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abstracts

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4AM1995-BER01

INTERANNUAL VARIABILITY IN THE BERING SEA ICE COVER AND ITS INFLUENCE ON PRIMARY PRODUCTION AND RELATED PROCESSES IN THE MARGINAL ICE ZONE

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The Bering Sea ice cover demonstrates major interannual variability in its southern extent, which inevitably affects the annual phytoplankton bloom at the southern ice margin in spring. The timing and intensity of this bloom is important, since it is the first major annual primary production episode in the region. We have conducted research at the ice edge through seven annual spring blooms, including heavy and light ice years. In this paper, we examine the relationships among interannual variations in physical dynamics, ice extent and characteristics of the spring bloom. We investigate the hypothesis that geographic location and short-term variations in weather are the primary influences on the timing and productivity of ice-edge blooms. Interannual variations in ice extent affect the ice edge bloom primarily through effects on the geographic areas swept by the ice edge as it retreats.

4AM1995-BER02

INTER-ISLAND VARIATION IN THE DIET OF FEMALE NORTHERN FUR SEALS *CALLORHINUS URSINUS* IN THE BERING SEA

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The diet of female northern fur seals *Callorhinus ursinus* was examined during the summer breeding season at three different breeding locations in the Bering Sea: St. Paul Island (1988, 1990) and St. George Island (1988, 1990) of the Pribilof Islands Group(U.S.A.), and Medny Island (1990) of the Commander Island Group (Russia). Dietary information is based on the analysis of fecal material collected on the rookeries. Prey consumption varies annually according to the physical and biological environment surrounding each island. Juvenile walleye pollock *Theragra chalcogramma* was the most common prey of fur seals from St. Paul Island. The island is surrounded by a broad neritic environment on the continental shelf with widely separated frontal zones and is the greatest distance from the shelf-break. Gonatid squid *Gonatopsis borealis/Berryteuthis magister*, and *Gonatus madokai/Gonatus middendorffi* were the most common prey of fur seals from Medny Island; the Island is surrounded by a compressed neritic environment and is adjacent to a steep continental shelf-break and oceanic marine environment. A combination of pollock and gonatid squid was consumed by fur seals from St. George Island; the water surrounding has a oceanographic environment which is intermediate between the other two islands.

Variability in predation on walleye pollock is consistent with fishery information concerning the relative abundance and availability of pollock around St. George and St. Paul Islands. The abundance and availability of these prey resources are key factors influencing the health and growth of the fur seal populations in the Bering Sea.

4AM1995
CARRYING CAPACITY AND INTERNAL ORGANIZATION CHANGING THE SYSTEM WHILE KEEPING THE 'K'

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Carrying capacity is a macroscopic property of biological systems that implies nothing about the underlying mechanisms of growth limitation. We can describe carrying capacity in terms of individuals, biomass, or in terms of energy input and output as a function of system size. If we speak of energy requirements, the internal organization of the system becomes critical. Cells growing within an organism show a degree of "self-organization" or facilitation, whereas individuals in a population may either cooperate or compete for resources. Internal organization of a system may be defined by interactions affecting energy flow between various components of the system, whether between cells in an individual, individuals in a population, or populations within an ecosystem. Total metabolism and growth potential change not only with changing energy input, but also with changes in the internal organization of the system. Internal reorganization may affect system efficiency, thus changing the system biomass without a corresponding change in energy input.

A generalized model of system organization and carrying capacity, beginning with the growth of cells in an individual, is presented. We show that the changes in size and numbers of Pacific salmonids (Onchorhynchus spp.) may result from a reorganization of the system and not from a fundamental limit of carrying capacity. Finally, we speculate on endocrine systems which may represent an evolutionary control of internal organization, using growth and temperature during critical periods as signals to control final overall individual size independent of total prey biomass or growth potential.

4AM1995-POC01
SEA ICE IN THE BOHAI SEA OF CHINA

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The Bohai Sea and the northern coastal region of the Yellow Sea belongs to the middle latitude monsoon climate, has cold and dry winters and is partly covered with ice every winter. The ice conditions have been classified in the scale I-V based on the observed and historical records. The whole Bohai Sea was almost covered with ice in February-March 1969. A review of the conditions and dominant features of sea ice in the area is given in this paper. Since 1969, research and forecasting sea ice conditions have been carried out in the National Research Center for Marine Environmental Forecasts (NRCMEF) of China. The ice model has been coupled with an ocean model. This paper outlines the coupled model and numerical simulation for sea ice of the Bohai Sea. The ice model has been linked to a numerical weather prediction model for forecasting ice conditions in the Bohai Sea and the Northern Yellow Sea from the winter of 1989/1990. Forecasting results and services are also shown in this paper.

4AM1995-BER03
TAXONOMIC AND TROPHIC STRUCTURE OF MESOPELAGIC NECTON COMMUNITY OF BERING SEA

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61 species of mesopelagic fishes from 57 genera and 38 families inhabit in Bering Sea. Specimens of Myctophidae and Microstomatidae are the most common (8 and 5 species correspondingly). Other families have 1-2 species. Seven species of mesopelagic fishes are new to the

Bering Sea (Balanov, 1992; Balanov, Ilinskiy, 1992). Mesopelagic squids are not as common as fishes. Only 18 species from 10 genera and 7 families of squids inhabit the Bering Sea.

Most mesopelagic fishes and squids of Bering Sea are similarly in the North of Pacific Ocean. Endemic species of mesopelagic necton are absent in Bering Sea. The variety of deep-sea necton is increase toward the straits of the Aleutian Islands.

Stenobrachius leucopsarus (Balanov, Ilinskiy, 1992) contribute the biggest biomass of mesopelagic fishes of Bering Sea and it is a dominant species of the mesopelagic fishes in the Northeast of the Pacific Ocean (Willis, Pearcy, 1980; 1982).

Planktivorous mesopelagic fishes play a major role in consumption of zooplankton in mesopelagial of Bering Sea. Euphausiacea, Copepoda, Coelenterata and Appendicularia are the basic food. Predatory mesopelagic fishes feed on most species of planktivorous. *Stenobrachius leucopsarus* and *Leuroglossus schmidti* (Balanov, 1994). However leading role in consumption of fishes and squids in mesopelagial of Bering Sea belong to migration and non-migration midwater squids.

4AM1995-FIS01
DENSITY-DEPENDENT EFFECTS AND REGIME SHIFTS
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One method of demonstrating density dependent effects is to add young fish to a system until the capacity to support these fish is exceeded. The additions of large numbers of hatchery-reared chinook smolts to the Strait of Georgia provided an opportunity to study density dependent effects because a shift in the ocean regime appears to have decreased the capacity to sustain the earlier larger stock sizes.

4AM1995-FIS02
PRODUCTIVITY OF GENERATIONS OF MASS COMMERCIAL FISH (NORTH-WEST PACIFIC) AND CLIMATE CHANGES
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For the majority of populations of commercial fish species, the biomass and ODU (total permissible catch) determine the level of recruitment and productivity of generations. Moreover, the appearance of one or two highly productive generations may lead to a sudden increase of that species, and the appearance of low productive generations may lead to a sudden (sometimes disastrous) reduction of abundance and catches of species. We should underline that highly productive generations in one species of fish (for example cold-water type) does not mean the appearance of high productive generations in another species (for example subtropical).

The main years affecting abundance of commercial fish in cold-water and subtropical group, such as far-eastern (Pacific) sardine, herring and pollock of the Okhotsk Sea (Fadeev,1992) were 1988, 1989. In the subtropical group of the Kuroshio, the abundance of sardine year classes from 1988 and 1989 were low among all previous 16 years and similarly for the 5 following years. The year classes of pollock and herring were highly productive during the same time period.

It is interesting that during these years the strong sun activity (Chistyakov, 1989) and in separate regions of the Pacific Ocean highscale changes took place.

The appearance of El-Nino in this period and usual increasing of temperature of surface water in the equatorial region of the Pacific was accompanied by the decrease of water temperature in some other regions of the western of Pacific.

The area of Kuroshio, was the main reproduction zone of mass pelagic fish (subtropical group: sardine, mackerel, anchovy, jack mackerel). The considerable cold period duration (XII) was characterized by the delay of spring biological activity. The duration of cold period, which was calculated according to the change of the sign of heat balance on the ocean surface, in 1988 exceeded 7 months.

The analysis of hydrometeorological conditions in the Okhotsk Sea in 1987-88 shows that in spite of severe winter conditions (Dec., Feb.), when surface air temperature in separate periods decreased to 7-12°C lower than the yearly average. The ice conditions in spring turned out to be good for herring and pollock.

As a result of water heating, release of ice, negative anomalies formed during winter conditions were reduced to 0°C, and in the northern part of the region positive anomalies on the surface were observed, and the thermocline was situated at a depth of 150-200 m. This was higher than the average. This caused the positive anomalies in the layers till 0.5-1.0 5°C. The above mentioned factor may be caused, by intensification of Pacific waters influx, and that influx was caused by cyclonic activity of atmosphere, which was displayed in predominant trajectories of cyclons' movement along Kuril island's arc.

According to the late of oceanographical survey on the vessel "Tamga" in the central part of the Okhotsk Sea the undersurface waters in May have the on 0.5-1.5 higher than in 1987 and the difference became higher with the depth, evidently for the account of intensification of North Pacific waters influx. Favorable ice conditions of spring 1988 led to the fact that to the middle of June the of water on the surface even in the western part (the most "ice" part of the sea) was higher than the average (the calculations of V.I. Chernyavsky). The prevalence of the high atmospheric field in May, June and July (the Okhotsk Sea) was the cause of good weather, and this was favorable to intensive heating of surface waters and the wakening of waves.

Thus in two adjacent regions the hydrometeorological processes influenced the productivity of mass pelagic fish generations. In Kuroshio zone the abundance of sardine was the lowest level, and the abundance of other species (mackerel, anchovy) was lower than the average level for many years.

The Okhotsk Sea region was characterized by high-productive generations of Pacific Pollock and Pacific herring, and this shows the different influence of regional climatic changes on generations of fish, consisting of different complexes.

4AM1995-FIS03

CONDITIONS OF EXISTENCE AND FUNCTIONING OF BOTTOM FISH COMMUNITIES ON THE CONTINENTAL SLOPE OF THE NORTH-WEST PACIFIC

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This paper considers the distribution of bottom fish communities on the continental slope of the Northwest Pacific, in relation to oceanographic conditions; more specifically with respect to the North Kurils and Southeast Kamchatka regions.

The near bottom layer of the continental slope is the primary place of existence of the bottom fish communities. The distribution of water temperature in this layer is considered as one of the main factors determining the distribution of mass commercial bottom fish (halibut, sea perch, rockfish, rattails, skates, etc.) in the North Pacific.

The water temperature in this layer is not significantly subjected to seasonal fluctuations. It is 2-8°C, depending on region and season. The optimum range of water temperature is 2-5°C for commercial fish species on the continental slope (except kichiji rockfish). The range of water temperature where the maximum concentrations of most species are found is 3-4°C (for kichiji rockfish 1-2°C).

The optimum water temperature for commercial fishes on the continental slope has to do, as a rule, with the Warm Intermediate Water Mass (WIWM) or occurs at the border between Cold Undersurface Water Mass (CUWM) and WIWM. Those water masses are components of the Subarctic structure of water mass of the North Pacific. The range of optimum depths for most commercial fishes of the continental slope in the Northwest Pacific is 300-600 m.

A few zones of high concentrations of commercial fishes were found on the continental slope off the North Kurils and South-East Kamchatka in 1992-1994. One is Southeast of Kamchatka peninsula; the second zone is from Capr Lopatka to Paramushir Islands, the third zone is near the Fourth Kuril Strait, and the last zone is from Onekotan Island to the seamount east of the Share rocks.

The conditions of existence and functioning of bottom fish communities on the continental slope in the mentioned regions is the same, usually, as in all the Northwest Pacific. They are scattered within the CUWM and WIWM of Subarctic structure water mass and carried from Northeast to Southwest by Kamchatka-Kuril current along the east coast of Kamchatka and Kuril Islands.

4AM1995-BER04

NORTHERN FUR SEAL AND STELLER SEA LION AS INDICATORS OF CHANGES IN ECOSYSTEM OF BERING SEA

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Total numbers of northern fur seals and sea lions in Northern Pacific have followed the same tendencies during last 30-40 years period: best condition for both was in 1950s, after that the number of animals declined, especially the Steller sea lion population. The number of fur seals on Commander Islands was 120-130 thousand animals in last of 1950s and increased to 220-250 thousand animals in middle 1960s. Longitudinal tagging programs indicated a high immigration fur seals from Pribiloff Islands during that time. The same tendency occurred for sea lion. The number of sea lion on Commander Islands increased approximately 3-5 times from 1950s to the middle 1960s, a new reproductive rookery was created on Medny Island. Fast population growth of sea lion explain from immigration animals from eastern Pacific too. The migration of fur seals and sea lions to Commander Islands may be explained from differences of food availability in that area. The analysis of fisheries data showed higher levels of herring in Western Bering Sea, than in Eastern Bering Sea. The decline of herring stock in 1960s-1970s resulted in the of decrease of both species, especially sea lion in Northern Pacific.

4AM1995-POC02

THERMAL AND DYNAMIC STRUCTURE OF WATERS OFF THE SOUTH COAST OF HONSHU

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Analysis of IR images from NOAA, data of oceanographic observations, JMA facsimile maps of the sea surface temperature (SST), water temperature on the horizon 100m and currents in 1986-1995 showed the non-meander Kuroshio path off the south coast of Honshu since 1992. Maximum of repeatability (for a year) of the nearshore Kuroshio path was in 1994 for the late 20 years (since 1975).

While attenuation of the large-scale meandering of the Kuroshio off the south coast of Honshu is observed but spring intensification of meandering (in March-May) is observed in 1992-1995. This intensification is characterized by significant deviation path Kuroshio southward to 32°00'-32°30'N and extension of cold water area between coast of Japan and the Kuroshio. Spring intensification was pronounced in 1993 and 1995. In April 1995 before meander formation mesoscale perturbation on the north boundary of the Kuroshio south-eastward from the Kii Peninsula in form "capsizable wave" with cyclonic rotation was observed. After meander formation two cyclonic eddies was observed: 1- above-mentioned, 2 - in the south part of the meander. However, when meander was absent on the facsimile maps of currents, cold water mass exist almost always south-eastward from the Kii Peninsula with a cyclonic rotation (diameter about 80 km) on the southern limits. This phenomenon was clearly visible on the maps of thermal structure (from IR images).

Local negative SST anomalies (from mean 1961-1990) and temperature anomalies of the 0-200m layer occurred in the Kuroshio meander off the south coast of Honshu in January-May 1988-1991, when positive anomalies occurs in the neighbouring regions. Since 1992 positive SST anomalies prevail off south coast of Honshu in January-April.

4AM1995-MEQ01

TETRAPLOID INDUCTION IN THE MUSSEL *MYTILUS EDULIS* USING A NEW CHEMICAL, 6-DYMETHLAMINOPURINE (6-DMAP) DURING EARLY DEVELOPMENT

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Triploid induction in molluscs has been successful on a large scale, but an all triploid population can only be achieved by a cross between tetraploidy and diploidy, which makes tetraploid induction more important. Previous research on shellfish chromosome manipulation were usually conducted using cytochalasin B(C. B.), an expensive and toxic chemical inducer. 6-dymethylaminopuine (6-DMAP) is a new chemical, which is very cheap and less toxic, would be used to obtain the same results.

In this study, eggs/embryos of the mussel M. *edulis* were subjected to treatment with 400 μM 6-DMAP in filtered seawater for 20-30, 50 or 120 min. post-activation to inhibit the first or second cleavage respectively, in an attempt to induce tetraploids. Observation on the experimental embryo samples was conducted under epi-fluorescence microscope, using DAPI staining, and the chromatic change was photographed. The chemical was observed to cause chromatic de-condensation, block the pronuclear migration and the chromosome separation, and prevent the formation of the cleavage furrow and the polar lobe. Treatment at first cleavage produced 82.8% tetraploid rate, and inhibiting second cleavage produced 58.6%. Considering its effectiveness, cheapness and lack of toxicity, 6-DAMP should be the preferred chemical inducer for future chromosome manipulation research in, at least, bivalve molluscs.

4AM1995-SB01

MODEL ON CARRYING CAPACITY OF SCALLOP

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The high density of shell fish culture cause a decline in the yield and benefit to fishermen per unit area, and a deterioration of the marine environment. On the basis of experimental data, a model of the carrying capacity of scallop is built to obtain the maximum sustainable yield (MSY) and maximum economic yield (MEY). The model includes four parts: 1. Submodel on culture

environment. It includes the factors affecting the scallop and food of scallop (T, O^2, $S^0/_{00}$, N and P etc.). 2. Submodel on the food of scallop. The temporal and spatial dynamics of the phytoplankton biomass and abundance of POM were considered. 3. Growth submodel of scallop includes the following factors: weight per individual, height of shell, growth rate, death rate and the ratio of closing muscle in weight of scallop etc. 4. Benefit submodel of scallop includes the yearly price change of the adductor muscle and the discount rate of currency. The experiments show that the model conforms to the growth dynamics of scallop. The model is a useful improvement for the management and culture of scallop.

4AM1995-MEQ02

AN ECOLOGICAL STUDY ON HARMFUL BLOOM IN ZHOUSHAN FISHING AREA

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Harmful blooms frequently appear in the East China Sea including the Zhoushan fishing area. Dominant species are *Noctiluca scientillans, Ceratium fucus, Ceretium tripos, Gymnodinium spp. Prorocentrum minimum, Pendimium depressum, Trichodesmium euythraeum, Tri, Thiebantii* etc., *Skeletonema costatum, Nitzchia pungens, Rhizosolenia gracilis* and *Ditylum brigtwellii.*

Eutrophication, upwelling, temperature, currents etc. are main factors of causing harmful bloom.

Harmful blooms are a serious problem in the East China Sea. It harms fisheries, marine culture and especially harms human public health. Some events of PSP and DSP shellfish poisoning have been observed in the Zhoushan fishing area.

4AM1995-FIS04

ECOLOGICAL PROFILE IN THE HANGZHOU BAY AND ZHOUSAN FISHING AREA

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Hangzhou Bay lies on the northwest of the continental shelf of the East China Sea, off the Qiantang River where both Shanghai (a huge industrial city) and Zheflang province occur.

The Zhoushan fishing area is a very famous and traditional fishing ground in China. In this paper, the ecological profile of the area is described. The physical and chemical status in this area is given. It includes climatology factors, physical factors and water quality etc. Ecosystem analysis for chlorophyll *a*, primary production, phytoplankton and zooplankton, benthos was made. The distribution and quantitative fluction of some key species such as *Skeletonema costatum, Calanus sinicus, Labidocera euchaeta, Tortanus vermiculus, Moerella iridescens, Nepthys polybranchia, Trichiurus haumela, Pseudosciaena croea, Pseudosciaena polyactis, Sepiella maindroni* were described.

Biomass dynamic of phytoplankton, zooplankton and benthos were described.

Fisheries landings and fisheries resource fluctuations of the Zhoushan fishing area also were analyzed.

4AM1995-MEQ03
THE IMPACT OF POLLUTION ON ECOSYSTEM IN CHANGJIANG (YANGTZE) RIVER ESTUARINE AREA, HANGZHOU BAY AND ZHOUSHAN FISHING AREA

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An environmental impact assessment of pollution on the ecosystem based on both historic and monitoring data collected in 1994 in the Changjiang estuarine area, Hangzhou Bay and Zhoushan Fishing area has been made.

1. Water Quality: based on survey results and meeting water quality standards (GB3097-82, National sea water standard) for as follows: inorganic Nitrogen, inorganic phosphorous, oil, COD, coliforms, copper and zinc. 77% InQ-N, InO-P 22.8% exceeded III class water quality stands. Distribution of N, P, COD, oil, Coliform organic-P-pesticide, organic-Cl-pesticide and PCB etc. have been described.

2. A test of residual toxicity of pollutants on marine organisms in the Changjiang estuarine area, Hangzhou Bay and Zhoushan Fishing area has been made. In the test, petroleum hydrocarbon and heavy metals (Cu, Zn, Pb, Cd) were assessed. Based on the results, it was shown that concentration levels of total petroleum hydrocarbon (TPH) was found in different types of organisms. In the fish body, concentration levels of TPH ranged from 1.40-7-56 ug/g DW, average value was 3.5lug/g, DW (shallow water) and 3-08 ug/g, DW (off sea). In the cephalopod, the average value was 7.71 ug/g, DW. Concentrations ranged from 5.40-9-89 ug/g, DW. The average value of THP was 3.26 ug/g, DW (shallow water) and 2.9 ug/g, DW (off shore) in butterfish body.

3. Based on 2348 samples of 38 species of marine organisms in Hangzhou Bay and Changjiang estuarine area, concentrations of heavy metals (Cu, Zn, Pb, Cd) in 4 types of marine organisms was found.

4. An analysis of the present quality of ecosystem is described. Based on upon a grouping of function and species, exceeding standards and limits; for the three defined zones within the study area is described. For the description of present quality, the available monitoring data were used.

4AM1995-FIS05
FISHERIES STATUS IN ESTUARINE FRONTAL ZONE OF CHANGJIANG (YANGTZE) RIVER AND ADJACENT WATER

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The natural environment in estuarine frontal zone of the Changjiang River and adjacent waters creates an important spawning and feeding ground for many economic fishes, and it is also an important fishing area. Based on survey data and historic literature. This paper deals with fisheries status, analyzes characteristics of fish fauna and ecological types and briefly introduces migration, distribution and status of fisheries resources and production.

4AM1995-FIS06
A REVIEW OF THE SIZE OF DEMERSAL FISH STOCKS IN THE INVESTIGATION AREAS OF CONTINENTAL SHELF SOUTH-WEST OF NANSHA ISLANDS AND ITS DEVELOPMENT FEASIBILITY

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Based on a total of five test fishing, in the period of 1990 and 1992-1993, the present standing stocks of demersal fishes and its potential harvest were calculated to be $15.34X10^4km^2$ in the areas of the shelf southwest of Nansha Islands. In the investigation range, the results compared by areas showed that the maximum stock density of demersal fishes presented in a small test fishing area within the Eastern Sunda Shelf, averaging 2.21 t/km^2 and the standing stock was $11.8X10^4t$. It was considered that the Eastern Sunda Shelf could be a rich area for demersal fish stocks in southern part of the South China Sea. It was looked upon as an important area for exploitation. This paper reviewed the stock status for four main fishing grounds in the investigation area. The number of the trawl fishing boats that would be acceptable operating in the area was also estimated and views of stock exploitation were presented as well.

4AM1995-FIS07

THE INFLUENCE OF STOCKS DENSITY OF GREY URCHIN STRONGYLOCENTROTUS INTERMEDIUS AND PACIFIC BAY SCALLOP PATINOPECTEN YESSOENSIS ON SIZE AND WEIGHT CHARACTERISTICS OF SPECIES AND BIOMASS OF POPULATION

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In 1991 and 1994 stock research on grey urchin and Pacific Bay scallop in Uspenia Bay (Japan Sea) were conducted. A high increase of urchin stock density (from 5.5 per square meter in 1991 to 27.5 per square meter in 1994) was found. The total biomass increased more than four times and the average sizes decreased from 125 till 84.3 g.

In 1994 two patches of Pacific Bay scallop were investigated. They differ by the density, size composition and stock. The average length of individuals with density of one per square meter was 13.2 cm, while the weight was 208.5 g and in the area with a density of 15 species per square meter the length was 11 cm and 135.3 g. It should be noted that the high density patch was more than twice the first.

The data confirm the impact of density on the size of bottom invertebrates, and increase of total biomass occurs when the growth of abundance takes place.

4AM1995-MEQ04

SOURCES, FATE AND TRENDS OF CONTAMINANTS IN THE STRAIT OF GEORGIA: CHEMOSTRATIGRAPHY AND CHEMOMETRICS

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Evaluating the effectiveness of regulation and industrial remediation to reduce environmental concentrations of man-made pollutants presents an ongoing challenge to scientists. Chemostratigraphy and chemometrics, are two discriminating and practical methodologies for achieving this goal. Chemostratigraphy allows what may be termed as "retrospective monitoring" of many contaminants accumulating in an ecosystem. The method, which involved dating sediment cores and determining contaminant burdens, does not require advance knowledge of the contaminants to be monitored. Under ideal circumstances a history of contaminant deposition is revealed, and light is shed on the sources, trends and effect of any industrial process changes. Chemometrics encompasses a variety of multivariate techniques designed to deal with data sets that may consist of large numbers of analytes and/or samples. Chemometric methods allow the efficient extraction of the information content from huge data sets. Often most of the variance can be expressed in two or three derived parameters (e.g., principal components) which can then be presented in an easily comprehended form. Together, chemostratigraphy and chemometrics provide a powerful tool, which we have used to test the effectiveness of efforts by coastal B.C. pulp and paper mills to reduce the emission of toxic

components, especially dioxins and furans, in their effluent. Age-dated sediment cores show that 2, 3, 7, 8 -tetrachlorodibenzofuran concentrations increased dramatically with the introduction of chlorine dioxide. Principal Components Analysis (PCA) applied to chlorinated dioxin and furan data from crab digestive gland (hepatopancreas) samples collected since 1987 shows that the mixture of dioxins and furans has become less toxic in all pulp-mill effluent. However, both chemostratigraphy and chemometrics demonstrate that pulp-mills are not the only source for these compounds to the B.C. coastal environment. With PCA, it has been possible to distinguish between crabs from mills and crabs from harbours. The crabs from different mill sites can be differentiated by PCA and show variation with time, whereas crags show no variation form harbour to harbour and their dioxin/furan patterns do not change with time.

4AM1995-FIS08

BIOMASS AND PRODUCTIVITY OF MARINE MACROBENTHOS OF THE EAST CHINA SEA

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Macrobenthos play an important role in the marine food chain of the East China Sea. They are important prey items and some species are also commercially important. Influenced by the continental climatic changes, the complicated oceanographic conditions and sedimentation features, benthic faunas in the East China Sea are therefore very complicated. Marked distributional and seasonal variations in biomass and high productivity are the main characteristics of the benthic fauna. The present paper deals with the general features of the abundance distribution pattern of the macrobenthos and the benthic productivity is estimated as well. The main conclusions are: 1) As compared with other shallow water areas of the midlatittide sea, the biomass of macrobenthos in the shelf region of the East China Sea is rather low; 2) From the inner shelf region to the out shelf region and further to the slope region, the total biomass decreases with the increase of the depth; 3) Three high biomass areas can be detected on an annual average, which coincide with the feeding and breeding grounds or the fishing grounds very well; 4) There exists distinct seasonal variation in total biomass of the macrobenthos. Spring has the maximum biomass. Winter takes the second place and autumn has the minimum; 5) The predominant groups of benthic organisms are polychaetes, molluscs, echinoderms and crustaceans. Biomass composition of benthos in the inner shelf of the East China Sea is characterized by high biomass of echinoderms, while molluscs predominate the benthic community in biomass in the outer shelf. All group of benthos shows distinct seasonal variation in biomass; 6) The biological productivity is rather high, since high recruitment rates of the populations is observed in most of the dominant species, though their total biomass is comparatively low.

4AM1995-POC03

BOUNDARY EFFECTS OF DIFFERENT SCALES OBSERVED WHILE INTERACTION OF SEA CURRENTS AND SEAMOUNTS IN THE PACIFIC OCEAN

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During almost two decades (1968-1985) TINRO conducted intensive studies on the Pacific Ocean's seamounts in connection with assessment of biological productivity and valuation (graduation) of ichthyofauna nearby the seamounts (1, 2, 5, 9). These investigations in most cases were accompanied by different-scale oceanographic surveys conducted near the top of the seamounts that allowed analysis of the boundary effects connected with ejection of large volume of biogenous substances into upper layers of the ocean (2, 3, 8). This allowed the study of the evolution of vorticity fields nearby the isolated seamounts (4, 6). One example of a vorticity field with dense packing of some vortexes in the area of Poulkovskaya seamount (Eltanin fracture zone) is given on Fig. 1. Calculations of geostrophic currents have been undertaken out from 1,500 db of subsurface on all standard horizonts. Composition sketch has been executed on the basis of current calculations on each

horizont in relation to the last horizont (1,500 m) of measurements. Poulkovskaya seamount, due to the wide range of oceanographic surveys, turned out to be a fruitful object for studying Taylor's column (3). The results of mathematic modelling showed satisfactory coincidence with data of field ocean experiments (10). Theoretical studies of the topographic vortex formation are presented in a Dr. dissertation of V.N. Zyryanov (1993). Many theoretical results of Zyryanov are reflection in unpublished oceanographic data available in TINRO. For example, inversion of Taylor columns in the upper layers of the ocean occurs while stratification is increasing. Similarly double conical dipoles, generation of vortexes-satellites in the flow not only after the seamounts, but also before them also occurs.

While interaction of internal waves with the area of horizontal heterogeneity of density field was located above the ridge, you can observe the area of increased intensity of internal sea-waves above it, in which peak values are proportional to the correlation of ocean depth to ridge height (H/h). In the area of the searidges you can frequently observe frontal zones oriented along their axes or along the normal to them, depending upon background currents. When internal waves of tide period is being spread through frontal zone, located above the ridge, the transformation of these wave and generation of other modes take place. In the case the of frontal zone above the ridge in the transition region you can note several power-carrying modes (3, 4). In the open sea the amplitude of internal tide fluctuations observed usually makes up 5-15 m, sometimes reaching 20-30 m. In the areas of seamounts the interaction of internal waves of different scale vortices and Rossbi waves with bottom relief leads to more bottom relief leads to more considerable vertical fluctuations of water masses along seamounts' slopes and above them, reaching hundreds of metres, sometimes spreading almost to the sea surface (4, 6, 7, 8). This results from frequent nearby seamounts of lenges of water of different volume scales with expressed anomalies in relation to surrounding background conditions, where concentrations of biogenous elements can exceed background values by an order or greater (3, 8). In the same manner in the vertical plane plankton organisms can move, which serve as food for fish populations. As a rule there is a great biomass of hidrobionts on some seamounts (5, 9, 11).

4AM1995-FIS09

HYDROMETEOROLOGICAL REGIME OVER THE OKHOTSK SEA AS APPLIED TO NAVIGATION AND FISHING

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The Okhotsk Sea has unique natural climate which is different from land and sea in similar latitudes.

The weather climate conditions of the Okhotsk Sea play a major role for navigation and fishing.

Analysis of the spatial-temporal distribution of the main meteorological parameters over the Okhotsk Sea (air pressure, air temperature, sea level temperature, wind speed and direction, fogs, sea waves, icing and weather's characteristics at standard pressure levels) showed special features.

An approximate estimation of the empirical distribution for main meteorological values by theoretical laws has allowed the calculation of probable weather's characteristics and some quantitative and qualitative regularities in changes of involved hydrometeorological values.

The air pressure, air and sea temperature distribution was satisfactory approximated by the normal low (normal probability). A biomodal distribution wind speed was observed bimodal distribution with local minimum for winds 6-9 m/s (9 %) and maximums for strong winds (15-19 m/s) and weak winds (1-5 m/s). It is probably for this element that there is a combination of two distributions in the frequencies.

In the cold period (from November to April) over the Okhotsk Sea, there was a positive difference between sea water temperature and air temperature (from 4-6°C in the South to 18-20°C in North of the Sea). Analysis of multy-year daily means and external air temperature revealed a high probability (73-84 %) of cold waves and warmth. Its especially common for the winter period which is from 120-130 days in the South to 210-220 days in the North of the Okhotsk Sea.

The combined indices of hydrometeorogical fields were calculated and the probability of optimum conditions for sea-going vessels operations were defined.

4AM1995-BER05

POLLOCK SPAWNING DENSITY DISTRIBUTION IN THE SOUTHEASTERN BERING SEA

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Walleye pollock (*Theragra chalcogramma*) is a gadoid fish species widely distributed over the Bering Sea which is the object of one of the most important fisheries in the world. In the eastern Bering Sea, spawning occurs over areas of the basin and shelf, the overall spawning period spanning several months. It was one of the major target of the foreign and joint-venture fisheries operating in the eastern Bering Sea. In addition to the standard data collection and sampling procedures, observers from the National Marine Fisheries Service (U.S.) aboard these fishing boats recorded special information from 1984 to 1989 from which the density distribution of pollock spawners was estimated. This information allows the definition of the spatial location of the major spawning groups over the southeastern Bering Sea, and the timing of the spawning and the characteristics of the spawners (e.g. length and age distributions) in the different areas. By weighting the spawning densities by the total fishing effort for the 6 years spanning this study, an overall picture of the recent spatial/temporal distribution of the intensity of the spawning is obtained. The interannual variability in the distribution of the spawners in relation to the physical environment is investigated.

4AM1995-FIS10

STUDY ON DYNAMIC OF THE STOCK RECRUITMENT RELATIONSHIP (SRR) OF PENAEID SHRIMP IN THE BOHAI SEA

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Recruitment has considerably fluctuated annually since the early 1960's during the development of Penaeid shrimp fishery in autumn. Penaeid shrimp recruitment, especially the spawning stock, has significantly decreased in the Boahi Sea since the 1980's. The relationship between the stock and recruitment can be well described by Beverton-Holt and Ricker models based on CPUE of the spawning stock and the catch in autumn, in the Bohai Sea from 1983-1994. The formula and parameters are $R_t^{-1} = a + bS_t^{-1}$, where a=0.0039, b=0.0117, R^2=0.74 ($p<0.001$), R_t=catch in fall fishing season and S_t=CPUE of the spawning stock. Results indicate that the recruitment was decreased largely by the spawning stock size. There was considerably decrease of the spawning stock in the 1980's, which was 34.4% and 44.2% to that in 1960's and 1970's respectively. The spawning stock in 1990's decreased about 20% comparing that in 1980's. Environmental factors on the spawning grounds played less role in SRR model. Further, shrimp farming along the coast of Boahi Sea is a new factor affecting the recruitment since 1980's. The shortage of spawning stock is the main limiting factor to recover in recruitment to the levels of the 1970's. It is difficult to increase the spawning stock in the Bohai Sea, so artificial spawning and larval release has become an important way to raise recruitment of Penaeid shrimp in the Bohai Sea.

4AM1995-POC04
LONG-PERIOD BAROCLINIC ROSSBY WAVES IN THE NORTH PACIFIC
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Satellite-borne altimeter measurements of sea-level in the North Pacific are revealing several-centimeter oscillations near annual period that show clear westward propagation. In low latitudes, south of 30°N, the observed propagation speeds agree remarkably well with the theory for long first-mode baroclinic Rossby waves, based on local climatological vertical stratification. At middle and higher latitudes (40-50°N), the agreement is poorer, with observed propagation speeds 2-3 times larger than simple theoretical predictions. Simple theory, however, neglects mean flow and mean gradients of internal potential vorticity, which can significantly alter propagation characteristics of baroclinic planetary waves. In particular, the slopes of mean isopycnal surfaces in the North Pacific are such that, in the upper several hundred meters in midlatitudes, an effective internal potential vorticity gradient occurs that is several times larger than the planetary vorticity gradient (beta). Modifications of simple theory to take account of these effects will be displayed and their consequences discussed. Baroclinic planetary waves presumably play a significant role in the time-dependent response of the ocean to annual and longer-period forcing.

4AM1995-SB02 Invited
MEASURING CARRYING CAPACITY USING THE BIOMASS SPECTRUM
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The theory of prey-predator energy flow in aquatic ecosystems, together with observed stability between areas of both overall slope and internal configuration of biomass groups within the biomass spectrum, suggests that the spectrum offers a practical means of measuring the productive energy flow. It may therefore be a useful alternative method for determining the relative capacity of a defined water body to support biological production over specified ranges of organism body-size. The method has the advantage that production from the whole spectrum is predictable from measurement of only a part of it. Experience to date also suggests that requisite information integrated over time periods of the order of the annual seasonal turnover can be acquired and fitted to the spectrum at reasonable expenditures of effort. There is too little experience to judge its potential usefulness for assessing shorter term perturbations. However, Pacific Ocean data reflecting ecosystems affected by the sea migrations of salmon could provide a useful index of the sensitivity of local overall production to temporal changes in its elements.

4AM1995-BIO01
VERTICAL DISTRIBUTION OF MESOPLANKTON IN THE JAPAN SEA
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Analysis of data from winter and spring surveys were used for the investigation. Samples of mesoplankton were collected by vertical hauls from 1000 m to the surface from six standard layers. The area of surveys was the northwestern part of Japan Sea. All samples were collected by Jady planktonic net and processed by TINRO. They were divided to three size fractions and coefficients of catch efficacy were used to calculate their biomass.

Surface waters were not favourable for phytophagies in winter and in early spring, because phytoplankton is still absent. The main accumulations of zooplankton were concentrated in lower layers. The maximum was in 200-500 m (near 600 mg/m\3). Biomass of plankton in 0-200 m was near 500 mg/m\3, and in winter the maximum was in the 50-200 m layer and in spring maximum was in the 10-50 m layer. The depth of least abundance of plankton was in the 50-100 m layer. Copepods

were the most abundant group. On the other hand, Euphausiids (*Thysanoessa longipes*), Amphypoda (*Themisto japonica*) and Chaetognatha (*Parasagitta elegans*) played a major role in the total zooplankton biomass. All of them are active diel migrants. *Metridia pacifica* is the only copepods species which undertakes diel migrations. Diel migration coefficients (correlations of night and day biomass) for these species were from 3 to 10. Ontogenetic migrations also takes place.

4AM1995-FIS11

PATTERNS OF FOOD UTILIZATION OF TWELVE SPECIES OF FLATFISHES CO-OCCURRING IN THE BOHAI SEA OF CHINA

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Contents of 4527 stomachs (698 empty) of 12 species of flatfishes collected during the 1982-1983 Bohai Sea Fisheries Resources Investigation were examined. The food habits, diet diversity, similarity) of prey taxa, trophic niche breadth and diet overlap were systematicly analyzed. Altogether, 97 prey species belonging to coelenterata, nemertinea, polychaeta, moffusea, crusiacean, echinodermata, heinichordata and fish were found in the examined stomachs and 5 of them were considered principal preys for the flatfishes: *Alpheus japonicus, Oratosquilla. oratoria, Alspheus distinguendus, Loligo japonicus* and *Crangon affinis*. Some species of flatfishes had relatively high diet overlap, but differences did apparently exist in the diet compositions of the predators on the whole. *Paralichthys olivaceus* was piscivorous on fish and *Psudopleuronectes yokohamae* shared polychaeta and mollusca with *Pseudopleuronectes herzensteini* as their main prey group. *Pleuronichthys cornutus* was classified into polychaeta-mollusca eater group, with a strong tendency to add crustacean to the diet. *Verasper variegatus, Cynoglossus semilaevis, Eopsetta grigorjewi* and *Cleisthenes herzensteini* were crustacean eaters. *Plalichthys bicoloratus* was classified into mollusca-crustacean eater. *Cymoglossus abbreviatus, Cynoglossus joyneri* and *Zebrias zebra* were grouped into crustaicean-fish eaters. However, *Zebrias zebra* also took a certain number of polychaeta and *Cymoglossus abbreviatus* and *Cynoglossus joyneri* preyed on some mollusca. Trophic relationships among the flatfishes were complicated, but they occupied distinctive microhabitats in different feeding seasons and selected their own prey items, which was favourable to the stability of the flatfishes community in the Bohai Sea.

4AM1994-BIO02

PRODUCTION PROCESSES IN POPULATIONS OF ANIMALS IN OKHOTSK SEA

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For improved resources management it is necessary to know the productivity of separate species as well as the ecosystem structure, methods of populations production determination, and the minimum quantity of available information needed. Concrete application of this approach is carried out on benthos animals (1970-1985). Ecological characteristics of mass species were generalized; functional dependencies of metabolism, ration, fruitfulness on body mass, temperature, density of the population were determined. Production characteristics and specific production of 92 species were calculated. It is shown that production size of populations depends on the origin of species, and P/B-coefficient of population structure and temperature conditions, and as a rule, lowers at lower temperatures.

Specific production of subtropical and boreal species lowers at lower temperature. It lowers at increasing of body mass, as it is well described by the degree of function with the index when the temperature is from -0.2 to -0.5C.

Dense dependence of a yearclass during a number of years is well described by the Ricker curve.

4AM1995-BIO03

ROLE OF PLANKTON PREDATORS IN TROHPIC WEBS IN THE EPIPELAGIC OF WESTERN PART OF THE BERING SEA

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Chaetognath are considered as the main plankton predator. *Parasagitta elegans* is one of the most abundant in western part of Bering Sea. This species forms the basis of zooplankton biomass together with euphausids and copepods. In the spring reaches 19-33 % of zooplankton biomass, and in autumn 31-64%. The biomass of *P. elegans* increased in 1990.

The increase of *P. elegans* abundance was accompanied by decrease of biomass of the zooplankton small-size group, consisting of copepodits and as consequence - the biomass of large copepods decreased also.

P.elegans was the common representative of predatory plankton. Basic trophical connections of this species is similar to different groups of zooplankton: amphipods, euphausids, copepods (small and large), fish larvae and detritus also.

Moreover chaetognaths were found to form a small part of the daily ration other chaetognaths, especially in fall. The influence of this species on plankton communities increased due to increase of its biomass in 1990. In 1986 *P. elegans* consumed 17 g/ sq.m of organic substance and 25 g/sq.m - in 1990 -s.

P.elegans was forage for various fish; walleye-pollock, herring, capelin and salmon. The share of this species in the ration of fish does not exceed 10-15 % and with increase of *P. elegans* biomass its share increases too. A whole *P. elegans* pass a very small part of its production on to higher trophic levels and so this species forms one of the considerable trophical dead ends in Bering Sea.

4AM1995-BER06

ON TEMPERATURE VARIABILITY OF WATER REGIME IN THE NORTH-WEST PART OF BERING SEA

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During May - December of 1952 - 1991 in northwest part of Bering Sea, the vessels of TINRO - TURNIF undertook the oceanographic research on standard hydrological sections "Novarinsky" and "Olutersky". The research on this sections, however, has been irregular and not systematic in character.

Hydrological section "Novarinsky" is on the southeast of cape of Novarin from 62°02'N, 179°07'E to 60°34'N, 179°32'W. The section starts on shelf (85 m) and goes across the shelf to the 500 m isobath.

Hydrological section "Olutersky" starts on the shelf near cape Olutersky (59°46' N, 170°20' E) and traveled southeast to 57°22'N, 172°03'E, to a depth of 3,600 m.

Samples were collected from middle water temperature of layers 0-20 m, 0-50 m, 0-100 m, 0-200 m, 50-100 m, 50-200 m, 100-200 m using N.N. Zubov methods. It was determined that by analysis of temperature that there were five types of thermal regimes: anomaly cold, cold, normal or middle, warm, anomaly warm.

The middle value of temperatures from many years was collated and graphs produces of seasonal water layer migrations were compiled. The analysis of the temperature curves discovered some peculiarities of season movement.

In the "Novarinsky" section, the maximum temperature (8.1°C) of 0-20 m layer occurred in August for the 0-50 m layer, in September (6.2°C), for 50-100 m layers and 0-100 m in October (3.6°C and 4.6°C). The minimum temperature in the 50-100 m layer was marked in June (0.4°C).

In the "Olutersky" section the maximum temperature (9.0°C) of 0-20 m layer occurred in August, for the 0-100 m and 0-200 m layers in October (4.7°C and 3.5°C), for the 50-100m and 50-200 m layers in November (3.3°C and 2.8°C).

The character of the seasonal change of the middle temperature in the "Novarinsky" and "Olutersky" sections showed that maximums coincide in all layers of water (0-100 m). But the layer 50-100 m was the exception, the maximum temperature of water in this layer in the "Olutersky" section was one month later, than in the "Novarinsky" section. The middle temperature of water years in layers 0-20 m, 0-50 m, 0-100 m and 50-100 m was higher in the "Olutersky" section, than in the "Novarinsky" section.

4AM1995-POC05

TRACER STUDIES IN NORTH PACIFIC SUB-SURFACE AND INTERMEDIATE LAYERS WITH SUBARCTIC/SUBTROPICAL CIRCULATIONS AND ISOPYCNAL MIXING IN AN MRI OGCM

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Numerical experiments for chemical tracer distribution were made with an MRI North Pacific ocean general circulation model (OGCM) with special interests in (1) origin of the salinity minimum water with continuous Tritium release in the marginal seas and (2) subarctic subduction with the historical injection of CFCs (chlorofluorocarbons) at the sea surface.

Experiments of marginal sea injection of Tritium-like tracers (1) with several decay-time constants were designed to infer an apparent origin of the low salinity water associated with salinity minimum in the North Pacific Intermediate layer. Double core structure of tracer distribution was identified in the 30°N section (sigma-theta 26.5-27.5). It was explained in terms of the combined effect of the basin-spanned horizontal tracer advection due to the intermediate clockwise general circulation and the east-southward isopycnal tracer diffusion by the parameterized isopycnal eddy mixing.

The CFC simulation (2) was directly compared with the available CFC sections (175°E and 30°N) data. Major CFC core structure which appears around at (400m depth, 160°W), was possibly caused by surface subduction of CFC in the west and central subarctic gyre. A shallower CFC extreme is associated with shallow salinity minimum in the southward flow of the California Current.

4AM1995-FIS12

STUDY ON CULTIVATION CARRYING CAPACITY OF KELP *LAMINARIA JAPONICA* IN SUNGO BAY

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Sungo Bay is the main intensive mariculture region of kelp Laminaria japonica in northern China. In order to reveal its optimal cultivating density model, total cultivation quantitative and its cultivating potency, the estimation of cultivation carrying capacity of kelp in the bay was initiated in late 1993. Because the ratio of N:P is only 2:1 in the bay, therefore, nitrogen was regarded as the key factor in this research project. The total resource of inorganic nitrogen, including nitrogen carried by

current and rainfall, released by cultivated bivalves and redissolved from seabed to water column was investigated in different seasons. The nitrogen content in kelp in different growth stages and in fouling algaes in different season were analyzed. From these results, the nitrogen demand of each kelp plant was then obtained. By comparing the total nitrogen resource with the total nitrogen demanded of kelp and fouling algae, the cultivation carrying capacities of kelp in the bay in different growth stages and in different cultivating regions was estimated. Furthermore, an optimal cultivating models for the bay was recommended based on both cultivation carrying capacity and the currently used kelp cultivating model.

4AM1995-POC07

INTERANNUAL VARIABILITY OF TEMPERATURE CONDITIONS AT SHELF OKHOTSK WATER IN SPRING, 1983-1995

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The oceanographic data, obtained April-June 1983-95, have been used to investigate the shelf and slope of Okhotsk sea in areas of walleye pollock sprawning. The sea was conditionally divided into statistical regions: SWK - South Western Kamchatka, CWK - central area of West Kamchatka, NWK - North Western Kamchatka, SB - Shelikhov Bay, SH - Swan Hill, NES - North Eastern Sakhalin, CES - central area of East Sakhalin, SES - South Eastern Sakhalin, IK - Iono-Kashevarovsky, IA - Iono-Ajansky, TA - Taujsky, OK - Okhotsky.

Average area temperature, salinity at standard horizonts, and the range of their interannual variability - were calculated for each region. Temperature conditions of shelf water in spring of each year were classified to one of five categories: "anomalous warm", "warm", "normal", "cold", "anomalous cold".

Correlation of temperature variability in different regions distinguished two types of interannual temperature change for the 0-100m layer. The first type was observed at regions (SWK, CWK, NWK, IK, SH), because of the prevailing role of the West Kamchatka Stream to temperature regime formation there. The second type was observed on the shelf regions (SB, TA, IA, OK, NES). The thermal conditions in these regions were formed mainly by intensivity of winter cooling, and these conditions usually remained to next cooling period. There was close correlation of interannual temperature variability in these regions and maximum of ice cover occurred in the Okhotsk Sea. Interannual temperature changes in regions (CES, SES) had much in common with the second type, but differ by some features.

The question of the tendency of sea climate is of great interest. Due to a forecast, based on a 11-years cyclic of the geomagnetic field, the period of "warm" years that began in 1982 changed to a period of "cold" years at the beginning of 90s. The data "showed" that springs during the 1983-1995 period were either "warm" or "normal". The temperature of 0-100m layer in 1993 and 1994 had a tendency to decrease but spring 1995 was "warm" after a winter with low ice coverage.

4AM1995-MEQ05

RELEASE OF PAHs FROM COAL-ASH IN SEAWATER

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Release of PAHs from coal-ash was determinated by Fluorescence Spectrophotometer. The level of PAHs released before and after soaking in seawater was determinated by Reversed High Efficiency Liquid Chromatography. The results showed that the release and absorption of coal-ash in seawater static state is reversible, i.e. little PAH was released. That PAHs from the fine coal of heat and power plant that was dumped in the sea has little effect on the marine environment.

4AM1995-FIS14

SELECTION OF PARAMATERS FOR PHYSICO-STATISTICAL SCHEMES OF LONG-PERIOD PREDICTION OF PRODUCTIVITY OF MARICULTURE FARMS (FOR POSJET BAY, SEA OF JAPAN)

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The main task of estimating the long-term productivity in marine farms by means of physico - statistical methods has been the choice of the most informative predictors. The weather regime in Primorye and, in particular the marine farms areas is defined by complex interaction processes in the Sun-Atmosphere-Earth system over the Far-East. The influence of weather conditions on hydrological regime and productivity of marine farms enables the use of sinoptic-statistical patterns for prognosis purposes.

The purpose of the present work is to estimate the periodicity of abiotic parameters, their interactions and stability of the hydrometeorological conditions for the last 60 years in marine farms in the vicinity of the Posjet Bay and Sea of Japan. This was accomplished by analysis of synoptic-biotic connections to choose the most informative predictors of the model. Simultaneously, hydrometeorological and biological investigations during the 14 years period was made to solve this problem. To study long-term deviations, temperature and salinity of sea surface, air temperature, wind velocity, the duration of ice period, indexes of atmospheric circulation, Volf numbers and the total temperature for different stages of development of cultivated mollusks were chosen as parameters to estimate. The influence of these parameters on productivity of marine farms was analyzed as well as the duration and periodicity of different stages of development for commercial organisms. Multidimensional and spectral and statistical methods of processing time sets of parameters, the line trends, cycles of long-period deviations and mutually correlated dependencies were determined. They enabled one to choose the most informative predictors for further forecasting.

4AM1995-POC06

SPATIAL-TEMPORAL DISTRIBUTION OF WATER TEMPERATURE AT THE AREA OF THE MARICULTURAL NATURAL RESERVE "ZALIV VOSTOK" (SEA OF JAPAN)

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Water temperature is one of major environmental factors effecting marine animals. The area of our studies, Vostok Bay, is used as a survey area for scientific investigations by the Institute of Marine Biology. The northern part of the Bay was declared as an integrated marine reserve. Our studies were dealing with the changes of the water temperature in the Bay under various time schedules.

The results indicated that the temperature regime in Vostok Bay shows noticeable diurnal, month, seasonal, and annual variation. The daily temperature variation was most pronounced in the upper 5 m layer. The greatest variation in surface water temperature in late summer totals 1°C, while in early autumn in equals 4.2°C. Deeper than 5 m the changes in water temperature usually do not exceed 0.5°C. The maximum of water temperature in the layer of 0-10 m falls into the period of 6-10 p.m., but no pronounced minimum is observed. A strikingly water stratification was a remarkable feature of the water temperature distribution throughout the summer season. In early autumn the water temperature has a noticeable tendency to cool which begins in shallows. The water temperature distribution shows north-south gradient with the temperature difference of 1.4°C between extreme points. In the southern part of the bay the waters along the eastern shore are by 2.1°C warmer than at the opposite side of the bay.

The annual cycle of surface water temperature has a single minimum and a single maximum (-1.6°C in January-February and 24.3°C in August). In different years both quantitative and qualitative changes of water temperature distribution pattern were observed.

Hence, the specific features of the water temperature in Vostok Bay are defined by combined effect of numerous factors; mostly the climate pattern and water circulation.

4AM1995-MEQ06

SOURCES, TRANSPORT AND AIR/SEA EXCHANGE OF ATMOSPHERIC TRACE SUBSTANCES OVER THE EAST CHINA SEA AND THEIR IMPLICATIONS FOR REGIONAL BIOGEOCHEMICAL CYCLES

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During the past six years, we have focused on characteristics of atmospheric particulate substances over the China Sea, in particular the East China Sea, as part of the China American Air/Sea Experiment and related programs. Atmospheric sampling was conducted: (1) at Qingdao and Xiamen, along the coast of the China Sea, (2) during a research cruise in the East China Sea, (3) at Mallipo at the east coast of the Yellow Sea in South Korea, an d(4) at Xi'an and Beijing in the interior of China. We were especially concerned the following substances: crustal material, anthropogenic and marine biogenic S-containing aerosols, aerosol nitrate, sea-salt aerosol, and certain pollution-derived trace elements.

Detailed results of our research which will be resented here include: (1) temporal and geographical distributions of the concentrations of these substances, (2) particle size distributions of non-sea-salt sulfate, nitrate, methanesulfonate (MSA), sea-salt, and a variety of trace elements, (3) source identification of certain species, (4) transport patterns of trace substances from the North Central China to the western North Pacific, (5) estimates of air-to-sea fluxes of certain trace substances, and (6) atmospheric inputs of trace substances to the Yellow Sea compared with inputs from rivers.

4AM1995-FIS13

THE ABUNDANCE AND DISTRIBUTION OF COMMERCIAL SEA URCHINS IN PETER THE GREAT BAY (JAPAN SEA)

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The distribution of commercial species, particularly grey and black sea urchins and Pacific trepang was investigated in Peter the Great Bay (Japan Sea).

In the investigated region the accumulation of black sea urchins (abundance, high density and biomass) was observed in the island zone (4.12 m, biomass 288.7 g/m). Abundance and biomass of grey urchins was considerably (2-3 times) less than the black. This can be easily explained as *Strongylocentrotus intermedius* is a boreal species that it does not form a large stocks in the shallow part of the sea.

The density of trepang in a large part of the area was 0.3-0.5 m and only in separate small areas does it increast to 1.0-1.5 m. The analysis of data, from the beginning of this century shows that the density in trepang's stocks on a large part of the area was rather stable (the factor of time) and was 0.3-

0.6 m (in different years). This density did not depend on commercial fishing of trepang in the above mentioned region, and it did not depend on the conditions of replenishment of the population.

Areas, occupied by the stocks of commercial echinodermata has been reduced. One of the causes of this phenomenon, evidently, was the silty bottom of the bay. It caused redistribution of it and other bentos-groups. And such characteristics as the average density in a location, the range of preferred depths and the type of ground are rather stable in time.

4AM1995-POC08

SOFTWARE MEASUREMENTS BY CTD MEASURING COMPLEX IN A MODE OF SCANNING ON A DEPTH DURING VESSEL MOTION

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The perspective technique of measurement of hydrophysical parameters of the top layer of the ocean (up to 250 m) during vessel motion has wide application in oceanographic research. The analysis of incoming information from sensors with the help of a personal computer, permits the experiment. The features of the software allowed measurements of various horizontal scales are during experiments on the scientific vessel "Academician M.A. Lavrentyev" in Okhotsk Sea in 1994-1995. For reception of a continuous profile the choice of scale for averaging of measurements depending on the characteristics of a measuring complex, linear scales of the investigated phenomenon and speed of towage was made. A method of transformation from a irregular grid of basic points on to a regular grid with the help of interpolation was undertaken. Restrictions, conditioned by features of a method of measurements and characteristics of devices to the vertical and horizontal resolution of a regular grid was undertaken. Examples of hydrologic profiles in Okhotsk Sea for various horizontal scales are described.

4AM1995-SB03

THE PROBLEM OF CRITERIA FOR CARRYING CAPACITY OF THE NORTH PACIFIC FOR SALMON

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There may be approaches to the assessment of carrying capacity:

1. Direct evaluation of the agreement between the parameters of habitat and population parameters.
2. Search for indications of the fullness or overfilling of the carrying capacity.

In June - October 1944 a salmon ecology research cruise was made by R/V "Rastsvet". Catches included mostly chum (Russian and Japanese). They fed jointly and did not differ in terms of fatness. Some difference was found in the composition of food diet and diurnal differences of feeding activity in chum and other salmon species. A considerable part of chum catches consisted of individuals that had flabby muscles and herring-shaped body. Such a phenomenon was not recorded in the other species of salmon. This led us to associate the appearance of flabby tissue with the high density of chum in feeding areas. This assumption is testified by the emergence of flabby pink salmon in Sakhalin in the years of extremely high abundance. Among the flabby chum there were individuals of both Japanese and Russian origin. Verified differences in the protein composition of muscles were detected between flabby and standard chum. Hence, we suggest the following working hypothesis.

1. The criterion of exceeding the carrying capacity of the ocean should be the appearance in salmon populations of degeneration features, or exceeding by those features of a certain level which can be taken as the background level.
2. The appearance of individuals with flabby muscles may be regarded as an external sign of being in excess of the carrying capacity.

3. Based on the knowledge presently available it would be reasonable to assume that carrying capacity of the ocean is exceeded only in respect of some large populations (or groups of populations) of the most abundant salmon species only, rather than for one or another species as a whole, moreover not for the entire genus Oncorhynchus.

4AM1995-BIO04

THE ECOLOGICAL STUDY ON PHYTOPLANKTON IN MAXIMUM TURBID ZONE OF CHANGJIANG ESTUARY

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In the surveying area, the time and spatial variation of phytoplankton is related to characteristics of tide. The results were as follows:

1. The amount of phytoplankton biomass in spring tide was larger than that in the neap tide in both flood and dry seasons. In flood season, the amount in spring tide was 6.8 times as high as that in neap tide; in dry season, the amount in spring tide was 6.1 times as high as that in neap tide.
2. The amount of phytoplankton biomass in tidal flood was larger than that in the tidal ebb both in spring and in neap tides and in flood and dry seasons.
3. The quantitative spatial distribution was not even in spring tide flood and dry seasons. The variation of density distribution was obvious. The amount of phytoplankton biomass in both spring and neap tides of the dry season in 1988 was much larger than that in flood season. This had a close relation with the spatial distribution of phytoplankton outside the survey water area. The species composition was not complicated and low salinity and coastal species were dominant such as *skeletonema* and *Coscidiscus*. But some high salinity, off-sea tropical species such as *Rhizosolenia robusts Rhcalcas -avis* constituted a higher percentage in flood season. It was a special phenomenon.

4AM1995-BIO05

THE CHARACTERISTICS OF THE PHYTOPLANKTON COMMUNITIES IN THE PRAWN PONDS AND THE RELATIONSHIP WITH SHRIMP DISEASE

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The characteristic of the phytoplankton communities in the prawn ponds and the coastal waters in Dalian area were studied. The result showed that the structure of the phytoplankton communities were very different from that in the ocean. The communities include a number of benthic populations. The kinds of species and the number of the cells in the prawn pond changed suddenly compared with that in the ocean. Many of the dominant species were tolerant of toxic or nontoxic red tide organisms. Succession time of the dominant species was short and they change rapidly. There was a negative correlation between the diversity index of the phytoplankton communities and shrimp disease and a positive correlation between the phytoplankton communities and the state of prawn growth.

4AM1995-FIS15

MARINE ALGAE COMMUNITY IN SUBLITTORAL ZONE FROM SOME REGIONS OF THE NORTHERN PACIFIC

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A comparative analysis of macrophyte floras from 15 regions of the northern Pacific using theoretical graph methods on the basis of data collected in a research expedition and in the literature.

The author shows the floristic composition of the algal communities distributed along the Pacific coast.

Dominant species of the marine algae community in different regions were determined.

4AM1995-MEQ07

ESTIMATION OF SURFACE CIRCULATION IN WINTER IN THE EAST CHINA SEA AND THE YELLOW SEA REGIONS AS A ROLE OF CONTAMINANT TRANSPORT FOR REAL TIME SERVICE

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Transport of chemical contaminants is mainly affected by the surface circulation in the East China Sea and the Yellow Sea regions. Based on SST chart derived from AVHRR images, daily surface circulation's can be easily estimated for real time information.

A branch of Tsushima Current was found to flow northwestward into the Yellow Sea from the south of Jeju Island, forming a permanent warm flux in the central part of the region. However, there were coastal cold fluxes flowing southward from both Korea and China sides of the Yellow Sea. Influx of warm water in the center and outflux of cold water from both sides are typical surface circulation patterns in this region.

4AM1995-POC09

STRENGTHENING OF WINTERTIME MIDLATITUTDE WESTERLIES OVER THE NORTH PACIFIC SINCE MID 1970'S AND DECADAL VARIABILITY OF THE NORTH PACIFIC

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Strengthening of the wintertime midlatitude westerlies over the North Pacific since the mid 1970's was examined by using wind velocity and sea level pressure fields estimated from the ship-report data archived in Comprehensive Ocean-Atmosphere Data Set (COADS). It was found that the difference of the wind fields between the two decades of 1966-75 and 1976-85 can be well explained by the wind fields calculated under the assumption of the geostrophic balance using the difference of the sea level pressure fields between the two decades. This fact confirms that the strengthening of wintertime midlatitude westerlies in the latter decade over the North Pacific occurred. Corresponding to this change in wind fields, upper ocean thermal structure also drastically changed. Recent studies of these changes are briefly described.

4AM1995-MEQ08

A STRATEGY FOR ASSESSING THE EFFECTS OF CONTAMINANTS ON MARINE ECOSYSTEM: CASE OF TOKYO BAY AND POSSIBILITY OF MODEL DEVELOPMENT IN EAST CHINA SEA

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High concentrations of phosphorus and nitrogen as well as organic matter contaminate the enclosed seas in Japan. Degradation of water quality due to eutrophication have severely affected aquaculture and natural living resources. Bottom water anoxia has increased both temporally and spatially. Toxic chemicals are fouling sediments where marine organisms feed. It is important to understand the complex interactions between nutrient loads, eutrophication, anoxia and chemical contaminants.

Since hydrodynamic transport is an important factor in determining the distribution of the various ecological constituents, we present the simulation results of circulation in Tokyo Bay, which is characterized by tidal current, density current driven by density gradient between freshwater discharge and saline warm outer ocean, and wind driven current. The model results were verified with continuous field data of velocities, salinity and temperature for 40 days obtained between September - October 1989.

Eutrophication and anoxia process were analyzed by a coupled hydrodynamic and ecological model, which is essential for providing control alternatives.

A strategy of assessing sources, transport and effects of contaminants in East China Sea will be discussed.

4AM1995-BIO06

VARIATIONS IN THE TRANSFER EFFICIENCY FROM PHOTOSYNTHETIC AND BACTERIAL CARBON PRODUCTION INTO ZOOPLANKTON DURING A SHIFT OF ZOOPLANKTON DOMINANCE FROM COPEPODA TO DOLIOLIDA

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The significance of bacterial carbon production has been generally recognized, but the fate of the carbon within aquatic food webs remains open to question. Results of field experiments indicated small transfer efficiencies of radiotracer originally taken up by bacteria into zooplankton fraction within 24 hours (e.g., about 0.03% into the >100μm fraction; Ducklow et al. 1986), suggesting that the microbial loop is a respiratory energy sink.

We have conducted ^{13}C tracer experiments within a mesocosm (5m in diameter and 18m in depth) in the Seto-Inland Sea, Japan, to compare the transfer efficiencies of bacterial and photosynthetic production into the >100μm fraction. Every few days, seawater at 0.5m was collected in bottles (4.5 l) and incubated for four hours after the addition of ^{13}C-glucose. Identical incubations but ^{13}C-bicarbonate addition were done on other days. These two series of incubation experiments (each performed eight times) spanned a shift of zooplankton dominance from copepoda to doliolida over 19 days. The transfer efficiency of bacterial production varied from 0.2 to 1.5% (mean: 0.5%), a value far higher than those shown in previous studies. The efficiency seems to vary among different ecological systems, being higher in our doliolida dominated system. The transfer efficiency of photosynthetic production varied from 0.1 to 2.71% (mean: 0.96%), and was sometimes smaller than that of bacterial production. Our results, obtained with short incubations, suggested that the microbial loop is not necessarily a sink, but possibly a link of magnitude similar to that of the photosynthetic food chain.

4AM1995-FIS16

SIZE DECREASES AND OLDER AGE AT MATURITY IN CHUM SALMON IN NORTH AMERICA

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Long term changes in size and age at maturity were monitored for two populations of chum salmon *Oncorhynchus keta* in western North America. One population was from Fish Creek, a tributary of the Salmon River that enters the ocean at the head of Portland Canal near Hyder, Alaska. Chum salmon from Fish Creek are known for their large size. Size and age samples were collected from this stream from 1972 to 1995. The other population of chum salmon was from the Quilcene National Fish Hatchery (U.S. Fish and Wildlife Service) which is located on the northwestern side of Hood Canal, near Quilcene, Washington. Size and age samples were collected from this facility from 1973-1994.

Both the Fish Creek and Quilcene Hatchery populations for chum salmon show significant declines in mean size at maturity of all age groups starting about 1980. Mean weight of both populations has declined about 46%. The mean age at maturity for both populations increased while growth decreased. Changes in size and age are discussed in relation to anomalies in oceanographic/climate changes during the past 20 years and in relation to the increase in population density of chum salmon in the ocean feeding areas.

4AM1995-BIO07

COPEPOD ASSEMBLAGE AS FOOD FOR LARVAL JAPANESE ANCHOVY, *Engraulis japonica* AROUND THE TSUSHIMA STRAITS, SOUTHWESTERN JAPAN SEA

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This study was aimed at elucidating food conditions of postlarval Japanese anchovy (*Engraulis japonica*) in the southwestern Japan Sea shelf waters. It was based on several series of net samplings and hydrographic observations at a station in northeastern parts of the Tsushima Straits from 1992 to 1994.

Total number of copepods peaked in March, May and November. The temperate copepods (mainly *Calanus sinicus* and *Paracalanus parvus*) contributed to form the March peak, while the temperate-subtropical copepods (*Paracalanus aculeatus*, *Clausocalanus arcuicornis*, *Euchaeta plana* and *Oithona plumifera*, etc.) produced the November peak. The May peak was dependent on components of both of the other two peaks. The postlarval anchovy showed three annual peaks (May, July and September) in number. Gut contents analysis revealed that copepod eggs and/or nauplii (mainly Calanidae, Paracalanidae type and *Oithona* spp.) were numerically the most significant food for the postlarval anchovy (SL: 5-9 mm). Food composition reflected seasonal succession of copepod species in the waters studied, and food of the autumn larvae consisted of a greater variety of copepod nauplii than that of the spring larvae. The occurrence of copepod assemblage with a higher species diversity in autumn was closely related to the inflow of the "Upper Water of the Tsushima Current" characterized by low salinity water (< 34.0 PSU).

These facts suggest that seasonal and interannual fluctuations of the Tsushima Current water affect food availability for the larval anchovy through copepod's reproduction in the southwestern Japan Sea.

4AM1995-FIS17

DENSITY DEPENDENT EFFECTS ON GROWTH AND RECRUITMENT IN SOME FISH AND SQUID POPULATIONS IN THE SEA OF JAPAN

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To clarify density dependent effects on biological parameters of marine organisms, comparison of the relationship between stock size and biological parameters has been shown to be effective. In this study, some examples of interannual fluctuations in growth and recruitment observed in the Sea of Japan will be introduced and discussed with regard to density dependent effects. Interannual fluctuations in growth were observed for the sardine *Sardinops melanostictus*, yellowtail *Seriola quinqueradiata*, pink salmon *Oncorhynchus gorbuscha* and bastard halibut *Paralichthys olivaceus*. There were significant correlations between stock abundance and fish size (in length) except for the yellowtail, while no clear cut effect of water temperature on growth was found. The relationships between recruitment and spawning stock size or abundance in the early life stages suggest that the reproduction relationship was a scramble (Ricker) type for the sardine, and a contest (Beverton-Holt) type for the bastard halibut and Pacific common squid *Todarodes pacificus*. The water temperature was also significantly correlated with the recruitment of sardine and Pacific common squid. These examples suggest that the stock size has strong effects on growth and recruitment in fish and squid populations. However, since there are few data about how stock size affects actual growth and recruitment, a more precise ecological study is required to clarify the role of density dependent effects.

4AM1995-MEQ09

STUDIES ON BASIC ORGANISMS CONSTRUCTION AND ENVIRONMENT STATUS IN ZHUJIANG ESTUARY AND ITS ADJACENT SEA AREAS

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Based on data collected from 1987 to 1994, the basic organisms composition and dynamic change of water environment in Zhujiang estuary and its adjacent sea areas were analyzed and discussed. The results were follow as:

1. The nutrient in Zhujiang estuary was quite rich. Inorganic nitrogen, phosphorus and petroleum concentrations exceeded standard values of secondary type seawater. Other inorganic chemical and physical factors, organic matters, basic biomass and population structure varied with the seasons. Annual means of chlorophyll *a* and primary productivity were 4.02mg/m^3 and 309mgC/m^2.d respectively. The plankton was dominated by species habited in fresh sea water. Diversity indexes and even values were different between rainy and dry seasons.

2. Inorganic nitrogen contents in the waters of Yamen River mouth were excessive. Chlorophyll *a* content and primary productivity there were 4.63mg/m^3 and 243mgC/m^2.d respectively. The diversity indices of plankton were within normal levels. Their species and ecological construction varied with the seasons.

3. Nutrient values in Dapeng Bay were lower than in the two estuaries, but there were excessive standard levels for nitrogen and phosphorus in some stations. Biomass in spring and autumn were higher than in summer and winter. Species composition and diversity were different than in the estuaries. Salinity, water quality, basic biomass and species in the sea near Zhujiang estuary were different other areas.

4. Protect ecological environment in Zhujiang estuary and its adjacent sea areas are matters of common concern for Macau, Hong Kong and Guangdong province. It is necessary that the ecological environment and biological resources in the waters continue to be monitored and an assessment be carried out on the SSDS plan in Hong Kong.

4AM1995-POC10
ICE MOTION VECTORS DERIVED FROM IMAGE SEQUENCE OF NOAA SATELLITE

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The sea ice motion is crucial to the design of marine facilities and to the investigation of sea ice dynamics. At present, there are two kinds of methods to calculate sea ice motion vector from the sequential satellite images: one is the correlation-relaxation method (C-R), the other functional analysis method (FAM). The former is principally a pattern recognition on the basis of statistical correlation. The difference of C-R to its original maximum cross correlation method (MCC) lies in that C-R method takes into account the consistence of the motion vector field. The latter assumes that the change in the image grey value is totally the result of differential motions within the scene, and the motion vector can be extracted from the solution of the advective equation.

In this paper, a continuous five-day sea ice images of NOAA satellite is was analyzed. After a series of preprocessing, such as image registration and radiance calibration, the daily mean motion vector of sea ice was calculated by use of the two methods mentioned above. The results showed that the motion information can be extracted for the C-R method as soon as the feature of sea ice in the images was obvious. However, the greyvalue normalization of the image sequence was necessary to the FAM in order to eliminate the influence of non-advective processes, such as solar illumination and atmospheric condition. The calculations from two methods distinctly reflect the characteristics of daily mean motion of sea ice. The response of ice motion to the mean wind and tide is discussed.

4AM1995-FIS18
SECOND WINTER OF THE PINK SALMON IN THE SEA

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Eleven specimen of 1+ aged pink salmon, 44.5 - 55.0 cm fork length and 0.9 - 2.2 kg weight were caught in the Sea of Okhotsk and adjacent Pacific waters from November 1994 to January 1995. An examination of the scale samples showed that all specimen (5 females and 6 males) were from the 1992 yearclass, mostly circuli had spawned in 1994. The scale of all these pink have the second winter circuli, consisted of 3-5 closed circuli (3.9 - in average). Total number circuli ranged 34-39 (35.9 - in average). November - December is presumed as a start period of the second zone of closed circuli forming.

All examined specimens fed actively. Fat concentration in their muscle did not differ from one of 0+ aged pink. Gonads of all fishes were disrupted, except for one female which had mature eggs (87.5 g weight) with mature index - 11.3%.

Possibility of the pink maturing in age 2+ will be discussed.

4AM1995-MEQ10
RELATIONSHIPS BETWEEN TRACE METAL BIOACCUMULATION, METABOLISM AND HIGHER LEVEL EFFECTS IN COASTAL BENTHIC ECOSYSTEMS

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Anthropogenic activities result in the accumulation of substantial concentrations of trace metals in coastal sediments and it is important to understand the impact of these metals on coastal benthic communities. However, establishing relationships between concentrations of metals in

sediment and the effects of those metals at higher levels of biological organization has proved challenging. In this paper we will discuss the importance of using a mechanistic strategy in addressing this problem. We have carried out numerous mechanistic studies in the laboratory to evaluate relationships between metal exposure, bioaccumulation, metabolism and detoxification and higher level effects including growth and reproduction in benthic species. The results of these studies will be presented and a working paradigm developed for evaluating metal toxicity *in situ*. We will then examine several studies in which these strategies have been applied to field sites with historic metal contamination and sites with new sources of metals such as exploratory drilling rig. Relationships between parameters developed in laboratory studies and higher level effects on the benthic community will be discussed.

4AM1995-FIS19

PREDATION ON JUVENILE PENAEID PRAWN *Penaeus orientalis* AND FISH JUVENILES BY PERCH *Lateolabrax japonicus* IN THE ESTUARIES OF THE BOHAI SEA

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A stomach sampling program has been carried out aimed to examine the predation on juvenile penaeid prawn (*Penaeus orientalis*) by fish predators. The stomachs of 1598 young perch (*Lateolabrax japonicus*, Cuvier et Valenciennes) collected from three estuaries of the Bohai Sea were analyzed in the period 1992 to 1994. There were a total of 44 prey taxa found in the stomach of the perch. The consumption of the juvenile penaeid prawns (include juveniles released for enhancement) took place mainly from June to July. The overall frequency of occurrence of the juvenile penaeid prawns in the stomach of perch was 15%. In the water of Bailang estuary, the occurrence of juvenile penaeid prawns in the stomach of perch was 22% while it was 11% and 2% in the Xiaoqing and Qikou estuaries respectively. Maximum frequency of occurrence of the juvenile penaeid prawns in the stomach appeared in 1994 (22%) while it was 19% in 1992 and 9% in 1993. The predation of the juvenile prawns was generally increased with the size of the young perch. The size of juvenile penaeid prawns in the stomach ranged from 2 to 6 cm. The average number of juvenile penaeid prawns per hundred perch stomach was 20. Apart from the predation on the juvenile prawns, the young perch often preyed on juvenile fishes such as Scald sardine (*Harengula zunasi*, Bleeker), *Ilisha elongata* and Mullet (*Mugil so-iuy*, Basilewsky), other crustacea and plankton etc.. confidence intervals for the estimated frequency of occurrence were computed using bootstrapping.

4AM1995-BIO08

SIZE-FRACTIONATED CHLOROPHYLL, PRIMARY PRODUCTION AND NEW PRODUCTION IN THE EAST CHINA SEA

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Size-fractionated measurements of Chlorophyll *a*, primary production and new production in the East China Sea, were conducted in April 1994. Averaged for the whole study area, netplankton (20-200 um), nanoplankton (2-20 um), and picopankton (< 2um) were responsible for 20%, 33%, and 47% of the total Chlorophyll *a* respectively. Based on the contribution of different size-fractions to the total Chlorophyll *a* the study area could be divided into 3 regions: coastal and inner shelf region (<50m in depth) dominated by nanoplankton; the Kuroshio water with the dominating fraction of picoplankton; and the area between coastal water and Kuroshio water characterized by high standing crop of netplankton. Total primary production (TPP) in the study area varied from 200 to 2770 mg C/m^2d, with the highest values in coastal waters (like St. 502, 503) and the front area (St. 410), and the lowest values in outer open waters (like St. 517). Contributions to TPP from different size fractions followed the same pattern as Chlorophyll *a*, but a proportion of the production was contributed by the smaller fractions. New production, on the other hand, was quite different from Chlorophyll *a* and PP. It mainly contributed b), the largest fraction --- netplankton whose f-ratio was

up to 0.58, followed by nanoplankton with the f-ratio of 0.07-0.24, and then came the last picoplankton with a ratio of less than 0.12. Correlation analysis shows that phytopankton biomass and production were controlled mainly by the availability of nutrients (especially in the outer open waters) and light (especially in the coastal shallow, waters), but the influence on the large fractions was greater than on smaller ones. The size structure shift seems to be multi-controlled and need further dynamic studies.

4AM1995-MEQ11
VARIATIONS AND DISTRIBUTIONS OF DIO IN THE EAST CHINA SEA

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A columetric analytical system was designed for determining total dissolved inorganic carbon dioxide (DIO) in seawater. The optimum analytical conditions were obtained and the accuracy and precision of this system as ±1μ mol/kg and ±0.07%. With this system, the variations and distributions of DIO in the East China Sea as obtained during three China JGOFS cruises in 1993 and 1994. The investigated area was 32°00' N - 25°00' N, 121° - 129°E. The DIO of this area ranged between 1.890 - 2.100 mmol/kg. It was higher in the coastal sea than in the open sea, and it increased from 25°00' N to 32°00' N. DIO also increased with the depth. The seasonal effect was that the DIO was higher in spring than in autumn. The diurnal variation of DIO in sea water was higher between 6:00 - 12:00 a.m. The Taiwan warm current, Kuroshio water, river input and biological activities may contribute to the variations and distributions of DIC in the East China Sea.

4AM1995-SB04
HISTORY OF CARRYING CAPACITY AS AN INDEX OF ECOSYSTEM PRODUCTIVITY

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Through overview of major textbooks of ecology, the history of carrying capacity concept as an index of ecosystem productivity was examined. In the textbooks of ecology today, the carrying capacity concept is defined with the logistic population growth equation. However, the carrying capacity concept was first developed by Errington (1934), independent from the logistic model, as a characteristic level of abundance for wild animal populations, which was determined primarily by the amount of 'cover' in the area. The concept of carrying capacity was then combined with the parameter K in the logistic equation; until that time K had been called the upper asymptote. Regardless of being considered with or without time changes, the parameter K in the logistic equation shares all of the ecosystem constraint and environmental forcing on population growth through density effect. The common understanding of the concept of carrying capacity is the asymptote population biomass supported by an ecosystem under the limitation of food, shelter etc. and under the effects of predation and exploitation. Apart from the logistic equation, the term carrying capacity has been used to indicate the general productivity of an ecosystem, as a constraint on population growth.

4AM1995-BIO09

APPEARANCE OF PLANKTONIC ANOMALIES IN FAR-EASTERN SEAS AND IN ADJACENT WATERS OF THE PACIFIC OCEAN

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Numerous appearance of planktonic anomalies is described. This phenomenon was expansive during last year. The data of the taxonomy and the distribution of anomalous planktonic organisms in Far-Eastern seas and in adjacent waters of the Pacific Ocean were considered. The anomalous live animals were studied in the aquarium conditions. The fixing of animals in 4% formaldehyde water solution was studied for plankton samples. A correlation between anomalous and healthy animals was investigated. The areas of intensive anthropogenic impact and the areas without anthropogenic influence as well as geophysically active area of the marine environment were inspected.

The supposition was done that the appearance of numerous anomalies in the plankton of Far-Eastern seas and in adjacent waters of the Pacific ocean have been a result of the increase of geophysical activity of the Earth and in some areas probably due to influence of radioactive wastes.

4AM1995-POC11

RECENT CHANGES IN WATER CHARACTERISTICS AROUND THE KURIL REGION DURING SUMMER

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Water characteristics (potential temperature, salinity and nutrients) as a function of potential density around the Kuril region was investigated during the summer from 1988 to 1994. Waters around the Kuril region was classified into several subarctic and subtropical waters. In 1990, a warm and oligotrophic water was distributed more widely around the Kuril region. It seems to be affected by extraordinary deep WCR-86B (Kuroshio warm-core ring) possessing subtropical characteristics near the Bussol' Strait. During the coalescence of WCR-86B, different outflowing pattern from the Okhotsk Sea was observed near the Kuril Islands. At the same time, the East Kamchatka Current water showed more cold and fresh water characteristics in the subsurface layer lighter than 27.0 isopycnals. A well defined seasonal thermocline was developed in 1990 summer. On the other hand, during summer of 1994, a very cold subsurface water less than C originated from the East Sakhalin Current was observed more wider area on 26.6° isopycnals, and the temperature of deep warm water on 27.4 isopycnals was exceeded 2.5°C, 0.3° higher than another summer, in the Kuril Basin. It suggests that the splitting of the anticyclonic eddy in the Kuril Basin affected the flow path of subsurface cold waters.

4AM1995-BER07

SPATIAL - TEMPORARY CHARACTERISTICS OF THE WARM INTERMEDIATE WATERS OF THE DEEP BERING SEA

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At present time, TINRO in common with FERHRI has formed bank of oceanological data of the Bering Sea, consisting of 23,000 stations. More than 60% of the stations of shelf are included there. There are 7,000 observations of the deepwater area. They allow to one calculate the average month values of temperature and salinity for squares of 1° latitude and 2° by longitude.

The average monthly charts of temperature and salinity distribution in the warm core intermediate strata (WIS) and its depth have been made. By T,S-characteristics four types of WIS are distinguished: Central (C) with temperature >3.75°C and salinity >33.8 psu in core, Aleutian (A) - >3.75°C and <33.8 psu, Western (W) - <3.75°C and >33.8 psu, Eastern (E) - <3.75°C and <33.8 psu.

Type C is formed as a result of Pacific water transformation, entering via deepwater straits Near and Amchitka. Type C turns into type A near Aleutian islands from the Bering sea. Type A is able to form from the Pacific as well and then to penetrate into the Bering sea in small portions. Type A of the eastern periphery of deepwater basin was teared by winter shelf waters slipping down along the continental slope and turns into type E. In winter and spring type E joins with continental slope and occupiers zone of 100 miles in width. In May-June while vertical water movements stop, continental slope was occupied again with waters of type A, but type E is gradually forced out to the west and mingles with water of type C.

In the Russian zone, type C deepens and turns into type W which keeps its characteristics during over the year.

In early fall the results of inflowing weakening of Pacific waters, type C practically disappears and it formed only in early winter.

4AM1995-POC12
WHETHER LOCAL PROPERTIES OF CABBELING EFFECT IN MARINE WATERS CAN INFLUENCE GLOBAL PROPERTIES OF THE CLIMATIC SYSTEM

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The global circulation systems of the Northern Pacific are divided by climatic Subarctic Frontal Zone (in the southern ocean by subantarctic front). The conservative sharp cross-structure of the Subarctic Front was weakly changed by the meteorological forces. The meteorological cyclones change a position of the front as a uniform unit, while preserving the cross structure. Hence it follows that there was an internal source of self-maintenance in the dynamic balance of the front. It may be the cabling process at the front. The available potential energy of cabling was transformed into kinetic energy of convergence.

The absolute value of cabling energy increased the cooling of marine water (other conditions are fixed). If the position of the front was connected with fixed TS - index, then the cabling can become the stabilizing factor of a climatic system. At global heating of the Pacific Ocean the cabling acted as a barrier and to constrain the increase of southern anticyclone at the expense of northern cyclone, while limiting progress of warm waters for the north.

A simple model for energetic analitical valuations is presented.

4AM1995-BER08
THE DISTRIBUTION OF ZOOPLANKTON AND STOMACH CONTENTS OF WALLEYE POLLOCK, *Theragra chalcogramma*, IN THE BERING SEA

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The distribution of zooplankton and stomach contents of walleye pollock were investigated by NFRDA scientists on board the Korean research vessel, Pusan 851, in the Donut Hole and Bogolsof area (53°00' -58° 15'N, 166° 26' W-175° 00' E) of the Bering Sea in July 1994. Zooplankton was

collected at 48 stations from surface to 200 meter depth by Bongo net with 60 cm diameter and 333 μm mesh size. Walleye pollocks were sampled by midwater trawl net from the same area.

The density of zooplankton ranged from 4.4 to 16123.5 mg/m^3 in survey areas. Higher values were obtained from the Bogoslof areas (1925.7 mg/m^3) than from the Donut Hole (1494.6 mg/m^3). Copepods and euphausiids were the predominant constituents, which comprised 79.2% and 11.9% of total zooplankton abundance (ind./m^3), respectively. The distribution of zooplankton density coincided with that of Chlorophyll *a* and nutrients including nitrate, phosphate and silicate. This fact showed the general features of marine ecosystem that the high values of zooplankton density were to succeed the high values of primary production.

The stomach contents of walleye pollock (276 fishes) caught showed a high frequency of occurrence of copepods and euphausiids. The percent of IRI (index of relative importance) of copepods and euphausiids increased with the size of walleye pollock, whereas that of copepods decreased. These two groups were significant as the prey of walleye pollock in the Bering Sea.

4AM1995-FIS20
A DENSITY-DEPENDENT EFFECT ON THE REPRODUCTION CAUSED BY THE DECREASE IN SARDINE POPULATION OFF KOREA

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The population of sardine occurred in Korean coastal area increased from the mid-1970s. However, it began to decrease after 1986 due to the decrease in recruitment to the stock. The spawning area of sardine spread over the southern part of the Korean waters from the south of the Yellow Sea to the Jeju Island through the Tsushima Island and up to the south of the East Sea when the population increases. However, from 1987 when the stock density of sardine decrease rapidly, spawning was observed mainly in the west off the Tsushima Island.

The densities of eggs and juveniles increased since the late 1970s and reached at peak in 1986 followed by the decrease. They showed a slight increase in 1992 but decreased again. Consequently, the recruitment of 1 and 1+ fish appeared to increase moderately in 1993 and 1994. There was a tendency of the increased reproduction that gonad weight per unit body weight increased whereas the length at maturity decreased compared to that in the year when the population grows. It is likely that density-dependent effects on reproduction of sardine was occurred as the population decreases.

4AM1995-POC13
CHANGES IN DEEP WATER CHARACTERISTICS IN THE EAST SEA (SEA OF JAPAN): A REGIONAL EVIDENCE FOR GLOBAL WARMING?

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East Sea (Sea of Japan) is a typical Marginal Sea surrounded by Korea, Russia and Japan. Its average depth is around 1700 meters and the shallow waters are continually exchanged with the Pacific surface waters through narrow straits of less than 150 meters depth.

However, its maximum depth is over 4000 meters and it is generally believed that deep water convection occurs within the basins. Furthermore, the replenishment of deep water appears to proceed rather rapidly, as reflected in its extremely homogeneous temperature and salinity and very high concentrations of dissolved oxygen (DO) over 200 μM for waters below several hundred meters, known as East Sea Proper Waters (ESPW).

Even with very small variations, however, temperature and salinity profiles of ESPW show structures similar as in the open ocean, indicating different water masses within such basins such as Deep Waters and adiabatic Bottom Waters.

A recent survey confirmed the earlier observations that properties in Deep Waters have been continuously changing at least during the last 25 years as follows:

1. Increase in potential temperatures of Deep Waters over 0.1°C.
2. Deepening of the depth of DO minimum from less than 1000 meters in late 1960s to below 1500 meters in 1994.
3. Decrease in thickness of adiabatic Bottom Waters and in their DO concentrations by 20 μmoles/kg.

A possible "Change in Mode" for the deep water formation such as:

1. Increase in Upper Deep Water formation
2. Decrease in Bottom Water formation

as a result of the decrease in downwelling potential due to an increase in temperature of surface waters in the deep water formation regions associated with recent global warming. Detailed age determinations of Upper Deep Waters, Lower Deep Waters and Bottom Waters are in progress to investigate the hypothesis discussed above. Further details will be discussed at the meeting.

4AM1995-BIO10
TROPHIC INTERACTIONS IN THE PLANKTONIC FOOD WEBS

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Changes in patterns of phytoplankton biomass are directly linked with changes in zooplankton community structure because of grazing, and indirectly linked with changes in planktivores because of predation on grazers. The impacts of gelatinous macrozooplankton predation on mesozooplankton may be significant, and as such impacts cascade down to the lower trophic levels, resulting in changes in Chlorophyll *a* concentration. This "top-down control" hypothesis was supported by field observations and by laboratory experiments of biomanipulation that phytoplankton blooms had followed an increased gelatinous macrozooplankton abundance. When gelatinous macrozooplankton were removed, the abundances of adult copepods, copepodites and nauplii were higher than those in the control with natural density of gelatinous macrozooplankton at the end of incubation resulting in lower Chlorophyll *a* concentration in most of the experiments. When gelatinous macrozooplankton were added the results were reverse.

4AM1995-BIO11
THE CULTIVATION AND THE INDUCED MUTAGENESIS IN THE RED ALGA GRACILARIA VERRUCOSA (HUDS.) PAPENFUS

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Investigation of *Gracilaria verrucosa* cultured to obtain strains of high productivity for commercial cultivation have been carried out in the northeastern area of the Amur Bay. When cultivation of gracilaria on artificial substrata the formation of reproductive organs occurred in a year of spore development. The results suggest that cultivated gracillaria spores do not evolve simultaneously, so the vegetative development period of the alga may last for more than a year. The seaweed crop was more 100 g. with 1 m. of the thread substrate.

Selection works has been done using chemical mutagens: phenol, colchicine and gamma-irradiation. The majority of progeny of algae, which were exposed to mutagenic influences, differ from parental specimens. They lost the ability to sexually reproduce and had a more branched and

fine thallus. New forms of Gracilaria which differs form wild by morphological characters and vegetative reproduction has been obtained by the method of gamma-irradiation (doses of 50 to 250 Gy) of the thallus with following heteroauxin.

It is supposed that radiation causes somatic embriogeny and the origin of nonattached form of Gracilaria.

The strain of Gracilaria, which as obtained by the method of induced mutagenesis, is useful as initial material for further selection.

4AM1995-POC14
DIAGNOSIS AND ADAPTATION CURRENT CALCULATIONS IN THE NORTH PACIFIC

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Calculations were carried out using the finite element thermohydrodynamical model for the primitive equations. The integration domain includes zone from 30°S to 60°N. One was covered with a grid of 2 x 1 degrees of longitude and latitude respectively. Input data consist of the climatic seasonal wind stress, temperature and salinity.

1. Diagnostic calculations: Numerical calculations began from the state of rest. In the first five days an abrupt increase of the kinetic energy was observed. After this period the increase became weaker reaching 1 per cent by the 7th day. These calculations were continued during 30 days. By that time all main components of the circulation system were formed. The mass transport in the Kuroshio current was 45 Sv. Final results have shown two trajectories of the current south of Japan. One passed along the shore of Japan and the other went south off the Idzu ridge. The maximum value of the velocity in the Kuroshio jet at the 50 m level was about 50 sm/sec. In the equatorial zone the behaviour of the velocity was typical for diagnostic calculations. In the upper 200 m, the analysis of the vertical velocity sign have shown regular zones of upwelling and downwelling connected with the cyclonic and anticyclonic circulation in the main gyres. Meridional heat transport was unreal with maximum value about 4 PWT (1PWT=1.E15 WT).

2. Adaptation calculations: Diagnostic results were used as input data for the adaptation study. The equations of the conserving temperature and salinity were added to equations of motion. This problem was solved for 30 days. The results shown that maximum velocity in the Kurosio jet at 50 m was about 30 cm/sec. Behaviour of the vertical velocity sign was more regular.

In the equatorial zone the main components of the circulation were formed. At the 75-250 m levels a counter current with value 30 cm/sec was found.

The merdional heat transport decreased to 1PWT and its maximum was near 10°N.

4AM1995-POC15
DIAGNOSIS OF TWO KUROSHIO PATHS

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The diagnostic calculations of the Kuroshio current south of Japan were carried out. Analysis of temperature/salinity data from the Far East Hydrometeorological Institute represent two main states of the Kuroshio: non-large-meander path and large-meander path. The calculations include estimations of 3D velocity fields for two periods as well as the analysis of the difference in the balance

of terms of equations for these two modes. The analysis was done using both the vorticity equation and the vertical velocity component equation. The inflow mass transport was calculated in the model on the basis of the hydrological data and wind-stress.

After diagnosis a short term adaptive calculations were carried out with the use of the heat/salt Eqs. to estimate the tendencies of the development of the hydrological fields.

4AM1995-FIS21
POPULATION DYNAMICS OF SOME MAIN COMMERCIAL FISHES IN THE EAST CHINA SEA AND YELLOW SEA

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By using G.I.S. technology and time series analysis methods, this paper describes the dynamics of structure, number and distribution pattern by following the main commercial fish populations in the East China Sea and Yellow Sea. The populations are hairtail *Trichiurus haumela*, small yellow croaker *Pseudesciena polyactis*, large yellow croaker *P.crocer*, filefish *Navodon septentrionalis*, mackerel *Pneumatophorus japonics*, harvestlish *Pampus argenteus*.

The structures of these populations have become simpler. Formerly their remainders dominated spawning stocks but recently recruitments of stocks exceeds the remainders. The maturation of large yellow croaker, for example, usually took several years and the population had complicated structure in the 1950s. The life span of large yellow croaker and small yellow croaker could reach to twenty-nine and twenty-three years in the 1950s, and had decreased to seven and two years respectively at present. With the population structure getting simpler, growth rates of these populations had been getting faster, the body of maturity group getting smaller, and the fishing grounds for these populations had also changed.

It demonstrated that the population structure of a species has a certain stability in their comparatively stable environment. If the environment was disturbed beyond its tolerance limits, it will regulate itself to a new situation. According to correlation analysis, fishing is a main reason for numeric decrease and structural simplification of these populations.

4AM1995-FIS22
MESOPELAGIC FISHES AS THE MOST IMPORTANT ITEM OF THE EPIPELAGIC FISH COMMUNITY OF OKHOTSK SEA

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Mesopelagic fishes (mainly deep-sea smelt) as well as pacific salmon appear to be a substantial component of the Okhotsk Sea epipelagic fish community. Total fish biomass increased 2-5 times during nighttime when the mesopelagic fishes (m.f.) ascent to surface. At present when walleye-pollock abundance abruptly decreased in the southern part of Okhotsk Sea m.f. are presumed to be a main consumer of the plankton, transferring the most of organic substance to the higher trophic levels in this region.

Annually m.f. feed approximately 3.37 mln.t. of food, mainly planktonic crustacea. Annual predation of m.f. is about 50-100 th.t, mainly by walleye-pollock, salmon, squids.

4AM1995-MEQ12

MOVEMENTS OF THE STARRY FLOUNDER *PLATICHTHYS STELLATUS* IN RELATION TO ITS ROLE A SENTINEL SPECIES FOR CONTAMINANTS IN NORTHEASTERN PACIFIC ESTUARIES

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The concept of using a "sentinel" species for contaminant monitoring is that the species monitored would represent not only their own contaminant exposure, but also the types and levels of contaminants present in the ecosystem being monitored. Knowledge of the movements and residency (or "home range") of the sentinel species is critical to the reliability, and applicability, of results derived from tissue analyses. Body burdens of organic and inorganic contaminants in starry flounder *Platichthys stellatus* are monitored by management agencies of major northeastern Pacific estuaries (San Francisco Bay, Puget Sound, Fraser River Estuary) to assess and index water quality. In this study, conducted in the Fraser River Estuary, we used ultrasonic and radio biotelementry to determine the migratory patterns and home range of both mature and sub-mature starry flounder. For the study of sub-mature specimens, a combination of stationary and mobile radio-tag receivers and a global positioning system (GPS) were used to document the date, time, and geographic position (latitude and longitude) of subsequent detected movements. These data were then related to published data on contaminant uptake and other information regarding the utility of starry flounder as a sentinel species. Data from 1993 and 1994 showed that, on average, the fish moved about 500 m day^{-1}, with a wide range. These observed movement rates would enable sufficient time for sub-mature starry flounder to accumulate metals and organics from broad reaches in the estuary. Uptake of contaminants is likely via the food chain, and some data are also given on the variation of food sources within the estuary. Sexually mature starry flounder appear to move well out of the estuary into the Strait of Georgia; thus, body burdens of contaminants in mature specimens are not considered to be representative of the management area. Sub-mature starry flounder can provide representative contaminant information for the Fraser River Estuary; sub-mature starry flounder are not recommended for point-source contaminant monitoring because of the high morility of this group within the lower Fraser River. Prior to the selection of a sentinel fish species for a particular water body, we recommend obtaining basic data on movements and home range of the species to improve confidence that body burden and/or health data would represent *in situ* conditions.

4AM1995-FIS23

LONG-TERM VARIATION OF OCEANIC FRONT IN WESTERN OF THE EAST CHINA SEA AND FISHERIES

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Analysis of oceanographic hydrologic data collected during 1960-1989 in the western China Sea indicated a sharp coastal oceanic front, distinguished by marked gradients of temperature and salinity, between the Changjiang Diluted Water and the Taiwan Current Water, and the Huanghai Cold Water. In this paper, some characteristics of interannual variations of the oceanic front, and its relation to fisheries were described. On the October 1982 and 1984, there were maximum horizontal gradient of hydrologic properties cross the frontal zone, during same period, the most successful catches were recorded in the frontal zone.

4AM1995-MEQ13
STUDY ON DEGRADATION OF PETROLEUM BY MARINE FILAMENTOUS FUNGI

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Four kinds of Petroleum were degraded by three strains of filamentous fungi isolated from coastal water. The experimental results indicated filamentous fungi differed greatly from marine bacteria in degradation of petroleum. Filamentous fungi mainly degrade longer that C_{18}chain hydrocarbon contrary to marine bacteria. There was a difference in ability to degrade petroleum at the levels of single and mixture strains. In addition, Nitrogen and Phosphorus nutrient accelerated degradation of petroleum by marine bacteria, but had no obvious effect on filamentous fungi.

4AM1995-FIS24
COMPARISON OF TWO VIRTUAL POPULATION ANALYSIS METHODS

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This paper examined two virtual population analysis (VPA) methods of Gulland (1965) and Separable (Pope and Shepherd 1982) methods using one set of simulated data. Results indicated that both the separable VPA method and Gulland VPA method do not perform well when the terminal fishing mortality was not tuned using effort data. When the tuning methods were used the estimations from both methods are improved. The Gulland method made virtually identical solutions, in contrast, the separable VPA method produced deviated results for different starting values. However, when the starting value was close to the true value, the separable VPA performs better than the Gulland method.

4AM1995-MEQ14 Invited
IMPACT OF THE THREE GORGES PROJECT ON THE ESTUARINE ENVIRONMENT AND LIVING RESOURCES OF THE CHANGJIANG RIVER

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In order to evaluate the feasibility of the "Three Gorges Project" and to predict the change of estuarine environment and its biological communities, monthly multidisciplinary surveys were carried out in August 1985 - October 1986. The relationship between the river discharge and the hydrographic, hydrochemical and sedimentary environments and the biological communities and living resources in the Changjiang River Estuary and adjacent seas has been analyzed and discussed. After completion, the Three Gorges Reservoir will store water in October to the levels of 150-180 meters and the distributional range of the brackish water in the Changjiang estuary will decrease from the original 4,500 to 1,800 km^2, and the estuarine salinity will rise by 1-4 parts per thousand. The 30 isohaline will shrink backwards to the river mouth. The contents of nutrients, organic compounds and pollutants in the estuarine water will slightly decrease accordingly. The amount of silt transportation to the sea will also decrease and the sedimentation pattern will be greatly changed. These will change the species composition, the distribution pattern and abundance of living organisms; the biological productivity will also be accordingly decreased. The change will affect the stock of important fishes and invertebrates to various extents. The location of the center of fishing grounds will also be change somewhat. While in the period from January to April, increasing runoff will benefit the reproduction and recruitment of fish population.

4AM1995-BIO12
ABUNDANCE AND DISTRIBUTION OF PARTICULATE ORGANIC MATTER IN THE EAST CHINA SEA

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Particulate Organic Matter (POM) plays an important role in marine food webs, especially in the coastal waters. Particulate Organic Carbon (POC), Particulate Organic Nitrogen (PON) and ATP were measured in the East China Sea in the Spring (April) and Autumn (October-November) of 1994. The living POC was estimated based on the formula "Living POC = 250*ATP". On the average, POC was 280 ugC/l in Spring and 541 ugC/l in Autumn. PON was 39 ugC/l in both seasons. The living POC accounted for less than 10% of the total amount of POC in the two seasons. In other words, POM in the East China Sea was mainly contributed by non-living POM. The POC and PON had the same distribution patterns. In spring, the high level area of POC and PON occurred in the centre of the shelf area, but occurred near the Changjiang River Estuary in Autumn. The distribution pattern of POC and PON was coincident with that of ATP in Spring, indicating that POM mainly came from biological processes in water column. Evidence could also be found from the low C:N ratio in POM (7.63). In Autumn, the concentrations of POC and PON decreased gradually from the Changjiang River Estuary toward the open area. It seemed that most of the POM might came from the outflow of Changjiang River. In autumn, the C:N ratio was also high (15.23).

4AM1995-BER09
COMPARISON OF THE ROLE OF WALLEYE POLLOCK IN GROUNDFISH FOOD WEBS OF THE EASTERN BERING SEA, ALEUTIAN ISLANDS, AND GULF OF ALASKA

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Diet comparisons of major groundfish species in the eastern Bering Sea, Aleutian Islands, and Gulf of Alaska are made with respect to trophic level of the diet and rankings of most important prey items by area. Interannual variability of apparent trophic level of groundfish species in the eastern Bering Sea is calculated using food habits data from 1985 to 1992. Food web diagrams of the prey of each groundfish predator are shown with prey types categorized by trophic level and whether they are pelagic or demersal. Historical levels of total catch and estimated trophic level of the total catch over time in each area are presented.

The results highlight the importance of walleye pollock as a nodal species in the eastern Bering Sea. It is a key prey item for many groundfish predators, it has the largest biomass of any groundfish species , and it dominates the groundfish catch in that area. The importance of pollock as prey for piscivorous groundfish is not as great in the Gulf of Alaska and is least important in the Aleutian Islands region where Atka mackerel dominates the groundfish biomass.

4AM1995-BIO13
VARIABILITY OF MARINE LIVING SYSTEMS

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Introduction:

At present, there is an evident trend to look more at holistic approaches seeking for principles to manage marine biotic resources. The reasons for this seem to be rooted, at least in part, in the apparent inability of our present population-managed techniques to prevent resources from collapsing, as well as in the need to more fully and efficiently use natural resources and to avoid collateral effects, particularly in terms of environmental impact.

This presentation aims at discussing one of the most important features of living systems: their natural variability and those of its effects resulting in the inadequacy of present-day management techniques.

Natural variability has often been neglected, not so much in the theoretical treatment as in the evident necessity of reducing some of the enormous complexity of living systems for us to understand and manage them. Many models, either mathematical or not, tend to assume constancy in parameters and processes. Such is the case of, for instance, population growth and the associated carrying capacity concept; or recruitment, and the related sustainable yield.

However natural variability has, as we are only learning, much more important effects than previously thought operating on considerably higher frequency than normally expected. Populations, communities and ecosystems are changing continuously, and we are faced with considerably more complex systems than we previously realized.

The presentation shows some aspects of these variations at the population, community and ecosystem levels and discusses some potential consequences of it in terms of our present ability to manage multi-individual living systems. It emphasizes decadal-scale shifts as a source of large scale variability not previously recognized, but also briefly discusses other scales of variation, such as the ENSO events, interannual and intrannual variability.

Examples are presented in small pelagic, demersal and benthic species; in productivity and in some physical environmental indices.

Tentative contents:

1. Fisheries and the Regime Problem: overfishing or decadal shifts?
   small pelagic forage fishes
   small carnivores
   demersal species
   benthic species
2. ENSO effects on productivity and availability.
   the variation of chlorophyll productivity
   zooplankton major changes in the California Current System
   Temperate vs tropical small pelagics in the Gulf of California
3. Variability of large marine ecosystems.
   Intrannual variability
   Interannual variability
   Decadal scale variability
4. Adding up: Do we need a new conceptual framework here?

4AM1995-BIO14

DISTRIBUTION CHARACTERISTICS OF SURFACE LAYER CHLOROPHYLL A ON DIFFERENT SPATIAL SCALES IN THE EAST CHINA SEA

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Chlorophyll *a* concentrations in the surface layer by continuous flow measurement were collected from ten transects (118-129°E. 24-32°N) in April, 1994. Chlorophyll *a* concentration was sampled every second, or every 8 meters at a sailing speed of 15 knots. The inlet of the pumping system is located near the bottom of the ship, so the sampling depth is about 5m. The findings are as follows:

1. High frequency variation of the 10 meter scale with amplitude of 0.1-0.2 mg/m^3 influenced by short temporal scale and small spatial scale physical processes such as turbulence, surface wave was common.

2. Patches of kilometers scale were found frequently along the transects. In certain samples the variation of chlorophyll *a* concentration reached 1.5mg/m^3 within 1 km.
3. Large scale distribution pattern of 100 kilometers were also found, which shows the geographical distribution of large temporal and spatial biological, physical and chemical processes.
4. The amplitude of power spectra tended to decrease when wave-number increases. This showed that the bigger variation corresponded to larger spatial stretch.

4AM1995-FIS25

STUDIES ON CHARACTERISTICS AND SUCCESSIONS OF FISHERY RESOURCES STRUCTURE IN THE CHINA SEA

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There are abundant fishery resources of various species and the fauna is complex in the China Sea. Among the main coastal fishery resources, warm-water species accounted for 69.2%, warm-temperate species account for 23.1 %, and cold-temperate species only account for 7.7%.

Resources of single species were not abundant. The distribution of major dominant species were regional, so they were relatively independent, but utilization of them was irrational. Most of the benthic species were over exploited, only some fishes, shrimps, crabs and cephalopods of middle and upper water layer still have a certain potential.

In the past 40 years, the fishery resources of dominant species were replaced frequently, changes of structure occurred. The proportion of bottomfish resources declined yearly; pelagic fishes, shrimps, and crabs showed an increasing tendence at the same time

The decline of resource and structural changes were due to improper exploitation and over fishing. The increased rate of marine effort was much greater than that for stocks in the past 40 years.

In this paper, some suggestions are made for rational use of fishery resources and to sustain stable yields.

4AM1995-MEQ15

PARTIAL PRESSURE OF CARBON DIOXIDE IN THE EAST CHINA SEA AND CARBON FLUX AT THE INTERFACE BETWEEN AIR AND SEA

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The surface water of and the air above the East China Sea were sampled in April and October of 1994 and Pco_2 of samples determined with the estimate GC flux of carbon in the area. The air Pco_2 in the near coastal zone was higher (>360 ppm) than that in the open sea (about 350 ppm). An anthropogenic impact both from China mainland and Japanese islands was found from the distribution of the air Pco_2. A negative correlation between salinity and Pco_2 of seawater along the coastal sea demonstrated there was carbon dioxide input from rivers (>420 ppm) of China mainland, especially the Changjiang River which caused a rather wide zone of high Pco_2 out of the Changjiang estuary locating in the northwest of the investigated area. The Taiwan warm current and Kuroshio water with high salinity, high temperature, and low Pco_2 (<330 ppm) covered most of the area of the East China Sea. In contrast to stable salinity and temperature Pco_2 in seawater, a significant dinual variation (maximum 14 ppm) consistent with that of nitrate and phosphate, i.e. increase during the night and decrease during the day, implying that the photosynthesis of phytoplankton was responsible for the variation. The differences in Pco_2 between air and sea was positive (12 ppm to 61 ppm) near coast due to the influence of rivers with high Pco_2 and negative (-20 ppm to -71 ppm) off shore influenced

by Kuroshio water with low Pco_2. As a whole, the East China Sea can be considered as a sink for air CO_2.

4AM1995-MEQ16
RIVER INPUT OF NUTRIENTS INTO THE EAST CHINA SEA AND THEIR BIOGEOCHEMICAL CHARACTER

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Water of the East China Sea (among 25.2 - 32 N and 121.4 - 129E) was sampled in April and October of 1994 and nutrients were determined. The input of high nutrients coming from Changjiang, Qiantangjiang and Oujiang Rivers caused a considerable gradient of nutrients between coastal and open seas, especially for nitrate. The Yellow Sea cold water mass was characterized with high silicate and ammonia in spring and significantly affected nutrient distribution of north of the Sea. The Taiwan warm current water with high salinity, temperature and low nutrients towards the Changjiang Estuary also contributed to the distributions of nutrients. Regeneration a very high nutrient concentration was found in deep water off the slope, but in the early spring the Kuroshio water was isolated by shelf water, so that upwelling at the slope could not affect the nutrient distribution on the shelf. At a part of the shelf a stratification of temperature so nutrient has started to form in early spring. A nutrient depletion at the surface of the middle of the East China Sea, especially for phosphate, and a good positive correlation between nutrients and AOU displayed the important role of biological processes in nutrient distribution of the water column. A denitrification process in the Kuroshio water can be found under 50-200 m in depth by a maximum of nitrite and depletion of nitrate.

4AM1995-BER10
THE BERING SEA OCEANOGRAPHIC DATA MASSIVE AND SOME RESULTS OF ITS PROCESSING

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The number of hydrographic stations sampled in the Bering Sea from 1932 to 1988 are estimated to be 35,701. The data set has been sorted in the spherical trapezia (1 between the parallels and 2 between meridians). Monthly and seasonal averaged data has been used for analysis of the distribution of temperature, salinity and density in the active layer. At the lower levels averaging the annual mean data was adopted. The hydrochemical data have been averaged by seasonal.

The Bering Sea current was calculated by applying the A.S.Sarkisyan's model (D1). Two anticyclonic gyres were found to be elements of the large scale circulation of the Bering Sea: the first was located to the south of Navarin Cape, the second on the shelf to south of the St. Lawrence Island.

During the year, two periods with different features of the large scale sea surface temperature distribution were distinguished in the Bering Sea. The annual changes of hydrological characteristics were not observed in the warm intermediate layer core.

The charts of the lower boundary of the upper quasihomogeneous layer and layer of the abrupt oxygen decrease, as well the integral contents of dissolved oxygen in these layers showed that accumulation occurs.

4AM1995-MEQ17
ESTIMATION OF MERCURY CONTENT IN THE ECOSYSTEM OF WESTERN PART OF BERING SEA

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Mercury research was undertaken in 1993 on board of the vessel "Academic Alexander Nesmeyanov" in the Karagin-Olyutor region of the Bering Sea at 23 stations, which were situated in the deep-water region and on the shelf.

The object of investigate the sea water from surface microlayer (200 mkm) to 645 m, biota (plankton) and bottom sediments.

It was established that the concentrations of mercury in the upper layer of water (to 0.5m) changed from 0.015 up to 0.055 mkg/l, and gradually reduced to the North. One can not observe the mercury saturation of the surface microlayer as compared with lower layers. In the bottom layer of water the mercury content is higher than in the surface.

The highest content of mercury, 0.220 mkg/g of dry mass turned out to be in plankton.

As compared with Okhotsk Sea, high concentrations of mercury were observed in the surface layer of water and in plankton, but the surface microlayer of sea water is characterized by relatively low levels.

The increase of mercury in the surface waters, evidently was connected with the increase is the non-organic mercury combinations, which came from rain and snow. The high content of mercury in the plankton, was connected with the increase of predatory species, and these predatory species belonged to higher trophic levels which concentrate the mercury.

The data show that the main source of mercury in Bering Sea was from the atmosphere coming from volcanic activity from Kamchatka and from Aleutian Islands. The mercury of the bottom water layer evidently has no significance.

The results correspond to the data from 1981, which was collected during research on board the vessel "Academic Shirshov". These data confirm the role of volcanic activity in establishing the level of mercury in the ecosystem of western part of Bering Sea.

4AM1995-MEQ18
ANALYSIS OF NUTRIENT CONDITION OF RUSHAN BAY IN CHINA IN AUGUST

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Chemical oxygen demand (COD), inorganic nitrogen (IN) and inorganic phosphorus (IP) in Rushan Bay in August, 1994, were used to evaluate nutrient conditions by means of the single and synthetic indices evaluation methods. Result showed that the nutrient conditions in the mouth of the Bay and the inlet of the east and west valley was acceptable but the rest of the bay suffered from eutrophication. The IN was the main factor which caused the eutrophication.

4AM1995-SB05

CARRYING CAPACITY IN SIMPLE THEORETICAL POPULATION MODELS

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The concept of "carrying capacity" implies a natural milit to abundance. The logistic model is a first approximation to a wide variety of more realistic population growth models, and it contains an asymptotic population size (usually denoted K) that has become known as "carrying capacity". Investigation of "carrying capacity" in the logistic model is facilitated by an alternative solution of the differential (or difference) equations known as the Riccatti form: instead of describing abundance as a function of time, $N_t=f(t)$, we can describe abundance as a function of preceding abundance, $N_t=g(N_{t-1})$. In this form, K is the abundance such that $N_t=N_{t-1}$. This view allows abundance to exceed K, which is an equilibrium value, but not a limiting value. The Riccatti form of the logistic model actually describes a true upper limit to abundance N_t, however large N_{t-1} may be. This limiting value has no name, but corresponds much more closely to the intuitive concept of "carrying capacity".

The Riccatti form also provides a convenient analytical framework for theoretical population dynamics related to hatchery production (H), where $N_t=$ $g(N_{t-1}+H)$. It is well known that when the logistic growth model is cast as a difference equation, abundance limit cycles and chaotic behaviours may result. These phenomena have been associated with high values of the natural rate of increase (r), but they may also result from low values of r and high values of hatchery production. This raises an important practical question of whether simple theoretical models are "mathematical toys", or whether they provide useful insight to the possibility of hatchery-generated instability in real fish populations.

4AM1995-BIO15

AGGREGATION OF EUPHAUSIIDS AND HAKE ALONG THE OUTER CONTINENTAL SHELF OFF VANCOUVER ISLAND

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Both euphausiids and Pacific hake form dense aggregations off the coast of British Columbia along regions of steeply sloping bathymetry such as the continental shelf break. Because of their strong prey-predator interaction, the extent and cause of spatial overlap is ecologically significant. We report results of detailed outer-shelf and slope region surveys of euphausiid and hake biomass, water properties, and current patterns. In daylight hours, fish and zooplankton scattering layers were separated vertically by about 20 m but the densest patches of both shared horizontal location both along shore and cross-shore. The daytime depth of the euphausiid layer was in California Undercurrent water, but details of location and scattering layer density were better explained by flow-field characteristics than by water properties. Specifically, the densest aggregations were slightly shoreward of the inshore margin of the shelf-break current in a region of upward-domed isopycnals and onshore convergent flow at the depth of the scattering layer.

4AM1995-BIO16

YEAR-TO-YEAR CHANGES IN ZOOPLANKTON COMMUNITY COMPOSITION OFF THE WEST COAST OF CANADA

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Zooplankton biomass and species composition have been sampled since 1985 at a set of standard locations on the continental margin off Vancouver Island (southwest coast of British Columbia, Canada). From these data I have estimated average zooplankton seasonal cycles and time

series of annual anomalies within each of three statistical sub-areas (defined based on current and bathymetric patterns). The ten year time series is now long enough to show some very clear signals:

1) Shelf vs. adjoining continental slope regions have similar zooplankton communities at the level of species occurrence, but very different patterns of species dominance and seasonal cycles. The spatial scale for this community dominance pattern matches the scale of mesoscale eddies and bathymetric features (about 30-50 km in a cross-shore direction). The major groups competing for dominance are: euphausiids (*Euphausia pacifica* and *Thysanoessa spinifera*), "subarctic oceanic" copepods (*Neocalanus* and *Metridia*), "continental shelf" copepods (*Calanus*, *Pseudocalanus*, and *Acartia*), chaetognaths (*Sagitta elegans* and *Eukrohnia*), and urochordates (*Salpa* and *Dolioletta*).

2) All three regions show large (3-10 fold) interannual changes in the abundance of these major zooplankton taxa. The dominant time scale for the fluctuations is at least 3-5 years (several to many generations).

3) In contrast to seasonal variability, the multi-year "anomaly" fluctuations are shared among all three statistical regions (average correlation about 0.5; >0.7 for many of the dominant taxa). This implies that year-to-year differences are dominated by large scale rather than local environmental forcing.

4AM1995-BER11

THE FEEDING AND FOOD RELATIONSHIPS OF SOME FISH JUVENILES AND ADULT THREE-SPINE STICKLEBACK IN ESTUARIES AND COASTAL WATERS OF THE KARAGINSKY BAY (BERING SEA)

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The feeding common fishes from catches carried out with the purpose of accounting for young pacific salmon was investigated for: three-spine stickleback *Gasterosteus aculeatus*, whitespotted greenling *Hexagrammos stelleri*, crested sculpin *Blepsias bilobus*, pink *Oncorhynchus gorbuscha*, chum O. *keta*, coho O. *kisutch*, chinook O. *tschawytscha*. Instant diffuse competition into the fish assemblage of Karaginsky Bay inshore and river estuaries was estimated. In fresh waters pink were under high competition pressure. At high levels of salinity in the rivers the pink abundance was very low, it fed poorly in comparison with other species. As a result, competition for food was maximal. In marine waters the magnitude of competition was two orders less than in the rivers, which indicated that the best food conditions and hunter abilities of salmon juveniles occurred there. Unfavorable conditions for young pink feeding were in the north of the Karaginsky Bay, for chum in the central part. The young whitespotted greenling was a main competitor in the north of Karaginsky Bay and young pink was as a competitor in the central and south parts. In the inshore, the three-spine stickleback was not a competitor for another species because of its low abundance.

4AM1995-FIS26

DENSITY-DEPENDENT EFFECTS OF OCEAN SOCKEYE ABUNDANCE ON ADULT BODY SIZE OF BRITISH COLUMBIA SOCKEYE STOCKS

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Mean annual body lengths of maturing sockeye salmon *Oncorhynchus nerka W.* are positively correlated among major northern and central British Columbia stocks (Nass River, Skeena River and Rivers Inlet). Correlations are greatest between sexes within rivers, followed by age-classes among rivers. A common factor or factors affecting sockeye length in the North Pacific Ocean is suggested. The mean length of sockeye salmon caught annually in these B.C. fisheries was negatively correlated with the magnitude of Bristol Bay sockeye catches. This effect was only evident in sockeye returning after 3 years in the ocean (age 1.3). The mean length of sockeye returning after 2 years (age 1.2) was

not affected by the abundance of Bristol Bay sockeye. Age 1.3 sockeye from these B.C. stocks were significantly further from their natal streams than age 1.2 sockeye during the spring of maturation. Therefore, age 1.3 sockeye could compete with Bristol Bay sockeye in the Gulf of Alaska to a greater degree than age 1.2 sockeye. The pattern of annual marine growth measured from Skeena River sockeye scales collected during the 1960's provides additional evidence that the length of age 1.3 sockeye was partly determined by Bristol Bay sockeye abundance in the year of maturation. No such correlation was evident in scales collected from age 1.2 sockeye. These results suggest that sockeye populations have systematic distributions in the North Pacific.

4AM1995-FIS27

INTERANNUAL TRENDS IN MATURITY FOR GULF OF ALASKA WALLEYE POLLOCK: IS THERE EVIDENCE FOR DENSITY-DEPENDENCE?

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Maturity schedules for stocks of walleye pollock were estimated from length and maturity data collected during hydroacoustic surveys of the spawning stock in Shelikof Strait and other areas along the continental shelf of the Gulf of Alaska during March 1983-1994. A data set collected by U.S. observer sampling of the commercial joint-venture catch in 1984 and 1986 was also examined. A logistic response function was used to describe the relationship between percent maturity and length. Parameters were estimated by applying maximum likelihood procedures to length and maturity data. A multi-factor analysis of variance was used to examine areal differences in length at maturity.

Results indicate that female pollock are larger and older than males at 50% maturity. Also length at 50% maturity in both sexes shows substantial interannual variation. There is a trend of increasing size at 50% maturity for both sexes. For example, length at 50% maturity for female pollock has increased 9 cm in 9 years. An analysis of areal difference showed geographic differences in length at maturity. Comparisons of maturity trends to population abundance show inverse relationships and suggest a density-dependent response. Various hypotheses and observations are presented which may be relevant to the observed differences in length at 50% maturity.

4AM1995-MEQ19

EXPERIMENTAL STUDY OF OIL DEGRADATION IN THE SEA OF OKHOTSK

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In the last year we studied the mechanism of photochemical oxidation of saturated and aromatic hydrocarbons in laboratory experiments by influence of temperature and photocatalyzers. For these purposes we made two gauges which measured the photooxidation rates by yields of organic peroxides and by oxygen absorption. We observed:

a) photochemical reactions yielded by mechanisms of physical and chemical sensibilation;
b) aromatic hydrocarbons accelerated photochemical reactions;
c) in the case of photoinitiated oxidation the oxidation rate depended on: the type and concentration of photocatalyzer, film thickness, oil and water composition;
d) photooxidation products had strong surface properties and decreased water evaporation rate across the hydrocarbon films;
e) photooxidation occurred within a few minutes after the beginning of illumination and was more intensive than microbiological oxidation by oil oxidizing bacteria in very favorable conditions.

In the laboratory, using sea water and ice experiments with Sakhalin marine oil (the Sea of Okhotsk), we investigated the rates and mechanisms of photochemical oil oxidation in systems of air-oil-water, air-oil mousse-water, air-oil in water emulsion and air-oil-ice from the influence of: temperature, oil thickness, water and ice composition and intensity of sun light.

These results were found:

a) the rate of photooxidation depended from intensity of light;
b) the oil-water surface dumped the photooxidation rate;
c) high molecule products such as resins and asphaltenes were formatted by photochemical oxidation;
d) photooxidation occurred within a few minutes after sun light illumination and was more intensive then microbiological oxidation by natural community of oil oxidizing bacteria.

Computer modelling was used for description of these experimental results.

4AM1995-MEQ20

EXPERIMENTAL STUDY OF WATER CARBONATE SYSTEM IN LARGEST RIVER ESTUARIES OF WEST PACIFIC

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The increase of CO_2 concentration in the atmosphere is observed due to natural and anthropogenic factors. This increase can because by global climatic changes. The oceans occupy two-thirds of the earth's surface, and are an active regulators of atmospheric CO_2 because of the buffering capacity of marine water. In addition, carbonates removal in river waters considerable influences the maintenance of CO_2 in marine water. The composition of marine water is substituting for carbonate composition of river water in the zone of marine and river water mixing.

Authors of this article determined the carbonate system's elements during summer-winter period (1989 - 1992) within estuaries of some largest rivers such as the Anadyr, the Amur, the Yangtze, the Mekong, as well as in the Bering Sea, the Sea of Okhotsk, the Sea of Japan, and the East and the South China Seas. Measurements of salinity, temperature, pH, total alkalinity, partial pressure of CO_2 in the marine waters were made during investigations.

The calculations of HCO_3, CO_3, total inorganic carbon content, carbonate and residual alkalinities was carried out by standard GEOSECS procedure for two systems: pH - Total alkalinity and pH -pCO_2. Differences between these parameters for different systems were discussed and the influence of river inflow, biological processes and the areas of carbonate mineral transformation was determined. A mathematical factor analysis to determine the correlation between the carbonate system's elements and other hydrobiological parameters, i.e. salinity, pH, total alkalinity, temperature, nutrients, total organic matter, particulated matter, phytoplankton content, primary production was carried out. On the base of the results, maps of the distribution of elements were investigated.

The influence of a river inflow and biological processes on variation of CO_2 concentration and on the estuary hydrochemical regime is discussed with the maps of space distribution of carbonate components and the Park's diagrams.

The results indicate an active transformation of carbonate system's elements in the zone of marine and river water mixing.

4AM1995-BER12

FOOD WEB STRUCTURE OF DEMERSAL FISH COMMUNITY IN THE EASTERN BERING SEA

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The food web structure varied by season and area. In order to understand the dynamics of the Bering Sea ecosystem, it is very important to clarify the food web structure.

The food web structure in each season and area, and biological factors affecting these structures using catch and stomach data from the walleye pollock fishing ground, during the early 1970s, was analyzed.

Walleye pollock was the key predator species and prey in the demersal fish community of the eastern Bering Sea shelf edge area. The skeletal food chains were as follows:

Winter	
South	Copepoda, Euphausiacea - Age 3 pollock
North	Copepoda, Euphausiacea - Age 1 pollock - Age 3 pollock
Spring	
South	Copepoda, Euphausiacea - Age 3 pollock
North	Copepoda - Age 2 pollock - Ages 6 and over pollock
Summer	
South	Euphausiacea - Age 2 pollock
North	Copepoda - Age 1 pollock - Ages 4 and 5 pollock
Autumn	
Shallow South	Euphausiacea - Age 0 pollock - Age 2 pollock - Ages 6 and over pollock
Deep South	Euphausiacea - Age 3 pollock

Ages 2 and 3 walleye pollock were eaten by Pacific cod, sablefish, arrowtooth flounder, Greenland turbot, and Pacific halibut in any season and area.

These structures were affected by the population density, species and body size compositions of the community members. The density of Copepoda seemed to be high in north area in spring. Age 1 pollock was distributed more in the northern area than the southern area and age 0 pollock moved into the bottom layers with age 2 pollock in Autumn. The prey size selection was very important to form the prey-predator relationships in the community, and the predator had a tendency to select smaller sized pollock in same age group, therefore the average body size of the prey population was apparently increased by predation.

4AM1995-MEQ21

INFLUENCE OF DRILLING MUD POLLUTION ON ZOOPLANKTON AND BERING SEA WATER BIOTESTING

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Intensive expansion of drilling development on the shelf, where traditional fishing areas are found, makes the problem of quick and effective control over the level and localization of new for high-latitudinal hydrobionts forms of toxicants difficult.

Experimental research on biological test objects of Bering Sea allowed the study of dose effect relations of drilling muds, zooplankton reaction levels and biotest the environment.

The study was conducted with local and American drilling compounds, being on Far Eastern Seas' shelf.

The most safe compound for the zooplankton fraction proved to be chrome lignosulfonate. Barite foam has a negative influence, causing mortality at minimum concentration of 0.05 mg/l. A group of bottom zooplankton species were highly sensitive to detergent influence at concentration from 1 to 10 mg/l.

Bering Sea biotesting did not show the toxicological influence of water samples on sea urchin embryos and larvae.

Experimental tests in the areas of gas and oil deposits showed the negative influence of drilling muds on bioresources and indicated the most sensitive zooplankton species.

4AM1995-BIO17
DEMOGRAPHY OF CALANUS OFF SOUTHERN CALIFORNIA: WHAT DO CHLOROPHYLL AND MACROZOOPLANKTONIC BIOMASSES TELL US?
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I measured rates of egg production, severity of food limitation, and naupliar survival at coastal and oceanic sites off southern California, and tested their correlations with the commonly measured variables, biomass of chlorophyll and of macrozooplankton, to infer possible causation. Neither variable was a precise predictor of demographic properties. Egg production and per capita recruitment of nauplii were positively correlated with chlorophyll, and the stimulatory effect of added food was negatively correlated; these results suggest food limitation of recruitment. Early naupliar survival was negatively correlated with macrozooplanktoic biomass, suggesting that predation/cannibalism is a significant source of variability. However, variability in survival of the feeding naupliar stages could not be explained by either variable.

4AM1995-POC16
DISCUSSIONS IN VLADIVOSTOK WORKSHOP - PHYSICAL OCEANOGRAPHY
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PICES Workshop on the Okhotsk Sea and Adjacent Areas was held in Vladivostok, Russia, on June 19-24, 1995. The workshop was started by five keynote lectures including that on Physical Oceanography of the Okhotsk Sea and Oyashio Region by Dr. L.D. Talley. There were the eight symposium sessions:
(1) Circulation and water mass structure of the Okhotsk Sea and north-western Pacific,
(2) Sea ice and its relation to circulation and climate.
(3) Waves and tides.
(4) Physical oceanography of the Japan Sea.
(5) Communities of the Okhotsk Sea and adjacent waters: composition, structure and dynamics.
(6) Abundance, distribution, dynamics of the common fishes of the Okhotsk Sea.
(7) Salmon of the Okhotsk Sea: biology, abundance and stock identification.
(8) Biodiversity of island ecosystems and seasides of the North Pacific.

The summary of the discussions and adopted recommendations relating physical oceanography in these symposium, in the SSC meetings and in the plenary session will be presented.

4AM1995-POC17
SALINITY BALANCE IN THE DENSE WATER FORMATION AREA OF THE OKHOTSK SEA
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Dense water is formed in the shelf region of the northwest Okhotsk Sea due to active sea ice generation throughout the winter season, and this water is thought to be an origin of the North Pacific Intermediate Water. Alfultis and Martin (1987) estimated the annual rate of the dense water formation as about 0.5 Sv. This estimation suggests that a huge amount of salt is transported from the surface layer to the bottom layer of the shelf region. This salt loss is too large to be supplied by horizontal advection and/or horizontal mixing in the surface layer of the Okhotsk Sea. The high-salinity and low-temperature dense water keeps its temperature near the freezing point but loses its high

salinity nature when it flows out into the central part of the Okhotsk Sea. The vertical mixing over the Kashevarova Bank forced by strong tidal currents is thought to be one of the causes of this water mass modification. The salinity balance in the dense water formation area will be discussed by taking the tidal mixing into account.

4AM1995-BER13

THE PAST 60 Ky HISTORY OF PRODUCTIVITY AND BOTTOM WATER FORMATION OF THE EAST BERING BASIN: EVIDENCE FROM CARBON ISOTOPES OF *Uvigerina peregrina*

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The stratigraphy of carbon isotope ratios ($\delta^{13}C$) on benthic foraminifera *Uvigerina peregrina* of core RC14-120 from the Aleutian Basin shows major shifts in paleproductivity and extent of bottom water formation within the basin during the past 60 Ky (late Wisconsin-Holocene). The late glacial epoch, relative to the post glacial, was generally marked by a drastic decrease in productivity. The decreased productivity, which is attributed to the presence of extensive sea ice over the basin, is consistent with reduced glacial productivity in the Southern ocean and has bearing on the debate relating to reduced CO_2 in the glacial atmosphere.

A notable positive shift in $\delta^{13}C$ about 26 Ky BP is linked to a period of intense bottom water formation locally. It is suggested that the bottom water genesis was a consequence of sinking of dense water derived from brine rejection from Bering Sea shelf ice and the event was an amplified analog of the modern processes. Our findings suggest that the high-latitude marginal seas (e.g. Bering Basin, Okhotsk Sea) were a likely major source of deep waters to the glacial North Pacific.

4AM1995-SB06

PROS AND CONS OF "CARRYING CAPACITY"

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The concept of "carrying capacity" proved to be rather useful while stimulating investigation of processes of interaction between different parts of ecosystems and between biotic and abiotic factors. But a very simplified theoretical model, that has given birth to the notion, has led many scientists to the idea of the absolute value of the "carrying capacity" and possibility to extend the concept to a multispecies or ecosystem level.

With the help of theoretical considerations and examples of observational data we demonstrate the existence of the limits in which the conception of "carrying capacity" can be really useful.

The main factors determining the changes of carrying capacity in space and time are analyzed. These factors can be natural and anthropogeneous. Though the study of natural processes is fundamental to our understanding and modelling, but in many cases anthropogeneous factors lead to degradation or destruction of ecosystems, and the main attention should be given to them. Different kinds of anthropogeneous factors and their relations to natural factors are analyzed.

4AM1995-BIO18

DISTRIBUTION AND ABUNDANCE OF PHOTOSYNTHETIC PICOPLANKTON AND THE ENVIRONMENTAL LIMITATION IN THE XIANGSHAN BAY OF ZHEJIANG

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Studies on the temporal and spatial distributions and abundance of photosynthetic picoplankton, including prokaryotes and eukaryotes, the environmental control, and the apparent growth rates of *Synechococcus* in the Xiangshan Bay were carried out in February and August 1992. The results obtained showed that abundance of the two categories of photosynthetic picoplankton were higher in summer (the average abundance of cyanobacteria was 3.29×10^3 cell/cm^3 and that of picoeukaryotes was 1.61×10^3 cell/dm^3) than in winter (the average abundance was 1.23×10^3 cell/dm^3 for cyanobecteria and 0.37×10^3 cell/dm^3 for picoeukaryotes). In winter cyanobacteria abundance was lower in the Bay mouth than in tidal central and the southwest parts of the Bay, while a reverse distribution trend appeared for picoeukaryote abundance. In summer the abundance for the two categories of photosynthetic picoplankton in the Bay mouth was close to that in the central and the southwest parts of the Bay.

Diurnal variation of the picoplankton abundance was closely related to tides and suspended solid concentration. Apparent growth rate of *Synechococcus* was higher in summer than in winter. Seawater temperature and light availability were major factors goveming population of the two categories of photosynthetic picoplankton.

4AM1995-BIO19

FOODWEB IN DEMERSAL FISH COMMUNITY IN THE PACIFIC CONTINENTAL SLOPE WATERS OFF THE NORTH KURILS

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Demersal ichthyophauna of the Pacific continental slope waters off the North Kurils in the depth range from 150-200 m down to 3500-3800 m consists of about 200 fish species. According to feeding type they can be divided into several trophic groups: planktophage, benthophage, predators, and fishes with the mixed feeding.

The least abundant group is planktophages represented by benthopelagic fishes which are less dependent on the bottom and able to migrate into the upper layers for feeding. Their main feeding organisms include planktonic crustaceous: Euphausiacea (Pacific Ocean pearch, Attka makerel, Alaska pollock), planktonic Amphipoda (spiny lumpsuckers, liparids of genus Allocareproctus, Careproctus, Elassodiscus, etc.) and also jelly-fish Ctenophora (*Aptocyclus ventricosus*, irised lords) and Appendicularia (*Zaprora silena*). Moreover, plankton is a basis of feeding stock for juveniles of many predators and fishes with mixed feeding (e.g., rockfishes, thornyheads, etc.)

Benthos was very important for feeding of small cottids, sea poachers, many flounders, some skates. Commonly, these fishes have low abundance in continental slope waters because of the sharp decrease in the benthos biomass compared with shelf waters.

The group of predators was represented by Pacific cod, large cottids, large liparids (*Liparis spp., Polypera simushirae*), lincods, rockfishes, sablefish, halibuts, turbots, large rattales. Their feeding basis consisted of fish (mostly, pollock), squids, octopuses, large crustaceouses. Moreover, large Alaska pollock and Pacific Ocean perch can predateion on squids, myctophids, and other mesopelagic fishes.

Fishes with the mixed feeding were represented by some skates, rock greenling, small rattailes, antimora, threadfin bakeling. Their food sources include both the benthic organisms (bottom crustaceouses worms, shells, echinoderms etc.) and nekton (fish, squids, octopuses, etc.).

The trophic linkages among fishes of different groups are complex and multiform.

4AM1995-POC18

THE FORMATION AND EVOLUTION OF THE EAST SEA DENSE WATER AND CHANGJIANG DILUTED WATER DIFFUSION AND THEIR RELATIONS WITH TAIWAN WARM CURRENT

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By the matching analysis of the hydrographic data and simulated current fields, we find that the formation and evolution of the East China Sea Dense Water Core (ECSDWC) and the Changjiang Diluted Water (CDW) diffusion were closely associated closely with the seasonal features of the Taiwan Warm Current (TWC).

1. The formation and evolution of all ECSDWC was developed in the TWC. The decreasing temperature and increasing density of the Taiwan Warm Current with the feature of high temperature and high salinity was important in the formation of ECSDWC in autumn and winter. The deformation of ECSDWC was caused by the development of the TWC in the upstream and the blocking of ECSDWC which was moving with considerable volume in downstream. The final modification was attributed to the decrease of sea surface temperature.

2. The Changjiang Diluted Water diffusion was observed in the winter of some years. In spring and summer, the diffusion of CDW was developed by the advance of the Taiwan Warm Current with the feature of low density and the movement and deformation of ECSDWC. In autumn, part of CDW stayed in the centre of the northern East China Sea. The tow of TWC and the lead of the density front caused CDW diffusion offshoreward between the Taiwan Warm Current low density water and the East China Sea dense water core. The diffusion process of the CDW always developed in the sea waters north of the Taiwan Warm Current low density water.

4AM1995-POC19

SPACE-TIME VARIABILITY OF HYDROLOGICAL CONDITIONS IN THE REGION OF INTERACTION OF KUROSHIO AND OYASHIO IN SUMMER OF 1986-1989.

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Space and time variations of the water regime in the region of the subarctic front in the North-West Pacific (30-43°N, 135-150°E) was investigated using data from of oceanographic expeditions carried out from 1986-1989.

During the research the Kuroshio meandered in two regions: 145-150°E (1986) and southward from Honsyu (1987).

In the summer of 1988, the maximum velocity of Kuroshio, its width and thickness, water transport in the layer 0-1,000 m between 137°E and 150°E essentially change from 78 to 128 cm/s, from 96 to 150 miles, from 543 to 744 m and from 45.9 to 58.3 million m^3/s accordingly. A total decrease of Kuroshio's water transport was observed under its movement to the east. This situation took place mostly owing to the decrease of current velocity and its thickness. Water transport in the cyclonic eddies to the south of Kuroshio was equal 29.5-36.7 million m^3/s and comparative with the main stream of Kuroshio.

Averaging of data on the four sections (137°, 138°50", 147°, 150°E) shows that from 1986 there was a decrease of Kuroshio's intensity till summer of 1988, when it was minimum, after that the current water transport increased noticeably.

In the years of higher Kuroshio's intensity (1986 and 1989), there was marked fluctuations of current water transport from 137° to 150°E, equal to 30.9-38.9 million m^3/s. In the year of low Kuroshio's intensity (1988), the range of fluctuations decreased three times (12.4 million m^3/s).

The high intensity of Kuroshio branch at 150°E was observed in the summer season of 1986 and 1989 (17.6 and 13.3 million m^3/s accordingly), that coincided with decreased water transport of the main stream near the shore of Japan. In 1987 and 1988 the intensity was of the branch two times less. In the years of high water transport, the Kuroshio and its branch at 150°E, in one case (1986). There was simultaneous intensification of the currents system in the zone of subarctic front, and in another case (1989), the increase of Kuroshio's intensity was accompanied by the weakening of Oyashio near the south-eastern coast of Hokkaido. The warm waters in the Kuroshio's branch on 150°E in summer of 1989 penetrated to 42°N, but in 1986-1988 it did not reach far to north of 41°N, in 1988 these waters were 120 miles farther to south, than in 1989. This situation impacted on the temperature regime far to north of 40°N.

The maximum quantity of waters with the temperature less then 5°C at 150°E, took place in 1986 and after that there was a tendency to their decreasing. Simultaneously, with this process on the northern section near the southeastern coast of Hokkaido there was observed an increasing of average water temperature in the layer 0-200 m from 1986 to 1989. Noted earlier two thermic values show that in 1986 far to the north of 40°N waters of subarctic origin predominated and this resulted in marked cooling of this region of the ocean.

4AM1995-FIS28

INFLUENCE OF THE IRRATIONAL TRADE AND PHYTOPHAGY UPON THE STATE OF KELP BEDS OF LAMINARIA JAPONICA ARESCH. F. LONGIPES (MIYABE ET TOKIDA) YU. PETR. BY THE COAST OF THE NOTHERN PRIMORYE (THE JAPAN SEA)

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North of Primorye (Zolotoy Cape - Gilyak Cape) the disappearance of Laminaria japonica beds was the result of interaction by two factors. The estimated biomass in 1985 was 74,500 tons which was severely damaged by irrational trade, with the resulting decrease of sporophyt density and disturbance to the structure, stability, and balance in the Laminaria - Phytophageous system.

Since 1989 the Laminaria kelp beds decreased due to the influence of the sea urchins of the Strongylocentrotus genus. The abundance of sea urchins has increased from one to 10-20 individuals per square meter in 1985 (40-68 individuals in 1994). The small specimens of sea urchins with carapace of 30-40 mm in diameter were predominant, about 80% of their total numbers. The biology of sea urchin, their migration patterns and understanding what regulates their density is important to success of providing favourable ecological conditions for Laminaria kelp in the Northern Primorye.

4AM1995-BIO20

STABLE CARBON ISOTOPES IDENTIFY DIFFERENT FOOD-WEBS BETWEEN SHELF AND SLOPE REGIONS WEST OF VANCOUVER ISLAND

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The margins of the NE Subarctic Pacific form a continuous gradient of physical and biological properties from near-shore to high-seas ecosystems. Transitions between ecosystems can be gradual

with indistinct boundaries, or rapid with clear boundaries. Enhanced exchanges may link continental shelf ecosystems closely with deep ocean ecosystems, whereas reduced exchanges imply that shelf ecosystems may be sustained by internal processes. In this study, we examine the use of the stable carbon isotope ^{13}C as a tracer of the origin and pathways of the planktonic food-web during spring west of Vancouver Island, Canada. We focus on a comparison of continental shelf and slope/deep ocean food-webs. We found consistent and significant differences in ^{13}C anomalies between shelf and slope/deep ocean regions from phytoplankton through 2 size classes of zooplankton to larval fishes in spring, at a time of the seasonal transition in currents that should be expected to facilitate cross-shelf exchanges. All components of these food-webs had higher (less negative) ^{13}C anomalies on the continental shelf. Phytoplankton samples from the shelf were dominated by diatoms, whereas those from the slope region had no strong patterns of dominance. The higher ^{13}C anomalies of phytoplankton on the continental shelf probably reflect faster growth rates in this region, resulting from higher nutrient concentrations. These higher ^{13}C anomalies are then transferred to zooplankton and larval fish, thereby acting as tracers of the source of energy to these higher trophic levels. This provides a means to identify which food-web is crucial to the early growth and survival of commercially important marine species off Vancouver Island.

4AM1995-POC20

CONFORMITY OF SPACE-TEMPORAL STRUCTURE OF THE FAR EAST SEAS ICE CONDITIONS

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Influenced by the same hydrometeorological conditions forming climate and weather of the Far East, the Sea of Japan, the Okhotsk and Bering seas compose a single thermodynamic system with numerous direct and opposite connections. One of the most indicative factors of this system is ice coverage.

Marginal 10-day ice cover distributions from December to May for 1960-1990 were used for quantitative estimations of the ice condition conformity during the winter season as well as for 10-day periods. Extreme values of conformity were fixed between the Okhotsk Sea and the Tatar Strait regions (direct link), and between the Okhotsk and Bering Sea regions (opposite link). The Peter Great Bay region as a rule was in an indifferent state relative the rest of the region.

Taking into consideration the evolution of ice conditions on the Far East seas, and large-scale hydrometeorological processes that have been observed before and during this evolution, the possible mechanism of large-scale ice regime peculiarities forming was determined. Some recommendations for working up of interpolative and prognostic algorithms of ice predictions were purposed for the separate regions as well as for the whole region.

4AM1995-BER15

SOME ESTIMATIONS OF THE SPACE-TEMPORAL STRUCTURE OF ICE CONCENTRATION, AGE, AND SHAPES IN THE BERING SEA

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Study ice elements (concentration, age, shapes, and etc.) was the next stage in the process of understanding ice conditions in the sea. All available information about ice conditions from 10-day charts mean distribution of ice and its variability for the period of 1960-1990 were calculated. The Bering Sea basin was divided on 104 elementary domains and histograms of different ice ranges were constructed. An analysis of received distributions permitted us to trace the character of ice element field redistribution and to make suggestions about the influencing processes. Difference and similarity

in variability fields of ice concentration, age, and shapes are discussed. Some aspects of long-term and interannual variability of ice conditions of the Bering Sea were also analyzed.

4AM1995-BER24
USE OF SIMPLE PROBABILISTIC MODELS FOR PROGNOCTIC EVALUTIONS OF SOME CHARACTERISTICS OF THE BERING SEA ICE CONDITIONS

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The ice cover, position of ice edge and in particular, their extreme values, are the most significant characteristics of the ice regime. Analysis of the combined and marginal distributions of the ten-day ice cover values and the position of ice edge over separate portions of the sea, as well as some of the large-scale atmospheric circulation indices allowed conclusions to be drawn on the possibility of the probabilistic forecasting of the different gradations in the indicated ice parameters and in their dependence on alternation of atmospheric circulation form. It is also shown that for the approximation of the atmospheric circulation form's sequence a simple first order Markov chain model may be applied. The alteration of the ice cover gradation with the ice edge displacements seems not to be in agreement with simple Markov models. The results of the probabilistic forecasting models were rather hopeful. Moreover, the probabilistic analysis of the development of the Bering Sea ice conditions, combined with the large-scale atmospheric processes preceding and accompanying them allowed the possible development of mechanisms in the formation of the ice regime extreme state and the peculiarities of its evolution.

Taking into account that the probabilistic estimates have rather perspective from of the prognostic information, the problems are finally discussed on the wider utilization of the probabilistic models.

4AM1995-SB07
IS INTERANNUAL VARIATION IN THE SPATIAL DISTRIBUTIONS OF TUNA CATCHES AN INDICATOR OF SPATIAL VARIATION IN OCEANIC AND COASTAL CARRYING CAPACITY?

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Fishery catches for skipjack tuna in the Western Equatorial Pacific, bluefin tuna and albacore in the North Pacific show interannual and decadal spatial variation. Coherent variation in physical forcing which could alter prey abundance and availability is also observed. It is hypothesized that tunas are responding to changes in the distribution and availability of forage. The question of whether this spatial variation represents variation in carrying capacity is discussed.

4AM1995-POC21
OBSERVATIONAL EVIDENCE FOR RECENT LONG-TERM CHANGES IN THE NORTH-WESTERN JAPAN SEA

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The Japan Sea oceanographic and hydrochemical data obtained at the KEEP-MASS International expedition on board R/V "Academic Aleksandr Vinogradov" (July, 28 - August, 3, 1992) were analyzed to compare with results of Gamo, Horibe (1983) and Gamo et. al. (1986) based on data of 1977, 1979 and 1984. Seventeen KEEP-MASS CTD stations to 2000 m have been sampled by CTD probe (GUILDLINE, model 875) in the North-Western Japan Sea from the Korea (Tshushima)

Strait to the Northern part of the Japan Basin. Eight hydrochemical samples have been taken by Niskin bottles on standard levels and near the bottom. In these casts the temperature and pressure have been determined by protected and unprotected thermometers. These data are adequate to determine the main features of thermohaline and hydrochemical parameters distribution in the upper, deep and bottom sea layers.

The observed temperature difference between the Japan and Tsushima basins reached 0.10 - 0.06 C in upper layer; 500 - 1000m of deep water and 0.06-0.01 C in the lower 1000-2000 m layer. It was higher than that in Gamo, Horibe (1983) results. In the Japan Basin a specific deep local minimum of oxygen concentration was registered in the 1750-2100 m layer which is deeper than that in Gamo et al. (1983,1986). Values of the oxygen concentration minima slowly decreased from 1979 to 1992. The volume of homogeneous bottom water also decreased from 1979 to 1992.

The deep waters above the 2600 m layer had large scale horizontal heterogenety in 1992. It was observed in both CTD and bathymetry methods. Particularly, the regular rise in deep water temperature at certain stations near to the North-Western continental slope of the Japan Basin (namely continental slopes of the Peter the Great Bay, Northern Prymorye and the Tartar Strait) was observed. Our results showed that the positive deep water temperature anomaly near the areas of deep water ventilation, as the depth and value reduction of the deep minimum oxygen concentration, was evidence for recent long term climatic changes in the Japan sea.

4AM1995-FIS29
EXPRESSION OF DENSITY DEPENDENCE IN POPULATION MODELS

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I will give an overview of the expression of density dependence in population models, including production, spawner-recruit, delay-difference, and age-structured models. In particular, models with constant recruitment implicitly assume a density- dependent response, and models without density dependence have populations which increase or decrease exponentially. A general formulation of population models [(1/N) dN/dt =f(N,t)] with parameters for density dependence and environmental influences is used to establish conditions for population regulation. While some environmental influences can constrain the population within certain bounds, true population regulation cannot be achieved without functional dependence on the population itself. Density-dependent effects on may also occur in populations, which complicates the resultant dynamics. In addition, species interactions alter the effects of population regulation. The presence of multiple factors affecting a population creates uncertainty about its future response. Interactions among factors lead to confounding of population effects.

4AM1995-FIS30
DENSITY-DEPENDENT EFFECTS ON GROWTH AND MATURING OF PINK SALMON DURING MARINE ANADROMOUS MIGRATION

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Since 1986 pink stocks of even years display trends to increased abundance in the Sakhalin-Kuriles region. On the south-eastern Sakhalin pink catches increased from each generation to 5-8 times in 1986-1990 and in 2-2,5 times in 1990s. On the Southern Kuriles the increase made up 4,2-6,8 thousand tonnes. The total biomass of pink salmon migrating through Okhotsk Sea waters grows significantly. This trend was more characteristic for stocks migrating later. Changes of the proportion of catch values in the South-Eastern Sakhalin and Southern Kuriles region were the following: 1:59 (1986), 1:10 (1988), 1:2 (1990), 1:1 (1992), 1:0,8 (1994).

In 1994 pink of Southern Kuriles stock differed by a low value of gonad maturity (mean gonado-somatic index 9,1 versus 9,8% in 1993) and by less body weight (in August - 1,14 versus 1,48 kg and in September - 1,11 versus 1,98 kg in 1993). Low rates of pink growth and maturing of gonads was likely related to the carrying capacity of total pink in there range. The increasing density of pink distribution can be determined by salmon concentration in front of straits and oceanographical fronts.

4AM1995-POC22

VENTILATION AND DEEP WATER FORMATION IN THE JAPAN SEA: A NEW ASSESSMENT BASED ON RECENT TRACER MEASUREMENTS

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Based on new dissolved oxygen measurements made in the Japan Sea during the spring of 1995, it is shown that the well-known trend of decreasing dissolved oxygen in the deepest waters of the Sea, first reported by Gamo and his co-workers (Journal of Marine Research, vol. 44, 781-793, 1986), has continued. Generally, the rate of decrease of the oxygen concentration in the deepest waters of the Japan Sea (depths greater than 3,000 m) is about 1.5 micromoles per kilogram per year between 1969 and 1995. Using Russian oxygen data from the Japan Sea recently made available it can be shown that this trend in the concentration of oxygen can be seen at least as far back in time as 1950. In addition to the dissolved oxygen data, new chlorofluorocarbon (CFC) measurements were collected in the Japan Sea during a joint U.S.-Russian expedition in the spring of 1995. The CFC observations have been used to suggest that the deepest waters of the Japan Sea have not generally been well-ventilated during the past 20 years. A simple model based on CFC and dissolved oxygen addition, and biological consumption of dissolved oxygen in the abyssal Japan Sea, is used to put useful constraints on the degree to which deep water is presently being formed in the Japan Sea.

4AM1995-POC23

INTERDECADAL CHANGES HYDROGRAPHY IN THE GULF OF ALASKA, 1970-95

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Temperature and salinity versus depth at the mouth of Resurrection Bay, Alaska (60 N, 149 W) (GAK 1) have been measured since December 1970 with various temporal sampling intervals, ranging from hours to months. Interdecadal fluctuations of temperature are seen throughout the 263 m water column. The largest amplitude changes, more than 1 C from 1972 to 1986, are in the temperature at 200-250 m. In contrast with temperature anomalies observed off California, these are coherent with depth. This suggests a barotropic type forcing rather than a vertical propagation or baroclinic influence. These subsurface temperature anomalies are well correlated with the coastal air temperature anomalies at Sitka, Alaska, so coastal air temperatures have been used as a proxy data set to extend the ocean temperature time series back to 1828. Up to 30 percent of the low frequency coastal air temperature variance can be accounted for with the 18.6 year nodal tide signal. Sea surface temperatures anomalies for the Gulf of Alaska and Bering Sea imply that the interdecadal ocean temperature fluctuations at GAK 1 are representative of changes in upper layer thermal structure over this broad zonal region. Similar variations are seen in the British Columbia air temperature record.

The relationships will be discussed between GAK 1 hydrographic parameters and coastal freshwater discharge, upwelling indices, Southern Oscillation Index and the North Pacific Index. These interdecadal variations have been associated with changes in biomass in the Gulf of Alaska.

4AM1995-POC24

THE STRUCTURE OF FRONTAL ZONE OF OYASHIO CURRENT

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The structure of the frontal zone of the Oyashio Current was investigate on the basis of data (5 surveys) obtained in late July, 1995 in the area 41°31'-42°30'N, 146°45'-148°30'E.

The frontal zone was well defined in a surface layer in the fields of temperature and density and less defined in the field of salinity. Maximal gradient of surface temperature in the frontal zone varied from 1.8 to 2.4 o/mile, of salinity - from 0.028 to 0.078 oo/mile, of density - from 0.081 to 0.098 units/mile. Thus, the frontal zone of Oyashio was an extremely active dynamic formation. Sometimes parts of the frontal zone had shifted up to 30 miles in one-two days.

The width of the frontal zone varied from 3 to 17 miles. Usually the thermic frontal zone at surface was multi-frontal with two or more frontal divisions.

In the temperature and salinity fields, the Oyashio frontal zone existed in the whole upper 200 m layer. Thermal and haline frontal zones coincided on a surface rarely, being a distance of 10 and more miles from each other. However, below 20 m horizon both frontal zones was merged, with the rare exception.

The frontal zone in the field of density in upper 10-20 m layer was caused mainly by contrasts of temperature. Horizontal gradient of density rapidly decreased with depth because of compensation effect of coincidence of thermal and haline frontal zones, and disappeared at 50 m depth.

Maximal horizontal temperature gradient in frontal zone was distinguished in the 30 m upper layer, and salinity gradient maximumized in lower layer (50-100 m).

4AM1995-BER16

WATER STRUCTURE AND CURRENTS OF KAMCHATKA AND BERING SEA REGIONS IN SUMMER 1993

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The scheme of currents (geostrofic flows) and water structure was investigated from data (survey of three vessels) obtained in June 15 - July 10, 1993 in the western part of the Bering Sea and Pacific waters off Kamchatka and Commander Islands.

During the surveyed the most significant differences in water circulation in comparison with the summer of 1991 (Read et al., 1993) was related to the Alaska Stream and Western Subarctic Gyre. In 1993, which was different from 1991, the Alaska Stream was highly developed. Oceanic waters entered the Bering Sea through the Near Strait with Alaska Stream northern branch. Other branches of this current promoted a water movement from the south of the Commander Islands and Near Strait. Western Subarctic Gyre was absent.

The analysis of water structure allowed differentiation of the Bering and Pacific modifications of subarctic waters by thermic signs (Table).

Characteristics of water structure of the Kamchatka and Bering Sea regions.

Characteristics	Bering Sea water	Pacific water
h, m	<15	20-25
H, m	10-20	20-46
T,°C/m	0.55-2.85	0.48-1.56

Characteristics	Bering Sea water	Pacific water
Hc, m	39-130	82-152
Tc, °C	<1.6	1.6-2.9

h-thickness of upper quasi-homogeneous layer;
H-depth of thermocline;
T-maximal vertical temperature gradient in thermocline;
Hc-depth of cold subsurface layer core;
Tc-minimal temperature of cold subsurface layer.

4AM1995-MEQ22
DETECTION OF PROTEOTOXICITY OF ENVIRONMENTALLY EXPOSED MUSSELS USING THE CELLULAR STRESS RESPONSE
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Organisms are often exposed to many types of stressors in their environment yet have a limited capacity to adapt to stress induced damage without adversely affecting such significant processes as growth and reproduction. It has been suggested that cellular level biomarkers may provide an early warning of adverse effects on populations. As part of an integrated study to evaluate biomarkers of contaminant-induced protein damage in San Diego Bay we examined the accumulation of the major stress proteins, stress70 and cpn60, in gill and mantle tissue of muscles exposed to contaminants in San Diego at six locations. We found the expression of the response to differ between tissues in terms of the specific isoforms expressed and total accumulation. When compared with the bioaccumulation data these data suggest that tissue specificity may be a function of classes of contaminants which induce the response. Further, it appears that these tissue level responses correlate with impacts on growth and reproduction. The accumulation of stress proteins will also be discussed in relation to other data collected on genotoxicity and potential toxicity. The strengths and weaknesses of this integrated study will be recapped and discussed.

4AM1995-BIO21 Invited
STABILITY AND IMPORTANCE OF DETRITUS FOOD CHAINS IN THE MARINE FOOD WEB
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The importance of detritus food chains in the marine food web for the stability of marine ecosystems was shown from the view point of (1) the feeding types of animals comprising the food web, and (2) the energy flow among marine communities in the world oceans.

The former view was evident from the fact that many marine animal species do not conform to specific trophic levels, and the ability of a given species to utilize alternative foods has a great buffering action which tends to stabilize population sizes in the complex marine ecosystem communities.

The latter can be evaluated by comparing the potential solar energy available for primary production in the world oceans, the primary productivity measured actually in the world oceans, and the possible productivity calculated from the commercial fish catch.

4AM1995-BIO22
INFLUENCE OF HIDROMETEOROLOGICAL FACTORS ON FORMATION OF FOOD BASE ELEMENTS OF PLANKTOFAGS IN NORTHERN PART OF THE JAPAN SEA
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Krill (*Euphausiacea, Crustacea*) is one of the most important food component of marine plankton in the Far Eastern seas of Russia. long term (1973-1977) observations of krill reproduction in

northern part of the Japan Sea (Tartar Strait, Chikhachev Bay, 50-51°30'N) is summarized. It was established, that successfulness of annual recruitment and reproduction of populations of two monocyclic species of this plankton group depended on the biogeographic nature of the species and the thermal mode of the waters. Reproduction success of populations was tested through spawning intensity. The spawning intensity was measured as eggs and krill naupleus density per unit of surface area of the water (covered by the Jeddy network). The reproductive season of Arcto-Boreal species *Ohyzanoessa raschii* in northern part of the Japan Sea is Spring - Summer and Wide-Boreal *Aupausia pacifica* - Summer- Autumn calendar seasons.

The environment variability was measured through: temperature of water in active layer, high-altitude and sea level pressures along with the frequency of repeatability of wind directions. Temperature data were obtained during 16 oceanological expeditions in the Tartar Strait in different months of ice free season in 1973-1976. Also data of four coastal hydrometeorological stations (CHS) for period with 1961 till 1986 were analyzed.

Comparison of data temperature anomalies of water at the surface on four coastal CHS in a Tartar strait for 1961-1986 has shown one phasing of their change, that testifies to the unity of factors that form a thermal mode of waters in this region of the sea. The main factors, that form the water structure were as follows: the degree of winter cooling of waters, the intensity of Tsusim Current and pattern of atmospheric circulation, in particular, the fluctuation of intensity of Okhotsk anticyclone and anomaly geopotential H 500.

In the northern part of the Japan Sea (Tartar Strait), a main element of the thermal structure of waters, was cold subsurface layer (CSSL) determining conditions of inhabiting and reproduction of hidrobionts. In the summer season it was localized lower in the thermocline, down to depths 90-110 m or to the bottom on offshore waters. CSSL capacity and location of its southern and east borders in a strait has seasonal, and interannual variability and it defines warm or cold character of conditions of the environment.

Anomalies of water temperature at a surface in 1973-1977 were abnormally warm (1973 and 1974) and abnormally cold (1976) years. In the summer season, in the in between year, 1975, the shift of a sign abnormality has took place; 1977 has appeared close to among years norm. Capacity CSSL in August of a cold 1976 was much greater, than in warm 1973, and temperature of a water in CSSL nucleus in August 1977 reached -1.5, and in 1973 only -0.3 degree of Celsius.

Favourable environment for reproduction of the Arcto-Boreal O. *raschii* have appeared in two years in northern part of the Tartar Strait: the cold and close to among years mean one. For Wide Boreal A. *pacifica* favourable environment appear in warm years. Thus, successfulness reproduction for these species was in opposite conditions. In conditions of thermally unstable 1975, the spawning intensity of both species populations was appreciably decreased, than in favourable years. The change of a level of krill population recruitment was reflected in a condition of food base of the planktofeeders only with following year and also will have an effect for the second year. This late circumstance depends on the life length of these crustaceans which last two years or more in each cohort.

This research permits development of a technique for the forecasting conditions of food for commercial fish by forecasting thermal mode of waters.

4AM1995-BER17

BIOCHEMICAL ANALYSIS OF ZOOPLANKTON FROM THE SOUTHEASTERN BERING SEA

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During the spring of 1991 zooplankton samples from the southern Bering Sea were collected for species composition and abundance, and biochemical analysis. This paper examines the importance of nearshore community versus deep water environment relative to the nutritive value and the feeding environment for larval fish, in particular walleye pollock (*Theragra chalcogramma*). All plankton samples were fractionated into three sizes groups. The biochemical composition was analysed in terms of protein, lipid, fatty acids, and carbohydrates. Two essential fatty acids, eicosapentaenoic acid (20:5*n*-3) and docosahexaenoic acid (22:6*n*-3) were identified in all samples. Higher concentrations of both fatty acids were found in zooplankton collected from the shelf station than in the deep water stations and higher in the smaller sized zooplankton than in the large sized zooplankton. Total energy values (kJ/g) were 20% higher for zooplankton on the shelf than in deep waters. Also, protein values were much higher on the shelf than in the deep waters. The reverse was true for lipid values but the quality of lipid for zooplankton on the shelf was higher than in deep waters. Small sized *Metridia pacifica* dominated the biomass on the shelf while larger sized *Neocalanus cristatus* dominated the biomass in deep waters. *Thysanoessa longipes* were found in high concentrations along the shelf break.

4AM1995-BIO23

ZOOPLANKTON DATA TAKEN AT FACE VALUE - THE POTENTIAL FOR ERRORS

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A longterm oceanographic sampling program called "Cooperative Plankton Research" (COPRA) was developed for the west coast of British Columbia in 1990. This program organized the collection of both biological and oceanographic data from various surveys conducted throughout the year for the development of a longterm database. A total of 14 stations are located in five different regions along the coast. Opportunistic sampling of those stations was conducted throughout the year and at various times of the day. As a result of the diel migratory behaviour of zooplankton we initiated a pilot study in 1993 to ascertain the variability in night/day catch ratios of various species of zooplankton. We identified the significance of the variability of the diel catch ratios relative to the COPRA longterm database. Night/day catch ratios varied depending on the species, sex, stage, and size. Preliminary estimates for the night/day catch ratios for euphausiids ranged from 0.73 to 8.43, and for copepods from 1.79 to 5.35.

This issue must be considered if any cooperative, opportunistic sampling program such as PICES and GLOBEC are to be developed. Developmental methodology must be standardized to ensure uniformity between different Institutions. This paper alerts readers to the potential errors inherent in methodology and application.

4AM1995-BIO24

VERTICAL DISTRIBUTION OF THE COPEPODS METRIDIA OKHOTENSIS AND METRIDIA PACIFICA IN THE SOUTH PART OF THE OKHOTSK SEA IN SUMMER 1989, 1994

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Changes in fine-scale vertical distribution of calanoid copepods *Metridia okhotensis* and *Metridia pacifica* in the south part of the Okhotsk Sea were examined.

Plankton sampling was carried out in July and August 1989, 1994. Samples were collected by vertical hauls from 1,000 m to surface with a plankton net (49 sm diameter, 0.33 mm mesh openings) at 15 stations.

Metridia okhotensis and *Metridia pacifica* occupied nearly 30% of zooplankton biomass at all stations.

Populations of *Metridia okhotensis* and *Metridia pacifica* were represented II-V copepodite stages, adult females and small quantity of adult males.

Copepods were concentrated in two strata, the surface (0 to 100 m) and mesopelagic (200 to 500 m) layers, throughout the day at all stations. Copepodites II stages were distributed only in the surface layer (0 to 100 m) during both day and night. Younger *Metridia okhotensis* and *Metridia pacifica.* Copepodites III-IV stages were dominant in both strata. Although most females V copepodite stages and adult females demonstrated diel vertical migration, a significant number of females did not migrate upward but remained in the deep stratum at night.

Such populations of *Metridia okhotensis* and *Metridia pacifica* in south part of the Okhotsk Sea demonstrated bimodal vertical distribution in summer.

4AM1995-BIO25

A STUDY ON THE PELAGIC ECOSYSTEM IN THE FRONTAL REGION OF CHANGJIANG ESTUARY

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Based on the results of multidisciplinary investigations in the estuary of the Changjiang River (30°30'-31°50', west of 124°30'E) in August and December of 1988, August of 1989 and September of 1991, this paper emphasized the features of pelagic ecosystem in the frontal region located in the estuary of the Changjiang River.

The distribution of chlorophyll *a* showed a decreasing concentration from the mouth of the Changjiang River to the east. In summer there was a clear plume of chlorophyll *a* which expands to east or northeast. In the plume, the concentration rapidly increases and the horizontal and vertical borders of the plume may be roughly determined by an isoline of 3.0 mg/m^3. A strong stratification of chlorophyll *a* has been observed in the plume. In winter, the concentration decreased and the plume disappears. The vertical distribution was homogeneous.

The mean values of phytoplankton in the study area were $2505.4x10^3 ind/m^3$ (1988,8), $303.5S10^3$ ind/m^3 (1988,12) and $189222.0x10^3$ (1989,8), respectively. The phytoplankton showed patchy distribution and high the biomass region was mainly formed in the plume frontal zone. 114 species of phytoplankton have been identified in the area and there are 5 species which dominate. These species were divided into three ecological committees. Low salinity species of estuarine coast

were the main part of phytoplankton communities. The dominant species of different ecological characteristics appeared in different water layers.

The average biomass of zooplankton in the study area was 488 mg/m^3 (1988,8), 350mg/m^3 (1989,8) and 68.32mg/m^3 (1988,12), respectively. In summer, the biomass distribution increased gradually from the northwest to the southeast and high biomass was mainly distributed within the range of 122°20'-122°50'E, 30°50'-31°20'N in the plume frontal zone of the Changjiang estuary. 94 species of zooplankton were identified, and 9 dominant species occurred. Among them, 69 species were crustacea. These species were divided into five ecological communities of zooplankton and low salinity neritic community was the most basic ecological community in the plume frontal zone.

The temporal and spatial variations of chlorophyll *a*, phytoplankton and zooplankton were closely related to salinity, water masses, tidal current, runoff, nutrients, illumination and the relationship of inter species.

4AM1995-BER18

CHANGEABILITY OF CARBON DIOXIDE SYSTEM COMPONENTS IN NORTH-WESTERN PART OF THE BERING SEA

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Space changeability of pH (NBS-scale), total alkalinity and calculated from them total inorganic carbon CT and partial pressure of carbon dioxide PCO^2 (apparent dissociation constants of Edmond-Gieskes) in North-Western part of Bering Sea during the "Academic Alexander Nesmeynov" cruise in 15-23 June of 1992 (39 stations) and in 22-30 July of 1993 (28 stations) was investigated.

The analysis of vertical profiles of CT, pH and PCO^2 in the part of continental slope region, in the Komandorskiy hollow region and in the Aleutian hollow region distinguished three layers, typical for the vertical thermo-haline structure of the Bering Sea. There was the upper mixed layer - UML (pH=8.20-8.40; PCO^2=180-310 ppm; CT=1.91-1.98 mM), the cold intermediate layer from 60 to 200 m - CIL (pH=8.01; PCO^2=520 ppm; CT=2.17 mM) and the warm intermediate layer from 250 to 500 m - WIL (pH=7.60-7.55; PCO^2=1500 ppm; CT=2.36 mM).

Total alkalinity to chlorinity ration was minimum in CIL (0.122), one was higher in UML (0.123) and one increased with depth after CIL to 0.125 in 1000 m depth.

Observed changeability of carbon dioxide system components was explained by photosynthesis, by decomposition of organic matter, by mixing waters and by gas exchange between the ocean and the atmosphere.

It was shown that ventilation of CIL at the period of autumn - winter convection processes results in 100% oxygen saturation and at the same time 125% carbon dioxide supersaturation occurred.

4AM1995-BIO26

WHERE ON THE GLOBE CAN WE EXPECT STRONGEST GLOBAL ENVIRONMENTAL CHANGES?

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The energy and mass exchange on the planet is not homogeneous in the space and time and requires reliable forecasts and appropriate working hypothesis. We propose to pay special attention to the study of biogeochemical cycles and development of earth ecosystems in subduction areas and active fracture zones near plate tectonic borders being important sources of electromagnetic and seismic

waves. The energy discharge and related ecosystem composition shifts are expected to be more clearly expressed in such areas as well as in the areas of strong meteorological activity (typhoons and hurricanes, others episodic events). Elevated shallow and deep earth mantle earthquake activity in seismic areas of the World Ocean floor could create specific conditions for the biogeochemical cycling of the matter and life processes in ecosystems existing in related coastal and open sea areas. Effects of biophysical resonance of waves generated in the areas of earthquakes, subduction zones, deep ocean trenches probably can elect the variation (including periodical ones) of species composition and productivity of marine ecosystems as well as to generate appearance of new species through consequent changes in the genetic level, affecting the evolution of the life in the Ocean.

4AM1995-MEQ23

BIOGEOCHEMICAL PROCESSES CONTROLLING MATERIAL TRANSPORT IN SOME ESTUARINE AND COASTAL AREAS OF NORTHERN PACIFIC

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Biogeochemical processes taking place in coastal areas of some marginal seas of Northern Pacific have been studied on the basis of Vernadsky and Chizhevsky's ideas and of modern ecosystem approach. Special attention was paid to estuarine zones of large rivers (Amur River, Razdolnaya River and Mekong River) as well as to some arid areas of the coastal zone of Baja California Sur, Mexico (La Paz, Conception and Topolobampo bays). The concept of biogeochemical barriers is used to explain the transport of material and migration of elements including heavy metals at the land-sea and bottom-sea interfaces. Different effects (physical, chemical, biological, sedimentological) of biogeochemical barriers on the transport of the material from a river drainage basin into marine environment are described and discussed in the paper. It is shown that the areas of primary accumulation of elements in plankton and sediments in the plumes of the Amur River (the Sea of Okhotsk), Razdolnaya River (the Amursky Bay, the Sea of Japan), and Mekong River (areas of South China Sea adjacent to the Mekong delta) were controlled by river discharge, terrigenic suspended matter composition, planktonic characteristics, anthropogenic sources in rivers and estuaries affecting terrigenic and biogenic sedimentation in the contact zone. Behavior of elements in coastal areas of Baja California Peninsula was determined mainly by episodic discharges of fresh water and terrigenic material into the marine environment after strong cyclonic events. Dependence between processes mentioned and geophysical activity was expected in some cases in areas of convergent tectonic plates.

Meaningful for the global environmental change connection between geophysical, geological, geochemical, hydrophysical, hydrochemical, hydrobiological fields and ecological stability of estuarine and marine environments in the zones of active exchange of matter and energy is considered and explained by space-sun-earth-ocean interactions.

4AM1995-POC25

THE MACROSCOPIC KINETIC ENERGY OF FLUID MOTION

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The semiempirical theory of turbulence proposed that shear contains energy. Ka-Kit Tu-ng et. al. (1981) proposed the concept of "shear energy" considering the shear flow. Based on continuity principle (Leibniz, 1687) an analytical formula for macroscopic kinetic energy was derived. The formula generalize the Gyarmati's one and confirm the Landau and Lifshits assumption about the dependence of internal energy on the rate of strain tensor.

Besides from the Gyarmati "internal rotation" energy the formula contains the internal shear energy and internal shear-rotation energy. For a one-dimensional flow with constant shear the

generalization for the macroscopic kinetic energy results to additional "shear internal energy" term equal in Boussinesq approximation to the Gyarmati's "internal rotation "term.

4AM1995-FIS31
GENETIC AND ENVIRONMENTAL VARIATION OF BODY SIZE IN A PINK SALMON STOCK

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Body size, fecundity, and egg size are positively related to fitness--to the number of offspring produced by an individual salmon or to the productivity of a stock. Variation of phenotype (body size and correlated traits) is partly caused by environmental variation (including both density dependent and independent sources) and partly by genetic variation. Variation of phenotype over generational cohorts of a stock, between stocks within years, or within a cohort of a single stock is due to a combination of environmental and genetic factors. We analyzed variation of body size, within and among 119 full sib families of pink salmon at Auke Creek, in Juneau, AK (Can. J. Fish. Aquat. Sci. 51:9-15) and variation of fecundity, and egg size. We also estimated the regression of body size in offspring on that in parents. These families were incubated in separate containers, tagged with coded microwires, released as unfed fry to the sea, and recovered and measured as returning mature adults. Heritability (the proportion of phenotype variation due to genetic as opposed to environmental causes) of body size of sibling males in one generation was moderate to high, but low in females. Heritability of fecundity was moderate to high, but of egg size was low. However the regression of lengths of offspring on those of their parents was not significant, an inconsistency with analysis of siblings. This inconsistency may be explained by large environmental variation of body size from year to year. Mean length of pink salmon in Auke Creek has declined from over 520 in the 1970's to less than 440 mm in the 1990's (S.G. Taylor, US NMFS Auke Bay Laboratory, Juneau, AK 99801). Similar trends are apparent in records of hatchery broodstocks around the Gulf of Alaska since about 1980. This variation over generational cohorts has likely been environmental; there is no evidence of plausible genetic selective factors acting on Auke Creek pink salmon (e.g. size selective fishing). Density dependence may be a plausible explanation for the 20-yr decline because abundance of Alaska pink salmon has increased simultaneously. However average body size of all southeast Alaska pink salmon has declined steadily since around 1958, well before abundance began to increase (Marshall and Quinn 1985), suggesting that density independent factors have been important.

4AM1995-MEQ24
MODERN SEDIMENTATION FEATURES OF THE SEA AREA AROUND CHANGSHAN ARCHIPELAGO

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On the basis of marine sedimentation data from comprehensive survey of sea island resources of Liaoning during 1989-1992, and through the analysis of surface sediment sorts, distribution of clay minerals and modern sedimentation rate of 6 cores of 210pb. This paper studies the modern sedimentation features of the sea area around Changshan Archipelago.

4AM1995-BIO27
INTERDECADAL VARIATIONS IN ZOOPLANKTON BIOMASS, CHLOROPHYLL CONCENTRATION AND THEIR PHYSICAL ENVIRONMENT IN THE SUBARCTIC PACIFIC

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Interdecadal variations in zooplankton biomass and chlorophyll concentration in summer during 1956-92 in the central and western subarctic Pacific and eastern Bering Sea were compared with each other and with those in the climatic and oceanic conditions, such as the sea surface temperature and salinity, and density stratification in the upper layer in those areas. The zooplankton biomass and chlorophyll concentration in the western and central subarctic during mid 1960s - mid 1970s were a few times higher than the periods before and after it. Those values in the eastern Bering Sea have increased in the mid 1960s with peaks of chlorophyll concentration and zooplankton biomass in the later 1960s and early 1980s, respectively. The period of higher plankton biomasses correspond to the period of weaker density stratification in summer caused by warmer winter and cooler summer.

4AM1995-BIO28
FOOD WEBS OF ZOOPLANKTON AND MICRONEKTON COMMUNITIES IN THE TWO COLD WATER MASSES AROUND JAPAN

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Vertical distributions of macrozooplankton and micronekton, and the natural abundances of carbon and nitrogen stable isotope ratios, the indicators of the food web structure, were measured in the western North Pacific off northeastern Japan and in the Japan Sea. There are many conspecifics in both areas, however the depth range of habitats in the Japan Sea was generally deeper than that in the Pacific Ocean. The result of the carbon isotope analysis indicates that the pelagic food web in the Pacific Ocean was derived from a single carbon source, whilst there was more than one carbon source in the Japan Sea. The broad vertical migration range of macrozooplankton from near the surface to near the bottom in the Japan Sea implies the potential for the utilization of benthic derived carbon. According to the nitrogen stable isotope analysis, the trophic level of carnivorous macrozooplankton was close to that of the mesopelagic fish. In the Pacific Ocean, many species of mesopelagic fish distribute below 500m, whilst in the Japan Sea, the thermocline at the boundary of the lower cold water(the Japan Sea Proper Water) stops most mesopelagic fish species from migrating through this temperature discontinuity. Therefore some of the macrozooplankton which compete for food resources with mesopelagic fish in the Pacific Ocean were able to occupy both the food and habitat niches of mesopelagic fish in the Japan Sea. This is one example of the usefulness of stable isotope ratios for assessing food web complexities within an ecosystem.

AM1995-FIS32
MACROPHYTOBENTHOS OF SUBLITTORAL OF THE PRYMORYE REGION (THE JAPAN SEA)

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In 1994, data was collected on the macrophytobenthos of the sublittoral area from the Povorotny Cape to the Sosunov Cape. Near the Primorye coast the macrophytobenthos was represented by the polydominant plant associations consisting of one and two year blade-kelp of *laminaria Japonica Aresch, Costaria costata* (Turn) *Cystoseira crassipes* (Turn) C Ag, *Phyllospadix iwatensis.* The density of settlement of two year blade-kelp Laminaria was from 2 to 52 sp/m with a biomass of from 2 to 44 kg/m and the weight of one thallus was from 0.3 to 1.6 kg. The length of the plates varied from 80 cm to 575 cm. The density of the settlement of one year blade-kelp Laminaria changed

from 12 to 608 sp/m and the biomass from 0.05 to 18 kg/m. Juveniles of 3-7 cm in length were found among the large specimens (300 cm) in separate areas in the northern. In 1994 the settlement of *Costaria costata* was marked. It was in the company of *Laminaria japonica* kelp beds and sometimes it replaced all the density of the settlement. *Costaria costata* varied from 4 to 232 sp/m^2,biomass from 0.01 to 20 kg/m, the length of plates from 5 to 270 cm. At separate area of blade-kelp *Laminaria cichorioides* was found. The density of the settlement changed from 2 to 40 sp/m, and 0.2 to 13 kg/m biomass and the length of plate from 35 to 270 cm. The young plate was sterile, the old one was sporiferous.

In the northern coast Alaria mardinata Pet.R. settlement which reached 16 sp/m, 2,5 kg/m biomass. The majority of plants were sporiferous sporophyllus.

4AM1995-FIS33

NEW SPECIES OF ALGAE MACROPHYTES OF EASTERN KAMCHATKA

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In June-July of 1986, M.V. Sukhoveeva survey ship was used to collect samples of the composition and distribution of algae near the shore of Kamchatka Bay. The samples contained 76 species of algae and, 40 of them are new for the region (5-Chlorophyta, 10-Phaeophyta, 25-Rhodophyta). The biomass of which varies from 2 to 12 kg/m were the representatives of blade kelp Laminaria: *Laminaria longipes Bory, L.bongardiana P.et R. L.dentigera Kjellm., L. apressirhiza Ju. Petr.* et V.Voz., *L.yezoensis* Miyabe, *L.gurjanovae* A Zin , *Arthrothamnus bifidus* (Gmel.) J.Ag., *Alaria fistulosa* P.et R., A. *marginata* P et R ,that form polydominant associations. A. *fistulosa* A. *bifidus,l. bongardiana* are subdominants depending on the depth and the degree of protection. *Nereocystis luetkiana* (Mert.) R.et R. was found in drifting state, 2 kg of epyfytes from *Rhodochorton spetbergense Antithamnion sp.* was found as a thallus. Red:*Girrulicarpus gmelini* (Grun.) Tokida et Masaki,*Allophyllis cristata* (Ag.) Kutz, *Chondrus platynus* (Ag.) G. Ag. *Palmaria marginicrassa* lee, *Neohypophyllum middendorfii* (Rupr.) *Wynne, Mikamiella ruprechtiana* (A.Zin.) Wynne were often found among kelp beds of laminaria.

4AM1995-BIO30

SEASONAL VARIATION OF EXCYSTMENT ABILITY OF THE CYST POPULATION OF THE PLANKTONIC OLIGOTRICH CILIATE *STROMBIDIUM CONICUM*

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Incubation experiments of cysts of a planktonic ciliate which were isolated from natural surface sediment samples collected monthly in Onagawa Bay facing to the Sanriku Waters in the western North Pacific were done during the period from June 1992 to July 1994. Cyst populations of the oligotrich *Strombidium conicum* dominating in the bay was sampled. Live cysts were sorted every month with a micropipett, inoculated one by one into wells of a tissue culture plates and then incubated under a laboratory condition of 20°C in light for 1-3 months. During the incubation period, a number of the excystments are counted daily or weekly to illustrate the cumulative excystment curve. The results revealed that the mode of the excystment curves seasonally changes from year to year in a regular manner. While the cyst population experiences warm condition in summer excysts in rapid mode, excystment of that passed cold season was clearly a delayed mode. This cyclic annual variation in excystment mode was basically caused by seasonal change of the bottom mud temperature and results in synchronization of the excystments of the natural cyst population, which, in turn, helps to form rapidly and maintain their vegetative population in the upper water column during September - January.

4AM1995-BIO29

DISTRIBUTION AND LIFE CYCLE OF *Euphausia pacifica* HANSEN IN THE COASTAL WATER OFF SANRIKU, NORTHEASTERN JAPAN

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A series of oblique hauls with ORI nets were made at intervals of 2 months (April, June, August, October and December in 1993 and February 1994) in the coastal waters off Sanriku, northeastern Japan, to investigate distribution and life cycle of *Euphausia pacifica*. The results indicated that the biomass of *E. pacifica* was low in August and February, but it was high in April, especially onshore (about 100-150m depth), when the Oyashio coastal branch came close to the shore and water mass with temperature of 5-8°C prevailed. Additional samples with beem trawl nets and horizontal hauls with MTD nets in August suggested that *E. pacifica* stayed near the bottom layer at noon, but moved up to the middle layer at night in this season. Breeding of *E. pacifica* occurred onshore in February, peaked in April and continued until October. The main brood of April - born group grew quickly in the next February-April and reached about 17-18mm length at 1 age. The life span of *E. pacifica* was estimated to be about one and a half year. Further trophic significance of *E. pacifica* in the ecosystem of the coastal waters off Sanriku was discussed in light of prey-predator relationships.

4AM1995-BER19

OCEANOGRAPHY AND LIVING MARINE RESOURCES IN THE ALEUTIAN BASIN IN SUMMER

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An acoustic and midwater trawling survey of the Aleutian Basin for living resources was conducted in summer 1993. Our results indicate that: 1) The water from surface to 25 m depth showed the temperatures at 5.4-9.6°C, salinities at 32.4-33.2, and dissolved oxygen at 9.7-10.6 mg/L, while the water layer 50-200 m was occupied by the cold water mass with the temperatures of 1.3-4.9°C; 2) Ten groups of zooplankton were identified from the sampling of vertical zooplankton net, mainly including *Copepoda*, *Chaetogna* and *Aglantha*, of which *Eucalanus* sp., *Calanus cristus* dominated the total zooplankton by volume, while *Chaetoceros concavicornis*, *Nitzschia pungens*, *Melosira sulcata*, *Thalassiothrix frauenfeldii*, and *Rhizosolenia hebetata f. hiemalis* dominated the phytoplankton. 3) The main species, adult walleye pollock *Theragra chalcogramma* were mainly distributed in the southern part of the Basin and the Bering High Seas at 175-225 m depth. Age-0 juveniles were mainly distributed in the northeast part of the Basin extending from northwest to southeast with the highest concentrations located between the eastern continental slope and the Bering High Seas. In addition, ten other species of fish with small quantity were caught in the Basin, mainly including smooth lumpsucker *Aptocyclus ventricosus* and northern lampfish *Stenobrachius leucopsarus*. Smooth lumpsucker was widely distributed in the whole surveyed area, while northern lampfish was mainly observed in the southern part of the Basin with the densest area in the Bowers Ridges.

4AM1995-FIS34

THE PECULIARITIES OF ASIA PINK SALMON GROWTH AT THE DIFFERENT ABUNDANCE

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The significant interannual differences in abundance of fingerlings in 1990-1994 (Okhotsk Sea) have taken place, but one could not observe the appreciable changes in their sizes. At the end of December, the average length of fingerlings in the Okhotsk Sea was 27.8-28.4 cm. The annual abundance of mature pink salmon during migration was 439, 200, 230, 420 th.t. in the period 1991-1994. The interannual size and weight differences of mature pink salmon were determined in winter-

spring period during joint inhabit of different pink salmon groups. The influence of density-dependent factor on the size and weight structure, tempo of maturity, the terms of pink salmon spawning migration are discussed.

4AM1995-BER20

CONCEPTUAL MODELING OF RED KING CRAB YEAR-CLASS STRENGTH IN THE BRISTOL BAY REGION OF THE BERING SEA

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From a regional workshop we developed a stage by stage table of life history events with ecological processes pertaining to survival rates. The information included the location and timing of eight life stages, along with the coincident physical oceanographic and biological factors that could influence the productivity and survival rate of the stages. Hypotheses emerged relating survival to physical factors: a critical number of degree-days is necessary to bring on ovary maturation; after fertilization cool temperatures will delay hatching, and high temperatures will increase egg mortality; a high percentage of successful hatch is linked to an optimum temperature; timing of hatching depends on a water quality cue that is related to the abundance of a particular diatom; for the larval stages, water-mass mixing due either to tide or Ekman transport increases nutrients used in primary production and consequent larval growth and survival; high-profile, rocky bottom with sessile fauna is critical for survival of the glaucothoe larval stage during settling, consequently an increase in the strength of currents moving larvae away from this bottom type would increase mortality. Other hypotheses were related to predation and biological factors. These ecological relationships were redesigned as mathematical functions and set into the structure and logical flow of the conceptual aspects of a simulation model. The conceptual model showed the simultaneous influence of particular factors on several life stage processes. Inferences are drawn for decadal period dynamics, implications for fishery management, and needs for at-sea research to clarify understanding.

4AM1995-POC26

THE INFLUENCE OF METEOROLOGICAL FIELDS TO THE FORMING VARIABILITY OF THE SEA SURFACE TEMPERATURE ON THE NORTHWESTERN PACIFIC

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A statistical study of the influence of meteorological fields to the forming variability of the sea surface temperature (SST) was based on the time series of monthly mean SST for 5-degree latitude and longitude grid, cloudiness and various computing features of the winds (30°-55'N, 130-160°E) for the 1967-1985 period. Cross correlation function have been calculated with time lag from 0 to 6 month. The results of calculation showed that the correlation coefficients (r) between time series of SST anomalies (SSTA) and time series of meteorological features were not constant from month to month and for various areas of the Northwestern Pacific. Maximum value of r (about -0.6) between time series of SSTA and monthly mean wind speed observed in winter monsoon period in region off the south and east Honshu. More high negative values r in this region were found between SSTA and monthly sums of speed northwesterly and north wind in November-March. The relationship of SSTA with wind features was weak in the northern areas of the Northwestern Pacific. On the contrary, extreme negative values of r between time series of SSTA and monthly cloudiness occur in the northern and northeastern areas for lag 0-6 and r decrease south-eastward. Extreme negative r between SSTA and cloudiness predominated in April-June. High r between SSTA and November wind features were found. These r decrease weakly for lag 1-3. Extreme r between SSTA and cloudiness was for lag 1-2. The results obtained would be useful for forecast of large-scale SST variability.

4AM1995-FIS35
INFLUENCE OF FEEDS COMPOSITION AND STOCKING DENSITIES ON RELATIVE NUMBER OF SALMON TROUT DWARF MALES IN ARTIFICIAL CONDITIONS

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This investigation attempts to clear up the mechanism of structure formation for salmon trout populations. The experiment was conducted at Rjazanovski salmon-breeding plant (South Primorje) in 1988-1989. Four rations, distinguished by animal protein, lipid contents, and some stocking density variants were used for different size groups. It was stated that share of dwarf males in all groups about 180 days amounted to 8-11% relative to total males numbers.

4AM1995-POC27
LARGE-SCALE VARIABILITY OF THE THERMOHALINE WATER STRUCTURE IN THE NORTH PACIFIC ALONG 50-N

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During the period 1991-1993 "INPOC" programme four oceanographic surveys along 50-N were carried out using CTDs. Some peculiarities of the large-scale variability of the thermohaline water structure were studied by volumetric analysis of thermohaline characteristics. As indicator of this variability, the location of boundary between eastern and western subarctic water subtypes was used. Sufficient differences of the thermohaline processes in western and eastern parts of the section was noticed. In order to interpret this variability mean components of heat balance and wind tension on the sea surface during the period 1987-1993 and their anomalies for each month were calculated for region between 40-58°N and 145°E to 145°W. The results of the joint analysis of processes on the sea surface and in depth suppose the presence of some interaction mechanism between eastern and western parts of the region. It was noted that some processes in the west and east of the section have approximately opposite phases.

4AM1995-POC28
MESOSCALE STRUCTURE AND WATER DYNAMICS OF THE SUBARCTIC FRONTAL ZONE NEAR EMPEROR SEA MOUNTS CHAIN

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An analysis of structure of the Subarctic frontal zone near Emperor Seamounts Chain (ESMC) was carried out on a base of historical hydrological data and CTD stations sampled during fall 1992 and spring periods of 1992 and 1993. The section located between points 51-30'N, 180°E and 32°N, 160°E. To interpret these data and define more exactly fronts positions two minute time interval records of the sea surface temperature and salinity were used also. The water structure of the region basically corresponded to dynamic picture based on long-term historical data; boundaries of the main water types have been traced pretty well by the sea surface temperature and salinity records.

The main features of the Subarctic Current and Kuroshio Extension and accompanying them thermohaline fronts in this region are follows:

- Subarctic Current in vicinity of ESMC sharply turns to north- east; Subarctic front crosses the seamounts chain near 42°N, then also displaces sharply to north; to east of ESMC (172°E) it locates on 43.5-44.2°N;

- the Kuroshio Front passed through the section on 40.5°N in spring of 1992 and have been displaced to spring of 1993 to 38°N;
- the Kuroshio Extension bifurcates to east of Shatsky Ridge and its northern band forms deep anticyclonic meander, which center locates on 36°N, 165°E and might be traced to depth of 2000 m;
- northern band of the Kuroshio Extension passes ESMC through the gap between seamounts Nintoku and Jingu (40-38°N), and turns immediately to south;
- southern band of the Kuroshio Extension passes the ESMC to south of 34°N.

4AM1995-POC29

THE ROLE OF OCEANS SURFACE TEMPERATURE ANOMALIES IN FORMATION OF SHORT-RANGE CLIMATE VARIABILITY IN SIMPLE COUPLED ATMOSPHERE - OCEAN MODEL

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The processes of global atmospheric circulation interaction with the oceans upper layers were studied with simple coupled models of atmosphere and oceans.

Two layer nonlinear quasi-geostrophic model of atmospheric circulation on b- plane was used. The oceans was represented by a model of mixed upper layer with constant depth. Horizontal circulation in oceans was caused by zonal surface wind stress and was described by the Stommel equation. Temperature field in ocean's model was formed by heat exchange with atmosphere and by horizontal advection.

The spectral Galerkin's method was used for numerical calculations. In the atmospheric model two zonal modes and two running waves with zonal numbers 6 and 8 were used.

In the stationary state, through nonlinear interaction of atmospheric waves and zonal flow caused oscillations with periods not exceeding about 7 days. When the system was forced with annual periodicity (annual changes in heat input to atmosphere-oceans system) there was observed a simple 1 year or additional strong 2 year, 4 year (2+2) or 3 year variability. This interannual variability was produced due to non-every year transitions of atmospheric circulation between different regimes when external forcing was changed. In this case even small "external" OST anomalies caused the break or shift with large disturbances in established oscillations. It lead to irregularity in the spectrum of interannual variability in atmosphere-ocean system. The predictability of such influences are discussed.

4AM1995-MEQ25

STRESS PARAMETERS IN FISH: THEIR USE IN MONITORING

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Various stressors (such as sealice, transport, water pollution, acidification, etc.) cause similar changes in (ultra) structure and enzyme activity of skin and gills of fish. These similar responses to different stressors are called "general stress responses". We are determining these general stress responses in a quantitative way, with the aim to establish them as stress parameters. The objective of the project in Qingdao is to validate the use of our stress parameters, the sea-bream (Sparus macrochephalus).

The stressor used was exposure (up to 15 days) to a mixture of heavy metals in concentrations as they occur in heavily polluted areas of Jiaozhou Bay (West from Qingdao). We measured plasma

chloride, plasma glucose, skin peroxidase activity, Na/K-ATPase activity in gills, and analyzed the histology of skin and gills (LM and EM level). The results obtained so far show no harmful effects of 'Jiaozhou Bay metal concentrations' whereas 5 times higher concentrations clearly affects many of the parameters within 2 days. The idea is to use the same parameters in future experiments with organic pollutants and pesticides.

4AM1995-POC30
VERTICAL STRUCTURE OF CURRENTS IN THE SOUTH-KURIL RIDGE

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Studies of the vertical structure of currents in such straits of the South Kuril Ridge such as Kunashir, Ekaterina, Freeze, Bussol and Diana was performed using numerical modelling. A quasigeostrophic barocline model was used to calculate the vertical structure of the currents by given condition on the surface. Bottom topography and shore hydrography were also considered.

Input data were fields of the average monthly atmospheric pressure and salinity and archived data of the decadal surface temperature for the period of 1964-1985.

Vertical profiles for current velocities in different seasons (winter, spring, summer, autumn) were built for the coldest 1974, the most warm 1977 and for statistically average 1975. It was shown that seasonal variability of the current structure and water exchange through the straits of the South-Kuril Ridge between the Sea of Okhotsk and the Pacific Ocean during the above years.

4AM1995-BIO30
CHANGES IN PLANKTON COMMUNITY OF OKHOTSK SEA

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In the summer 1994, in comparison with similar period 1993 in community of zooplankton of epipelagic changes, connected to penetration thermic of waters of Kamchatka current far for the north have taken place.

In Sakhalin Bay, eastern-Sakhalin waters and southern deep-water hollow has sharply increased biomass of euphausiids *Thysanoessa raschii*, biomass which in 1993 was low. In region Southern Smoked with Okhotsk-seas of the party congestions Euphausia pacifica were concentrated. Powerful shoal of congestions *Th.longipes*, which in 1993 were marked in top epipelagic echosounders, in modern to filming is not found out.

Sharp increase of number *Calanus plumchrus* has taken place: on the extensive area congestions 5 copepodits in top of epipelagic in day time and night time (in 1993 among copepods were observed dominated Metridis's).

In Sakchalin's regions high number had Parathemisto libellula, which usually inhabit in the most cold regions area of Okhotsk and Bering seas, its (her) penetration far by south speaks about change of intensity of circulating processes. Cold-waters and shalphic species C.glacialis inhabited almost on whole area a bay Shelichow and in shoal-waters zone - up to 440-650 mg/cubic.m. In the Sea of Okhotsk this kind serves the indicator of cold waters and penetrates for south depending on particular (specific) hydrological of a conditions: in more cold years at coast western Kamchatka's up to 51 30. In anomalic current to a warm year the southern border of congestions C.glacialis was limited on south 55 30.

In north-east part of Okhotsk sea zooplankton was largely "limacinas". Limacina helicina was submitted predominary young small-sized (0.2-1.5 mm) speciments, large (more than 3-4 mm)

specimens was little bit. Probably, summer spawning of Limacinas has passed successfully, therefore the condition of fodder base Hishiging-herring can be appreciated as satisfactory.

Thus, because from increase of dynamic processes, the whole system of circulation of Okhotsk sea has appeared returned on a quarter otherwise.

4AM1995-BER21
SPECIFIC FEATURES OF FEED OF BERING SALMONS IN SUMMER PERIOD

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Owing to distinctions in quantitative to a structure of planktonic communities Okhotsk and Bering seas together with the next waters Eastern Kamchatkas, the feed of salmons had some characteristic features. The qualitative feedings structural was similar, but dominant in different regions other objects became.

In summer period at migration on spawning, matures pink continues actively to feed, thus and in western part of Bering Sea, and in waters East Kamchatka the basis of fodder base for it serve nekton and large zooplankton - euphausiids and Pteropods. The copepods in some cases also included in dominant group (up to 25-38 %).

In feed of chum in Bering Sea and waters East Kamchatkas nekton is had with smaller significance, and prevail pteropods (in a greater degree Clione limacina), euphausiids, and then nekton. The share copepods and hiperiids in the food of the chum is insignificant.

Daily rhythm of feed chum and pink was expressed by parabolic.

At sockeye salmon all of length groups from 20 up to 60 the basis food in the Bering Sea made (by way of the importance) euphausiids, pisces, hiperiids and pteropods, and in eastern-kamchatka waters - squids, hiperiids, euphausiids, small-sized medusae and ctenophores. With increase of the sizes in foods the contents of euphausiids was increased.

Composition food of 50-70 everywhere prevailed nekton (fishes and squids). At chinook 50-70 in the Bering Sea and waters of eastern Kamchatka also nekton (but predominary fishes).

Dolly Varden in the Bering Sea fed as typical planktofag, in food constantly prevailed euphausiids (50-95 %), share of which, as well as at soakeye, grew with increase of the sizes fishes; on the second place on the importance were hiperiids, and only on third - nekton. The highest indexes of filling of stomach were at dolly varden (from 96 up to 223), least - at of sockeye (25-100).

4AM1995-FIS36
ROLE OF DENSITY-DEPENDENT EFFECTS ON THE POPULATION FLUCTUATION OF JAPANESE SARDINE, SARDINOPS MELANOSTICTUS

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Over 40 years time series of the reproduction index of Japanese sardine was compared with the time series of the population abundance, annual egg production, and indices of biological characteristics, such as individual growth rate, to examine the density-dependent effects on the population fluctuation.

The relationship between reproduction index and population abundance suggested that the sardine has two different equilibrium population levels; in the orders of 10^5 tons in the 1950s and

10^7 tons in the 1980s, respectively. With this shift of the equilibrium levels, the migration range, which will be a index of carrying capacity, was also changed from small to large. The individual growth rate was changed negatively with the population abundance, and at the same time, the first mature age shifted from two years old to tree or four years old. It may be a result of the ecological adaptation to the change in carrying capacity, and may form a negative feedback loop in the population regulation system.

On the other hand, the annual egg production correlated positively with the population abundance even in high abundance and low nutritional condition in the 1980s. This relationship may be a positive feedback loop in the regulation system and bring a shift of the equilibrium level through the continual recruitment success, as in the 1970s, or the succession of recruitment failure, as the period from 1988 to 1991. The recruitment success in the 1970s corresponded to the increase of zooplankton density in feeding grounds of the sardine. Therefore, environmental changes will be a trigger or driving force of the positive feedback process.

4AM1995-POC31

A STUDY ON THE VERIFICATION METHOD OF THE MARINE ENVIRONMENT FORECASTS IN THE NORTH-WEST PACIFIC

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Our missions are to open the numerical forecasts on marine environmental elements.

1. Numerical sea ice prediction:
A numerical model was proposed for forecasting sea ice edge, concentration, thickness and drift. The ice model, atmospheric model and sea model are included in the ice forecast system.

2. Sea wave prediction:
We have been running the second and third generation models to predict the height, direction and period of sea wave for every day.

3. An examination method was made to test the operational model's ability. For each test factor, the following ten factors was tabulated: average deviation, mean absolute error, RMSE of forecast, tendency correlation, anomaly correlation standard deviation of forecast error, absolute correlation, skill index, scatter index, ability index.

4. A sea wave height objective analysis method was designed by the way of Cressmen successive approximation technique. This analysis method includes four parts:

a. Observation data processing unit.
b. Successive approximation analysis of pressure field.
c. Successive approximation of wave height field.
d. The statistic and output of the analyzed result.

4AM1995-MEQ26

THE IMPACT OF GRAIN SIZE OF SEDIMENT ON MARINE ENVIRONMENTAL QUALITY

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Marine bottom environment is the main ecological environment area and now scientists pay more attention to bottom environment quality and take it as an important part to protect. To study and monitor the pollution of bottom environment, especially, the content, distribution, pattern of exist and toxicity to livings of each pollutant is very important to assess the environmental quality. The sediment is the important substances basis of marine bottom environment. The distribution of

sediment grain size influence the abundant ability of pollutants. Therefore, there are difference among the pollutant concentrations owing to different grain size of sediment, even the sediment or suspended sediment exposure in environment of the same pollution degree.

On the basis of coastal zone investigation in 1983 and bay surrey in 1987, this paper described the relation between grain size of sediment and pollutants (Cu, Pb, Zn and Surphide) in shallow sea, tidal flat, bay and estuary, which is the nonlinear function $D_{50}=ae^{-bp}$. The range of median size of sediment was obtained in different hydrodynamic environment when standardization values of pollutants (P) is more that 1.0. Through the change of benthon community resulted from the change of grain size of sediment at the beach of Shicheng Island indicates that the impact of grain size on sediment of sediment environment quality and ecology.

4AM1995-FIS37
CHANGES IN THE RELATIVE ABUNDANCE OF DEMERSAL AND BENTHO-PELAGIC FISHES AROUND THE COAST OF HOKKAIDO, OBSERVED IN THE DATA FROM TRAWLERS AND DANISH SEINERS

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Data from commercial fisheries is conventionally used to detect indications of changes in abundance of fishes in fishing grounds. In the coastal area of Hokkaido, the data reported by trawlers and Danish seines are available to calculate indices of relative abundance index* (Tanaka, 1985), both of which are corresponding with the biomass of fishes, show that changes in the abundance of the fishes have been different between species in recent 25 years. They were classified into three types: decline and remains at low level in kichiji rockfish and flatfishes, fluctuation in bentho-pelagic fishes such as walleye pollock in the Pacific coast and spasmodic elevation followed by acute drop without recovery in saffron cod and Pacific cod. Further, I discuss the relative capacity of the coastal fishing ground around Hokkaido.

The equation for the stock abundance index (P) is

$$P = \Sigma A_i \frac{C_i}{X_i}$$

where A_i is the area of fishing section I, which is separated by 10 x 10 minutes' graticule, C_i is the catch weight and X_i is the fishing effort.

4AM1995-BIO31 Invited
THE LINK BETWEEN THE CLASSICAL FOOD CHAIN AND THE MICROBIAL FOOD WEB: THE ROLE OF KEYSTONE PREDATORS

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Zooplankton organisms that have the potential to structure the entire pelagic food web by their feeding impact('top-down' control) are considered keystone predators. Such keystone predators are known both among protozoa (e.g. *Noctiluca*) and metazoa (*Mnemiopsis, Aurelia, Daphnia*). A broad feeding spectrum is characteristic for many keystone predators. Their prey comprises organisms belonging to the herbivore ("classical") food chain as well as the microbial food web. I will present examples from the North Sea, The Black Sea, and some lakes to demonstrate how the feeding activities of such pivotal grazers can directly or indirectly alter the energy flow and size structure of planktonic food webs.

4AM1995-SB08

EVOLUTIONARY EVIDENCE FOR A FINITE MARINE CARRYING CAPACITY FOR SALMONIDS

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PICES has chosen as one of its research focuses to examine the salmonid carrying capacity of the North Pacific Ocean. In this talk I will provide one operational definition of the term "carrying capacity", and will review evidence bearing on the question of whether or not the productivity of the north Pacific ocean is sufficiently limited to affect salmon production. If ocean carrying capacity is large relative to current or potential salmon abundances, then the marine abundance of salmon will have little impact on the productivity of the component populations. In this case, salmon management can proceed as it has in the past, concentrating on independently managing individual freshwater populations without reference to the abundance of other stocks of the same species, or the abundance of other species.

I will show from anatomical analysis that chum salmon have a distinctive gut structure that allows substantial dietary specialization and consequently reduced trophic overlap with the other species of Pacific salmon. The observed anatomical differences are consistent with the known feeding behaviour of the six species in the open ocean, and with the development of dietary and behavioural specialization to minimize trophic competition. It appears that the gut structure of chum salmon has therefore evolved to minimize inter-specific trophic competition by allowing efficient feeding on gelatinous zooplankton, a branch of the food chain unexploited by other species of *Oncorhynchus*. This observation therefore implies that on evolutionary time scales salmon abundances were sufficiently high for competitive interactions to allow anatomical and behavioural specialization to occur. A finite marine carrying capacity therefore must exist. What is currently unclear is whether modern salmon abundances are large enough to significantly impact salmon production.

4AM1995-FIS38

LATITUDINAL VARIATION IN $d^{15}N$ AND $d^{13}C$ ALONG 180□W: IMPLICATIONS FOR OVER-WINTER MIGRATION OF CHUM SALMON (O. KETA)

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$d^{15}N$ and $d^{13}C$ isotope ratios of chum salmon *Oncorhynchus keta* collected from a standard transect along 180°W in the Pacific Ocean and Bering Sea were related to latitude, year, and size of the animals collected. $d^{15}N$ varied both with latitude and bodysize; $d^{13}C$ varied only with body size. The effects of body size were discontinuous, with $d^{13}C$ and $d^{15}N$ independent of size for chum salmon £ 500 mm fork length (£ 2,000 gm body weight). $d^{15}N$ and $d^{13}C$ changed linearly with body size for larger fish. Unlike $d^{15}N$, $d^{13}C$ levels were unrelated to either sampling year or latitude. $d^{15}N$ increased with latitude from the North Pacific Ocean into the Bering Sea, and also showed some variation between years at a given latitude. The estuarine-like dynamics of the Bering Sea appear to cause elevated and more variable $d^{15}N$ values because of more intense nutrient recycling; $d^{15}N$ levels in tissues, therefore, act as both a marker of trophic level and geographic location. Comparison of spring and summer $d^{15}N$ levels in chum salmon caught in the same area of the North Pacific Ocean suggests that chum salmon may overwinter in the Bering Sea and move south into the North Pacific Ocean in the spring. This migration pattern is the opposite of the standard model of chum salmon migration in the North Pacific Ocean.

4AM1995-FIS39
THERMAL LIMITS AND OCEANIC MIGRATIONS OF PACIFIC SALMON

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A series of coordinated joint research surveys by Canada and Japan examined the limits to the distribution of Pacific salmon in the north Pacific ocean since 1992. In addition, all available historical survey data on the distribution and abundance of salmon in the north Pacific and adjacent seas collected by Canada, Japan, and the USA since 1956 were also assembled. These data (N=20,363 observations) demonstrate that there are sharp thermal limits on the distribution of Pacific salmon, and that ocean temperature effects must have therefore played an important role in the evolutionary development of Pacific salmon.

Analysis shows that these thermal limits are:
a) extremely sharp and statistically well-defined,
b) seasonally varying in a regular pattern,
c) expressed as a threshold, with no measurable effect of temperature on distribution except at the edges of the distribution, and
d) largely stable over decades and different areas of the north Pacific ocean.

In order to achieve the observed seasonal thermal limits, salmon must migrate north ca. 1,000 kms through fall and winter to reach cold waters, and then migrate south in the spring and summer into warm waters. This "reverse migration" appears to be unique in the animal kingdom, and contradicts the generally accepted theory that salmon move south in winter and north in summer in a counter-clockwise migration pathway largely unrelated to ocean temperature. The pattern of seasonal and geographic variation in the thermal limits appears be the result of salmon trying to maximize growth relative to the amount of food available in different seasons.

4AM1995-BER22
DISSOLVED SILICA IN BERING SEA DEEP AND BOTTOM WATER

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Neither the enormously high concentrations of silicic acid, higher than in any other ocean basin, nor the source, rate of supply and flushing of the deep and bottom water of the Bering Sea basins have been adequately explained. These questions will be discussed using the available data, and a model describing the silicate distribution is proposed. The source of the Bering Sea bottom water is North Pacific water from ~3500-4000 m depths, which enters through the westernmost pass in the Aleutian-Komandorskiy island arc (Kamchatka Strait) with high silicate concentrations, and then circulates into the other basins. The bottom water slowly displaces the deep water upward; at the same time silicic acid concentrations are increased by regeneration both within the water columns and from the bottom. Model results suggest bottom water regeneration rates are about 4 to 5 times faster than those in the water columns, and that total residence times for the deep water are about 250-300 years. The deep Bering Sea acts like an "appendix" to the North Pacific Ocean -- it may be an important location to monitor certain aspects of both climate change and anthropogenic pollution.

4AM1995-MEQ27

$^{15}N/^{14}N$ ISOTOPE RATIOS IN THE SUBARCTIC NORTHEAST PACIFIC ECOSYSTEMS: NITRATE UTILIZATION AND TROPHIC STRUCTURE

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The $^{15}N/^{14}N$ of dissolved nitrate, size-fractioned suspended particulate organic matter (SPOM) and zooplankton were investigated along a [NO3-] gradient transect (127°W to 145°W) from a wind-driven upwelling coast region to the open ocean, a high nutrient and low chlorophyll region (HNLC), in the subarctic northeast Pacific Ocean. Subsurface nitrate d15N decreased from 5.3o/ooto 3.1o/oo with an average of 4.1 ° 0.9o/oo. However, surface nitrate d15N decreased from 12o/oo to 8o/oo along the same transect as the [NO3-] increased from 3 to 12 mM in spring. Plankton had a similar isotopic trend, decreasing approximately from 8.5o/oo to 3.5o/oo for SPOM and from 11o/oo to 7.0o/oo for zooplankton. More data from two springs and one autumn show three patterns for the relationship between SPOM d15N and [NO3-], which existed in the high-nutrient low-chlorophyll, the coastal and the boundary areas, respectively, suggesting that SPOM d15N was regulated by both nitrate utilization and supply. The 15N-enrichment difference between phytoplankton and zooplankton was 2.2o/oo in the coastal region, but was 3.9o/oo in the open ocean, corresponding to the fact that microzooplankton grazing, which would prolong the food chain, is significant in the open ocean. The d15N range among seven zooplankton groups was 3.7o/oo probably with an increasing hierarchy of: (pteropods, salps, euphausiids, copepods) - (medusas) - (amphipods, chaetognaths).

4AM1995-MEQ28

ANALYSIS OF ECOLOGICAL EIGENVALUE OF PLANKTON DURING RED TIDE OCCURRENCE IN THE XIANSHAN GULF, ZHEJLANG IN 1988

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Red tide occurred three times in 1988 in the Xangshan Gulf on the coast of Zhejiang province. Based on the data from monthly survey, the ecological eigenvalue analyses of plankton with three red tides were made using indices such as biomass, dominance, aggregated intensity and those of communical structure and focusing on the lanktonic status before, during and after algal-blooms. The two red tides occurred in January in the gluf were mainly caused by *Skeletonema costatum*, while the third one in December was almost soly by *Eucampia Zoodiacus*. *Centropages mcmurrich* was the dominant zooplankton found in three accidents. During red tide outburst, the quantity of phytoplankton was 1000 times greater than non-red-tide time; the distribution of dominant species was highly aggregated and the dominance ranged between 80-90%; communical indices of abundance, diversity and homigeneity were low whereas the monohomogeneity was high. It was indicated that if the zooplanktoic populations grow too large during a red tide outburst the recovery of community structure of both phytoplankton and zooplankton disturbed or toppled in the outburst would be retarded seriously.

4AM1995-BIO32

AN ECOLOGICAL STUDY ON ZOOPLANKTON IN MAXIMUM TURBID ZONE OF ESTUARINE AREA OF CHANGJIANG (YANGTZE) RIVER

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The paper deals with biological characteristics and process of biomass, species composition, community structure, etc. of zooplankton in turbidity maximum of the Changjiang estuary area.

The result shows that the average biomass was 98.9 mg/M^3 in flood season. It was much less than that of the volume of biomass (439mg/M^3) in the estuary front area off the Changjiang estuary in the same season. In addition, the number of species composition also was less than that in estuary the front area. Although the community structure of zooplankton took the form of complex structure, the estuary blackness species were dominant. The dominant species were *Labidocera euchaeta, Shmackria poplesia, Tortanus vermiculus*, etc.

The biomass, species composition, dominant species and community structure very obviously with season and tidal variation.

4AM1995-BIO33

AN ECOLOGICAL STUDY ON ZOOPLANKTON IN PLUME FRONTAL ZONE OF CHANGJIANG (YANGTZE) RIVER ESTUARINE AREA III VERTICAL DISTRIBUTION OF DOMINANT SPECIES

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During the periods of flood season August 1988 and dry season December 1988, an investigation of vertical distribution of zooplankton was carried out in the plume frontal zone of estuarine area of the Changjiang River. Samples was vertically collected from 22 stations in 7 sections are as follows:
Period of flood season: *Fanilia avirostris* dominant species is mainly distributed in 10-0 m layer. Its density value at section A reached 1700 ind./m^3. The main distribution of *Calanus sinicus* was obvious at sections A and B. *Sagitta enflata* is mainly distributed in Taiwan warm current and its influencing waters. At section B outside Changjiang estuary, *Sagitta enflata* is mainly distributed above 20 m layer. Its high density, range and layer were related to the high density of *Calanus sinicus* and *Fanilia avirostis*.
Dry season: Based on the analytical results for zooplankton samples of 15 stations at 4 sections, vertical distribution of zooplankton of winter season type as quite different from that of summer type. Layers of vertical distribution of most zooplankton was not obvious. *Labidocera euchaeta* is distributed under 20 m layer at sections A and B but *Calanus sinicus* is distributed above 1 0 m layer.

4AM1995-POC32

THE ICE OF THE SEA OF JAPAN

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The main features of the Sea of Japan ice cover are given in the report. The studied features were the following: time of ice forming, development and drading, peculiarities concentration distribution, ice age and shape, hummocks, ice pressure, diffuse ice, fast ice, drive, thickness and volume of ice forming in sea. The fundamental ice characteristics are presented for severe, medium and mild winter.

The principle attention is paid to winter period, when the maximum distribution of ice cover can be observed in the sea.

4AM1995-MEQ29

DISTRIBUTION AND BEHAVIOR OF BUTYLTIN COMPOUNDS IN ABURATSUBO BAY AND ADJACENT WATERS IN JAPAN

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The concentrations of organotin compounds in seawaters, sediments and organisms have been reported by many researchers. It is recognized from these results that marine pollution by organotin compounds is a serious problem. However the behaviour of organotin compounds in the marine environment has not been demonstrated. Therefore, the distribution, seasonal change and depositional behaviour of butyltin compounds were investigated in Aburatsubo Bay.

The TBT concentration in the surface seawaters was higher than in the bottom waters, and ranged from 10-48 ng/l in the off shore to 230-1400 ng/l at the most inner station in the bay where many pleasure boats are moored. The TBT concentration was higher in June and July than in other months, this seasonal change of TBT is probably related to boat paintings as recognized at Pool Harbor by Langston et al. The TBT concentration in sediments ranged from 0.02 to 2.42 μ g/g, and 100-10,000 times higher than the TBT concentration in bottom seawaters. The TBT concentration in sediments increase toward the inner part of the bay where the sediments contain a large amount of organic materials. 6-44% of TBT in the seawater existed as a particulate form. The TBT concentration decreased gradually in the following order: surface suspended particulate matters (SPM), bottom SPM , deposited materials collected in a sediment trap, and sediments. The present results imply that sedimentation is one of the important pathways removing organotins from seawater.

4AM1995-FIS40

DENSITY-INDEPENDENT NICHE DYNAMICS IN DEMERSAL FISH ASSEMBLAGES: ARE FISH COMMUNITIES SATURATED?

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Density-dependent interspecific competition was examined in shelf/slope demersal fish assemblages off Sendai Bay, Japan. Well-partitioned patterns of resource use have previously been observed in these assemblages. A total of 255 trawls were conducted using research vessels in May and November during 1989 to 1992. From each cruise, the density, distribution pattern and diet were determined for each of the dominant fish species: walleye pollock *Theragra chalcogramma*, Pacific cod *Gadus macrocephalus*, brown hakeling *Physiculus maximowiczi* and threadfin hakeling *Laemonema longipes*. Autecological analyses of habitat and diet revealed that walleye pollock and Pacific cod share similar resources, and are thus potential competitors. A linear regression analysis was then conducted between the density and niche overlaps of the potential competitors. Assuming a density effect on niche dynamics, a negative correlation would indicate the competitors compete exclusively.

The results of the analyses, however, revealed a positive correlation. This suggests that walleye pollock and Pacific cod converge in a common environment, rather than competing exclusively. The present results are ascribed to the unsaturation of demersal fishes in the community: they occur in numbers below the carrying capacity at which competition occurs. This unsaturation was perhaps due to density-independent factors, such as environmental forcing or fishing activities.

4AM1995-BIO34
TESTING CONTAMINATED SEDIMENT ACUTE TOXICITY IN JINZHOU BAY WITH MARINE AMPHIPODS

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Jinzhou Bay sediments contain heavy metals and organic contaminants. To assess the biological effects of these compounds in the sediment, seven sites in a transect cross the bay along SW-NE contaminant concentration gradients were chosen for assessment. Sediment toxicity was measured by conducting 10-day flow - through sediment acute toxicity test with amphipod species *Ampelisca abdita*, the end point was morality. The result of this study showed the mortality was reduced along SW-NE contaminant concentration gradients, which was coincident with the in situ ecological distribution of benthos in the transect of Jinzhou Bay.

4AM1995-MEQ30
ON THE CHEMICAL CONTAMINANTS OF SURFACE SEDIMENTS IN THE SOUTHERN PART OF THE YELLOW SEA

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Surface sediments of the Yellow Sea were investigated for chemical contaminants in April 1994. Sediment COD ranged from 1.15 to 13.63 mg/kg dry wt. with higher values in the central part. High organic carbon and nitrogen contents were also found in the surface sediments of this region. Heavy metal (Cd, Pb, Zn, Ni, Co) contents, though close to naturally found level, showed geographic variations. PAH concentrations were generally low in the surface sediments of the Yellow Sea except naphthalene and phenanthrene which could be detected in the central part. Some organochlorine pesticides such as delta-BHC and dieldrin were found in the central part of the study area.

4AM1995-FIS41
INTERNAL VARIATION IN NEON FLYING SQUID ABUNDANCE AND OCEANOGRAPHIC CONDITIONS IN THE CENTRAL NORTH PACIFIC

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Neon flying squid, *Ommastrephes bartramii*, had been the target species of Japanese squid driftnet fishery in the Central North Pacific during 1978-1992. Interannual variation in flying squid CPUE in this fishery was highly correlated with the Hokkaido University's research driftnet CPUE at 175°E in July when the highest CPUE of the fishery took place. This trend seemed to be strongly affected by surface water temperature structure around the Subarctic Boundary. Importance and possibility for monitoring neon flying squid abundance will also be discussed.

4AM1995-BIO35
PRIMARY PRODUCTIVITY OF THE EAST CHINA SEA

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Being under the influence of several distinctive water masses, the ecosystems of the East China Sea show diverse ecosystem properties. Phytoplankton biomass and primary productivity are among such properties. On the contrary, in the Yellow Sea the spatial and temporal pattern of primary production are rather simple and stratification is the major controlling process. According to the

CZCS images, in the northwest region of the East China Sea, runoffs from the Changjiang river seemed to sustain active primary production during summer, while in the eastern region where the Tsushima Warm Current passes, phytoplankton biomass was kept low throughout the year.

About 20 P-I incubations were made from a summer cruise in 1994 and water column primary productivity was estimated from fluorescence profiles and P-I parameters. The estimates of water column primary productivity ranged from 70 (Kuroshio region) to 726 $mgC/m^2/day$ (Changjiang river plume area).

Deep chlorophyll maximum layers were formed at most of the stations during the summer. Such DCM contribution to the water column primary productivity ranged from 7.6 to 66.2%. The stations in the Kuroshio region showed the lowest values of water column primary productivity because the DCMs were too deep to have enough light for active growth.

4AM1995-POC33
AN APPLICATION OF A THREE-DIMENSIONAL COASTAL OCEAN CIRCULATION MODEL TO THE SOUTH CHINA SEA

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A three-dimensional coastal ocean circulation model is described briefly. The model is a primitive equation, time-dependent, sigma coordinate, free surface model, incorporating a turbulence closure model to provide a realistic parameterization of the vertical mixing processes. An implicit numerical scheme in the vertical direction and a mode splitting technique in time have been adopted for computational efficiency. With the introduction of the realistic coastline and bottom topography which maximum depth is set to 1000 m and the consideration of the effects of nonlinearity, beta plane, wind stress, temperature and salinity, a sixteen level version of the model has been applied to the simulation of the wintertime mean circulation of the South China Sea (SCS). The preliminary results were very encouraging. Driven by the monthly climatological wind stress and temperature and salinity, the quasi-steady state of the circulation showed the features as: a cyclonic eddy occupies the whole SCS in the upper layer which was in good agreement with the observed results; there existed a vertical shear of the current, the current pattern in the lower layer was different to that in the upper layer, there was an anticyclonic eddy in the 800 m depth; the SCS Warm Current was well produced in the simulation; some mesoscale vortexes were also reflected. Preliminary discussion of the dynamic mechanism of the circulation has been made: the topography played an important role in the existence of the current patterns, the effects of the temperature and salinity was considerable.

4AM1995-POC34
THE CIRCULATIONS EAST OF TAIWAN AND IN REGIONS WEST AND EAST OF THE RYUKYU ISLANDS DURING EARLY SUMMER 1985

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A modified inverse method was used to compute the circulations east of Taiwan, in the East China Sea and east of the Ryukyu Island from hydrographic data obtained during the early summer of 1985. The computational region covers and area west of 129°E and from 21°45'N to 35°N. The computed results showed that: 1) The volume transport (VT) through section 21°45'N east of Taiwan was about $24X10^6$ m^3/s during early summer of 1985. The Kuroshio had two current cores. One was located near Taiwan, and its velocity was very large and its maximum velocity was 226 cm/s at the 100m level, which is close on the maximum velocity of the beginning of the Kuroshio east of the

Philippines. The other was located further to the east, and its maximum velocity is 159 cm/s; 2) Through a transect northwest of Miyakojima Island and a transect southwest of Okinawa Island the volume transports of Kuroshio in the East China Sea both were about 24X 10^6 m^3/s. The maximum velocity of the Kuroshio at these two sections was 194 and 128 cm/s, respectively, and both were located on the shelf break; 3) Beneath the Kuroshio there was a southwestward flow. The VT of a countercurrent east of the Kuroshio was about 7.8X10^6 m^3/s; 4) East of Okinawa Island there was a northeastward current, and its VT was about 12.6X10^6 m^3/s, in which its part comes from the recirculation. It has tow current cores. One was located at the subsurface layer near Okinawa Island, and its maximum velocity was 39 cm/s. The other was located further to the east. There was a southwestward abyssal boundary current east of Okinawa Island; 5) There were several different scale eddies in this computational region. For example, at section 21°45'N east of Taiwan there was an anticyclonic warm eddy east of the Kuroshio; there was a meso-scale cyclonic cold eddy east of Miyakojima Island, and the distributions of temperature and density both showed its existence.

4AM1995-POC35

THE MAIN FEATURES OF INTERACTION BETWEEN PHYSICAL AND BIOLOGICAL PROCESSES IN COASTAL, SHELF AND DEEP BASIN WATERS

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There are several scales of interaction between land and ocean. Large-scale interaction is mainly the object of hydrometeorological investigation, but in smaller scales the main objective becomes the study of physical, chemical and biological influence of land on corresponding processes in the ocean.

At present we can see three successive frontal zones, that are due essentially to the land influence: 1) coastal zones, where geochemical barriers are formed by interaction between land and sea waters; 2) shelf-break, where coastal waters interact with deep sea waters; 3) marginal sea boundaries, where the interaction between the sea and open ocean waters takes place.

For all of the indicated zones the specific scales and specific hydrophysical processes can be defined, which are responsible for the most prominent features of bioproductivity in different areas. Analysis of these processes and their effects was made on the basis of complex measurements during 1988-1991 in estuaries of rivers Amur, Yangzi and Mecong, and in shelf zones of Japanese and Okhotsk seas.

4AM1995-POC36

THE METHANE DISTRIBUTION IN COASTAL MARINE

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Mapping of methane in the ocean can help us to understand various processes that produce or remove it. In this paper, we present the distribution of methane, discuss the relationships between methane and other factors (temperature, salinity, oxygen, nutrients, CHL a and so on) and estimate its ventilation to the atmosphere in Tokyo Bay, East China Sea, Hamana Lake and Ise Bay (in Japan) during 1993-1995. These results suggested that:

1. The surface concentration of methane was greater that atmospheric-equilibrium concentration of methane. The highest levels were found along the coast.
2. The relationships between methane and other parameters exhibited good correlation. The methane distribution was mainly controlled by physical oceanographic processes.
3. The bottom maximum, which we attributed to input of methane to the water column from the anoxic sediment, was found in some stations.

4. There was a correlation between methane concentration and Chlorophyll *a* at some station. It was postulated that some methane was produced in situ.
5. Extrapolation of methane emission data from this study indicates that the annual fluxes of methane to the atmosphere were calculated to be 0.58 Tg for estuary, 0.41 Tg for shelf and 2.11 Tg for open ocean.

4AM1995-POC37
THE STRATIFICATION CONDITIONS FOR DOUBLE-DIFFUSIVE PROCESSES IN THE NORTH PACIFIC ALONG 50°N

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The general characteristics of the North Subarctic Pacific are that colder, fresher (dichothermal) waters overlies warmer, saltier (mesothermal) water below. The water column between subsurface temperature minimum and intermediate temperature maximum is stable because salinity distribution has a stabilizing influence on the density. These properties distribution are appropriate for the double-diffusive convective instability. Diapicnal fluxes of heat and salt, related with double-diffusive processes are typically much greater than the fluxes resulting from molecular diffusion.

The CTD-data obtained during INPOC cruises in the North Pacific along 50°N (1991-1993) was used to calculate Turner angle in the layer between subsurface temperature minimum and intermediate temperature maximum.

Large fractions of the water column between the subsurface temperature minimum and the intermediate temperature maximum can be involved in double-diffusive convection. The favourable stratification conditions for salt fingers were limited in space and related to intruise finestructure.

Most favourable stratification conditions for double diffusive convection were formed in the area between Kuril Islands and 160°E. This water was defined as East-Kamchatka subtype of Subarctic thermohaline structure and it was characterized by strongly marked dichotermal stratum with extremely low temperature and deepest depths of the intermediate temperature maximum. The less pronounciated area was located between 170 W and 160 W and related to strong intrusive layering in the recirculation area of the Alaska Stream.

From INPOC data the hydrographic evidence for double-diffusive convection was not clear because diffusive-convective staircase was not found. However, the temperature and salinity profiles exhibited irregular steppiness and numerous temperature inversions due to intrusive layering. These features of the vertical thermohaline structure and favourable background stratification conditions allowed characterization of the region near Kuril Islands as an area where double-diffusive convection was at least theoretically possible and diffusive convection can be a potential important processes affecting the enchanced vertical fluxes of heat and salt from the warm and salty intermediate water upwards towards cold and fresh subsurface layer.

4AM1995-POC38
THE SURFACE FLUX OF CARBON DIOXIDE OVER THE SHELF EDGE REGION IN THE EAST CHINA SEA

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The CO_2 exchange between atmosphere and seawater has been discussed. The physical process of exchange at sea surface can be related closely with the atmospheric forcing. We report the result of a dynamics analysis of the CO_2 flux across the sea surface, and a computed example over the shelf edge area of the East China Sea.

The analysis and calculation show that the CO_2 vertical flux at seawater was mainly dependent on the CO_2 concentration difference between seawater and the atmosphere, and its exchange was coefficient affected by the wind velocity and temperature. This flux increased quickly fast with the increase of wind velocity, but with the increase of temperature was small.

During the three expeditions in October 1993 and April and October 1994, the CO_2 vertical flux at sea surface was directed downward over the shelf edge of the East China Sea. Because the CO_2 partial pressure difference between seawater and atmosphere was negative and the flux value was -45.5$\mu g\ m^{-2}h^{-1}$ average.

4AM1995-BER23

CHANGES IN MORTALITY, GROWTH, RECRUITMENT, AND SPATIAL DISTRIBUTION OF CRABS IN THE EASTERN BERING SEA: DENSITY-DEPENDENT EFFECTS OR ENVIRONMENTAL REGULATIONS?

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We examined the effects of density-dependence on population parameters and spatial distributions of the red king crab *Paralithodes camtschaticus* and Tanner crab *Chionoecetes bairdi* populations in the eastern Bering Sea. During the past three decades, abundances of these two crab populations fluctuated a great deal, with a more than 20-fold difference between the peak and low crab abundances. Changes in population abundances were accompanied by changes in the population parameters (natural mortality, growth and recruitment) and spatial distribution of crabs. During a period of rapid increase in population abundance, natural mortality is generally low and growth rate is very high. At the same time crabs expand their spatial distributions greatly. When population abundances peak, natural mortality increases dramatically and growth rate decreases. Subsequently as population abundances decline, spatial distributions of crabs begin to contract. Strong recruits to crab populations generally occur under intermediate or low spawning stocks, and poor recruitments generally are associated with extremely low or high spawning stocks. However, recruits are highly autocorrelated. The density-dependent influences on the population parameters, especially recruitment, are confounded with the effects of environmental conditions.

4AM1995-MEQ32

EFFECT OF AQUACULTURE ON THE SANGO BAY ECOSYSTEM

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The Sango Bay is a semi-closed bay located in the east of Shandong Peninsular, People's Republic of China. More than 20 species including the shellfish and algae are maricultured in this bay, which covers more than 30% of ca. 133.4 km^2 sea waters.

Year-round monthly investigation were twice carried out in 1983-1984 and 1989-1990 respectively, in order to find out the effect of aquaculture on the ecosystem. From the data, the process of biological, physical and chemical oceanography, we identified the variation in the composition and structure of the Sango Bay ecosystem.

1. Increased eutrophication process, including the increased concentrations of COD and nutrients, etc., due to increased animal excretion, discharged waste water from shrimp aquaculture pond and reduced water exchange between inside and outside of the bay.
2. Variation in the community of phytoplankton, zooplankton and benthos was due to the introduction of a large amount of new species and variation of the environment.
3. Feedback from the changed ecosystem on the aquaculture, resulted in a decrease of production and quality of aquaculture species.

4AM1995-MEQ33
BENTHIC FORAMINIFERS AS INDICATORS OF MARINE POLLUTION: AN EXAMPLE FROM LIANYUNGANG PORT, JIANGSU, CHINA

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Both environmental scientists and biologists have been paying attention to the impacts of marine pollution on marine organisms. Few of them, however, have recognized foraminifers as an indicator of marine pollution. Fortunately, marine micropaleontologists have found foraminifers are sensitive to marine pollution. As a pollution indicator, foraminifers virtually have many advantages. Worldwide, the existing work correlated foraminiferal response to marine pollution (of organic matter or heavy metals). However, researchers did not consider the chemically existing forms of the pollutants. In fact, the toxic effects of heavy metals on aquatic life are not always correlative to the total element amount. By contraries, they are largely controlled by certain chemical states.

In our present studies, we correlated different chemical states of pollutants and their concentrations to the foraminiferal features (including taxonomic composition and distribution, test abnormalities and abundance) by using computer statistical analyses. A series of multiple regression equations (R-SQ: 0.9971-0.7738) were established based on a set of field data and laboratory analyses. With the equations, we calculated the pollutant concentrations and their chemical forms from foraminiferal analyses data. The results showed foraminiferal analysis were applicable and potential in marine pollution monitoring.

4AM1995-MEQ31
ANALYSIS OF DATA ON METAL ACCUMULATION IN AHNFELTIA TOBUCHIENSIS IN STARKA STRAIT

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Concentrations of Ahnfeltia in Peter the Great Bay are located in contact zone of land and ocean - in zone of high productivity and intensive anthropogenic influence. Flows of all kinds of toxicants entering to sea from different sources are concentrated just in this zone.

In this connection exposure of correlation of level of physiological and chemical process functioning in biological organisms with level of metal presence in environment should allow to increase forecast data base of species existence.

Samples have been collected from at 20 stations: 7 -near Daragan Cape, 7 - near Ivantsov Cape, 6 - near Engelm Island. It was found the heightened content of Fe, Zn, Mn in algae taken near Daragan Cape, Fe and Zn are components, mainly, of local pollution, formed by direct influence of definite factors. LPD (limited permissible concentration) for them exceeded 7 and 17 times accordingly. In parallel with the typical dichotomy it was observed the anomal "rossetted" branching (number of appendages in "rossett" are 3-12) in algae from the side of slip of fish factory ship "Popov". Analogous phenomenon was noted at experiments on studying the influence as complex so some metals in different concentrations on physiological state of ahnfeltia. A wide range of accumulation coefficients was found for Mn, sometimes the reverse connection was observed to be between metal content in water and algae. Cd and Cu concentrations of investigated area were subjected to insignificant fluctuations. It arouses anxiety the availability of high concentration of lead (up to 310mkg Pb/g of dry matter) near Ivantsov Cape. Pb is present in coastal waters, mainly, in suspended form and possesses the less migration avility than other elements, that is why, pollution is local. Mercury, belonging to priority of pollution matter, occurred only at some stations, but its absence even as traces has unfavorable influence on biological organisms. Comparison of algae samples has shown

that for each 100g of algae taken near Ivantsov Cape there are 15.5% of dead thalluses, whereas near Engelm Island it is 11%, and near Daragan Cape - 4.5%.

4AM1995-BIO36

REGRESSION CORRELATIONS IN SUMMER MEZOPLANKTON COMMUNITY OFF SOUTHERN KURIL ISLANDS (NORTH-WEST PACIFICA)

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The main feature of plankton communities summer succession in subarctic zone is vernal bloom of phytoplankton vanishing that is succeeded by "blooms" of certain zooplankton groups. We tried to monitor this process off southern Kuril Islands on the data of wet plankton biomass obtained during 18 surveys in July-October of 1980 and 1988.

It was found that the time of phytoplankton bloom finish was determined by critical value of water column vertical stability, and times of certain zooplankton species' "blooms" (*Calanus plumchrus, Eucalanus bungii, Euphausia pacifica, Parasagitta elegans*) were determined by certain values of surface water layer temperature. Biomass changes for other investigated species (*Metridia pacifica, Oithona similis, Pseudocalanus minutus, Calanus cristatus*) did not have any similar successive regularities. The values of biomass of each species on every stage of succession depended on some oceanographical parameters and the abundance of other species. These relations (synchronic and asynchronic) were determined by statistical methods, and their biological interpretation was discussed. (Examples of relations: *C.plumchrus, P.minutus* ->phytoplankton (negative); phytoplankton -> *E.bungii* (positive); *P.minutus* -> *O.similis* (positive); *C.plumchrus, E.pacifica* ->*P.elegans* (positive); *O.similis* -> *E.bungii* (negative) e.t.c.).