

PICES XIV FIS_Paper-2256 Poster

Monitoring of Pacific salmon *Oncorhynchus keta* W. in the Sakhalin-Kuril Islands region using DNA markers

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Chum salmon, *Oncorhynchus 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

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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 *Palliatius*, *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 speciation. 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*, *Palliatius*, *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, Salmoniformes, 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.

PICES XIV FIS_Paper-2517 Oral

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.

PICES XIV FIS_Paper-2272 Oral

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.

PICES XIV FIS_Paper-2291 Poster

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.

PICES XIV FIS_Paper-2365 Poster

Interdecadal 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.

PICES XIV FIS_Paper-2333 Poster

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.

PICES XIV FIS_Paper-2593 Poster

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 remainder 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.

PICES XIV FIS_Paper-2591 Oral

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 Tsushima 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.

PICES XIV FIS_Paper-2318 Poster

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.

PICES XIV FIS_Paper-2380 Poster

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.

PICES XIV FIS_Paper-2527 Poster

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 (steno-haline, mesohaline and euryhaline), anadromous and freshwater (steno-haline, 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, salmon, 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 salmon 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.

PICES XIV FIS_Paper-2602 Oral

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 this 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).

PICES XIV FIS_Paper-2392 Poster

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 m² 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.

PICES XIV FIS_Paper-2282 Oral

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/m³ in the southeastern Hokkaido water, 15.0°C-17.4°C and 0.3-0.5mg/m³ in Sanriku water and 16.5°C-17.5°C and 0.5-1.0mg/m³ 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.

PICES XIV FIS_Paper-2449 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

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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 m²; 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.

PICES XIV FIS_Paper-2364 Poster

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 41°21'–45°20'S and 150°01'–157°30'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.

PICES XIV FIS_Paper-2444 Poster

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, $K = 0.1774/\text{yr}$ and $t_0 = -3.36$. For females, the von Bertalanffy growth parameters were estimated as $L_{\infty} = 946.02$ cm, $K = 0.137/\text{yr}$ and $t_0 = -3.93$. For males, those were estimated as $L_{\infty} = 842.3$ cm, $K = 0.21/\text{yr}$ 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.

PICES XIV FIS_Paper-2305 Oral

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 done 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.

PICES XIV FIS_Paper-2313 Poster

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.

PICES XIV FIS_Paper-2315 Poster

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 Vrangal Bay (Sea of Japan)

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The benthos and fish larvae of Vrangal 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 Vrangal 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/m². On soft bottom sediments of Vrangal 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 pallasii* 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 Olyutorsky 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/km²) occurred in the Oyashio current, and minimal density (0.3 tons/km²) 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 8⁰C-12⁰C 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, Khabarovsk Territory and Sakhalinsky Region. The salmon species were presented by *Oncorhynchus gorbusha* (pink), *O. masou* (cherry), *O. keta* (chum), *O. tshawytscha* (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.

PICES XIV FIS_Paper-2308 Poster

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.

PICES XIV FIS_Paper-2519 Oral

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.

PICES XIV FIS_Paper-2399 Poster

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 goosfish 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 goosfish in the East China Sea ecosystem. This study showed that the abundance of small yellow croaker stock was influenced by the predation of yellow goosfish as well as human fishing activity. Finally, considering the foraging ecology of yellow goosfish 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/km² 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 repletteness 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.

PICES XIV FIS_Paper-2269 Oral

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.

PICES XIV FIS_Paper-2329 Poster

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.

PICES XIV FIS_Paper-2495 Oral

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.

PICES XIV FIS_Paper-2345 Oral

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

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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

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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 $\geq 91\%$. 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

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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

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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.

