PICES XIV S6-2217 Oral

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

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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.

PICES XIV S6-2555 Oral

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

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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.

PICES XIV S6-2589 Poster
Distributional pattern and population structure of Greenland turbot *Rheinchardtius hippoglossoides* in the Bering Sea

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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.

PICES XIV S6-2324 Poster
Impact of some biological features and environmental factors on distributional patterns of North Pacific deep-water fishes

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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.

PICES XIV S6-2320 Oral
Modern state and annual dynamics of demersal fish communities in the Okhotsk Sea

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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

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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.

PICES XIV S6-2327 Poster

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

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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.

PICES XIV S6-2608 Poster

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

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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.

PICES XIV S6-2235 Oral

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

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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.

PICES XIV S6-2590 Poster

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

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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.

PICES XIV S6-2216 Poster

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

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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.