

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In nature, sea urchins and *Laminaria* inhabit the same environments, although sea urchins consume *Laminaria*. As sea urchins are valuable fishery targets and their marketable qualities depend on *Laminaria* abundance, the TINRO-centre investigated relationships between "sea urchins and *Laminaria*" at the biochemical level. It was observed that sea urchins and *Laminaria* produced a complex of biological and biochemical protective factors during different parts of their life cycles, allowing them to coexist.

Thus, "group" sprouting of zoospores is typical for *Laminaria* as it is connected with the peculiarities of egg cell fertilization. As a result, a great density of juvenile sprouts (up to 5 th. sp./m²) is formed and they prevent each other for further growth. During this periodof the sea urchin life cycle, activation of feeding occurs, and they fall upon *Laminaria* sprouts and thin them out providing the required favorable density for further algae growth. *Laminaria* sprouts don't contain inhibitors for sea urchin feeding. When *Laminaria* thalli reach reproductive maturity, the inhibitors are synthesized and push sea urchins away. At the same time sea urchins are spawning and their feeding activity falls, decreasing sea urchin attraction to *Laminaria*. After zoospore dissemination in

Laminaria thalli, inhibitors are destroyed and they again become available for sea urchins. This is favorable for *Laminaria* because it results in bottom purification from its old thalli and it allows for zoospore settling on pure substratum.

Phenomenon "Isoyake" along the Far Eastern coast and the methods of control

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The stocks of commercial brown algae *Laminaria japonica* Aresch in the coastal Japan Sea are in a depressed condition lately. This was first observed at the seaside of Japan in the early sixties, where the phenomenon of a significant decrease of large brown algae and its replacement by less valuable seaweed types was called "Isoyake". This phenomenon has spread to the coast of the Russian Far Fast Seas during recent years as well. At present there is a reduction in *Laminaria* fields, which are being replaced by the Corallinaceae family. A large portion of the hard stone substratum where the *Laminaria* grew before has already been occupied with crustose coraline algae.

As a result of experimental and industrial work in diverse places of the Primorye coast, TINRO has developed inexpensive and effective biotechnologies of recultivation of destroyed areas using methods of mariculture and amelioration to restore conditions for harvest of algae and for sea urchin feeding.

Intra-annual characteristics of the copepod community related to the ecosystem in the southern waters of Korea

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Zooplankton communities are influenced strongly by variation of the physical environment and by ecosystem indicators in their habitats. Intra-annual variability of zooplankton biomass is caused by the seasonal changes of oceanographic conditions and the occurrence of a frontal zone in the southern waters of Korea. We estimated intra-annual variability of copepods and the role of ecosystem indicators based on the bimonthly oceanographic survey during April 2004-February 2005. A total of 133 zooplankton taxa were recorded in southern waters of Korea in the present study. Copepods are the most dominant group accounting for 19.4-90.1% in April, and 43.4-91.1% in August, 2004 of the total zooplankton community analyzed during the study period. Seasonal differences in the zooplankton distribution were mainly influenced by divergence formed at a boundary line formed by currents of opposing directions, consisted of the South Korean Coastal Waters (SKCW) and the Yellow Sea Coastal Waters (YSCW). Of the 8 corresponding species of southern waters of Korea, *Acartia negiligens*, *Eucalanus mucronatus*, *Lucicutia flavicornis*are, *Cosmocalanus darwinii* are oceanic species; *Acrocalanus gracilis*, *Paracalanus aculeatus*, *Euchaeta rimana*, *Paraeuchaeta concinna* are neritic species. Oceanic copepods, *Eucalanus subtenuis*, *Eucalanus crassus* only appeared along the Yeosu-Geoje coast in August but they appeared in most areas in October.

During these surveys, the oceanographic condition in August, 2004 was strongly affected by the thermal front between the cold water masses off Yeosu-Geoje and the Tsushima warm current in the southern waters of Korea. Chlorophyll-a showed high density in the mid southern coastal area and western area of Jeju Island Anchovy eggs were distributed offshore with high density in the frontal area between coastal cold water and the warm current off southern area of Korea. We will discuss relationships between anchovy spawning grounds and occurrence area, species composition and size distribution of oceanic copepods. Species composition of oceanic copepods was compared with the results in 1980's and we will discuss the effects of long-term climate change and ecosystem regime shifts.

A study on the self-regulatory ecosystem management system in Korea

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The Korean government encouraged fishermen to establish a 'Self-regulatory management community' in order to prevent illegal fishing operations, to enhance and protect their fishing grounds, and to jointly manage their fishery resources for themselves. As of 2005, a total of 310 units of the communities had joined this program. The inshore self-regulatory community management system is designed to manage fisheries resources in inshore waters of Korea. The fishing patterns of inshore waters are diverse, and include boat fisheries, shellfish or seaweed culture fisheries, village cooperative fisheries, and diver fisheries. It is desirable that the management of these fisheries is implemented by local self-regulatory communities using an ecosystem-based precautionary approach.   However, the present condition of fisheries resources in this inshore system is depleted or overexploited.   Therefore, in addition to managing and conserving the resources, the enhancement of the depleted resources and restoration of suitable environmental conditions of the ecosystem are essential. We selected the hen clam, *Mactra chinensis*, which was a target species in the self-regulatory community in Busan city, to demonstrate an example of the practice in the self-regulatory management system to provide management guidance. We collected samples of the hen clam from November 2004 to August 2005 to estimate biomass and ecological characteristics, including growth parameters, survival rate, and natural and fishing mortalities. Acceptable biological catch (ABC) was also estimated under the harvest strategies. Finally, suitable management plans were suggested for this community management system

Changes in diet compositions of finless porpoise (*Neophocaena phocaenoides*) by growth in the west coast of Korea

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Prey organisms in the stomach of finless porpoises which were incidentally caught from 2001 to 2005 off the west coast of Korea were analyzed. A total of 24 species, including 8 fishes, 13 crustaceans and 3 cephalopods were identified as prey organisms, proving that the finless porpoise is a carnivorous feeder on a variety of prey. Prey organisms of finless porpoise were analyzed by IRI (Index of Relative Importance). The index showed that fish was the major prey item of finless porpoise, followed by crustaceans and cephalopods. Specimens were classified into seven groups by length in order to estimate the pattern of IRI with porpoise growth. Diet composition by group showed that finless porpoise fed on small animals such as crustaceans in the younger stages, but they switched their prey from crustaceans to more fish and cephalopods as they grew larger. The diversity (H') and the evenness (J') of the diet were also estimated.

Measures for sea urchin stock preservation under their active fishing

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One-year old gray urchins (*Strongylocentrotus intermedius)* as well as black urchins (*S. Nudus*) are intensively caught in the coastal Primorye (north-western part of the Japan Sea), resulting in a tendency of total stock decrease. At some sites all sea urchins have been caught. In this connection, it is necessary to develop a complex of measures that could maintain the stability of existing sea urchin populations and also favor the increase of their stocks. Evidently there is a need to conduct pre-fishing season assessment surveys of sea urchin stocks in order to calculate the optimum catch rate for each population and to create a system of protective measures for preservation of sea urchin settlement.

Because of this, FSUE TINRO-centre conducted extensive studies of coastal Primorye in 1996 – 2005 including an assessment of sea urchin settlements, condition of food supply, distribution and abundance of juveniles, and possibilities of replacement of *Laminaria* fields for sea urchin feeding. Analyzing these studies determined the

basic directions in management activities for increasing the stocks of this valuable hydrobiont in every concrete site all over the coastal Primorye.

PICES XIV   BIO_Poster-2621

Some features of the main macrozoobenthic groups on the Okhotsk Sea shelf along the northeastern Sakhalin Island

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Macrobenthic studies on the Okhotsk Sea shelf have been conducted in August 2002 according to the "Monitoring applied-research program of water biological resources and their habitat in regions of development of hydrocarbon fields on the northeastern Sakhalin shelf". The obtained quantitative indices, being compared with the results of researches carried out by TINRO-Center in 1977 (Koblikov, 1982) on the Okhotsk Sea shelf of Sakhalin Island, revealed some peculiarities in biomass distribution of the main macrozoobenthic groups for a great time interval.

Earlier, it was reported that in general the macrozoobenthos biomass had not changed much during the 25-year period, and its main biomass-forming groups remained the same (Pecheneva *at al*., 2005). Some increase in zoobenthos biomass for such a great period was found from the TINRO-Center survey (Shuntov *et al.*, 2003). Echinoderms (mainly, *Echinarachnius parma*) remain a dominant group among macrozoobenthic organisms. The insignificant decline in biomass of this group was recorded (from 248,4 g/m^2 to 206,0 g/m^2). In August 2002, the second place among the main macrozoobenthic groups was occupied by bivalves with the mean biomass 63,1 g/m^2, that is almost twice as much compared to 1977. Crustaceans occupied the third place, and their mean biomass increased a little from 52,6 to 56,4 g/m^2. The mean biomass of polychaetes practically has not changed; it constituted 5% (4,9% in 1977) of the total benthos biomass.

A significant increase in bivalves biomass, compared to the other macrozoobenthic groups, is connected, perhaps, with the decline in abundance of commercial crab species (mainly, snow crab opilio), for which bivalves are one of the basic nutritional component.

PICES XIV   BIO_Poster-2418

Monitoring of processes of dissolved organic matter production by phytoplankton using optical spectroscopy methods

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The processes of Dissolved Organic Matter (DOM) production by phytoplankton were investigated with the help of features of Laser-Induced (532nm) seawater Fluorescence (LIF) spectra (measured by ship-born fluorometer) and leaving-water radiance spectra (measured by SeaWiFS). The LIF spectra were used for calculation of such bio-optical parameters as chlorophyll-a concentration (labeled as C) and intensity of DOM fluorescence (labeled as Q). The functional relationship between these bio-optical parameters was analyzed. More then 100 thousand LIF spectra measured at the different regions of Ocean (including northwest Pacific) were used for the analysis. It was shown that a linear relation between C and Q is observed for some stages of evolving phytoplankton communities and for some seawater cases. Joint application of the linear relation parameters and ocean color satellite measurements is suggested for, first, identification and classification of phytoplankton communities, second, investigation of various processes influencing phytoplankton community condition. Also, investigation of the functional relationship is used for determination of the rate of DOM production by phytoplankton. Analyses of water-leaving radiance spectra were made in a similar manner assuming that these spectra were under the influence of chromophoric DOM and not fluorescence DOM. Lastly, LIF and satellite analyses were compared.

Southward biomass transport of major subarctic copepods by Oyashio current

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In order to see how much biomass of the four major subarctic copepods (*Neocalanus cristatus, Neocalanus flemingeri, Neocalanus plumchrus, Eucalanus bungii*) is transported to the mixed water region (MWR) by the southwestward Oyashio current, we estimated their annual transport by integrating seasonal observation data off the east coast of Japan. In each season from spring of 2001 to winter of 2002, hydrographic observations were made on a repeat section called the Oyashio intensive observation line off Cape Erimo (OICE), which extends southeastward from the southeast coast of Hokkaido Island. A vertical multiple plankton sampler (VMPS) was used to sample the planktons in four layers above 500 m depth and conductivity-temperature-depth sensor (CTD) data were analyzed to calculate geostrophic currents referred to 1500 m depth. Combining VMPS and CTD data and integrating with time and space, we estimated the net southwestward carbon mass of these four copepods across OICE to be 6.9×10^5 tons per year. Based on the results of other experiments deploying isopycnal floats in the Oyashio current, at least 5.9×10^5 tons of them are considered to traverse the Oyashio front southward to reach MWR, where these deeply-migrating copepods cannot reproduce in the surface layer because of its warm temperature. This suggests that most of the transported copepods are eventually consumed as prey in the food chain in intermediate layers of the MWR.

Zooplankton distribution along a transect off Sakhalin Island during early summer 2005

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Plankton sampling was undertaken in association with oceanographic measurements along a transect roughly at the 1000 m contour off Sakhalin Island during early summer 2005. The NORPAC net-collected zooplankton assemblage was dominated by calanoid copepods. The distribution pattern of zooplankton did not necessarily match that of ambient chlorophyll, although the overall abundance declined at northern stations. The subsurface chlorophyll maximum tended to be more prominent at stations located further off the coastline, and the contribution of near pico size fraction (< 5 um) appeared to be larger at these stations. At one station where the zooplankton abundance was far higher than elsewhere, chlorophyll concentration was also highly elevated with the contribution of smaller cells lower. Hydrographic control may well have been one of the major determinants of this case. Zooplankton distribution in this region at the time of investigation must be a product of interactions between hydrography and the distribution of potential food organisms.

Seasonal dynamics of species composition and community structure of neritic copepods in Amursky Bay (Peter the Great Bay, Sea of Japan)

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The north-western part of the Sea of Japan, where Amursky Bay as part of Peter the Great Bay is situated, could be characterized by biogeograhpical heterogeneity of its planktonic fauna due to its proximity to the transition zone between temperate and subtropical North-western Pacific regions. Species composition and dynamics of neritic copepods in Amursky Bay adequately reflect the geographical position of the study region and indicate changes of hydrological seasons. During the investigation (mid May – beginning November 1991), 14 species of pelagic neritic copepods (Calanoida and Cyclopoida) were recorded. *Acartia aff. clausi*, *Tortanus discaudatus* and *Pseudodiaptomus marinus* occurred in the plankton throughout the entire period of research, the other species had more marked seasonality in their presence in the plankton. Analysis of structure and

dynamics of the copepod community revealed 3 periods. During the first period (mid May – June), the neritic copepod community consisted of boreal species only, where *Acartia hudsonica* was dominant and *T. discaudatus*, *Centropages abdominalis* – subdominant. Community diversity was low (Shanonn-Wiener index 1.1-1.2). The second period (July – end of August) is marked by the appearance of subtropical species, dominated by *Acartia pacifica*, as well as the presence of boreal ones. The diversity values were the highest (up to 1.76). The third period (end of August – beginning of November) showed the predominance of subtropical copepods with the most abundant being *Oithona brevicornis*. The diversity index was the lowest (0.9). These results help to understand the terms and conditions (temperature and salinity) controlling seasonal dynamics of neritic copepods in the north-western part of the Sea of Japan.

PICES XIV   BIO_Poster-2360
Structure and distribution of zooplankton of Sakhalin Bay and Academy Bay (Sea of Okhotsk)

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In July 2003 in Sakhalin Bay and Academy Bay, representatives of 9 basic hydrobiological groups of holoplankton, 9 taxa of benthopelagic organisms, 9 taxa of meroplankton and an ichthyoplankton taxon were sampled.   In all, 51 species were identified: Copepoda 30, Coelenterata 7, Ctenophora 3, Euphausiacea, Cladocera, Chaetognatha, Hyperiida, Pteropoda, Appendicularia and Mysidacea 1-2 species for each. Some species (Ctenophora, jellyfishes, copepods) were observed for the first time in this area and in the Sea of Okhotsk. The eastern part of Sakhalin Bay is characterized by significant taxonomic riches and the greatest index of biodiversity. The least diversity was near the Amur Estuary and in the northwest part of Sakhalin Bay.

Zooplankton were placed into four groups. Group 1 is located in a southeast part of Sakhalin Bay; its basis is made with *Eurytemora herdmani*, *Pseudocalanus newmani*, larvae Bivalvia, *Acartia hudsonica*, *Evadne nordmanni*, and *Podon leuckarti*. Group 2 is located in the center of Sakhalin Bay; its basis is made with *Jaschnovia tolli*, *Pseudocalanus minutus*, *Pseudocalanus newmani*, *Oithona similis*, *Calanus glacialis*, appendicularians, larvae Polychaeta, Bivalvia and Cirripedia. Group 3 is located in a northwest part of Sakhalin Bay; the basis is made with larvae Cirripedia, *P. newmani*, *Oithona similis*, *Acartia longiremis*, and *Thysanoessa raschii*.   Group 4 is located in Academy Bay; the basis is made with larvae Cirripedia, *Pseudocalanus acuspes*, *P. newmani*, *P. minutus*, and *E. herdmani*. The structure and spatial distribution of groupings corresponded to the salinity structure of the water. Distribution patterns of species-indicators (Cladocera, *Eurytemora asymmetrica*, *Eurytemora pacifica*, *Sinocalanus tenellus*, *Acartia hudsonica*, *Tortanus derjugini*) indicated the flow of waters from the Amur Estuary to Sakhalin Bay occurred in a northeast direction, and in the center of the gulf there is a local circulation. These circulation patterns have been confirmed with satellite information.

PICES XIV   BIO_Poster-2316
Variability of chlorophyll-a concentration caused by wind upwelling in Peter the Great Bay in the autumn of 2003

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Chlorophyll-a concentration is one of the basic parameters of water bioproductivity. High bioproductivity is observed usually in the areas of upwelling. The highest values of the wind upwelling index at the northwest coast of the Japan Sea are observed in September and October. Variability of the wind parameters and chlorophyll-a concentration was investigated in detail for the autumn of 2003 on the base of the satellite data on ocean color obtained by SeaWiFS scanner and the meteodata set from NCEP (National Center for Environmental Prediction) of the GSFC DAAC (Goddard Space Flight Center; Distributed Active Archive Center).   The data were processed through the SeaDAS 4.6 software to construct fields of chlorophyll-a concentration and wind rate and direction. Preliminary analysis of these fields has shown chlorophyll-a concentration increases during periods of southwest or northwest wind strengthening to 8-10 m/s or more. The blooming starts over shallow areas and then spreads over deep areas of Peter the Great Bay.

Influence of organically enriched river run-off on the symbiotic community of scallops and polychaete worms

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Communities of scallop *Patinopecten* (=*Mizuhopecten) yessoensis* and polychaete worm *Polydora brevipalpa* inhabiting neighboring sites in Peter the Great Bay (Sea of Japan) were compared. Site 1 was a sand bottom in an unpolluted part of the bay, and site 2 was an organically enriched muddy sand bottom that was under the influence of Tuman River discharge. Temperature and salinity regimes of the near bottom water layer were similar at both sites. However, oxygen, phosphorus and carbon, and food potential for species of each community were different. It was found that the shells of the scallops sampled from muddy sand were more eroded than shells of individuals collected from the sand substrate. A statistically significant negative correlation between the degree of shell bioerosion and scallop shell height was observed. The bioerosion adversely affected scallop growth. Scallops from the muddy bottom sediments grew significantly slower than those from sand.

Food sources of scallops and polychaetes were determined using fatty acids as biochemical markers. Distribution of fatty acid markers in the scallop lipids reflected the dominance of flagellates and diatoms in their food. Odd-chained and branched fatty acids associated with benthic bacteria were mostly present in polychaetes indicating a significant contribution of bacteria to the polychaete diet. At site 2, enriched by organic matter, food potential for polychaetes was higher than at site 1. Thus, organic enrichment of the bottom sediments near the river estuary has an unequal influence on the different elements of the benthic community, being a boon for some species and an adverse factor for others. In turn, the consequences of interactions between species in the community may change under river run-off.

CCCC

Poster Session

GLOBEC and GLOBEC-like studies in the North Pacific: Observing pattern and inferring process

Co-Convenors: Harold P. Batchelder (U.S.A.) and Suam Kim (Korea)

Numerous GLOBEC and GLOBEC-like studies linking atmospheric forcing, ocean climate and physical variability, and ecosystem structure and pattern have occurred in the past decade. This POSTER session provides a forum for a review of the observational evidence linking climate to ecosystem pattern, and inferring the mechanisms or processes that link climate forcing to ocean physics and ecosystem pattern and dynamics. Presentations related to dynamics and processes on multiple temporal (event to seasonal to interannual and longer) and multiple spatial (local to mesoscale to regional to basin-wide) scales are encouraged. Inferring mechanism (process) from spatial and/or temporal patterns is emphasized in this session, but contributions on related topics are encouraged as well.

Wednesday, October 5, 2005 18:00-20:00

A.A. Bonk
Influence of the conditions of reproduction on the survival of herring embryos in the western Bering Sea (CCCC_Poster-2312)

Elena Dulepova
Production of zooplankton communities in the western part of the Bering Sea in 2000s (CCCC_Poster-2394)

Svetlana Yu. Glebova
Influence of an atmospheric regime on ice cover in the Okhotsk and Bering Seas (CCCC_Poster-2373)

L.S. Muktepavel
The influence of spatial-temporal variability of shore polynias on herring stocks in the northern Sea of Okhotsk (CCCC_Poster-2326)

L.S. Chernushova and V. Platonova
About various impacts of modern warming in a moderate zone of the Asian continent (CCCC_Poster-2348)

Nina I. Savelieva, Vladimir I. Ponomarev, Alexander P. Nedashkovsky and E.V. Dmitrieva
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Possible food resource partitioning by small epipelagic fishes and myctophids in the Kuroshio-Oyashio Transition Zone - A preliminary study (CCCC_Poster-2403)

Konstantin M. Gorbatenko, A.V. <u>Zavolokin</u> and S.I. Kiyashko
Abundance, dynamics and trophic status of jellyfish (Cnidaria) in the epipelagic zone of the Okhotsk Sea
(CCCC_Poster-2214)

Influence of the conditions of reproduction on the survival of herring embryos in the western Bering Sea

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Current herring stock abundance in the western Bering Sea (population of Korf and Karaginski Bays) is at a low level. In this situation, among a number of factors that might influence survival of herring embryos, we distinguish two groups based on their strength of the influence, and interactions between each other. The first group includes factors of direct influence on developing herring eggs, for example periodic drying of spawned eggs caused by tides, water temperature, salinity, oxygen concentration, type of substrate, effects of waves, density of eggs in spawning grounds and predation. The influence of the second group of factors on the eggs is indirect and expressed less; these factors include the abundance of spawners, the time of spawning, the area of spawn, the tides and the ebbs.

The role of any factor in causing mortality of eggs varies during embryogenesis and is determined mostly by the type of, and the situation in, a spawning ground. The current Korf-Karaginski herring population uses mostly lagoon and coastal locked regions for spawning. Survival of embryos differs in these two spawning grounds. In lagoon type spawning grounds, the embryonic survival from spawn till emergence is 27% whereas in the coastal locked type it is only 12%.

The principal cause of egg mortality in the lagoon type spawning grounds is the combined influence of drainage, thermal shock and predation. In the locked coastal spawning grounds egg mortality is mostly a result of drainage (a tidal effect) or by wave mechanical damage, whereas predation and water temperature are not important.

Production of zooplankton communities in the western part of the Bering Sea in 2000s

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Trophic and production characteristics of zooplankton were analyzed for the western part of the Bering Sea. According to a series of complex macro-surveys conducted in the western part of the Bering Sea during 2001-2004, the average zooplankton biomass was 123 g m^{-2} in the upper level in summer–fall, the biomass of phyto-euryphagous zooplankton was 85-91 g m^{-2} in this period and for predatory zooplankton, it was 32-37 g m^{-2}. On the whole, the share of the predatory zooplankton in the 2000s was lower than in the 1990s. The production of phyto-euryphagous zooplankton and predatory zooplankton for this area was 228 g m^{-2} and 50 g m^{-2} respectively. Besides "real" (*i.e.* production available for fishes) production of the zooplankton calculated (~100 g m^{-2}), it was established that salmon consume no more than 4 % of the biomass of various plankton groups. However, consumption of the hyperiids equals biomass of this plankton group and is probably connected with the underestimation of hyperiid biomass. These calculations show that in the beginning of 21st century zooplankton production and feeding resources of nekton are high enough in the western part of the Bering Sea.

Influence of an atmospheric regime on ice cover in the Okhotsk and Bering Seas

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Year-to-year changes in ice cover in the Okhotsk and Bering Seas exhibit an interesting feature: in certain periods the coverage in the two areas vary in phase, but in other periods they are out of phase. To investigate, the years were divided into four groups: those with 1. reduced ice coverage in both seas; 2. high ice coverage in both seas; 3. reduced ice in the Sea of Okhotsk and high ice coverage in the Bering Sea; and 4. high ice coverage in the Sea of Okhotsk and reduced ice in the Bering Sea.

In the case of the first group of years, the Aleutian Low was displaced northwestward from its mean position and located near East Kamchatka, so easterly winds prevailed and the winter monsoon weakened over both seas. In the second case, the Aleutian Low was in the eastern Bering Sea, and the winds were mainly northerly (winter monsoon aggravated) over both seas. In the third case, the Aleutian Low had a southeastern position in the Gulf of Alaska, and northerly winds prevailed over the Bering Sea and easterly winds over the Sea of Okhotsk. Finally, in the fourth case, the Aleutian Low was displaced toward the southwest and was located on the oceanic side of the Commander Islands. In this case, easterly winds blew over the Bering Sea and northerly winds blew over the Sea of Okhotsk.

PICES XIV   CCCC_Poster-2326
The influence of spatial-temporal variability of shore polynias on herring stocks in the northern Sea of Okhotsk

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The character of seasonal ice-extent variability causes either favourable or adverse conditions on herring spawning grounds, migration routes, and formation of commercial target stocks. Herring is one of the most important species in the Okhotsk population inhabiting waters of the northern Sea of Okhotsk. The features of spawning migrations and success in spawning (Ayushin B.N., 1947, Tyurnin B.G., 1975, *etc.*) depend on oceanological conditions and practically all herring strong year classes of this population occurred only when favourable ice conditions were present (Melnikov I.V., 2001). The aim of this paper was to examine features of the ice regime in the Sea of Okhotsk, such as shore polynias, and to estimate their influence on the formation of herring stocks.

The data of satellite surveys for the period of ice cover erosion were used in the analysis. The times of occurrence and steady development of shore polynias were determined and their areas were calculated. Tables of occurrence times and steady development of polynias are given. The averages of their areas (March - May) for basic herring spawning and foraging areas for the period from 1978 till 2004 are given. Some regularities of times of occurrence, means of the polynia area against a background of dynamics of intraseasonal anomalies of Kats indexes are determined.

The results suggest that ice conditions in the Sea of Okhotsk impacts herring migration and spawning success and the establishment of commercial herring stocks. The presence of such connections, taking into account the intraannual peculiarities of ice processes in the main spawning grounds, makes it possible to use ice condition data in forecasts of spawning and commercial stocks of the Okhotsk herring.

PICES XIV   CCCC_Poster-2348
About various impacts of modern warming in a moderate zone of the Asian continent

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We investigated several features of the dynamics of the thermal regime of the cold season, differing in their sensitivity to anthropogenic influences: monthly average temperatures of air of the coldest month of winter (January) and durations: a cold season and the period with the lowest temperatures. For our research we used 8 stations located in a moderate zone of the Asian continent mainly at 50-55°N, with the period of observation from 1917 for 2000. Our results showed a marked tendency to warming, with the most strongly pronounced warming during the last 20 years of the 20th century. Monthly average temperatures for January increased, and the duration of the cold season and its coldest period decreased. A geographic pattern of temporal warming patterns was found. Strongest early warming (during the late 1960s-early 1970s) occurred in Southeast Asia. Later, at the end of 1970s-early 1980s, warming began in the western part of Asia.

Changes differ for intensity and for territory. So, for the dynamics of average January temperatures for generally all territories, the intensity of warming increases not only with latitude, but also with direction towards the eastern part of the Asian continent. In that territory, temperature is rising about 3°C/80 years. The reduction of the duration of the cold season occurs practically synchronously in all regions and on average was 5-6

days/80 years. Changes in duration of the coldest period of winter are not so synchronous spatially, with the most intense reduction in the cold period (10 days/80 years) in the eastern part of the Asian continent.

We attempt to estimate the role of anthropogenic influence for the warming of the last decades of the 20th century by comparing thermal changes with population size in various cities. Average January temperatures and population size may be related but, for seasonal thermal processes there was no connection. It gives the basis to believe that modern warming is a consequence of the joint influence of natural and anthropogenic factors.

PICES XIV   CCCC_Poster-2406
High silica concentration in the bottom water of the northernmost area of the Anadyr Gulf in fall 2000 and 2002

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The Anadyr Gulf has a two-layered structure. The surface layer is freshened due to river discharge and ice melt. Weather conditions determine the seasonal and interannual variability of hydrological and hydrochemical characteristics. The most interesting phenomenon is the existence of cold saline bottom water ($\sigma_t > 27.0$; -1.99°C <T< -1.5°C; 33.7–34.2 psu) that occupies the northernmost area (off the Cross Bay) and is associated with a submarine canyon (50-70m depth). Very high concentrations of dissolved silica in bottom water (74.4 ± 13.69 μM/kg in 2000; 56.8 ± 4.9μM/kg in 2002) were accompanied by high phosphate (> 3μM/kg), nitrate deficiency (< 25μM/kg), and low oxygen content (less than 40% in 2000 but <60% in 2002). Silica concentrations like this occur to the south on the Bering Sea shelf ($\sigma_t = 26.95$ or 197-550m). To study interannual differences of silica and other nutrients in bottom water, we compare weather conditions in both years in the Anadyr Gulf. We suppose that observed high silica concentrations might be determined by both weak water exchange between the northernmost area of the Gulf and the adjacent regions of the Bering Sea, and by the destruction of organic matter supplied from the surface layers during high photosynthesis production. Organic matter incoming below the pycnocline might remain in the bottom layer of the canyon during warm periods, isolated from other layers by strong density gradients formed during winter convection. As a consequence, nutrients have accumulated in the bottom layers. Interannual variability also might be connected with dynamic processes on the shelf (upwelling during north wind forcing).

PICES XIV   CCCC_Poster-2450
Distribution of epipelagic fishes and squids in the Northwestern Pacific during summer, 1982-2004

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Research on the community structure and dynamics over large areas of the northern North Pacific Ocean is needed to understand the present and future ecological responses to climate change. Since 1982, the T/S *Oshoro Maru* and *Hokusei Maru* of Hokkaido University have been conducting summer monitoring surveys of the oceanography and ecology of the northern North Pacific using research driftnets and hydrographic observations. In the western Pacific, this monitoring is repeated annually in June along 155°E. In the present study, we describe the distribution of epipelagic fishes and squids along this transect during the summers of 1982-2004. The southern boundary of the transition domain (the Subarctic Boundary) fluctuated between 39°N and 43°N with a period of twenty years, but the position of its northern boundary (the Subarctic Front) remained relatively constant. Chum salmon (*Oncorhynchus keta*) were concentrated mainly north of Subarctic Boundary, but also occurred south of this boundary in some years. Red flying squid (*Ommastrephes bartramii*) and Pacific pomfret (*Bramma japonica*) migrated north across the Subarctic Boundary. In the early 1990s, the abundance of both species decreased, but red flying squid has increased in abundance since the mid-1990s, and pomfret has increased in abundance since the early 2000s. Factors affecting distribution will be discussed.

Carbonate system in "exotic" marine environments

Pavel **Tishchenko**[1], Chi Shing Wong[2], Klaus Wallmann[3], Keith Johnson[2], Galina Pavlova[1] and Natal'ya Khodorenko[1]

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At the present time, the thermodynamics of the carbonate system of seawater in the open ocean and the methods for its study are well understood. However, specific problems with theoretical descriptions and/or experimental determinations of carbonate parameters are presented for such marine environments as: 1) dumping sites of liquid CO_2 in the ocean; 2) estuarine waters; and 3) anoxic marine sediments.

The main problem in describing the carbonate system in these "exotic" areas is the absence of needed dissociation constants. It is shown that problems related with the determination of dissociation constants may be overcome using the Pitzer method (1991). Methods of determining pH and total alkalinity are discussed. Some model calculations and experimental observations are presented.

Features of temperature conditions in the Vostok Gulf and at the hydrometeorological station Nahodka

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The Vostok Gulf is situated in the south-east part of Peter the Great Bay of the Japan Sea. The sea biological station "Vostok" was created here in 1970. In 1991 the cultivation of marine organisms was organized in the gulf. Hydrometeorological conditions in the gulf have a significant influence on biological organisms. Atmospheric conditions and sea water surveys have been available since 1995. This ten-year record of air and water temperature is the basis of the present paper.   We compare the dynamics and temperature conditions of air and water in the Vostok Gulf and at the hydrometeorological station Nahodka. The comparison of 10-day averaged temperatures of air at both stations has indicated that temperature conditions are practically identical during the warm season and insignificantly differ during cold part of the year. The characteristics of water and air temperatures in the transition season in abnormally warm and abnormally cold years is of special interest from the point of view of their influence on biota. Those are 1997 (cold) and 1998 (warm). Time and dynamics of transition from negative to positive temperatures strongly differ in these years. Ice cover exerts the greatest influence on temperature during this period. In warm 1998 the ice cover decreased during mid-February, and the intensive warming of water began after this. In cold 1997, the transition through 0˚C occurred later, and the ice decreased in early March. As a whole, the lag in the rise of water temperature from air temperature at transition through 0˚C is insignificant. However, it noticeably differs in different "thermal" years.   The transition of air temperature to negative values in autumn differs considerably in warm and cold years. Undoubtedly, temperature exerts a significant influence on the biota of the Vostok Gulf.

Pelagic food web structure in the northern California Current system

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Ecosystems are complex adaptive systems characterized by the diversity and individuality of components, localized interactions (competition, predation, reproduction) and autonomous processes that change the structure of the system over time. As such, they are difficult to analyze, and predictions of the dynamics of individual

components have limited reliability. Our focus is to better understand the ecosystem processes that affect production and survival of juvenile salmonids. A first step in understanding these processes is to develop as full a description of the trophic structure of the system as possible. From that foundation, we can develop dynamic models based on functional groups or guilds at whatever level of complexity is needed to address a particular question. Here, we present an analysis of the trophic structure of the Northern California Current shelf pelagic zone (latitudes 40°N to 48°N), based on recent observations of diets of pelagic fishes during U.S. GLOBEC studies and other related research, combined with literature reports of diets for other organisms (such as zooplankton and top predators). We apply cluster analysis of predator and prey relationships, combined with life-history information to suggest functional groups for dynamic analysis. We also consider variation in food web structure both among years and across latitudes.

PICES XIV   CCCC_Poster-2403
Possible food resource partitioning by small epipelagic fishes and myctophids in the Kuroshio-Oyashio Transition Zone - A preliminary study

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We examined stomach contents of juveniles of Japanese sardine (*Sardinops melanostictus*), anchovy (*Engraulis japonicus*), mackerels (*Scomber japonicus* and *S. australasicus*), and juveniles and adults of seven myctophid fishes (*Ceratoscopelus warmingii*, *Diaphus perspicillatus*, *Myctophum asperum*, *M. nitidulum*, *Notoscopelus japonicus*, *N. resplendens* and *Symbolophorus californiensis*), which were simultaneously collected by four nighttime trawl tows in the surface (< 30m) of the Transition Zone in May 2002. Also, mesozooplankton were collected by a NORPAC net either from 150m or 40m depth to the sea surface. Copepods in 317 stomachs of these fishes and NORPAC net samples were identified to species or genera, counted and their prosome lengths were measured. Dry weight for each prey in the stomachs was estimated from length-weight relationships. An index of relative importance (IRI) of prey item i was calculated using frequency of occurrence (Fi), percentage in number (Ni) and weight (Wi): $IRI_i = (N_i + W_i)F_i$. In terms of IRI, the most important copepod prey differed by predators: *Paracalanus parvus* (sardine), *Corycaeus affinis* (anchovy), *Neocalanus cristatus* (mackerels), *Pleuromamma piseki* (*C. warmingii*, *D. perspicillatus*, *M. nitidulum* and *S. californiensis*), *P. xiphias* (*N. resplendens*), *Eucalanus californicus* (*M. asperum* and *N. japonicus*). Comparison of two NORPAC net samples taken from different depths in proximity indicated that *Paracalanus* and *Corycaeus* are more abundant in near surface (< 40m) in contrast to *Eucalaus* and *Pleuromamma*. These results suggest "resource partitioning" is occurring not only between epipelagic fishes and myctophids (the former mainly feed on epipelagic copepods and the latter on wide-ranging or deeper ones), but also within epipelagic fishes and myctophids.

PICES XIV   CCCC_Poster-2214
Abundance, dynamics and trophic status of jellyfish (Cnidaria) in the epipelagic zone of the Okhotsk Sea

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We examined the biomass, distribution, feeding habits and trophic level of jellyfish based on data from surveys of the epipelagic zone of the northern part of the Okhotsk Sea conducted in fall, winter and spring 1998-2005. In fall 1998-2003, the total biomass of jellyfish varied greatly from 0.7 to 3.0 mmt. In the beginning of winter 2002, it was high (0.7 mmt) and was by one-two orders of magnitude lower in spring 2004. Scyphomedusae dominated the jellyfish biomass. The percentage of hydromedusae was higher in spring than in fall. Two species, *Cyanea capillata* and *Chrysaora melanaster,* alternated as the dominant species by biomass in all years. Perhaps, changes of domination are determined by different impacts of oceanological factors on the survival of these scyphistomae species. In spring 2004, most of the diets (59-100% in terms of biomass) of medusae was comprised of planktonic crustaceans. Eggs of walleye pollock and larvae of fish were important prey items of jellyfish, especially of hydromedusae (up to 36%). We used stable-isotope ratios of carbon and nitrogen analysis to determine the trophic level (TL) of the most common species of medusae. In spring 2004, the

average TL of hydromedusae was equal to capelin and herring. The average TL of scyphomedusae was lower and similar to amphipods. Consequently, jellyfish are important predators and competitors of fish in Okhotsk Sea.

MEQ Poster Session

Convenor: John E. Stein (U.S.A.)

Posters on various aspects of marine environmental quality in the North Pacific and its marginal seas (excluding S7, S8 & S9 topics) are welcome.

Wednesday, October 5, 2005 18:00-20:00

Svetlana A. Alekseeva, Tatiana N. Zvyagintseva, Xuan Mquyen and Thi Mquyen
Polysaccharides of green alga *Caulerpa lentillifera* (MEQ_Poster-2374)

Dmitry L. Aminin, Boris V. Pinegin, Larisa V. Pichugina, Tatyana S. Zaporozhets, Irina G. Agafonova, Valentin M. Boguslavski, Sergei A. Avilov and Valentin A. Stonik
Immunomodulatory properties of cucumariosides (MEQ_Poster-2224)

Dmitry L. Aminin, Michael M. Anisimov, Nina G. Prokofyeva, Irina G. Agafonova, Galina N. Likhatskaya and Valentin A. Stonik
Screening of biologically active marine natural products in PIBOC (MEQ_Poster-2223)

Irina Yu. Bakunina
O-glycosyl hydrolases of marine bacteria (MEQ_Poster-2384)

Olga V. Bolkovaya, Olga N. Lukyanova, Nadezhda E. Struppul and Oleg N. Katugin
The content of selenium in a number of marine organisms from the upwelling zone off the Kuril Islands (MEQ_Poster-2396)

Yulia V. Burtseva, Natalia S. Verigina, Victoria V. Sova, Yulia V. Khudyakova, Mikhail V. Pivkin and Tatiana N. Zvyagintseva
O-glycosylhydrolases of marine fungi inhabiting in sea of Okhotsk bottom deposits (MEQ_Poster-2376)

Ludmila S. Dolmatova
The experimental evaluation of toxic effect of lead on the holothurian immunity (MEQ_Poster-2393)

Vera Ya. Fedorova, Svetlana A. Romanova, Anatoly V. Reunov and Tatiana N. Zvyagintseva
Use of 1,3;1,6-ß-D-glucans for detection of the some infection in potato and tobacco (MEQ_Poster-2398)

Hao Guo and Xiao-lei Yi
Characterization of HABs in China and management actions (MEQ_Poster-2230)

Seung Heo, Young-Shil Kang, Seung-Yoon Park, Jae-Kyoung Son, Pyung-Joong Kim, Kyoung-Soo Park, Yoon-Seak Choi, Hyung-Chul Kim and Hak-Jin Whang
Review on the basin-scale survey in the Yellow Sea between Korea and China (MEQ_Poster-2462)

Sung Il Lee, Seon Jae Hwang, Sung Hyun Hong, Young Yull Chun, Jong Hwa Park and Hyeok Chan Kwon
Ecosystem-based management of fisheries resources in Wangdol-cho in the East Sea, Korea (MEQ_Poster-2419)

Guofang Miao, Yongliang Wang, Ziqiang Zhai and Yi Cai
Impacts from 500hPa circulation systems on algal blooms outbreak in spring of East China Sea (MEQ_Poster-2455)

Tatyana Mogilnokova and Nataliya Konovalova
Saxitoxins content in the Aniva Bay scallops caused by seasonal blooming of toxic phytoplankton (MEQ_Poster-2453)

Alexander V. <u>Moshchenko</u> and Tatyana A. Belan
A quantitative evaluation of an extent of anthropogenic disturbance of soft substrata macrobenthic communities (MEQ_Poster-2209)

Natalia S. <u>Verigina</u>, Marina I. Kiseleva, Mikhail I. Kusaikin, Victoria V. Sova and Tatiana N. Zvyagintseva
Expression of 1,3-β-D-glucanase and α-D-mannosidase in sea urchin embryos *Strongylocentrotus intermedius*: Effect of nature compounds on developmental stages of fertilized eggs and enzyme activities (MEQ_Poster-2375)

PICES XIV   MEQ_Poster-2374
Polysaccharides of green alga *Caulerpa lentillifera*

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It is known that polysaccharides of seaweed possess various biological activity. Biologically active polysaccharides were isolated from brown, red and green seaweed. Polysaccharides of the seaweed *Caulerpa lentillifera* were investigated for the first time. *C. lentillifera* was cultivated in laboratory conditions. Polysaccharides were extracted with hot water (fr K-1), 1 M (fr K-2) and 4 M KOH (fr K-3) successively and the yield of the polysaccharide fractions of the dry alga weight was 2.7%, 4.0% and 3.5%, respectively. The molecular weights of polysaccharides of fractions K-1 and K-2 determined by gel filtration are 20-60 kDa and 20-40 kDa, respectively. Fraction K-3 is the high-molecular polysaccharide (>70 kDa). Monosaccharide composition of all fractions contained glucose, galactose, mannose and xylose in a different ratio. Monosaccharides were identified in the form of polyol acetates using GLC-MS. The ^{13}C NMR spectrum of fractions K-2 and K-3 show signals which are characteristic of α-1→4-glucan. Using ^{13}C NMR spectroscopy, it was shown that fraction K-1 included α-1→4-glucan and laminaran (1→3;1→6-β-D-glucan). In IR spectra of all investigated fractions absent characteristic for sulfate groups absorption at 1230-1255 sm^{-1}, 822 and 849 sm^{-1}. These data indicate that *C. lentillifera* polysaccharides under study are unsulfated.

PICES XIV   MEQ_Poster-2224
Immunomodulatory properties of cucumariosides

D.L. **Aminin**[1], B.V. Pinegin[2], L.V. Pichugina[2], T.S. Zaporozhets[3], I.G. Agafonova[1], V.M. Boguslavski, S.A. Avilov[1] and V.A. Stonik[1]

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The medicine Cumaside was created from a base of triterpene oligoglycosides, cucumariosides, from the Far-Eastern holothurian *Cucumaria japonica,* and its immunomodulatory properties were studied. The influence of Cumaside in low doses on mouse macrophages was accompanied by a more than two-fold stimulation of lysosomal activity and induced a rapid increase in cytosolic Ca^{2+} content. This preparation was shown to significantly increase the animal resistance against bacterial infections elicited by various pathogens. Cumaside stimulates phagocytosis, ROS, IL6 and TNF-α production in lymphocytes, increases the number of antibody producing cells, and amplifies the expression some of preliminary suppressed CD-markers. Cumaside was found to inhibit Ehrlich carcinoma tumor growth in the initiatory stages and increase the mouse survival after irradiation. At the same time the preparation did not affect the delayed-type hypersensitivity, proliferate activity of lymphocytes, cytotoxic activity of NK-cells and cytokine IFNγ and IL12p70 release. The mechanism of Cumaside action is discussed.

PICES XIV   MEQ_Poster-2223
Screening of biologically active marine natural products in PIBOC

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The search for biologically active compounds in the laboratory of Bioassay in PIBOC consists mainly of cell-based screening, image technology and ion channels as intracellular targets, and several *in vivo* models. This work includes application of various methods such as the technique of radioisotopes, ion-selective electrodes, fluorescent spectroscopy, cytofluorimetry, BLM technique and cell image analysis, which afford evaluation of interaction of substances with various types of cells, biological and model lipid membranes. We perform our

investigations using some cell cultures, embryos of marine invertebrates (Echinodermata), microorganisms including two-hybrid transgenic yeasts with human estrogen receptors, and lipid liposomes. We screen for chemicals with antimicrobial, antiviral and anticancer activity, immunomodulatory activity, inhibitors of cell adhesion, and compounds with antioxidant properties. High resolution MRI-tomography with 7T magnet (PharmaScan 70/16US, Bruker) allows us to search *in situ* for compounds with anticancer, antistroke and antiischemia activity, inhibitors of angiogenesis and hepatoprotective substances. The structures of complexes of some testing compounds with viral and cellular proteins and ion channels as potential therapeutic targets are theoretically predicting in experiments *in silico* by the methods of molecular modeling and the docking approach using Linux cluster of interdepartmental supercomputer center of FEBRAS. Examples of each type of mentioned above methods will be presented, and the problems and difficulties of each technique will be discussed.

PICES XIV   MEQ_Poster-2384
O-glycosyl hydrolases of marine bacteria

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The present report summarizes knowledge on the different O-glycosyl hydrolases, involved in cell wall antigens and brown seaweed polysaccharide degradation produced by marine bacteria. The data on distribution of α-galactosidases, α-N-acetylgalactosaminidases and fucoidanases among symbiotic and free-living marine bacteria are shown. The same enzymes are isolated, purified and characterized in detail (MW, pH optimum, T optimum, *etc.*). Inhibition of α-galactosidase with natural and synthetic compounds is investigated. The elements of structure, hydrolytic properties and substrate specificity of these enzymes are studied. α-galactosidase of the marine bacterium *Pseudoalteromonase* sp. KMM 701 is immobilized into hybrid polysaccharide-silica nanocomposite materials. Possible biotechnological application of these enzymes is discussed.

PICES XIV   MEQ_Poster-2396
The content of selenium in a number of marine organisms from the upwelling zone off the Kuril Islands

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Selenium is unevenly distributed in seawater, and there are zones of high and low concentrations of this element in the world ocean. Upwellings are active hydrologic structures, which provide saturation of seawater with various microelements, including selenium. The content of selenium was studied in a number of free-living and sessile marine organisms, caught in the upwelling zones off the central and northern Kuril Islands. Liver tissues have been analyzed in two squids (*Berryteuthis magister* and *Moroteuthis robusta*), seven bonefishes (*Theragra chalcogramma*, *Sebastes alutus*, *Sebastes borealis*, *Albatrossia pectoralis*, *Reinhardtius hippoglossoides*, *Hexagrammos octogrammus* and *Pleurogrammus monopterigius*) and one cartilaginous fish (*Bathyraja maculata*). Soft tissues have been analyzed in two bivalves (*Crenomytilus grayanus* and *Modiolus kurilensis*). The content of selenium has been determined on the AAS AA 6800 Shimadzu. Concentrations of this element in the liver of all examined species did not exceed 1.0 µg Se per one gram (µg/g) of dry weight, ranging between 0.108 and 0.998 µg/g, and the highest concentrations were found in walleye pollock (*Theragra chalkograma)* and robust clubhook squid (*Moroteuthis robusta)*. Soft tissues of bivalve mollusks contained 0.97-1.7 µg/g of selenium. Our data revealed rather low total content of selenium in various marine organisms (including sedentary residential, demersal and actively migrating species) occurring in the Kuril upwelling zone, which is not consistent with normally higher selenium content in organisms inhabiting upwelling regions in some other areas of the world ocean.

O-glycosylhydrolases of marine fungi inhabiting in sea of Okhotsk bottom deposits

Yulia V. **Burtseva**, Natalia S. Verigina, Victoria V. Sova, Yulia V. Khudyakova, Mikhail V. Pivkin and Tatiana N. Zvyagintseva

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Marine fungi are less studied than other ecological groups. Obligatory marine fungi are still main objects. However, recently interest in studying marine facultative fungi has been growing since many new metabolites have been isolated from them which have not been found in terrestrial fungi. Among the metabolites of marine fungi, enzymes degrading polysaccharides are of a special interest. The purpose of our work is to study the distribution of some glycosylhydrolases in filamentous fungi inhabiting in sea of Okhotsk bottom deposits. Content of some O-glycosylhydrolases (glycosidases and polysaccharide hydrolases) was determined in cultural filtrates from 57 marine facultative strains. It has been established that glycosidases are widely distributed in cultural filtrates of these strains: β-D-glucosidases (in 55 samples), N-acetyl-β-D-glucosaminidases (in 29 samples), β-D-galactosidases (in 17 samples), α-D-mannosidases (in 9 samples), sulfatase (in 1 sample). Amylases (in 55 samples), 1,3-β-D-glucanases (in 47 samples), pustulanases (in 33 samples) are the most widespread among enzymes degrading polysaccharides, whereas the enzymes splitting CM-cellulose (in 4 samples), fucoidan from *Laminaria cichorioides* (in 4 samples), galactan (in 2 samples) and guluronic acid (in 2 samples) are rare. The enzymes hydrolyzing fucoidan from *Fucus evanescens*, agar and *p*-Nph-α-D-fucoside were absent. It has been revealed that the habitat affects level of enzyme activity and the enzyme composition of facultative fungi. Thus our studied allowed us to reveal a series of strains promising as producers both of individual enzymes and of a set of enzymes splitting carbohydrate-containing compounds.

The experimental evaluation of toxic effect of lead on the holothurian immunity

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Toxic effects of lead on echinoderms are little studied. However, the studies are important both for the ecological forecast and aquaculture. We studied the influence of $Pb(NO_3)_2$ (2 and 4 mg/L) on apoptosis and expression of receptors to mitogen concanavalin A (con A) of coelomocytes and two phagocyte fractions of holothurian *Eupentacta fraudatrix*. After 48 h, apoptosis increased only in coelomocytes and one of the phagocyte (P1) fractions (92% of purity) of holothurians treated with lead at both concentrations, as assessed with DNA electrophoresis. Hoechst 33342 staining revealed that apoptosis increased 2- and 1.7-fold in coelomocytes of animals treated with 2 and 4 mg/L $Pb(NO_3)_2$, correspondingly. In P1, apoptosis increased by 36 % at 2mg/L and was not significantly changed at 4 mg/L $Pb(NO_3)_2$. FITC-conjugated con A binding to coelomocytes and P1 increased 2 and 1,7 times, correspondingly in animals treated with 2mg/L $Pb(NO_3)_2$, but not in another phagocyte fraction. The 4 mg/L concentration did not affect con A binding to any type of cells studied. However, viability of coelomocytes decreased only at 4 mg/L concentration. Cell viability decrease in P1 was shown already at 2 mg/L, and was higher at 4 mg/L concentration. The data obtained indicate that one of the phagocyte fractions and nonseparated coelomocytes are especially sensitive to lead, and both apoptosis and expression of receptors to con A increase mainly at 2mg/L concentration, but cell viability decrease is more significant at 4 mg/L concentration. We suggest that 2mg/L is a thresholod $Pb(NO_3)_2$ concentration damaging holothurian immunity.

Use of 1,3;1,6-β-D-glucans for detection of the some infection in potato and tobacco

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Among the substances inducing plant resistance in plants to the pathogens, significance is attached to carbohydrate-containing polymers, in particular the glucans having β-configuration of the glucoside linkages. Similar glucans can act as amplifier of the protective mechanisms of the plants or as suppressor, speeding up penetration of the pathogens in plant-host. The results of study on biological action of the 1,3;1,6-β-D-glucans have been obtained by enzymatic transformation of the laminaran are presented. We studied the influence of the different β-D-glucans (I, II, II, IV) on the development of some diseases (fungi, viruses, viroid) in potato and tobacco. The relationship between biological action of the β-D-glucans and their chemical structure had been shown. The effect of the β-D-glucans on the speeding up of the penetration hyphal material of fungi *Phytophthora infestans* in the tissue tubers potato have also been determined. However, glucan IV, with degree of polymerisation (DP) 35 have decreased expansion of mycelium fungi in the tissues leaf and tubers potato. The β-D-glucans IV had some inhibitory affect on tobacco mosaic virus and X-virus potato infection. The action of the β-D-glucans on the development of caused by potato spindle tuber viroid (PSTVd) had been evaluated. The effect of β-D-glucan with DP 20-25 was optimum for the detection of the maximum number of the plants infected by this viroid. The β-D-glucans with DP less 15 caused the very early acceleration of the PSTVd symptoms of the leaf potato.

Characterization of HABs in China and management actions

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Red tides (HABs) are an important environmental problem in China's coastal areas and can do great harm to coastal economies. The first record of red tides in China commenced in 1933, and from then on, more than 600 red tides have been recorded. There were only 14 records of red tides before 1979, but subsequently, 75 cases were reported in the 80s, 226 cases in the 90s and 399 cases from 2000 to 2004. The characteristics of marine red tides were described as being highly concentrated, and occurring over increasingly large areas, and over long periods of time. In Chinese coastal waters, red tides are believed to occur during all the 12 months of the year. In addition, poisonous and harmful species have increased over the last several decades. The dominant red tide organisms are *Prorocentrum donghaiense*, *Karenia mikimotoi*, *Phaeocystis* spp. in recent years. For the purpose of controlling and mitigating the damage of red tides, 18 red tide monitoring zones have been established. These routine monitoring programs have enhanced the discovery of red tides and have facilitated emergency response systems that play an important role in mitigating the impacts of red tides.

Review on the basin-scale survey in the Yellow Sea between Korea and China

Seung **Heo**, Young-Shil Kang, Seung-Yoon Park, Jae-Kyoung Son, Pyung-Joong Kim, Kyoung-Soo Park, Yoon-Seak Choi, Hyung-Chul Kim and Hak-Jin Whang

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The Yellow Sea is extremely important to the economy and to the health and well being of surrounding countries, Korea and China. Recently the Yellow Sea is under constantly increasing threat of degradation due to the increase of environmental pollution and over-fishing. A major part of the threat is due to the release of large

quantities of pollutants to the Yellow Sea that may be transported to near shore and even to the open ocean.

The governments of Korea and China have been aware of the importance of the Yellow Sea and reached an Environmental Agreement between Korea and China at the governmental level (November, 1993). According to this environmental agreement, the Yellow Sea Environmental Cooperative Research between Korea and China has been undertaken since 1997. The first research activity of the research between Korea and China was conducted by the KORDI in Korea and the Offshore Environmental Monitoring Network Center (OEMNC) of the State Environmental Protection Administration (SEPA) in China 1997. Since 1998, in accordance with the agreement of the 1998's Yellow Sea Environmental Cooperative Research Agreement between the Ministry of Maritime Affairs and Fisheries (MOMAF) in Korea and SEPA in China, the Korean host institution for this research has been changed from the KORDI to the West Sea Fisheries Research Institute (WSFRI) in Korea.

Up to now, research has been performed 8 times. The joint cruise had been conducted once a year at 33 stations in the 4 lines of the Yellow Sea where the 9 stations of the D line was newly added in the 7th cruise in 2003. The research parameters were temperature, salinity, dissolved oxygen, transparency, chlorophyll-*a*, pH, suspended solids, chemical oxygen demand, oil and grease, total organic carbon, nitrite, nitrate, ammonia, phosphate, silicate, and heavy metals (Hg, Cd, Cu, Pb, Zn, and As), grain size and sediment type, total nitrogen, total phosphorus, and polychlorinated biphenlys for sediment; phytoplankton and zooplankton. Additionally, 2 pilot studies, namely the distribution of dinoflagellate cysts and the vertical profiles of sediment chemistry using core samples, were examined in 2003. The samples were analyzed by scientists of both countries at the WSFRI, Korea and the OEMNC of the SEPA, China in turn. The annual report has been published every year during 1998~2004.

The scientific efforts to fix the cruise time in October and to extend research frequency, to twice a year, should be considered, and this requires the governmental supports such as research funds and other related administrational assistance on both sides. Finally, scientists should also pay a concentrated attention to standardize the analytical methods including quality control and to improve this Yellow Sea research as one of the most represented international projects in the Yellow Sea where sharing additional information available, if exist, such as dumping sites and material content, and of the freshwater quality will be of great help to broaden the output of this joint research project.

PICES XIV MEQ_Poster-2419

Ecosystem-based management of fisheries resources in Wangdol-cho in the East Sea, Korea

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The Wangdol-cho ecosystem (approximately 13.66km^2) consists of three reefs and is located in the East Sea in Korea. Wangdol-cho is an important area for habitat and spawning of organisms inhabiting the East Sea. In recent years the fishing ground surrounding Wangdol-cho has become overexploited, and underscores the necessity for the management of fisheries resources. We introduced an ecosystem-based approach in Wangdol-cho ecosystem to manage fisheries resources by considering ecological interactions of organisms in the ecosystem. We conducted a survey using gillnet and trap fisheries during 2002-2004 and analyzed the annual and seasonal changes in biomass. The dominant species in the ecosystem were *Gadus macrocephalus* and *Pleurogrammus azonus*. We collected the ecological information on all organisms in the ecosystem (including biomass, production, consumption, mortality, catch and diet composition by species). Using the ecosystem structure model (Ecopath), we constructed the structure of the ecosystem and analyzed ecotrophic levels of functional groups in Wangdol-cho ecosystem. The ecosystem dynamic model (Ecosim) was employed to conduct dynamic simulation of the ecosystem on the various levels of the fishing mortality or environment changes.

Impacts from 500hPa circulation systems on algal blooms outbreak in spring of East China Sea

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The latitude change of position where algal blooms frequently break out corresponds with the seasonal oscillation of Pacific Northwest Subtropical High. Algal blooms usually occur in northern or southern edge areas of the western ridge of subtropical high, where the cyclone systems are active. A hypothesis is suggested that the ocean upwelling is enhanced under the convergent wind fields in these cyclone systems. Nutrients are brought upwards by the ocean upwelling from the deeper ocean water. This process is regarded as the forming phases of algal bloom outbreaks. Then, with this area being controlled by the subtropical high, algal blooms break out when the appropriate environmental conditions (such as water temperature, light and salinity) are available.

A prediction method for algal blooms is developed based on the hypothesis above. Sixteen typical algal bloom events in spring of 2001, 2002 and 2003 were selected to investigate the impacts from 500hPa circulation system on algal bloom outbreaks in spring in the East China Sea. By analogue analysis four typical favorable patterns for algal blooms were concluded. With these patterns, eight experimental predictions of algal blooms in 2004 were made, which gave four correct predictions, two empty predictions, and two predictions with 48 hours deviation (earlier than the actual occurrences).

However, the mechanism hypothesis mentioned above lacks evidence from field work during algal bloom events. Further research will be developed through coupled hydrodynamic-ecological modeling associated with quantified data from satellite results.

Saxitoxins content in the Aniva Bay scallops caused by seasonal blooming of toxic phytoplankton

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We observed the seasonal changes of saxitoxin concentration in the tissues of scallop *Mizuhopecten yessoensis* caused by *Alexandrium tamarense*. The samples were taken in the coastal zone of Aniva Bay from May through October 2004. Scallop muscles and mantles were analysed for saxitoxin by the immunoassay method using the test-system «RIDASCREEN[R] FAST Saxitoxin» on EIA (enzyme immunoassay) EL301. A sensitivity of method is 5 mkg/100g. Period of vegetation *A. tamarense* takes place from May through late July. A "blooming" of the toxic species was recorded in late May and then in early July. The *A. tamarense* numbers over 3400 cell/l were recorded in May. The second peak of this species development took place in early July (3550 cell/l). Saxitoxin content in scallop muscles and mantles in early July did not exceed the permissible level (PL - 80mkg/100g) for Russia. The toxin content in the mantle was always higher than in muscle. By the end of July and in August, the saxitoxin content, as a result of accumulation, had increased compared with early July. Saxitoxin in the mantle of scallops remains for several months after the blooming of *A. tamarense*. Maximum concentration was determinated in two samples (97,95 mkg/100g in August and 107,48 mkg/100g in October). The average concentrations of saxitoxin in scallops' tissues did not exceed PC for Russia.

A quantitative evaluation of an extent of anthropogenic disturbance of soft substrata macrobenthic communities

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A method for the quantitative evaluation of the disturbance of soft substrata macrozoobenthic communities due to anthropogenic contamination is proposed. The method is based on the definition of dependencies of different parameters describing the community abundance and structure - biomass, population density, number of species, Shannon-Wiener and Pielou indices, *etc.* – on the level of total sediment contamination.   As particular characteristics of these disturbances the percent deflection of the values of biological parameters from the norm (initial almost horizontal section of model curves), and also magnitudes of ERL_q and ERM_q (Long *et al.*, 1995), which confine the area of the progressive degradation of a community (almost linear drop of the parameter values) is offered. The mapping of areas using these indices permits to estimate visually an extent and spatial scales of anthropogenic interference. The usage of the method displays that at the end of the past 20th century some water areas of the Peter the Great Bay, the Sea of Japan, were on the brink of ecological calamity. The results obtained by the method proposed and those derived by standard methods of the appraisal of ecological status of benthic communities are mainly adequate.

Expression of 1,3-β-D-glucanase and α-D-mannosidase in sea urchin embryos *Strongylocentrotus intermedius*: Effect of nature compounds on developmental stages of fertilized eggs and enzyme activities

Natalia S. **Verigina**, Marina I. Kiseleva, Mikhail I. Kusaikin, Victoria V. Sova and Tatiana N. Zvyagintseva

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It is known that the vitelline layer of sea urchin eggs consists of fucose, mannose, galactose, glucose, xylose, glucosamine, galactosamine and sialic acid by carbohydrate analysis. Therefore, enzymes under study in sea urchin embryos can be involved with metabolism of extracellular or cell surface glycoproteins during both the fertilization reaction and the cleavage period. The goal of the present work was to study composition and change of the activity O-glycosylhydrolases in the process of development sea urchin embryos *S. intermedius* and influence of compounds from brown seaweed at the same. High activities of the 1,3-β-D-glucanase and α-D-mannosidase were revealed in embryos at distinct developmental stages and unfertilized eggs. In contrast, low amounts of β-D-galactosidase and β-D-glucosidase were detected in the same conditions. After fertilization the high activity of α-D-mannosidase was revealed from blastula stage to mature larva and was increased twice after the pluteus stage. 1,3-β-D-Glucanase was decreased after gastrulation. The effect of different compounds (fucoidans from *Fucus evanescense* and *Laminaria cichorioides*; translam obtained by enzyme transformation of laminaran and 1,3-β-D-glucanase ihibitor from *L. cichorioides*) on enzyme activities and development of embryos were investigated. Fucoidans did not appear to change the development of embryos and expression of 1,3-β-D-glucanase and α-D-mannosidase. Translam (1,3;1,6-β-D-glucan) increased the speed of development of embryos in relation to control and respectively activity of the enzymes. In contrast, protein inhibitor of marine mollusk endo-1,3-β-D-glucanases decreased the speed of development of embryos and had no influence on enzyme activities.

W1

MEQ Workshop (including laboratory demonstration) — Review of selected harmful algae in the PICES region: I. *Pseudo-nitzschia & Alexandrium* and <u>HAB-S</u> Meeting

Co-Convenors: Tatiana Orlova (Russia) and Mark Wells (U.S.A.)

This workshop is the beginning of an annual series in which harmful algal bloom (HAB) species that impact all or most countries in the North Pacific are discussed in detail. In 2005, we will focus on two genera, *Pseudo-nitzschi*a and *Alexandrium*. Topics will include detection methods, ecosystem comparison, and new advancements in physiology and ecology from each of the member countries. In particular, we would like to stress those factors which need additional study in order to develop a predictive capacity for these HABs. Specific subjects will include: a comprehensive listing of both macro- and micro-nutrient requirements, toxin production, light and temperature requirements, environmental conditions, species and strain variability, cyst formation, shellfish species impacted, modeling, and genetics. We will document our knowledge on the ecophysiology of these HAB species as a result of this workshop. During future workshops we anticipate discussing additional HAB species, including: *Cochlodinium, Heterosigma akashiwo, Dinophysis, Heterocapsa, Chattonella, Gymnodinium catenatum*, and *Karenia mikimotoi*. This workshop will be preceded by a ½-day laboratory demonstration on detection techniques for algal toxins.

W1 (MEQ) Workshop
Thursday, September 29, 2005   13:00-18:00
13:00-18:00   **Laboratory demonstration on detection techniques for algal toxins**

Friday, September 30, 2005, 08:30-18:00

08:30-08:40   **Mark Wells and Tatiana <u>Orlova</u>**
Welcome and introduction

08:40-09:25   **Charles G. <u>Trick</u>**   (Invited)
Occurrence and effects of *Alexandrium* species in the environs of the North Pacific (W1-2422)

09:25-09:45   **Satoshi <u>Nagai</u>**
Microsatellite markers reveal population genetic structure of the toxic dinoflagellate *Alexandrium tamarense* (Dinophyceae) in Japanese coastal waters (W1-2572)

09:45-10:00   **Shigeru <u>Itakura</u>, Satoshi Nagai, Yukihiko Matsuyama and Mineo Yamaguchi**
Notes on *Alexandrium* bloom occurrence in Japanese coastal waters (W1-2266)

10:00-10:20   **Coffee Break**

10:20-10:35   **Ruixiang Li and Mingyuan <u>Zhu</u>**
The distribution and HAB formation of *Alexandrium* spp. in Chinese coastal waters (W1-2289)

10:35-10:50   **Changkyu <u>Lee</u>, Ensub Cho, Jongkyu Park, Changhoon Kim, Wolae Lim and Giyoung Kwon**
Occurrence of *Alexandrium* species in Korean coastal waters (W1-2597)

10:50-11:05   **Tatiana <u>Orlova</u>, Marina Selina and Inna Stonik**
Species of the genera *Alexandrium* from the east coast of Russia (W1-2281)

11:05-11:20   **Vera L. Trainer, B-T.L. Eberhart, J.C. Wekell, N.G. <u>Adams</u>, L. Hanson, F. Cox and J. Dowell**
Paralytic shellfish toxins from *Alexandrium* in Puget Sound, Washington, U.S.A. (W1-2445)

11:20-12:30	**Discussion and recommendation**
12:30-14:00	**Lunch**

14:00-14:45   **Stephen S. <u>Bates</u>**   (Invited)
Biology of the diatom *Pseudo-nitzschia*, producer of the ASP toxin domoic acid (W1-2508)

14:45-15:00   **Shigeru <u>Itakura</u>, Satoshi Nagai, Yukihiko Matsuyama and Mineo Yamaguchi**
Notes on *Pseudo-nitzschia* bloom occurrence in Japanese coastal waters (W1-2266)

15:00-15:15   **Ruixiang <u>Li</u> and Mingyuan Zhu**
The distribution and HAB formation of *Pseudo-nitzschia pungens* in Chinese coastal waters (W1-2288)

15:15-15:30   **Jinhui <u>Wang</u>, Nina Lundholm, Øjvind Moestrup, Yutao Qin and Ren Xu**
Preliminary study of *Pseudo-nitzschia* spp. in the Yangtze estuary (China) (W1-2236)

15:30-15:45   **Changkyu <u>Lee</u>, Ensub Cho, Jongkyu Park, Changhoon Kim, Wolae Lim and Giyoung Kwon**
Occurrence of *Pseudo-nitzschia* species in Korean coastal waters (W1-2597)

15:45-16:00   **Tatiana <u>Orlova</u>, Marina Selina and Inna Stonik**
Species of the genera *Pseudo-nitzschia* from the east coast of Russia (W1-2281)

16:00-16:20   **Coffee Break**

16:20-16:35   **William P. <u>Cochlan</u>, Julian Herndon and Nicolas C. Ladizinsky**
Inorganic and organic nitrogen uptake capabilities of the toxigenic diatom *Pseudo-nitzschia australis* (W1-2436)

16:35-17:45   **Discussion and recommendation**

17:45-18:00   **Summary and conclusion**

HAB Section Meeting
Saturday, October 1, 2005   8:30-18:00

08:30-09:00   **Hak-Gyoon Kim and Vera Trainer**
Welcome, goals of HAB Section meeting

Special Talks

09:00-09:30   **Gennady A. <u>Kantakov</u>, Marina S. Selina, Inna V. Stonik and Tatiana Y. Orlova**
Oceanological conditions and HAB monitoring in Aniva Bay, Sea of Okhotsk during 2003 (W1_HAB_Section-2510)

09:30-10:00   **Mark L. <u>Wells</u>, Charles G. Trick, William P. Cochlan, Margaret P. Hughes and Vera L. Trainer**
Domoic acid: The   synergy   of   iron,   copper   and   the   toxicity   of   diatoms (W1_HAB_Section-2427)

10:00-10:30   **Coffee Break**

10:30-11:00   **Mingyuan <u>Zhu</u> and Ruixiang Li**
Why the time of large scale HAB of *Prorocentrium* in the area south of Yangtze River Estuary changed in spring of 2005 (W1_HAB_Section-2238)

Database: HAE-DAT talks

11:00-11:30   **Hak-Gyoon Kim, Tatiana Orlova, Vera L. <u>Trainer</u>, Charles G. Trick, Yasunori Watanabe and Ming-Yuan Zhu**
Participation in the Intergovernmental Oceanographic Commission's Harmful Algae Event Database (HAE-DAT): The first year of PICES involvement (W1_HAB_Section-2599)

11:30-12:00   **Henrik Oksfeldt <u>Enevoldsen</u>, Monica Lion and Benjamin Sims**
Progress in the development of an international collaborative harmful algal event data base: The joint IOC-ICES-PICES HAE-DAT (W1_HAB_Section-2579)

12:00-13:30   **Lunch**

Discussion of HAE-DAT effectiveness and country reports

13:30–14:00   **Hak Gyoon <u>Kim</u>**
Korea report

14:00–14:30   **Tatyana Y. <u>Orlova</u>**
Russia report

14:30–15:00   **Charles G. <u>Trick</u>**
Canada report

15:00–15:20   **Coffee Break**

15:20–15:50   **Ming-Yuan <u>Zhu</u>**
China report

15:50–16:10   **Vera L. <u>Trainer</u>**
U.S.A. report

16:10–18:00   **Discussion including possible HAE-DAT modifications, goals of the HAE-DAT practical workshop (October 2), and future data efforts**

HAB Section Meeting, continued
Sunday, October 2, 2005   09:00-12:30

HAE-DAT practical workshop

09:00–12:30   **HAE-DAT entry of HAB data for the year 2001**

Please bring
- your country's HAB data for the years 2000 and 2001
- laptop computer

W1 Workshop Abstracts

PICES XIV W1-2445 Oral

Paralytic shellfish toxins from *Alexandrium* in Puget Sound, Washington, U.S.A.

Vera L. Trainer[1], B-T.L. Eberhart[1], J.C. Wekell[1], N.G. **Adams**[1], L. Hanson[2], F. Cox[2] and J. Dowell[2]

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The first illnesses and deaths in Washington State due to paralytic shellfish poisoning were documented in the 1940s, resulting in the establishment of one of the longest monitoring programs for paralytic shellfish toxins in commercial and recreational shellfish in the U.S. An analysis of the Washington Department of Health's monitoring data allowed us to examine temporal changes in shellfish toxin levels and geographical distribution of shellfish harvesting closures. When the values of toxins in shellfish were normalized to control for variable levels of toxin accumulation in different shellfish species, the observed increase in paralytic shellfish toxin levels in Puget Sound shellfish was not due to the shift in species monitored. A geospatial map of the first shellfish closures or paralytic shellfish poisoning event in each Puget Sound basin suggests that over time, toxigenic *Alexandrium* cells have been transported from northern to southern Puget Sound, with the initial "seed" population of cells in Washington State likely originating from the inland or coastal waters of Canada. Large-scale events, such as the bloom that occurred in the Whidbey and Central basins in 1978, may have been induced by global climate changes or shifts, such as the Pacific decadal oscillation. Although greater numbers of closures have been observed over time in many basins of Puget Sound, closures as a percentage of total samples analyzed have decreased or remained constant in all basins, indicating that the Washington Department of Health has increased its margin of safety by monitoring at more sites in recent years.

PICES XIV W1-2508 Invited

Biology of the diatom *Pseudo-nitzschia*, producer of the ASP toxin domoic acid

Stephen S. **Bates**

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This talk will summarize the current knowledge about the distribution, physiology and toxicity of *Pseudo-nitzschia* species. In 1987, *P. multiseries* was discovered as the source of domoic acid (DA) that caused amnesic shellfish poisoning in eastern Canada. Since then, a total of 12 species of *Pseudo-nitzschia*, worldwide, have been shown to be DA producers. Much of what has been learned about its physiology comes from studying *Pseudo-nitzschia* isolates in the laboratory. A commonality is that DA is produced when cells are stressed; so far by silicate, phosphorus, or iron limitation, or by excess copper. The presence of certain bacteria and of selenium enhances toxicity. A wide variability in toxicity is found among isolates of the same species, and toxicity can decrease over time. Some of this can be explained by genetic variation and perhaps by temporal changes in bacterial composition. The sexual reproduction of four *Pseudo-nitzschia* species has been documented, and toxicity may also reflect the stage in the sexual cycle. This genus is found on virtually every coast, and is selected for after iron enrichment of HNLC regions of the world's oceans. The role of domoic acid is still being debated. There is no evidence that it acts as an antifeedant. Laboratory, and now field, studies are showing that its siderophore-like properties may confer an advantage by chelating trace metals. Factors that trigger toxic blooms must still be deciphered. Without a resting stage, viable cells may accumulate in thin layers, until transported to surface waters. A greater understanding is needed before toxic blooms can be predicted.

Inorganic and organic nitrogen uptake capabilities of the toxigenic diatom *Pseudo-nitzschia australis*

William P. **Cochlan**, Julian Herndon, and Nicolas C. Ladizinsky

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The nitrogen uptake capabilities of the toxigenic diatom *Pseudo-nitzschia australis* were examined in uni-algal laboratory cultures at saturating photosynthetic photon flux densities (100 μE m^{-2} s^{-1}) and 15°C. The kinetics of nitrogen (nitrate, ammonium, urea and glutamine) uptake as a function of substrate concentration were estimated from short (10-min) incubations using the ^{15}N-tracer technique, and are compared to the long-term exponential growth rates of *P. australis* determined in semi-continuous, batch cultures grown on the various nitrogen substrates. Based on the estimated nitrogen uptake kinetic parameters, nitrate is the preferred nitrogen substrate at both saturating and sub-saturating concentrations, whereas rates of urea uptake by *P. australis* did not saturate even at concentrations as high as 36 g-at N L^{-1}. The growth rate (determined using cell abundance over time) of *P. australis* was slower for cells grown on urea (0.5 d^{-1}) compared to the cells grown on nitrate and ammonium, which both maintained significantly greater growth rates (*ca.* 0.9 d^{-1}). However, the particulate domoic acid content of the urea-grown cells was substantially greater than cells grown on either nitrate or ammonium. These results demonstrate the capability of this diatom to grow equally well on both oxidized and reduced forms of nitrogen, supporting our field observations that *P. australis* blooms during both upwelling and non-upwelling conditions off the west coast of North America. During these times, substantial differences in the nitrogenous nutrition of *P. australis* can be expected, and anthropogenic inputs of reduced N substrates could contribute significantly to its growth and toxicity.

Notes on *Pseudo-nitzschia* and *Alexandrium* bloom occurrence in Japanese coastal waters

Shigeru **Itakura**, Satoshi Nagai, Yukihiko Matsuyama and Mineo Yamaguchi

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In Japanese coastal waters, both *Pseudo-nitzschia* and *Alexandrium* species occur. *Pseudo-nitzschia* is one of the common phytoplankton in Japanese waters. However, in spite of intensive surveys conducted by the Fisheries Agency and several universities since 1993, domoic acid contamination (excess of quarantine level) in wild and aquacultured shellfish has not been detected so far. Therefore, only a few monitoring programs are set for ASP toxins in Japanese coastal waters. In contrast, PSP toxin contamination by *Alexandrium* (*A. tamarense*, *A. catenella* and *A. tamiyavanichii*) has been widely detected and an active monitoring program has been implemented for PSP toxins in Japanese coastal waters by the regional fisheries research organizations. Among the above three *Alexandrium* species, *A. tamarense* and *A. catenella* appear over a wide area and often cause toxin contamination in shellfish. From a morphological and genetic point of view, *A. tamarense* and *A. catenella* are closely related species, but these two species usually bloom in different areas in different seasons; rarely blooming simultaneously. Studies on these two *Alexandrium* species clarified that while they have the same life cycle (cyst and vegetative stages), their ecological and physiological characteristics are different. For example, duration of the cyst dormant period varies between *A. tamarense* (several months to half year) and *A. catenella* (several days to one week). Moreover, the temperature "window" for the cyst germination differs between *A. tamarense* (7.5˚C to 20˚C) and *A. catenella* (7.5˚C to 25˚C). These differences in cyst dormancy-germination characteristics would partly lead to spatial and temporal differentiation of blooming events.

Occurrence of *Pseudo-nitzschia* and *Alexandrium* species in Korean coastal waters

Changkyu **Lee**, Ensub Cho, Jongkyu Park, Changhoon Kim, Wolae Lim and Giyoung Kwon

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A twelve-month field survey of the potentially toxic genus *Pseudo-nitzschia* was carried out in Chinhae Bay, an area of commercial culturing and harvesting of oysters. Ten species of *Pseudo-nitzschia* were identified during the study: *Pseudo-nitzschia multiseries, P. pungens, P. multistriata, P. delicatissima, P. cuspidata, P. subfraudulenta, P. granii, P. fraudulenta, P. subpacifica*, and an unidentified *Pseudo-nitzschia* sp. *Pseudo-nitzschia pungens* had the highest cell abundance, followed by *P. delicatissima* and *P. multistriata*. Although *Pseudo-nitzschia* species varied depending on month and sampling site, most were present at higher cell densities in lower temperature waters except for *Pseudo-nitzschia multistriata*.

The motile cells of *Alexandrium tamarense,* PSP-producing species, appeared in January and reached their high concentration from March to May. Mussels became toxic in February and showed the highest level of toxicity from April to May. *Alexandrium* resting cysts were also found at every station surveyed, but the abundance was greatly variable depending on locality. Cyst collected in different seasons showed a large difference in the germination rate with showing relatively higher frequency in the cold water season; 9% (Oct.), 73% (Jan.), 68% (Apr.), and 44% (Jul.). Germination of *Alexandrium* resting cysts in Chinhae Bay was assumed to be largely controlled by the seasonal rhythmic pattern.

The distribution and HAB formation of *Pseudo-nitzschia pungens* in Chinese coastal waters

Ruixiang **Li** and Mingyuan Zhu

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Pseudo-nitzschia pungens in is a common and important species of phytoplankton in Chinese coastal waters. There were 5 recorded HABs caused by *Pseudo-nitzschia pungens*. In Bohai Sea, it is abundant in spring. In the Yellow Sea, high cell numbers appear in spring or early summer. High cell numbers occur in the East China Sea in early autumn or winter. In the South China Sea, *Pseudo-nitzschia pungens* is most abundant in the coast waters of Guangdong Province. Harmful blooms of *Pseudo-nitzschia pungens* usually are located south of Changjiang River (Yangtze River) Estuary. A *Pseudo-nitzschia pungens* HAB was found in upwelling area of Zhejiang Province in Aug. 1981. Two other blooms occurred in the western region of coastal water of Xiamen City in June 1987 and Dapeng Bay in Guangdong, respectively. These HAB's consisted of *Pseudo-nitzschia pungens* but also included other diatom species. It is reported that *Pseudo-nitzschia pungens* can be toxic, however, domoic acid has not been found in Chinese strains.

Microsatellite markers reveal population genetic structure of the toxic dinoflagellate *Alexandrium tamarense* (Dinophyceae) in Japanese coastal waters

Satoshi **Nagai**

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Transport of vegetative cells and resting cysts of the toxic dinoflagellate, *Alexandrium tamarense* (Lebour) Balech, which is responsible for paralytic shellfish poisoning (PSP), either in ships' ballast water or via translocation of shellfish stocks has been proposed as an explanation for its global increase. However, the extent of contribution to the apparent "cosmopolitanism" of this species could not be assessed, as techniques to distinguish unambiguously between populations were insufficient to test dispersal theories. However, recently highly polymorphic microsatellite markers have been developed to investigate the genetic structure of *A. tamarense* populations. Here we analyzed nine microsatellite loci among 10 samples along with Japanese and Korean coasts. The nine microsatellites varied widely in number of alleles and gene diversity across

populations. The analysis revealed that Nei's genetic distance correlated significantly with geographic distance in pairwise comparisons, and there was genetic differentiation in about half of 45 pairwise populations, clearly indicating genetic isolation among populations in compliance with geographic distance and restricted gene flow by natural dispersal through tidal currents among the populations. On the other hand, high P-values in Fisher's combined test were detected in 5 pairwise populations, indicating the similar genetic structure and the close relationship genetically.   These findings suggest that disturbance of genetic structures of *A. tamarense* populations by human activity and gene flow by a human-assisted dispersal have occurred between these populations.

Species of the genera *Alexandrium* and *Pseudo-nitzschia* from the east coast of Russia

Tatiana **Orlova**, Marina Selina and Inna Stonik

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Species of the genera *Alexandrium* and *Pseudo-nitzschia* from the east coast of Russia were studied by light and electron microscopy using field material and cultures. Ten *Pseudo-nitzschia* species were found: *P. pungens, P. multiseries, P. multistriata, P. calliantha, P. americana, P.* cf. *pseudodelicatissima, P. delicatissima, P. fraudulenta, P.* cf. *heimii*, and *P. seriata* f. *seriata*. The bloom-forming species were *P. pungens, P. multiseries, P. calliantha,* and *P. americana*, widely distributed along the Russian Pacific coast. Species *P. seriata* f. *seriata* and *P.* cf. *heimii* were observed only in Aniva Bay (the Sea of Okhotsk) at low densities. *P. delicatissima* was common but not numerous component of phytoplankton in study area. Eight species of the genus *Alexandrium* were recorded from the east coast of Russia: *A. tamarense, A. acatenella, A. catanella, A. ostenfeldii, A. insuetum, A. pseudogonyaulax, A. margalefi* and *A. tamutum*. Eight *Alexandrium* species were observed in the coastal waters of Sakhalin Island. Six species (excluding *A. catenella* and *A. tamutum)* were found in Peter the Great Bay of the Sea of Japan. Only three species *A. tamarense, A. ostenfeldii* and *A. acatenella* were observed in the coastal waters of Kamchatka and in the Bering Sea. It was shown that *A. tamarense* is dominant and the most widespread *Alexandrium* species on the Russian Pacific coast.   Twenty-six clones of *Alexandrium tamarense* and two clones of *P. multiseries* and *P. calliantha* were analyzed by HPLC. All of the isolates, excluding *P. calliantha,* were found to be toxic.

Occurrence and effects of *Alexandrium* species in the environs of the North Pacific

Charles G. **Trick**

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The distribution and occurrence of the historically significant red tide dinoflagellate, *Alexandrium* sp. will be reviewed. Using taxonomic observations, levels of PSP toxins in marine organisms and records of the health affects of consuming contaminated shellfish, I will consider the historical variability of this genus in the waters of the North Pacific ecosystem. From these geographic examples a comparison will be made to the intensively studied *Alexandrium* sp. blooms from other global locations to assess the probability that the North Pacific populations are controlled and transported through seed-bed reservoirs or through deep water lenses of cells or cysts or through transport of ballast waters. I will also review the contrasting mechanisms of species competition – survival and physiological dominance at relatively low community densities - and the variability of toxin content in both the cells and cysts, with emphasis on correlations to specific hydrodynamic features of individual North Pacific populations.   Our understanding of the relationship between toxicity, toxin composition, physiological state and genotype we assist in our contribution to human health issues associated with *Alexandrium* species.

Preliminary study of *Pseudo-nitzschia* spp. in the Yangtze estuary (China)

Jinhui **Wang**[1,3], Nina Lundholm[2], Øjvind Moestrup[2], Yutao Qin[1] and Ren Xu[1]

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A four-season field survey of harmful algae including *Pseudo-nitzschia* was carried out in the Yangtze estuary (China) during 2003-2004. Three species of *Pseudo-nitzschia* were identified during the monitoring; *P. multiseries,* the first recorded in China, *P. multistriata,* the first recorded in the Yangtze estuary, and *Pseudo-nitzschia pungens,* which had been frequently detected. *Pseudo-nitzschia* spp. were distributed mainly in the outer region of the Yangtze river front, where the salinity was near 25 psu and the temperature 20°C on June. *Pseudo-nitzschia* spp. were found in highly turbid waters, even up to 802 mg/L, but cell numbers were highest in higher temperature, low turbidity waters. Among the 6 *Pseudo-nitzschia* species recorded to date in Chinese coastal waters, *P. multistriata, P. multiseries* and *P. pseudodelicatissima* have been documented elsewhere in the world as domoic acid producers. Mouse bioassays of mussels from the Yangtze estuary indicate the presence of the ASP toxin, but the existence of domoic acid still needs to be ascertained by HPLC analysis. A preliminary study during the 1980s found only *P. pungens* in these waters, indicating that *P. multistriata* and *P. multiseries* might be alien species in the Yangtze estuary. *Pseudo-nitzschia* spp. occurred in almost all the diluted waters of the Yangtze estuary, but also were relatively high in upwelling waters. Cell abundances were slightly higher in surface water than near the bottom. Seasonal fluctuations of *Pseudo-nitzschia* spp. indicate higher abundances in summer and autumn than in spring and winter.

The distribution and HAB formation of *Alexandrium* spp. in Chinese coastal waters

Ruixiang Li and Mingyuan **Zhu**

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Alexandrium tamarense and *Alexandrium catenella,* two PSP-producing species, are both common species of the genus *Alexandrium* in Chinese coastal water. PSP poisoning events caused by these two species are found in coastal waters of the world as well as in Chinese coastal waters. HABs of *Alexandrium* sp. usually occur in South China coastal waters, such as coastal waters of Fujian and Guangdong Provinces. However, these HABs have expanded northwards along the coast in recent years. There were blooms of *Alexandrium* sp. in area near Zhoushan Archipelago in the spring of 2002 and 2004, together with *Prorocentrium dentatum*. During these two HABs, cell numbers of *Alexandrium* sp. reached 10^6 cells/L. In Oct. 2004, a HAB of *Alexandrium* spp. occurred in coastal waters of Dalian City in North Yellow Sea. As *Alexandrium* spp. are toxic, these blooms are of concern to the Chinese government and scientists. Monitoring of HABs and toxicity in shellfish products therefore has been strengthened in Chinese coastal waters.

HAB Meeting Abstracts

PICES XIV   W1_HAB_Section-2579   Oral

Progress in the development of an international collaborative harmful algal event data base: The joint IOC-ICES-PICES HAE-DAT

Henrik Oksfeldt **Enevoldsen**[1] and Monica Lion[2] and Benjamin Sims

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The IOC and ICES have jointly developed the Harmful Algal Event Data base HAE-DAT with the view to expand the partnership and thereby build a global harmful algal event database. To this effect PICES in 2004/05 became a full and equal partner in HAE-DAT. HAE-DAT provides a comprehensive format for reporting all types of algal events which are perceived by society as harmful. For the PICES region will additionally be recorded algal blooms which did not cause any harm. HAE-DAT is in the process of having its software platform upgraded and improved and of being developed with an associated mapping function. The progress will be presented for comments and discussion in conjunction with the evaluation of PICES experience in using the data input format.

PICES XIV   W1_HAB_Section-2510   Oral

Oceanological conditions and HAB monitoring in Aniva Bay, Sea of Okhotsk during 2003

G.A. **Kantakov**[1], M.S. Selina[2], I.V. Stonik[2] and T.Y. Orlova[2]

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During May-December 2003 regular water sampling was conducted at nearshore spots in Aniva Bay, Sea of Okhotsk. Seasonal dynamics of few species of harmful algae was observed with simultaneous oceanographic parameters observations. The variance of species of harmful algae regarding water masses properties, currents and methods for possible monitoring and detecting HAB events in the Aniva Bay are discussed.

PICES XIV   W1_HAB_Section-2599   Oral

Participation in the Intergovernmental Oceanographic Commission's Harmful Algae Event Database (HAE-DAT): The first year of PICES involvement

Hak-Gyoon Kim[1], Tatiana Orlova[2], Vera L. **Trainer**[3], Charles G. Trick[4], Yasunori Watanabe[5] and Ming-Yuan Zhu[6]

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     Xianxialing Road, Hi-tech Industrial Park, Qingdao, Shandong, 266061, P.R. China

During the PICES XIII meeting in Honolulu, Hawaii, the Harmful Algal Bloom Section member countries unanimously decided to adopt the IOC database as the official PICES HAB database. The ICES database is now called the HAE-DAT IOC joint ICES/PICES database.   During our HAB Section meeting on Saturday, October 1, 2005, an overall description of the PICES joint database with IOC/ICES and its goals will be discussed. Each country will report on involvement in the HAE-DAT effort that includes a description of monitoring programs in each country, what constitutes a "harmful event", the algae species currently described in the IOC database as harmful in each country, harmful levels, and "area codes" (coastline divisions into ~100-200 km sections for which frequency of HAB events are plotted.). A summary of the first year's participation in

the HAE-DAT collaboration will be given by a HAB Section representative from each country, including Dr. Kim (Korea), Dr. Trainer (U.S.A.), Dr. Watanabe (Japan), Dr. Zhu (China), Dr. Trick (Canada), and Dr. Orlova (Russia). Each presentation will detail the entry of data into the IOC web-based database for the year 2000 and subsequent years, if possible. The ease of HAE-DAT use and possible modifications required for northern Pacific Nations will be discussed. On Sunday morning, October 2, 2005, representatives from each country will work together to enter HAB data from the year 2001 into HAE-DAT at the extended HAB Section meeting.

PICES XIV   W1_HAB_Section-2427   Oral
Domoic acid: The synergy of iron, copper and the toxicity of diatoms

Mark L. **Wells**[1], Charles G. Trick[2], William P. Cochlan[3], Margaret P. Hughes[4] and Vera L. Trainer[4]

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[4]   NOAA, Northwest Fisheries Science Center, Seattle, WA, 98112, U.S.A.

Diatom blooms generated by the alleviation of iron limitation in High Nitrate-Low Chlorophyll regions of the oceans often are composed of pennate diatoms of the genus *Pseudo-nitzschia*, many species of which periodically produce the potent neurotoxin domoic acid. We show that toxigenic diatoms have an inducible high affinity iron uptake capability that enables them to grow efficiently on iron complexed by strong organic ligands in seawater. This adaptive strategy to acquire iron when present at extremely low ambient concentrations requires copper and apparently domoic acid, a copper chelator whose production increases sharply when both iron and copper are limiting. Addition of either domoic acid or copper to coastal seawater improves the growth of *Pseudo-nitzschia* spp. on strongly complexed iron during deck incubation experiments with natural phytoplankton assemblages. Our findings suggest that domoic acid is a functional component of the unusual high-affinity iron acquisition system of these organisms. This system may help explain why *Pseudo-nitzschia* spp. are persistent seed populations in oceanic high-nitrate-low-chlorophyll regions, as well as in some neritic regions. Our findings also suggest that in the absence of an adequate copper supply, iron-limited natural populations of *Pseudo-nitzschia* will become increasingly toxic.

PICES XIV   W1_HAB_Section-2238   Oral
Why the time of large scale HAB of *Prorocentrium* in the area south of Yangtze River Estuary changed in spring of 2005

Mingyuan **Zhu** and Ruixiang Li

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The area south of Yangtze River Estuary or the coastal water of Zhejiang Province of China is the most eutrophicated area in Chinese coastal water. It is the largest fishing ground and a region with frequent HAB events as well. A large scale HAB of *Prorocentrium* occurred in early May for three year from 2002 to 2004. The largest area of HAB reached 10,000 km^2 in 2004. However, there was no large HAB in early May of 2005. The preliminary analysis of cruise data showed that due to the cold winter with more precipitation, the nutrients in seawater were higher than other years, especially the concentration of silicate. The temperature of sea water in April was about 3°C lower than other years. There was a diatom HAB in April. In early May, however, the water temperature was almost the same as usual. The nutrients were low as there was a bloom of *Skeletonema costatum* in April. It is clear that the proper environment condition for the early development of *Prorocentrium* sp. is essential for the formation of large scale HAB in this area in May. However, in late May a large scale bloom of *Karenia mikimotoi* was occurred. In early June, *Prorocentrium* bloom was found out, which was one month later than last three years.

W2

MEQ Workshop
Introduced species in the North Pacific

Co-sponsored by the International Council for the Exploration of the Sea (ICES)

Co-Convenors: Yasuwo Fukuyo (Japan/PICES), Stephan Gollasch (Germany/ICES) and Glen Jamieson (Canada/PICES)

The workshop will include presentations on the status of introduced organisms in member countries and progress in developing inventories of introduced species; reports of activities related to research on vectors, including natural (currents and organisms such as turtles and birds), and anthropogenic (ballast water, hull fouling, fisheries, etc.) ones; reports of activities related to the Ballast Water Management Convention, especially measurement of compliance with ballast water exchange protocols, and measurement of effectiveness and development of systems of ballast water treatment. The workshop aims to have a discussion on the establishment of a Working Group on introduced species under the PICES Marine Environmental Quality Committee.

Tuesday, October 4, 2005   14:00-18:00

14:00-14:10   **Introduction by Convenors**

14:10-14:30   **Alexander Yu. Zvyagintsev**
Introduction of species into the northwestern Sea of Japan (W2-2581)

14:30-14:50   **Li-Jun Wang and Bin Wang**
Marine introduced species in China seas and action plans (W2-2563)

14:50-15:10   **Il-Hoi Kim**
Some non-indigenous marine invertebrates of Korea (W2-2606)

15:10-15:30   **Hiroshi Kawai, Takeaki Hanyuda and Shinya Uwai**
Macroalgal diversity of hull communities on trans-ocean coal carriers (W2-2600)

15:30-15:50   **Glen Jamieson, Colin Levings, Dorothee Kieser and Sarah Dudas**
Marine and estuarine non-indigenous species in the Strait of Georgia, British Columbia, Canada (W2-2429)

15:50-16:10   **John E. Stein**
Invasive species in the North Pacific – review of US research

16:10-16:30   **Coffee Break**

16:30-16:50   **Mitsunori Iwataki, Hisae Kawami, Kazumi Matsuoka, Takuo Omura and Yasuwo Fukuyo**
Phylogeny and geographical distribution of *Cochlodinium polykrikoides* population (Gymnodiniales, Dinophyceae) collected from Japanese and Korean coasts (W2-2565)

16:50-17:10   **Sergej Olenin**   (Invited)
Xenodiversity versus biodiversity: Invasive alien species in European coastal marine ecosystems (W2-2562)

17:10-17:30   **Stephan Gollasch**
Overview on introduced aquatic species in Europe – With focus on ICES Member Countries (W2-2574)

17:30-18:00   **Discussion**

Wednesday, October 5, 2005   14:00-18:00

14:00-14:20   **Dan <u>Minchin</u>**   (Invited)
Vectors and processes involved in biological invasions (W2-2532)

14:20-14:40   **Akiko <u>Tomaru</u>, Yasuwo Fukuyo, Masanobu Kawachi and Hiroshi Kawai**
Effect of mid-ocean exchange of ballast water on bacterial community in ballast tanks (W2-2570)

14:40-15:00   **Yasuwo <u>Fukuyo</u>, Katsumi Yoshida and Shin-ichi Hanayama**
Importance of inputs from scientists to effective implementation of ballast water management convention (W2-2603)

15:00-15:20   **Shinichi <u>Hanayama</u> and Miyuki Ishibashi**
Efforts of IMO to avoid secondary toxicity risk on the marine environment by chemical treatment of Ballast Water Management System (W2-2604)

15:20-15:40   **Helge <u>Botnen</u> and Stephan Gollasch**
Tests of a ballast water treatment system onboard an ocean-going vessel and hints on a new sampling device for larger volumes of water (W2-2623)

15:40-16:10   **Discussion on the establishment of a PICES Working Group to study on marine bioinvasion including the following two brief presentations:**

John E. <u>Stein</u>
Advantage of organizing a PICES Working Group on marine bioinvasions for future cooperation among PICES and ICES

Stephen <u>Gollasch</u>
Recommendation from the Chairman of ICES/IOC/IMO WGBOSV for the consideration by PICES in preparing the TOR for the new PICES Working Group

16:10-16:30   **Coffee Break**

16:30-18:00   **Discussion (continued)**

Tests of a ballast water treatment system onboard an ocean-going vessel and hints on a new sampling device for larger volumes of water

Helge **Botnen**[1] and Stephan Gollasch[2]

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Several ballast water treatment systems are currently in a testing phase with the aim to meet the ballast water discharge standards as set forth by the IMO Ballast Water Management Convention. A new ballast water treatment system, developed by the Norwegian vendor OceanSaver, was installed onboard of a car carrier after detailed land-based tests were completed. Onboard tests of the system started in June 2005 and are ongoing since. Results from the first onboard tests are presented. One challenge when testing ballast water treatment systems is to sample large volumes of ballast water to evaluate the systems performance regarding larger organisms (above 50 microns). To solve this problem a new sampling device was developed in cooperation with a German vendor of scientific sampling gear. The prototype was successfully tested onboard and details of this method will be introduced.

Importance of inputs from scientists to effective implementation of ballast water management convention

Yasuwo **Fukuyo**[1], Katsumi Yoshida[2] and Shin-ichi Hanayama[3]

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Several important guidelines in support of the Ballast Water Management Convention were established at MEPC 53 in July 2005. Evaluation of potential treatment systems to terminate organisms in ballast water will be commenced according to the guidelines. Now scientists are requested to develop techniques to measure < 10 individuals of organisms of a size > 50 μ in one m^3 of water with judging their viability and minimum dimension. Not only for evaluation of performance of treatment systems, but also for evaluation of implementation, i.e. quantification of organisms in discharging ballast water, above mentioned technology is one of the most important factors. Preparation of test water for development of treatment system is also difficult task of plankton scientists. According to the guidelines, 400m^3 water containing 10^3 ind/ml of organisms ranging between 10 and 50 micrometer is necessary. Such water must be prepared at least 5 times with approximately one-week interval. These are some examples of issues where planktologists must provide substantial operational solutions.

Overview on introduced aquatic species in Europe – With focus on ICES Member Countries

Stephan **Gollasch**

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Regions considered in this overview range from Arctic to the Mediterranean Sea and Irish waters to the Black Sea. In total more than 1,000 non-indigenous aquatic species have been recorded from European coastal and adjacent waters. The majority has been first recorded since 1950s. More than 500 taxa (range from unicellular algae to vertebrates) are established with self-sustaining populations. The dominating group of exotic species across all seas are zoobenthos organisms. Species movements for aquaculture purposes and shipping (ballast water and hull fouling) are the major introducing vectors.

Efforts of IMO to avoid secondary toxicity risk on the marine environment by chemical treatment of Ballast Water Management System

Shinichi **Hanayama** and Miyuki Ishibashi

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IMO's International Convention for the Control and Management of Ships Ballast Water and Sediments (hereafter referred to as the Convention) permits ships to use approved chemicals or products, if they want to treat their ballast water with chemicals for disinfections of invasive species. Chemical treatment is essential to achieve the discharge standards set by the Convention, especially the criteria for phytoplankton and bacteria. The chemical treatment system shall be approved by the IMO. The approval procedure by IMO is much stricter than that for physical and/or mechanical treatment systems, which requires only a Member State's approval. Because ballast water after chemical treatment includes some residues and byproducts, and this ballast water has higher risks than that treated physically and mechanically. According to chemical manufacturers, their treatment techniques (such as hypochlorite, hydrogen peroxide and peracetic acid) are widely used for disinfecting drinking water; the techniques for ballast water are under development at the moment. Their potential risks such as chronic toxicity, the rate of degradation, and the byproducts are not yet well characterized in real sea conditions. Early 2005, the IMO is going to commence the evaluation of these chemicals.

Phylogeny and geographical distribution of *Cochlodinium polykrikoides* population (Gymnodiniales, Dinophyceae) collected from Japanese and Korean coasts

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An unarmored dinoflagellate *Cochlodinium polykrikoides* has often caused mass fish mortalities in East and Southeast Asian countries. In Japanese and Korean coastal waters, blooms of this species have occurred every summer of the last decade, however, the local habitation of their seed population is still obscure. It is suspected that the seed population is transferred from offshore; a small number of motile cells was in fact found off the coasts of the East China Sea. On the other hand, putative resting cysts of *C. polykrikoides* were also found in this area. To clarify the intraspecific variety and distribution, SSU rDNA sequences of *Cochlodinium polykrikoides* strains from Japan, Korea, Philippines and Malaysia were analysed. In the phylogenetic tree inferred from gamma weighted neighbor-joining method, all strains formed a well-supported monophyletic group and branched out near the basal position of dinoflagellates. Sequence divergences between all Korean and most of Japanese strains were identical, while other strains had several substitutions. This indicates that the dominant population of *C. polykrikoides* in Japanese and Korean waters could be distinguished from other populations inhabiting Southeast Asian countries. Two *Cochlodinium* strains collected from Sumatra and the East China Sea near Nagasaki Peninsula resemble *C. polykrikoides* in appearance, because of the cingulum encircling the cell twice, the presence of the pigmented body in the dorsal side of the epicone, and formation of cell-chains. However, the larger cell size, position of the sulcus and shape of chloroplasts differentiate this species from *C. polykrikoides*. This species closely related to *C. polykrikoides* among dinoflagellates in the phylogenetic tree, but clearly distinguished from it based on their morphology and SSU rDNA sequences.

Marine and estuarine non-indigenous species in the Strait of Georgia, British Columbia, Canada

Glen **Jamieson**[1], Colin Levings[2], Dorothee Kieser[1] and Sarah Dudas[2]

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The Strait of Georgia is an important inland sea for seafood production, recreational activity, and maritime industry. Based on the literature and authoritative personal communications, we estimate that as of 2000, the following number of non-indigenous species (NIS) have established populations in the Strait or along its shoreline: algae - 22; vascular plants - 22; invertebrates - 65; fish - 3; birds - one; mammals - one. Some species' records may only represent range extensions and other species may be cryptogenic, and all records do not necessarily indicate continued species presence today. They may have been records of a small population that only sustained itself for a limited time period, during which it happened to be observed. Because of the lack of ecological surveys and monitoring in the Strait there is uncertainty about when most of the NIS arrived in the Strait, modes of introduction, and ecological impact. However, many species arrived accidentally with intentionally introduced species for culture from both the western Atlantic and Pacific Oceans. Other species may have arrived via ballast water, ship fouling, releases of live food organisms, the plant nursery and aquarium trade, and research and teaching activities. Because of the multiple pathways available for NIS to spread into the Strait, it is proving difficult to implement comprehensive effective control mechanisms to minimize or prevent further introductions. Current programs in place include quarantine procedures, ballast water control and management, and public education, and it is hoped these measures will reduce the rate of further introductions.

Macroalgal diversity of hull communities on trans-ocean coal carriers

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To elucidate the processes contributing to intercontinental introductions of marine macro-algae, we studied the biodiversity of the biota on the hulls of bulk carriers, and investigated the genetic diversity of taxa that are representative of introduced species in international port areas of Japan and overseas. We found more than 10 macro-algae and more than 50 benthic animals on the hulls of coal carriers operating between Osaka Bay and Australian/Indonesian ports. The richness of attached organisms differed depending on the location on the hull: they occurred more frequently near the ladder, sea-chests, and screws. The most dominant seaweeds were membranous/filamentous algae such as *Ulva* spp. and *Enteromoropha* spp. (green algae), and ectocarpalean brown algae. They showed apparently close genetic relationships with the natural populations in the ports of call of the coal carriers, which suggests frequent introductions of taxa by means of ship transportation.

Some non-indigenous marine invertebrates of Korea

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The invasion of non-indigenous marine invertebrates into Korean waters has been very poorly noticed up to now. However, there are at least six invertebrates that are well known invaders: *Mytilus edulis* Linne, *Balanus amphitrite* Darwin, *Balanus improvisus* Darwin, *Balanus eburneus* Gould, *Ciona intestinalis* (L.), and *Styela plicata* (Lesueur). *Mytilus edulis* is certainly the first invading animal to be observed all around Korean coasts. *Balanus amphitrite*, *B. improvisus* and *B. eburneus* were first noticed in 1970s and are now widely distributed along the south and east coast. *Ciona intestinalis* and *Stylela plicata* are uncertain for their first invasions. These tunicates and *M. edulis* occur very frequently in harbor areas and are problematic for the mariculture industry, although some of them (*S. plicata* and *M. edulis*) are used for food. These species occupied barren areas at first, but expanded their habitats and some of them are competing with native animals. Many more non-indigenous species are considered to have invaded Korean coasts, especially into the harbors.

PICES XIV W2-2532 *Invited*
Vectors and processes involved in biological invasions

Dan **Minchin**

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Over this last century a wide range of powerful and previously non-operating vectors became active in transmitting species over varying distances. Yet evidence for the arrival of a species is often unclear, as there are many arrivals of species not easily explained. Yet a good knowledge of species life-modes and of nearby human activities have implicated their arrival via some likely vector that may have involved a series of movements relayed from overlapping activities. Over time the power of a vector transmission may cease or become taken-up by a different transferral process. One of the main recent changes is speed of transmission. Formerly shipping journeys between Europe and eastern Asia took some ten or more weeks during which the carried species were subject to varying challenges that reduced their potency for founding populations on arrival. Aircraft presently distribute aquaculture stock, aquarium species and living foods to most world regions within a day and this will include the many accompanying biota, including diseases. New shipping and airline routes also provide new opportunities for species expansions. One notable area of concern is the new shipping routes likely to evolve through the Arctic Sea following climate warming during this century. This would provide the first cold-water direct passage between the North Pacific and Atlantic Oceans. Over the last thirty years many new leisure pursuits have evolved or expanded involving trade of plants and fishes for ornamental ponds (as well as their associated biota), sport fishing and aquaria and transmissions by fouling on leisure craft. Such movements usually involve small volumes of biota that can become widely distributed and may escape or become released. Many of these species are nurtured while in transit and so they and their associated biota are provided special advantages for survival. The size required to form a founder population and occasions when colonization is possible is an important gap in our understanding. Further, the capability of natural vectors may not be so completely understood, rare or infrequent meteorological or earth crust events or natural alterations to climate may all have some future consequence. Management requires these complexities to be unraveled so that a practical targeted action is possible and appropriate according to the expansion in the range of an impacting species. Preventive actions are best but not all invasive species can be predicted and some following arrival may be cryptic for some years before expansion. Should a species be identified at an early stage there is a possibility of eradication, otherwise mitigation methods may provide the only appropriate cost-effective approach. Unless regular monitoring of consignments and of likely arrival sites, with the knowledge of likely routes and assessment of the vectors involved, are undertaken we will find invasions taking place without our knowledge until some impact is revealed. In addition it is helpful to undertake a shared responsibility using recent knowledge with all stakeholders, including those that may be involved in production and transmission, from source to destination. There is also a need to strengthen working links between Pacific and Atlantic biologists in formulating risk assessments for known impacting species moving to and from the North Pacific.

PICES XIV W2-2562 *Invited*
Xenodiversity versus biodiversity: Invasive alien species in European coastal marine ecosystems

Sergej **Olenin**

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Evolutionary separation and specialisation of coastal marine life over millions of years created much of the biogeographical peculiarities of Europe. These peculiarities, in great extent, have been lost during the last five hundred years because of different human activities. Often beginning of marine bioinvasions is attributed to the 19th century; however the scale of invasions that must have occurred prior to appearance of first inventories of world flora and fauna is practically unknown. Since the time of early overseas voyages, ships were transporting organisms on and in their hulls as well as in rock and sand ballast. That process inevitably had to result in establishment of hundreds of coastal species that are now regarded as "naturally cosmopolitan", in fact being early introductions of the 16th – 18th centuries. In the beginning of the 3rd millennium, due to globalisation of human activities, the number and variety of available invasion corridors is rapidly growing. Results of this global exchange of species are evident in most marine coastal areas of Europe. Much of its present structural and functional diversity is of foreign origin. This human-mediated addition of non-native species was termed "xenodiversity" (Gr. xenos - strange) to indicate the diversity caused by nonindigenous (alien, exotic, introduced) species (Leppäkoski & Olenin 2000). The xenodiversity might be traced at different hierarchical levels: genetic

(hybridization and addition of genetically modified organisms); species (addition of alien species, elimination of native species); functional/community (emergence of novel or unusual functions, changes in community structure, alterations of food webs and ecosystem functioning) and, even habitat/landscape (habitat engineering, encrusting of solid objects, and changes in bottom micro-topography). The study of invasions in coastal marine systems, now being a rapidly growing ecological discipline only really began a little more than two decades ago. The scientific interest is in great deal driven by practical needs due to serious ecological and economical consequences of bioinvasions. In fact, the problem of biological pollution, became multidisciplinary, involving not only biological/ecological (genetics, ecophysiology, biogeography, *etc.*) but also technical and socio-economic aspects.

PICES XIV   W2-2570   Oral
Effect of mid-ocean exchange of ballast water on bacterial community in ballast tanks

Akiko **Tomaru**[1], Yasuwo Fukuyo[1], Masanobu Kawachi[2] and Hiroshi Kawai[3]

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This research was planned to clarify the change of bacterial community in ballast water tanks before and after mid-ocean exchange, and also during a voyage. Live and total bacteria numbers were observed using the spread plate method and the direct count method, respectively. DGGE (Denaturing Gradient Gel Electrophoresis) structure analysis was used to observe the composition. Samples were collected from the ballast tanks of a coal cargo ship *Shinchi-maru* by pumping up through a manhole and a sounding pipe as the vessel traveled between Soma, Japan and Newcastle, Australia. The results of live and total counts showed that bacteria numbers decreased after the mid-ocean exchange of ballast water. It suggested that the number of bacteria discharged at the loading port could be reduced by conducting a mid-ocean exchange. Results of DGGE structure analysis revealed that sub-clusters in band patterns were distinctively different before and after the mid-ocean exchange, and DGGE patterns from multidimensional scaling analysis showed that the bacterial composition was changing along with the duration of storage in ballast tanks. It is clear that the decrease of cell numbers and the change of composition in bacteria community occurred abruptly after the mid-ocean exchange, and also the composition was gradually changed during the voyage.

PICES XIV   W2-2563   Oral
Marine introduced species in China seas and action plans

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The China seas are located in the north-western part of the Pacific Ocean and consist of Bohai Sea, Huanghai (Yellow) Sea, East China Sea and South China Sea, covering three climatic zones (warm-temperate, subtropical and tropical). Diverse habitats are easily influenced by different alien species. It is estimated that there are one hundred and thirty-seven marine alien species in China. They have been introduced either intentionally for marine aquaculture and marine aquarium, or unintentionally by ships' hulls and ballast water. For example, 26 alien species had been introduced to China for marine aquaculture by 2001, including ten fish, two shrimps, nine shellfish, one echinoderm and four algae. In recent years, 16 cryptogenic HAB species have been found in the coastal seas of China; perhaps they were introduced by ballast water. Up to now, three marine alien species, including *Spartina alterniflora, Mytilosis sallei* and *Crepidula onyx*, have caused great damage of ecology and social economy of coastal China so the Chinese government is consistently paying more attention to invasive species. The Ministry of Agriculture was directed to coordinate a national strategy and plan to address the growing environmental and economic threat from invasive species, and further, to use their authority to prevent the introduction of invasive species and to restore native species.

Introduction of species into the northwestern Sea of Japan

Alexander Yu. **Zvyagintsev**

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Studies conducted by the Institute of Marine Biology of ship fouling began in 1975. Data on fouling of 600 ships in a various modes of operation in different regions of World Ocean has been assembled. It has revealed that 17 exotic species have been introduced to the northwestern Sea of Japan as a result of ship fouling and/or ballast waters. The location of the Sea of Japan at the border between two biogeographic provinces with different temperature regimes affects the natural distribution of species. The northwestern part of the sea might be inhabited by widely-boreal, subtropical and subtropical-low-boreal species living together. Using a scheme of Zenkevich (1940), we distinguished four groups of introduced species, which are now at different stages of acclimation.

(1) Introduced species that cannot adapt to new conditions even in harbor waters, where free ecological niches are usually available. This group includes two species of barnacle, *Balanus eburneus* and *B. trigonus*, which primarily have been found on foreign-going ships. They are extremely rare on cabotage ships, do not reproduce and are absent in bottom communities.

(2) Potential invaders are species that are in the first stage of introduction and have small-scale developments. This group includes *Gonothyrea loveni, Laomedea flexuosa, L. calceolifera, Polydora limicola, and Bugula californica.* They show greater ecological plasticity than the species of the first group and relatively frequently are responsible for the fouling of harbors. It is still not known whether the species of this group could naturalize in the Sea of Japan.

(3) Species that are at the stage of ecological explosion. This group is comprised of four species, *B. amphitrite, Hydroides elegans, Molgula manhattensis, and Ciona savignyi.* They demonstrate great qualitative characteristics in the fouling of ships and experimental plates.

(4) Naturalized species are a group of species that have been found not only in fouling communities, but also in the benthic community of the upper subtidal zone. These are *B. improvisus, Pseudopotamilla occelata, Corophium acherusicum, Campanularia johnstoni, Conopeum seurati* and *Schizoporella unicornis.*

W3

IFEP/MODEL Workshop
Modeling and iron biogeochemistry: How far apart are we?

Co-Convenors: Fei Chai (U.S.A.), Jun Nishioka and Yasuhiro Yamanaka (Japan)

Synthesis of data from three successful meso-scale iron enrichment experiments in the subarctic North Pacific (SEEDS-I & II and SERIES) is underway. This workshop will enhance communication between experimentalists and modelers. For the most part, iron is not explicitly represented in current ecological models. The goal of this workshop will be to examine the structure of iron biochemical models with respect to what is known about iron biogeochemistry. The purpose will be to establish a framework for organizing a 2-3 day workshop to address this problem in detail and to compare ecological models that describe how plankton ecosystem respond to meso-scale iron enrichment in the high-nutrient, low-chlorophyll waters of the subarctic Pacific.

Sunday, October 2, 2005   08:30-16:00

08:30-08:40   **Introduction by Convenors**

08:40-09:20   **Peter L. Croot**   (Invited)
The importance of iron speciation and kinetics in understanding iron biogeochemical cycling in the open ocean: Effects on budget estimates from meso-scale tracer release experiments (W3-2220)

09:20-10:00   **Naoki Yoshie, Yasuhiro Yamanaka and Shigenobu Takeda**   (Invited)
Development of a marine ecosystem model including intermediate complexity iron cycle (W3-2526)

10:00-10:20   **Coffee Break**

10:20-10:50   **Michio J. Kishi, Takeshi Okunishi and Yukiko Ono**
Lower trophic ecosystem model including effect of iron in the Okhotsk Sea and adjacent areas (W3-2551)

10:50-11:20   **M. Angelica Peña, K.L. Denman, C. Voelker and R.B. Rivkin**
Modelling the ecosystem response to iron fertilization during SERIES (W3-2363)

11:20-11:50   **Masahiko Fujii, Naoki Yoshie, Yasuhiro Yamanaka and Fei Chai**
Simulated biogeochemical responses to iron enrichments in three high nutrient, low chlorophyll (HNLC) regions (W3-2513)

11:50-12:20   **James Christian and Christoph Voelker**
Modelling the ocean iron cycle – The major uncertainties (W3-2536)

12:20-14:00   **Lunch**

14:00-16:00   **Discussion and development of a proposal for a workshop to compare ecological models describing how plankton ecosystem respond to meso-scale iron enrichment experiment in HNLC waters**

Modelling the ocean iron cycle – The major uncertainties

James **Christian**[1] and Christoph Voelker[2]

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The importance of iron as a limiting nutrient for oceanic ecosystems is now indisputable. The iron cycle in the ocean impacts the biogeochemical cycles of carbon, nitrogen, phosphorus and silica, but the cycle of iron itself is poorly understood. There are few if any robust estimates of residence time, and the sources and pathways by which it reaches the oceans, cycles within the water column, and ultimately is lost to the sediments, remain uncertain, and in some important areas current data appear contradictory or paradoxical.   The rapid disappearance of dissolved iron in open-water fertilization experiments, for example, is difficult to reconcile with scavenging rates that allow deep and mid-depth concentrations to be maintained at observed levels. This paper will identify critical points of uncertainty about iron in the ocean, including the variability and concentration-dependence of scavenging rates, regulation of dissolution of aeolian iron, and lower limits to phytoplankton iron requirements. We will discuss approaches to using models and observations to reduce the uncertainties, especially with respect to climate projections.

The importance of iron speciation and kinetics in understanding iron biogeochemical cycling in the open ocean: Effects on budget estimates from meso-scale tracer release experiments

Peter L. **Croot**

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The role of iron in limiting primary productivity in HNLC regions of the global ocean is now well established principally through meso-scale iron fertilization experiments. However our present understanding of the chemical processes affecting iron distribution, speciation and bioavailability still needs to be dramatically improved. One approach to this has been the development of budgetary schemes for the iron released during the meso-scale iron enrichment experiments performed to date. Experimental results from the Southern Ocean (SOIREE, EISENEX, SOFeX, EIFEX) have highlighted the importance of redox cycles and the kinetics of transformation between soluble, colloidal and particulate iron phases to the residence time of iron in the surface mixing layer. Similar processes were also found to be important in unperturbed HNLC South West Pacific waters during the recent meso-scale tracer experiment (FECYCLE), though more experiments of this type are needed. This study will examine the state of our present knowledge, identify the key mechanisms involved, and outline future schemes for improving our understanding of iron biogeochemical cycling in the open ocean.

Lower trophic ecosystem model including effect of iron in the Okhotsk Sea and adjacent areas

Michio J. **Kishi**[1,2], Takeshi Okunishi[3] and Yukiko Ono[1]

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A three dimensional physical-ecosystem coupled model, including effect of iron, is applied to the Okhotsk Sea and adjacent areas. In order to investigate sources of iron, we have modified a nitrogen-based ecosystem model (with six compartments of phytoplankton, zooplankton, DON, PON, NO_3, and NH_4, Kawamiya *et al.* (1995)) by including iron cycle with four iron components. We assume there are four main sources of iron to sea water: 1) atmospheric loading from Northeastern Asia; 2) riverine input from the Amur River; 3) solution from sediment; and 4) biological process of zooplankton and bacteria in the water column. The physical-ecosystem model simulation was conducted for one year period, from 1 January 2001 to 31 December 2001. After spring

phytoplankton bloom, the ecosystem model without iron cannot reproduce the observed surface nitrate distribution. But, the simulation with iron cycle shows good agreement with the observed sea surface nitrate in the Northwestern Pacific. During spring, dominated iron source to the surface ocean is from the atmosphere. The atmospheric iron loading contributes about half of iron needed for supporting primary production in Okhotsk Sea.

PICES XIV   W3-2363   *Oral*
Modelling the ecosystem response to iron fertilization during SERIES

M. Angelica **Peña**[1], K.L. Denman[1,2], C. Voelker[3] and R.B. Rivkin[4]

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We present results from a one-dimensional model designed to explore the planktonic ecosystem and biogeochemical response to the 2002 SERIES iron fertilization experiment in the subarctic NE Pacific. The ecosystem model simulates with the same parameter set both the 'average' annual cycle at ocean station Papa and the SERIES experiment. We seek to understand the role of iron fertilization in changing (i) planktonic ecosystem structure and function, (ii) the macronutrient fields of N and Si, and (iii) the inorganic carbon system (including surface ocean pCO$_2$). The model captures the initial bloom of small phytoplankton followed by the large bloom of diatoms, accompanied by a strong draw-down of the nutrient silicic acid. Generally this sequence proceeds more rapidly in simulations than in situ. It took considerable tuning of parameter values to obtain a high enough peak biomass of diatoms before they crashed. Key parameters were the sinking speed of diatoms, the scaling coefficient for aggregation, the relative preference of microzooplankton for diatoms, and the 'normal' or background degree of iron limitation of the diatoms. We discuss the sensitivity of model results to the assumed fraction of small phytoplankton that are calcifiers and to the uptake ratio by diatoms of silicic acid and nitrogen.

PICES XIV   W3-2526   *Invited*
Development of a marine ecosystem model including intermediate complexity iron cycle

Naoki **Yoshie**[1], Yasuhiro Yamanaka[1,2] and Shigenobu Takeda[3]

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Iron is an important micronutrient for marine phytoplankton, and it controls primary productivity and phytoplankton community structure. Development of iron cycle model, including interaction of chemical species, biological uptake and utilization of iron, will advance understanding the role of iron in regulating marine ecosystem and biogeochemical cycles. We have developed a marine ecosystem model explicitly including intermediate complexity iron cycle. The iron cycle component of the model consists inorganic iron species Fe(II)' and Fe(III)', iron complexed with organic ligands (FeL), and particulate iron (Fe$_P$). Biological compartments of the ecosystem model are based on NEMURO (North Pacific Ecosystem Model Used for Regional Oceanography), which developed by the CCCC/MODEL task team of PICES. The ecosystem model with iron cycle has been applied to station A7 (41°30'N, 145°30'E) in the western North Pacific, where diatom bloom occurs regularly in spring. Model simulations reproduced the time series of observed dissolved-iron concentration. We will discuss some other recent model studies regarding mesoscale iron fertilization experiments in the subarctic Pacific (Subarctic Pacific Iron Experiment for Ecosystem Dynamics Study (SEEDS; 48.5°N, 165°E) and Subarctic Ecosystem Response to Iron Enrichment Study (SERIES; 50°N, 145°W)).

Simulated biogeochemical responses to iron enrichments in three high nutrient, low chlorophyll (HNLC) regions

Masahiko Fujii[1], Naoki **Yoshie**[2], Yasuhiro Yamanaka[2,3] and Fei Chai[1]

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We applied a fifteen-compartment ecosystem model to three iron-enrichment sites, SEEDS (the Subarctic Pacific Iron Experiment for Ecosystem Dynamics Study; 48.5°N, 165°E) in the Northwestern Pacific, SOIREE (the Southern Ocean Iron RElease Experiment; 61°S, 140°E) in the Southern Ocean, and IronExII (the second mesoscale iron experiment; 3.5°S, 104°W) in the Equatorial Pacific. The ecological effects of iron in the model were represented by changing two photosynthetic parameters during the iron-enrichment period. The model results successfully reproduced the observed biogeochemical responses inside and outside the iron patch at each site, such as rapid increase in biological productivity and decreases in surface nutrients and CO2 inside the patch. However, the modeled timing and magnitude of changes differed among the sites because of differences in both physical environments and plankton species. After the iron enrichment, the productivity by diatoms was strongly restricted by light at SOIREE and by silicate at IronExII. Light limitation due to self-shading by the phytoplankton was significant during the bloom at all sites. Model sensitivity to duration of the iron enrichment revealed that long-term multiple infusions over more than a week would not be effective at SEEDS because of strong silicate limitation to diatom growth. Model sensitivity to water temperature showed that export production was higher at lower temperatures, because of slower recycling of particulate organic carbon. Therefore, the e-ratio had a negative linear correlation with temperature. Through this study, we conclude that ecosystem modeling is a powerful tool to help design future iron-enrichment experiments and observational plans.

W4

MONITOR Workshop
Filling the gaps in the PICES North Pacific Ecosystem Status Report

Co-Convenors: Vyacheslav B. Lobanov (Russia), Phillip R. Mundy (U.S.A.), R. Ian Perry (Canada) and Sei-Ichi Saitoh (Japan)

In 2004, PICES published the first status report on the marine ecosystems of the North Pacific (PICES. 2004. Marine ecosystems of the North Pacific. PICES Special Publication 1, 280 p.). It reviewed climatic, oceanographic, and fisheries conditions for all major regions in the North Pacific, with a focus on 1999-2003, and identified some of the critical factors causing changes in these ecosystems. Much was learned about the process of assessing the status of marine ecosystems, but much was also left out of the report. For example, benthic organisms, near-shore regions and contaminants were only sparsely discussed, and there were few attempts to provide synthetic or summary indices of ecosystem state that might be comparable among regions. In 2004, PICES also produced a report on Fisheries and Ecosystem Responses to Recent Regime Shifts, which included updated information that was not in the Ecosystem Status Report. The new MONITOR Technical Committee has accepted the responsibility to update this Ecosystem Status Report and to produce the next version. The purpose of this workshop is to examine the process used to develop and review the first status report (what worked, what did not), to consider other models of ecosystem status reports (*e.g.*, ICES, Global International Waters Assessment, and the recently released Millennium Ecosystem Assessment), and to identify themes and data sources that were poorly, or not at all, included in the first version. Presentations on these topics, and on existing monitoring programs that could contribute to the next Ecosystem Status Report, and on new sampling, observation and data processing technologies which might contribute directly to the next report, are invited.

Saturday, October 1, 2005   08:30-18:00

08:30-08:40   **Introduction by Convenors**

08:40-09:10   **R. Ian Perry and Skip McKinnell**
PICES report on the marine ecosystems of the North Pacific: Why, how, and what's needed next (W4-2424)

09:10-09:40   **David L. Fluharty**
Putting ecosystem science to work (W4-2362)

09:40-10:10   **Jacqueline Alder**   (Invited)
Millennium Ecosystem Assessment: Lessons learned (W4-2520)

10:10-10:30   **Coffee Break**

10:30-11:00   **P. Robin Rigby, Tetsuya Kato and Yoshihisa Shirayama**   (Invited)
Broadening our understanding of the North Pacific nearshore ecosystem: Integrating PICES and NaGISA (W4-2401)

11:00-11:30   **Sinjae Yoo**
Filling the gaps: The case of the Yellow Sea (W4-2542)

11:30-12:00   **Peter S. Rand, Xanthippe Augerot and Cathy D. Pearson**
Progress on a range-wide inventory for Pacific salmon monitoring data (W4-2509)

12:00-12:30   **Phillip R. Mundy**
Hypothesis-driven ecosystem monitoring in the Gulf of Alaska (W4-2595)

12:30-14:00   **Lunch**

14:00-18:00   **Discussion (with Coffee Break from 16:00-16:20)**

PICES XIV   W4-2520   Invited
Millennium Ecosystem Assessment: Lessons learned

Jacqueline **Alder**

Sea Around Us Project, Fisheries Centre, University of British Columbia, 2202 Main Mall, Vancouver, BC, V6T 1Z4, Canada
E-mail: j.alder@fisheries.ubc.ca

The Millennium Ecosystems Assessment (MA) was a global assessment of the world's major ecosystems. It is different from past global assessments such as United Nation's Environment Program GEO3 with its focus on the interaction of ecosystems and human well-being. The MA used a modified demand-pressure-state-response (DPSR) model to not only assess current trends and conditions, but also looked at possible futures and responses. The assessment also considered sub-global assessments at different scales from around the world. The marine and coastal aspects of the assessment were focused on two chapters: Marine Fisheries (Chapter 18) and Coastal (Chapter 19).   Aspects such as biodiversity, aquaculture fisheries as a 'food' system and management of coasts were included in other chapters within the three volumes. Although considered one of the most comprehensive assessments of its kind, there were gaps and deficiencies in coastal and marine areas, specifically: trends in basic oceanographic features, climate change on ecosystems, biodiversity, pollution, human health, economic valuations and human use (non-fisheries) and good examples of linkage between marine ecosystems and human well being that were not focused on fisheries. In addition to the gaps in specific aspects of marine systems, there was also weak links between the global and sub-global assessments, especially with a lack of a high seas sub-global assessment and only two assessments with a coastal component. Future MAs will likely be small and more focused. For marine and coastal issues, the focus should be on filling the gaps identified in this first assessment.

PICES XIV   W4-2362   Oral
Putting ecosystem science to work

David L. **Fluharty**

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The dialogue between scientists and the makers of decisions about how the ecosystem affects human activities and is affected by human activities is a key justification for investment in and prioritization of research. Investigation of how scientific perspectives are being used to inform decisions is one means of assessing gaps in North Pacific ecosystem science and research. This study focuses on the Alaska region [BSAI, GOA] to examine the current use of ecosystem information in decision-making by selected federal and state institutions, compares this usage with the content of the PICES North Pacific Ecosystem Status Report, and identifies possible gaps in coverage that could be considered in prioritization of future research. This process research process also identifies barriers and bridges to the use of ecosystem science to inform decision-making.

PICES XIV   W4-2595   Oral
Hypothesis-driven ecosystem monitoring in the Gulf of Alaska

Phillip R. **Mundy**

Alaska Fisheries Science Center, Auke Bay Laboratory, 11305 Glacier Hwy, Juneau, AK, 99801-8626, U.S.A.
E-mail: Phil.mundy@noaa.gov

The Gulf of Alaska Ecosystem and Monitoring Program (GEM) has assembled and published the basic hypotheses regarding the regulation of biological production and the current understandings of the relevant physical, chemical and biological sciences for the northern Gulf of Alaska. An interdisciplinary narrative attributes the short and long term changes in biological production to the consequences of climatic variability on annual and decadal scales. Ocean circulation is strongly shaped by the topography of the region, both terrestrial and submarine, and topography influences and interacts with climate. Key indicators of changes in production are identified in the hypotheses presented. The hypotheses are followed by summaries and syntheses of the status of these indicators from physical, chemical and biological oceanography, as well as birds, fish and mammals. Human factors that produce change in the region are also seen as important indicators of ecosystem change. Modeling is presented as the ultimate means of understanding the many indicators and their complex

interactions that are necessary to explain change in ecosystems. A discussion of modeling approaches and a summary of available models concludes the work.

Mundy, Phillip R. (ed.) 2005. The Gulf of Alaska: Biology and Oceanography. Alaska Sea Grant College Program, University of Alaska Fairbanks.

PICES report on the marine ecosystems of the North Pacific: Why, how, and what's needed next

R. Ian **Perry**[1] and Skip McKinnell[2]

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[2] PICES Secretariat, c/o Institute of Ocean Sciences, Sidney, BC, V8L 4B2, Canada

The PICES Report on the Marine Ecosystems of the North Pacific was published in late 2004, after two years of active work by a large number of scientists. It arose out of recognition that many unusual events had occurred in these marine ecosystems during the past 10 years, but there had been no attempt to connect them across the larger region of the entire North Pacific Ocean. The report that was published in fact was one part of a larger proposal for PICES to support regional analysis centers to collect and analyze ecosystem data. The ecosystem report was led by a Working Group (mostly the members of PICES Science Board) who developed a template of required information, and the chapters were written by lead authors (and co-authors selected by them) familiar with each region or species group. The next version of the Report needs to consider several issues:
1) is the previous approach the most efficient and effective, considering that a core report now exists and that the MONITOR Task Team will take responsibility for the report;
2) what are the significant data gaps? Do they represent actual missing information or a lack of awareness of existing data;
3) are there significant themes that were poorly or not covered, *e.g.* contaminants, benthos, near-shore;
4) to what extent should PICES conduct its own analyses and develop its own ecosystem indicators rather than synthesising previously published material;
5) better definition of the clients for, and users of, this report and its information and the best formats to present the information.
This presentation will discuss how the Ecosystem Report came about, what worked and what did not work well, our view of the significant data gaps, and propose a plan for creation of the next Ecosystem report.

Progress on a range-wide inventory for Pacific salmon monitoring data

Peter S. **Rand**, Xanthippe Augerot and Cathy D. Pearson

State of the Salmon Program, 721 NW 9th Avenue, Portland, OR, 97209, U.S.A. E-mail: prand@wildsalmoncenter.org

Salmon (*Oncorhynchus* spp.) are assessed in the 2004 PICES North Pacific Ecosystem Status Report using times series of catch statistics by nation. Our program endeavors to provide a more rigorous assessment of salmon across the North Pacific based on fisheries-independent monitoring data. We have embarked on a range-wide data inventory for anadromous Pacific salmon to provide (1) a consistent framework to describe current monitoring efforts and (2) a source for data to conduct quantitative range-wide salmon status and trend assessments. We have begun systematically characterizing monitoring activities which track parameters related to salmon population viability – abundance, distribution, diversity and productivity. We intend to classify each data set into a monitoring tier (1-3) based on the underlying biological knowledge of the target stock or population to help standardize data. We expect to complete the North American inventory and initiate the Western Pacific inventory over the next eighteen months. Our first two analyses using data sets from the inventory will be (1) a comprehensive gap analysis of current monitoring effort and (2) a phased assessment of salmon status and trends at the coarsest spatial scale, reflecting regional species groupings (referred to as Tier 1). The gap analysis will provide the first range-wide assessment of the distribution of monitoring effort and the range of data quality used to assess North Pacific salmon status and trends. Our coarse-grained, Tier 1 status assessment will draw more robust inferences on the population status of species, representing an improvement on relying solely on aggregated catch statistics.

PICES XIV   W4-2401   Invited
Broadening our understanding of the North Pacific nearshore ecosystem: Integrating PICES and NaGISA

P. Robin **Rigby**, Tetsuya Kato and Yoshihisa Shirayama

Kyoto University SMBL, 459 Shirahama Nishimuro, Wakayama, 649 2211, Japan. E-mail: robinrigby@yahoo.com

The costal zone cannot be ignored when assessing the oceans ecosystem. Easy to access, this zone, which acts as a nursery ground and primary food chain source, is exposed to the brunt of human incursion and environmental change. A global comprehensive assessment of the costal ecosystem has never been completed. Meaning that the few interregional ocean assessments prepared have either had to use fisheries catches as a measure of biodiversity, non-quantitative data or geographically patchy and incomparable data sources. The cost effective, standardized protocols for nearshore habitat assessment of biodiversity as promoted by NaGISA (a Census of Marine Life field project) are part of the effort to supply a baseline of information and create a network of researchers that will change this.   The basic information NaGISA is gathering on coastal communities will allow a comprehensive assessment of global biodiversity. The continuation of the protocols, as they are incorporated into local and national monitoring schemes are envisioned as perpetually providing similarly detailed data. The next step is to incorporate this essential nearshore information into ocean wide assessments. The integration of PICES and NaGISA, as outlined in this presentation is intended to advance this idea and in doing so form a clearer picture of the North Pacific Region.

PICES XIV   W4-2542   Oral
Filling the gaps: The case of the Yellow Sea

Sinjae **Yoo**

Korea Ocean Research & Development Institute, Sa-dong 1270, Ansan, 425-170, Republic of Korea. E-mail: sjyoo@kordi.re.kr

To assess the status of an ecosystem in an appropriate manner, theoretically we have to know its past trajectory and the present state should be evaluated as a point in the continuous trajectory. When preparing the chapter on the Yellow Sea and the East China Sea in the NPESR, it was evident that far less knowledge and information were available than were required to do the state assessment of YS/ECS ecosystem.   The picture was fragmentary in terms of geographical, temporal, taxonomical and thematic coverage. A basin-scale picture was lacking, in particular, on nutrient cycles, benthos, fish species biomass and population dynamics, pollutants and their ecological impacts. There were also problems in synthesizing data due to differences in sampling and analysis methods among nations. With such holes, it was even more difficult to single out the causes of ecosystem change. Some of the gaps can be filled in the near future with new international projects in the region. One example is YSLME (Yellow Sea Large Marine Ecosystem) project supported by GEF (Global Environment Facility). Of the five working groups established in the YSLME project, four working groups' activities are relevant to ecosystem status assessment; Fisheries, Ecosystem, Biodiversity, and Pollution. From proposed activities, historical data will be mined in a more methodical way. And basin-scale surveys are planned to collect up-to-date data of various variables. With better data coverage, a better theoretical development is desired.

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PICES Acronyms

AP	Advisory Panel	
BIO	Biological Oceanography Committee	
CCCC	Climate Change and Carrying Capacity Program	
CFAME	Climate Forcing and Marine Ecosystem Response Task Team	
F&A	Finance and Administration Commitee	
FIS	Fishery Science Committee	
GC	Governing Council	
GLOBEC	Global Ocean Ecosystem Dynamics Programme	
HAB-S	Harmful Algal Blooms Section	
HAE-DAT	Harmful Algae Event Database	
ICES	International Council for the Exploration of the Sea	
IFEP	Advisory Panel on Iron Fertilization Experiment	
MEQ	Marine Environmental Quality Committee	
MODEL	Conceptual / Theoretical and Modelling Task Team	
MONITOR	Technical Committee on Monitoring	
NEMURO	North Pacific Ecosystem Model for Understanding Regional Oceanography	
POC	Physical Oceanography and Climate Committee	
S1	Session 1	Science Board Symposium on *Mechnisms of climate and human impacts on ecosystems in marginal seas and shelf regions*
S2	Session 2	BIO Topic Session on *Life history and ecology of euphausiids in coastal and oceanic waters around the Pacific Rim*
S3	Session 3	BIO Topic Session on *Factors affecting distribution, foraging ecology, and life histories of top predators in the northwestern Pacific Ocean and its marginal seas*
S4	Session 4	CCCC/CFAME Topic Session on *The comparative response of differing life history strategists to climate shifts*
S5	Session 5	CCCC/MODEL Topic Session on *Modeling climate and fishing impacts on fish recruitment*
S6	Session 6	FIS/CCCC Topic Session on *Evidence of distributional shifts in demersal fish in relation to short/long-term changes in oceanographic conditions*
S7	Session 7	MEQ/FIS Topic Session on *Current and emerging issues of marine and esturarine aquaculture in the Pacific region: Carrying capacity, ecosystem function and socioeconomics*
S8	Session 8	MEQ/FIS Topic Session on *Ecosystem indicators and models*
S9	Session 9	MEQ Topic Session on *Ecological effects of offshore oil and gas development and oil spills*
S10	Session 10	TCODE Topic Session on *Marine data management and delivery systems to support ecosystem monitoring*
SB	Science Board	
SEEDS	Subarctic Pacific Iron Experiment for Ecosystem Dynamics Study	
SERIES	Subarctic Ecosystem Response to Iron Enrichment Study	
EBM	Ecosystem-based management	
TCODE	Technical Committee on Data Exchange	
W1	MEQ Workshop & laboratory demonstration on *Review of selected harmful algae in the PICES region: I.* Pseudo-nitzschia *& Alexandrium*	
W2	MEQ Workshop on *Intoduced species in the North Pacific*	
W3	IFEP/MODEL Workshop on *Modeling and iron biogeochemistry: How far apart are we?*	
W4	MONITOR Workshop on *Filling the gaps in the PICES North Pacific Ecosystem Status Report*	

Useful Information

Banks

1. **Alfa-Bank**
   26, Semenovskaya Str.,
   tel: 7 (4232) 49-16-50(1),
   it takes to get there about 5-7 min. from Hyundai Hotel, 10-15 - from Versailles Hotel.

2. **Baltiyskiy Bank Razvitie**
   10/b, Uborevicha Str.,
   tel.: 7 (4232) 22-84-61,
   about 3 min. from Hyundai (just the reverse), 15-20 from Versailles.

3. **Bolshoy Kamen' Bank**
   15/a, Okeansky Av.,
   tel.: 7 (4232) 49-14-32 (currency department),
   about 5-7 min. from Hyundai, 15 min. from Versailles.

4. **Russian Federation Sberbank's Primorsky Bank**
   22, Semenovskaya,
   tel.: 7 (4223) 40-65-79 (currency department),
   about 7-10 min. from Hyundai, 15 min.from Versailles.

Cybercafes

1. **Vladivostok cyber cafe**
   www.cybercafe.vladivostok.com,
   19, Uborevicha, 209,
   tel.: 7 (4232) 26-91-35,
   about 5-7 min. from Hyundai, 20-25 min. from Versailles.

2. **Iguana**
   www.iguana.vl.ru,
   23/a, Svetlanskaya,
   tel.: 7 (4232) 35-53-21,
   about 10 min. from Hyundai, 15 min. from Versailles.

List of local restaurants

Chinese cuisine

Restaurants

Bokhai ****
Cuisine: Mixed (Russian, Chinese)
Operation hours: 11 a.m. – 3 a.m.
Address: Naberezhnaya St., 20
Tel.: 7 (4232) 41-06-73/ 41-19-98
(about 15-20 min. from Hyundai, 5-7 min. from Versailles)

Imperator ***
Cuisine: Chinese
Operation hours: 10 a.m. – 5 a.m
Address: 2, Batareinaya St.
Tel.: 7 (4232) 40-15-46/ 40-02-95
 (about 15-20 min. from Hyundai, 5-7 min. from Versailles)

Man'chzhuriya **
Cuisine: Mixed (Russian, Chinese, Korean)
Operation hours: 11 a.m. – 2 a.m.
Address: 8/4, Mordovtseva St.
Tel.: 7 (4232) 20-52-14
(about 10 min. from Hyundai, 10-15 min. from Versailles)

Perekryestok ***
Cuisine: Mixed (Russian, Chinese)
Operation hours: 11 a.m. – 12 p.m.
Address: 1, Svetlanskaya St.
Tel.: 7 (4232) 41-28-21
(about 20 min. from Hyundai, 5 min. from Versailles)

Rendez-vous
Cuisine: mixed (Russian, European, Chinese)
Operation hours: 7 a.m. – 11 p.m.
Address: 29, Semenovskaya St., "Huyndai"
Tel.: 7 (4232) 40-73-20
(about 20 min. from Versailles)

Chainy dom po-vostochnomu ***
Cuisine: Chinese
1) Operation hours: 12 noon – 4 a.m.
   Address: 69, Svetlanskaya St.
   Tel.: 7 (4232) 22-00-58
   (about 20 min. from Hyundai, 30 min. from Versailles)

2) Operation hours: 12 noon – 11 p.m.
   Address: 37, Svetlanskaya St.
   Tel.: 7 (4232) 26-49-59
   (about 5-7 min. from Hyundai, 20 min. from Versailles)

Russian cuisine

Restaurants

Hocus - Pocus ****
Cuisine: mixed (Russian, European)
Operation hours: 12 noon – 1 a.m.
Address: Korabel'naya Naberezhnaya
Tel.: 7 (4232) 49-58-58/ 49-69-49
(about 10 min. from Hyundai, 15-20 min. from Versailles)

Berezka *****
Cuisine: mixed (Russian, European)
Operation hours: 10 a.m. – 11 p.m.
Address: 22, Svetlanskaya St.
Tel.: 7 (4232) 22-81-21
(about 10-15 min. from Hyundai, 10 min. from Versailles)

Ilona **
Cuisine: mixed (Russian, European)
Operation hours: 12 noon – 5 a.m.
Address: 9, Naberezhnaya St., hotel "Amursky zaliv"
Tel.: 7 (4232) 22-73-42

Pacific *****
Cuisine: mixed (Russian, Chinese)
Operation hours: 12 noon – 2 a.m.
Address: 29, Semyenovskaya St., "Hyundai"
Tel.: 7 (4232) 40-73-50

Porto-franco *****
Cuisine: mixed (Russian, European)
Address: 13, Svetlanskaya St.
 Operation hours: 12 noon – 12 p.m.
 Tel.: 7 (4232) 26-78-19
(about 10-15 min. from Hyundai, 5-7 min. from Versailles)

Stariy gorod ****
Cuisine: mixed (Russian, European)
Operation hours: 11 a.m. – 5 a.m.
Address: 1/10, Semenovskaya St.
Tel.: 7 (4232) 20-52-94, 20-98-28
(about 20 min. from Hyundai, 5-7 min. from Versailles)

Medis ****
Pancake bar
Cuisine: Russian
Address: Phokina St., near to "Yves Rosher"
Operation hours: 9 a.m. – 10 p.m.
Tel.: 7 (4232) 26-47-39
(about 7-10 min. from Hyundai, 15-20 min. from Versailles)

Isbushka ***
Cuisine: Russian
Address: 9, Phokina St.
Operation hours: 11 a.m. – 11 p.m.
Tel.: 7 (4232) 22-08-83
(about 10 min. from Hyundai, 10 min. from Versailles)

Morskoe ***
Cuisine: Russian, seafood
Address: 7, Phokina St.
Operation hours: 11 a.m. – 11 p.m.
Tel.: 7 (4223) 22-64-42
(about 10 min. from Hyundai, 10 min. from Versailles)

Prestizh-lakomka **
Cuisine: mixed (Russian, European)
Operation hours: 10 a.m. – 12 p.m.
Address: ½, Svetlanskaya St.
Tel.: 7 (4223) 41-42-30
(about 20 min. from Hyundai, 5 min. from Versailles)

Cafes

Coffee-time****
Cuisine: Russian
Operation hours: 12 noon - 2 a.m.
Address: 44a, Svetlanskaya St.
Tel.: 7 (4232) 26-89-46
(about 10 min. from Hyundai, 25 min. from Versailles)

Paparazzi*****
Cuisine: mixed (Russian, European)
Operation hours: 09:00-24:00
Address: 3, Phokina St.
Tel.: 7 (4232) 22-86-67
(about 15 min. from Hyundai, 5-7 min. from Versailles)

Studio-cafe *****
Cuisine: mixed (Russian, European)
Operation hours: the clock round duration
Address: 18, Svetlanskaya St.
Tel.: 7 (4232) 41-28-22
(about 15 min. from Hyundai, 3-5 min. from Versailles)

Pogrebok **
Cuisine:Russian
Operation hours: 12 noon – 11 p.m.
Address: 63, Svetlanskaya St.
Tel.: 7 (4232) 26-63-66
(about 15 min. from Hyundai, 5-7 min. from Versailles)

Japanese cuisine

Restaurants

Sem' samuraev *****
Cuisine: Japanese, seafood
Operation hours: 12 noon – 12 p.m.
Address: 41, Aleutskaya St.
Tel.: 7 (4232) 400-936
(about 10-15 min. from Hyundai, 10-15 min. from Versailles)

Versailles ****
Cuisine: mixed (European, Japanese)
Operation hours: 12 noon – 11 p.m.
Address: 10, Svetlanskaya St.
Tel.: 7 (4232) 26-93-52

Bars

Susi-bar "Futzi" ***
Cuisine: Japanese
Operation hours: from 10 a.m.
Address: 35, Phontannaya St.
Tel.: 7 (4232) 40-24-20
 (about 7-10 min. from Hyundai, 15 min. from Versailles)

Susi-bar "Edem" *****
Cuisine: Japanese, European
Operation hours: 11 a.m.- 12 p.m.
Address: 22, Phokina St.
Tel.: 7 (4232) 26-19-90
(about 15 min. from Hyundai, 10 min. from Versailles)

European cuisine

Restaurants

Beguemot ****
Cuisine: European, seafood
Operation hours: the clock round duration
Address: 4, Phokina St.
Tel.: 7 (4232) 26-91-19
(about 15 min. from Hyundai, 7 min. from Versailles)

Bingo ****
Cuisine: European
Operation hours: 2 p.m.- 5 a.m.
Address: 44, Svetlanskaya St.
Tel.: 7 (4232) 22-50-22
(about 10-15 min. from Hyundai, 20 min. from Versailles)

Oasis
Cuisine: European
Address: 4, Batareinaya St.
Tel.: 7 (4223) 45-49-70
(about 25 min. from Hyundai, 7-10 min. from Versailles)

Cafés

Iguana ****
Cuisine: exotic (African, Oriental, European)
Operation hours: 10 a.m.- 10 p.m
Address: 23-A, Svetlanskaya St.
Tel.: 7 (4232) 355-321
(about 10 min. from Hyundai, 15 min. from Versailles)

Montmartr *****
Cuisine: European
Operation hours: 9 a.m.- 4 a.m.
Address: 9, Svetlanskaya St.
Tel.: 7 (4232) 41-27-89
(about 15 min. from Hyundai, 3-5 min. from Versailles)

Frantsuzskaya buloshka **
Cuisine: European
Operation hours: 12 noon – 12 p.m.
Address: 9, Semyenovskaya St.
Tel.: 7 (4232) 22-14-47
(about 15 min. from Hyundai, 10 min. from Versailles)

Pub/restaurant

Gans *****
Cuisine: European
Operation hours: 11 a.m. – 2 a.m.
Address: 1-a, Phokina St.
Tel.: 7 (4232) 300-331
(about 15-20 min. from Hyundai, 5-7 min. from Versailles)

Italian cuisine

Restaurant

Mauro Janvanni *****
Cuisine: Italian
Operation hours: 12 noon - 12 p.m.
Address: 1б, Phokina St.
Tel.: 7 (4223) 22-07-82
(about 15-20 min. from Hyundai, 5-7 min. from Versailles)

Café

Mauro Janvanni ****
Cuisine: Italian
Operation hours: 11 a.m. – 2 a.m.
Address: 9, Okeansky Av.
Tel.: 7 (4232) 20-57-62
(about 7-10 min. from Hyundai, 15 min. from Versailles)

Korean cuisine

Restaurants

Koreisky dom ****
Cuisine: Korean
Operation hours: 11 a.m.- 11 p.m.
Address: 7/11, Semenovskaya St.
Tel.: 7 (4232) 26-94-64
(about 15-20 min. from Hyundai, 5-7 min. from Versailles)

Haekeumkang ****
Cuisine: Korean
Operation hours: 12 noon – 10 p.m., break: 5 p.m.-6 p.m.
Address: 29, Semenovskaya St., "Hyundai"
Tel.: 7 (4223) 40-73-10

Fast-food

Magic bell ***
Cuisine: Mexican
Address: 44, Svetlanskaya St.
Operation hours: 8 a.m. – 10 p.m.
Tel.: 7 (4232) 22-95-56
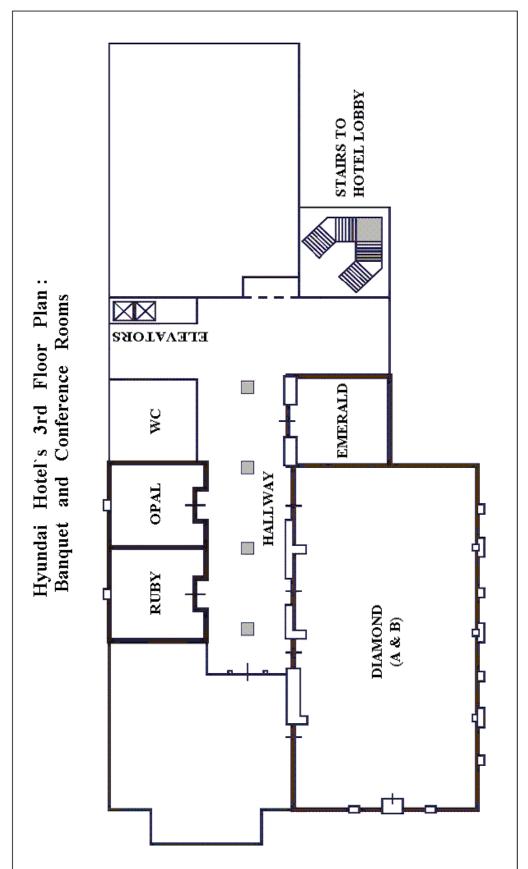(about 10-15 min. from Hyundai, 25 min. from Versailles)

Magic burger **
Address: 44, Svetlanskaya St.
Operation hours: 8 a.m. – 10 p.m.
Tel.:   7 (4223) 22-83-58, 22-94-47
(about 7-10 min. from Hyundai, 20 min. from Versailles)

Pizzeria

Restaurant Pizza-M ***
Cuisine: Italian
Operation hours: 12 noon – 12 p.m.
Address: 51a, Svetlanskaya St.
Tel.:   7 (4232) 26-85-11
(about 15-20 min. from Hyundai, 30 min. from Versailles)

Floor Plan for PICES XIV
September 28 – October 9, 2005

Hyundai Hotel's 3rd Floor Plan :
Banquet and Conference Rooms

ELEVATORS

STAIRS TO
HOTEL LOBBY

WC

OPAL

RUBY

HALLWAY

EMERALD

DIAMOND
(A & B)