North Pacific Marine Science Organization

Eleventh Annual Meeting

program

abstracts

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Table of Contents

Abstracts are sorted first by session and then alphabetically by the main author's last name. Presenter's names are in bold print. The Index of Authors lists all authors, including co-authors, in alphabetical order. Paper numbers and page numbers are also listed in the Index of Authors. Some of the abstracts in this collection have not been edited and have been printed in the condition that they were received.

Keynote Address

11AM2002 KA-347
THE OCEAN'S ROLE IN GLOBAL CHANGE: GLOBAL OCEANOGRAPHY HAS COME

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The ocean occupies 71% of the earth surface so it plays very important role in many aspects of global change.

The ocean is not only the main source, but also purifier of global fresh water. The ocean receives human-polluted water from land, provides the atmosphere purified fresh water through evaporation, making the global water cycle completed. What would happen to global water cycle with continuous decrease of riverine water discharge by dam construction, irrigation and so forth?

The ocean is not only a component, but also the main regulator of global climate system. Because of its huge heat capacity, thermal inertia and circulation characteristics, the importance of the ocean in global climate change has been recognized through TOGA, WOCE and CLIVAR. What should man do to further understand the ocean's role in global climate change, even beyond CLIVAR?

Ocean carbon cycle is an important integral part of global carbon cycle, which is one of the main issues of global change, associated with global warming. How much have we known about ocean carbon cycle? What should we do after JGOFS? And can we foresee how the ocean carbon cycle change with global warming?

The ocean will be the main protein source for humans. With global change, especially anthropogenic impact, can living marine resources be sustainably preserved in the future? What could and how should we do beyond GLOBEC for living marine resources?

In the present lecture, a review and prospect are made on the issues in the ocean, such as climate, fresh water, carbon cycle and living resources, *etc.*

In sum, global change is a big challenge to oceanography and at the same time provides good opportunity for it, which has made global oceanography come into being.

PICES XI
Abstracts

S1 Science Board Symposium
Technological advances in marine scientific research

Co-convenors: R. Ian Perry (SB), Vladimir I. Radchenko (BIO), Douglas E. Hay (FIS), John E. Stein (MEQ), Kuh Kim (POC), Igor I. Shevchenko (TCODE), Harold P. Batchelder and Makoto Kashiwai (CCCC)
Monday, October 21, 2002 11:00-17:30

This symposium will explore the potential for new technologies to advance the scientific activities conducted by PICES researchers. Technological advancements are occurring in a variety of research areas. For example, microscopic laser ablation techniques, nuclear DNA techniques, 'smart' tags, and acoustical tags for fish and mammals, are all improving stock identifications. For population assessments there are new developments in laser technology that can scan the upper 20-30m from aircraft and satellite technology and associated data analyses. Plankton studies are advancing through bio-optical recording and analysis systems. There are continuing developments in acoustical tools, such as towed vehicles with upward- and downward-looking transducers, and long-range sidescan SONAR. Some of the most rapid advancements are occurring in physical oceanography with the development of 'smart' drifters. New chemical techniques are also being developed to assess stable organochlorines, with implications for marine mammals and human health. This emphasis on technological advancements also includes new developments in information technology, numerical modeling, data processing and visualization. Invited talks on some of the most recent advancements in the scientific areas of physical/chemical oceanography and climate, biological oceanography, fisheries science, marine environmental quality, and ecosystem dynamics will be presented.

11:00-11:30	**Stephen C. Riser** (invited) Building a global ocean observing system with profiling floats (S1-016)
11:30-11:50	**Masafumi Kamachi, Tsurane Kuragano, Xiaobing Zhou, Yosuke Fujii** JMA operational ocean state estimation and prediction system in the North Pacific: COMPASS-K (S1-012)
11:50-12:10	**Alexey Ilyin, Oleg A. Bukin, Sergey S. Golik, Vladimir I. Tsarev, Alexander Yu. Major** Investigation of marine water and phytoplankton elemental composition by laser-induced breakdown spectroscopy (S1-009)
12:10-12:30	**Albert J. Hermann, C. Moore, Nancy N. Soreide** Recent advances in immersive visualization of ocean data: Virtual Reality through the web on your laptop computer (S1-007)
12:30-13:30	**Lunch break**
13:30-14:00	**Poster previews**
14:00-14:30	**Joji Ishizaka, Hiroshi Kawamura** (invited) Near future opportunities in satellite remote sensing of physical and biological properties of the Ocean (S1-011)
14:30-15:00	**Tommy D. Dickey** (invited) Toward global ocean interdisciplinary observations using emerging autonomous sampling technologies (S1-005)
15:00-15:20	**Coffee/tea break**
15:20-15:40	**Oscar M. Schofield, Scott Glenn** Development of coastal ocean observatories for synoptic oceanography (S1-017)
15:40-16:10	**Gabriel Gorsky** (invited) Can optical methods quantify, measure and classify zooplankton efficiently? (S1-006)

16:10-16:30 **Sukyung Kang, Suam Kim, David Welch, Kevin Telmer, Youn-Ho Lee**
The analysis on trace elements in chum salmon otolith using laser-ablation technology: Habitat characteristics and stock identification (S1-013)

16:30-16:50 **Jeffrey J. Polovina, Don Hawn, Evan Howell, Michael Seki**
A new approach to fisheries oceanography with advances in electronic tags (S1-015)

16:50-17:20 **Neville R. Smith** (invited)
Ocean Information Technology: Some new opportunities for marine data management (S1-018)

17:20-17:30 **Discussion**

Posters:

Irina Y. Bragina, Valery N. Chastikov
The experience of the optical plankton counter TRAP -7A application in the Okhotsk and Japan Seas, 2001-2002 (S1-001)

Irina Y. Bragina, Gennady A. Kantakov
The results of McLane Autonomous Zooplankton Sampler Application in the Okhotsk Sea, 2000-2001 (S1-002)

Yang Ho Choi, Young Jae Ro
Web-based realtime monitoring of water quality conditions in the Korean coastal waters (S1-003)

Joseph C. Huang
Revisit OTEC System (S1-008)

Katsumi Matsushita
An applicable automatic continuous sampling method of small pelagic organisms (S1-014)

Donghwa Sohn, Sukyung Kang, Suam Kim
Trace element analysis for the stock identification of Chum salmon (*Oncorhynchus keta*) in Korea (S1-019)

Vladimir N. Vologdin
Technique of a combined research of near-surface fish formations behaviour and structure with the help of sonars and echosounders (S1-020)

David W. Welch
POTENT: The Pacific Ocean Tracking & Evaluation NeTwork description & applications in marine science (S1-021)

11AM2002 S1-001 Poster

THE EXPERIENCE OF THE OPTICAL PLANKTON COUNTER TRAP -7A APPLICATION IN THE OKHOTSK AND JAPAN SEAS, 2001-2002

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"TRAP - 7A" – is an optical plankton counter that estimates the size-quantitative mesozooplankton characteristics up to the depth of 2000 m in the structure of sounding or towed measuring complexes. The optoelectronic sensor uses a shadow method as its optical principle of measuring. Similar optical counters such as "TRAP - 4" and serial device "OPC" (Focal Technology, Canada) use a similar method, however the "TRAP-7A" has some important advantages:

1. an optical way of the measuring volume formation is applied. Thus, the flow tunnel and concentrating devices are not required that removes problems connected with the influence of hydrodynamics and mechanical influence on plankton behaviour;
2. the infared-range is chosen for emanation, it raises the contrast of particle shadow and liquidates the parasitic light-striking problem, allowing more effectively to use an optical way of the measuring volume formation;
3. the pulse mode of emanation and photosensor with storing are used. In the OPC "TRAP-7A" i.e. the snapshots of the measuring volume contents are made with frequency of laser pulses;
4. the photodiode ruler is used as the photosensor, that practically excludes the influence of particle transparency degree on results of measurements.

Since April 2001, an *in situ* optical plankton counter "TRAP – 7A" (minimal opaque particle size 125 mm equivalent spherical diameter, maximum – 16mm) has been deployed for soundings on the ICTD-frame and zooplankton has been collected simultaneously (Juday net, 112μm - mesh size, total vertical hauls). The regions of deployment included shallow Aniva Bay (to bottom), the southwestern part Sea of Okhotsk and the northern part Sea of Japan (to 500m) at standard stations. The goal of the present investigation is the determination of the objects of sensing by the OPC "TRAP – 7A" and the field of foregoing optical device application.

The number of particles sensed optically were compared with the number and size of zooplankton individuals from Juday net hauls determined by standard methods. The average sizes of these groups were collated. There were significant differences of parameters, such as the number and average size of plankters and particles sensed by the "TRAP-7A". The given fact allows to assume that the object of the OPC "TRAP-7A" sensing is the seston. However, the profiles of particles (3-10 mm) determined with the "TRAP-7A" coincide with the presumptive distribution of dominant species (*Metridia okhotensis, M. pacifica, Pareuchaeta japonica, Calanus glacialis*, etc.), in accordance with the dynamic processes in each of the experimental points. Opportunities for the application of OPC for maintaining the original method of study the spatial - temporary zooplankton distribution / or the auxiliary optical device are discussed.

11AM2002 S1-002 Poster

THE RESULTS OF MCLANE AUTONOMOUS ZOOPLANKTON SAMPLER APPLICATION IN THE OKHOTSK SEA, 2000-2001

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Since 2000 the seasonal dynamics of zooplankton communities in the southwestern Okhotsk Sea have been studied using an Autonomous Zooplankton Sampler (McLane ZPS 6-50). The following activities occurred:

1. test sampling in shallow bays (Aniva, Terpeniya), accompanied by Sea Lion ROV surveys to control the sampling process;
2. diurnal tests in sounding regime on standard horizons of 225-0 m layer in deep-water part of the Okhotsk Sea;
3. autonomous sampling from July 2000 to March 2001 in La Perouse Strait. One of the purposes of this investigation was to study zooplankton development during ice formation and ice cover destruction. The series of autonomous samplings were executed simultaneously with measuring of oceanographic parameters by means of multiparameter sonde of seawater quality (YSI 6600) and current meter (3-D single-point Sontek Argonaut – MD).

As a result of analysis of collected samples, there were determined the specific composition, plankters concentration, and its biomass. The correlation between received oceanographic data and sampling results, also probable constructive changes of the foregoing sampler, range of its application are discussed.

11AM2002 S1-003 Poster

WEB-BASED REALTIME MONITORING OF WATER QUALITY CONDITIONS IN THE KOREAN COASTAL WATERS

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This study is based on the operational realtime monitoring system for the water quality conditions in Korean coastal waters at two locations. To establish warning system for harmful algal bloom and other emergent episodes for local fishery farming, it is necessary to obtain very detailed information for abrupt change of water quality conditions. To make effective warning messages possible, required such information is required on a realtime basis. This study developed a realtime monitoring system of oceanic conditions (current, sea level, salinity, dissolved oxygen, turbidity) in the Chunsu Bay and the Namhae Bay, western and southern coastal waters of Korea, respectively. The system consist of three major subsystem of data loggers with sensor array in the sea water, to which wireless internet data terminal such as pda is connected and host computer on the remote location. The system produces the database of oceanic conditions with sampling interval of 10 minutes continuously. Realtime monitored data can be browsed on the Internet web pages in terms of text and graphics with query function for the existing database. The display pages contain the time series plot of temperature and other conditions, statistics of data-based parameters, recall of the past parameters, etc. In this study, we will describe seasonal and high frequency variation of temperature as well as other oceanic conditions in terms of descriptive statistical parameters and spectral analyses. Results of multivariate analyses will be given with emphasis of regressing time series of dissolved oxygen to various oceanic processes. In particular, episodes of oxygen depletion in summer season will be highlighted and is attempted to forecast with a stochastic model.

11AM2002 S1-005 Invited

TOWARD GLOBAL OCEAN INTERDISCIPLINARY OBSERVATIONS USING EMERGING AUTONOMOUS SAMPLING TECHNOLOGIES

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There is need to greatly increase the variety and quantity of ocean measurements in order to make progress in solving problems such as global climate change, carbon cycling, variabilities in biomass and fish abundances, harmful algal blooms, and generally ocean prediction. It has become clear that data sets need to be interdisciplinary, collected concurrently, and span ten orders of magnitude in time and space scales if we are to observe, understand, and model key processes. Emerging technologies have recently enabled interdisciplinary sampling of the ocean with unprecedented resolution in time and space. Autonomous sampling of interdisciplinary variables can in principle be done using complementary platforms including moorings, drifters, profiling floats, gliders, and autonomous underwater vehicles (AUVs). Autonomous measurements now include several chemical, bio-optical, and biological as well as physical variables. Moorings have been used to test many of the sensors and systems that will be transitioned to other autonomous sampling platforms. Highlights of interdisciplinary mooring time series and AUV spatial mapping from coastal and open ocean environments results are presented. Processes that have been studied using these data include: sediment resuspension, bio-optical variability, ocean response in the wakes of hurricanes, biomass and primary productivity variability associated with eddies and fronts, tropical instability waves, Kelvin waves, ENSO, and monsoonal phenomena. Our results suggest the power of fusing new observational and modeling approaches and strategies. These include utilization of *in situ* and remote sensing data sets, inverse methods, data assimilation models, and adaptive sampling.

11AM2002 S1-006 Invited

CAN OPTICAL METHODS QUANTIFY, MEASURE AND CLASSIFY ZOOPLANKTON EFFICIENTLY?

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The need to understand and predict how global change will affect the abundance, diversity and productivity of marine populations is clearly identified by the international community. Zooplankton are the most important prey for larval and juvenile fish. They are especially sensitive to physical processes such as currents, turbulence, and light and temperature regimes. Variability in these physical conditions may affect the stability of biological processes. The Global Ocean Ecosystem Dynamics (GLOBEC) and the Census of Marine Life (CoML) are conceived as decade-long programs aimed to enlarge our understanding of the structure and functioning of the global ocean ecosystem and its response to physical forcing. These projects also strive for promoting the funding of research that assesses and explains the diversity, distribution and abundance of species throughout the world's oceans. These programs depend in a large part of the design and implementation of innovative biological sampling techniques for the marine environment and the design and implementation of databases.

Zooplankton is traditionally sampled by nets and sorted by trained operators. Since the mid 20th century a substantial technological effort has been invested in the development of electronic and optical sensing systems for zooplankton. This effort is strongly related to the evolution in electronics, computer and imaging technologies. Presented here is an overview of methods used for quantification and classification of zooplankton, from simple counters to holography. Results obtained by prototypes of new instruments and future trends in optical methods will be discussed.

11AM2002 S1-007 Oral

RECENT ADVANCES IN IMMERSIVE VISUALIZATION OF OCEAN DATA: VIRTUAL REALITY THROUGH THE WEB ON YOUR LAPTOP COMPUTER

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Ocean circulation is irrefutably three dimensional, and powerful new measurement technologies and numerical models promise to expand our three-dimensional knowledge of the dynamics further each year. Yet, most ocean data and model output is still viewed using two-dimensional maps. Immersive visualization techniques allow the investigator to view their data as a three dimensional world of surfaces and vectors which evolves through time. The experience is not unlike holding a part of the ocean basin in one's hand, turning and examining it from different angles. While immersive, three dimensional visualization has been possible for at least a decade, the technology was until recently inaccessible (both physically and financially) for most researchers. It is not yet fully appreciated by practicing oceanographers how new, inexpensive computing hardware and software (e.g. graphics cards and controllers designed for the huge PC gaming market) can be employed for immersive, three dimensional, color visualization of their increasingly huge datasets and model output. In fact, the latest developments allow immersive visualization through web servers, giving scientists the ability to "fly through" three-dimensional data stored half a world away. Here we explore what additional insight is gained through immersive visualization, describe how scientists of very modest means can easily avail themselves of the latest technology, and demonstrate its implementation on a web server for Pacific Ocean model output.

11AM2002 S1-008 Poster

REVISIT OTEC SYSTEM

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The earth, covered more than 70.8% by the ocean, receives most of its energy from the sun. That same percentage represents solar energy absorbed by the earth that hits the ocean's surface, most in the tropical region. The thermal energy replenished each day by the sun in tropic oceans represents a tremendous pollution-free energy resource for

human civilization. Ocean Thermal Energy Conversion (OTEC) technology refers to a mechanical system that utilizes the natural temperature gradients that exist in the ocean between the warm surface water and the deep cold water, to generate electricity and produce other by-products. The science and engineering behind OTEC have been studied since the early eighties. There are generally three types of OTEC cycles: closed-cycle plants utilize the evaporation of a working fluid, such as ammonia or propylene, to drive the turbine engine; open-cycle plants use steam from evaporated water to run the turbine, and hybrid-cycle plants combine the two. OTEC requires very low operation and maintenance costs and NO fuel consumption.

OTEC possesses formidable potential capacity for renewable energy and offers a total elimination of greenhouse gases in producing power. In addition to electricity and drinking water, OTEC can also produce many valuable by-products: such as hydrogen, air-conditioning, aquaculture, fishery farming, etc. The potential of these by-products, especially aquaculture and fishery farming, can easily translate into billions of dollars in business opportunities. This paper will examine major advancements in technology, evaluate costs and effectiveness, and assess overall market environment of the OTEC system.

11AM2002 S1-009 Oral

INVESTIGATION OF MARINE WATER AND PHYTOPLANKTON ELEMENTAL COMPOSITION BY LASER-INDUCED BREAKDOWN SPECTROSCOPY

Alexey A. **Ilyin**, Oleg A. Bukin, Sergey S. Golik, Vladimir I. Tsarev and Alexander Yu. Major
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Quantitative elemental analysis of marine water and phytoplankton was investigated using laser-induced breakdown spectroscopy during expedition in the Sea of Okhotsk in 2000 – 2001 (Supported by Grant No. C0148 "Integracia" program). Emission line Ba II 455.4 nm was detected in phytoplankton and in marine water from Cape Terpeniya to the oil-platform Moliqpack. Ba concentration varied from 0.2% up to 1% in phytoplankton and from 0.01% up to 0.2% in marine water. High concentration of Ba was revealed near oil-platform Moliqpack. The concentration of Ba in phytoplankton exceeds concentration in the marine water. The complex shape of laser pulse (several Q-switching pulses above free oscillation background) was used to improve contrast of emission lines. The detection limit for Na, Ca, Mg, Fe, Ba, Cu, Al, Zn is demonstrated. The technique of multi-pulse excitation without temporal signal selection ensures the approximately same detection limits, as well as in case with intensified CCD camera for such elements as Na, Ca, Mg and Ba. Emission line Na I 590 nm was used to compare measurements of marine water salinity. It was registered good agreement of LIBS and salintest measurements. Weak Na concentration was obtained in Sakhalin Bay where the Amur River drains.

11AM2002 S1-011 Invited

NEAR FUTURE OPPORTUNITIES IN SATELLITE REMOTE SENSING OF PHYSICAL AND BIOLOGICAL PROPERTIES OF THE OCEAN

Joji **Ishizaka**[1,3] and Hiroshi Kawamura [2,3]
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Satellite remote sensing of the physical and biological properties of the ocean is now matured phase. Thermal infrared data is popular to detect sea surface temperature (SST), and nearly 20 years of global time series is available. Passive microwave sensors can now measured sea surface temperature under the cloud although the resolution is lower than the infrared. Combining infrared and microwave data makes far more complete sea surface temperature data set. Active microwave altimeter can detect the sea surface topography and scatterometer can measured sea surface winds. All of those satellite sensors for physical properties are now operational, and the data are starting to be assimilated to numerical models for prediction of the ocean state. In terms of the biology, ocean color satellites can detect chlorophyll concentration as an indicator of phytoplankton biomass and nearly six years of global time series have been accumulated. The time series can be analyzed to understand the interannual variability of chlorophyll and primary production with present and future algorithms. Algorithms for open ocean chlorophyll are fairly robust, and accurate detection of chlorophyll concentrations from the optically complex coastal waters is

the challenge. Concurrently estimated suspended solid and colored organic matter for those areas are anticipated as new products. Detection of specific species or group of the phytoplankton is also expected.

11AM2002 S1-012 Oral

JMA OPERATIONAL OCEAN STATE ESTIMATION AND PREDICTION SYSTEM IN THE NORTH PACIFIC: COMPASS-K

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An ocean data assimilation system, COMPASS-K (the Comprehensive Ocean Modeling, Prediction, Analysis and Synthesis System in the Kuroshio-region), has been operated in Japan Meteorological Agency (JMA). The purposes of the system are to understand ocean variability in the western North pacific as a local response to a global climate change with assimilated four-dimensional data sets, nowcasting and forecasting of ocean states, and a contribution to the GODAE project. The model is an eddy permitting MRI-OGCM. Subsurface temperature and salinity fields are calculated by combining the TOPEX/POSEIDON altimeter data, satellite SST, subsurface ship and ARGO float data with a four dimensional optimum interpolation (4D-OI) method. Seasonal and interannual variabilities in the western North Pacific are investigated in reanalysis experiments from 1993 to 2001. Realistic space-time distribution of the physical quantities, the path of Kuroshio and its separation from Honshu are captured well. Prediction Experiments are also reported. Single trajectory and ensemble forecasts show that the system predicts the Kuroshio meander for 60 days. We also discuss the metrics for the prediction.

11AM2002 S1-013 Oral

THE ANALYSIS ON TRACE ELEMENTS IN CHUM SALMON OTOLITH USING LASER-ABLATION TECHNOLOGY: HABITAT CHARACTERISTICS AND STOCK IDENTIFICATION

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The otolith has been used to identify the age of fish, but the interest as a metabolically inert environmental recorder has accelerated in recent years. To identify the stock and habitat characteristics of chum salmon (*Oncorhynchus keta*) in the North Pacific Ocean, the composition of Ca and some trace elements (Mn, Zn, Sr) in otoliths was measured. Salmon otoliths were obtained from in the eastern (Canada and USA) and western (Japan and Korea) North Pacific during 1997-1999 spawning seasons, and laser ablation inductively coupled plasma mass spectrometry (LA-ICPMS) was used to differentiate chemical composition between stocks. Under the microscopic control in laboratory, laser beamed to the otolith from the primordial area to margin. Sr/Ca ratios, known as an indicator of salinity, were low at primordial area, increased suddenly at certain point, and oscillated periodically toward the margin corresponding to year-ring. Some examples from the eastern Pacific salmon indicated the estuarine type of Sr/Ca profile when young salmon resided near the coastal areas. Also, the zinc profiles oscillated and corresponded to the annual ring of the otolith. However, the profiles of Sr and Zn were oppositely oscillated after salmon migrate to the saline water, and the concentration of zinc declined toward rim of the otolith. By examining the patterns of profiles, it would be possible to distinguish habitat characteristics and salmon stocks.

11AM2002 S1-014 Poster
AN APPLICABLE AUTOMATIC CONTINUOUS SAMPLING METHOD OF SMALL PELAGIC ORGANISMS

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Heterogeneous distribution (i.e. patchiness) has an important role in early survival of small pelagic organisms in relation to the encounter phenomenon of prey and predator. Continuous sampler and/or systems are indispensable to detect the patchy distribution. Continuous samplers also have an important role in monitoring fluctuations of organisms in the ocean. Though some sensors were developed to know the distribution and fluctuation, it is necessary to sample since the sample itself has many valuable information. Though continuous sampling is also attained by enthusiastic human efforts, automatic continuous sampler is especially valuable in the place to be impossible admittance and human handling. This automatic continuous sampling method consisted of: (1) a collector of pipe diameter 150 mm, (2) 50 small frame nets, and (3) simple mechanisms to change in order the small net to sampling position and preserved position. This method is applicable to some instruments, sampler on ferry ship, mooring sampler, and vertical profiler on towing vehicle. The field performances (ferry ship type) were carried out on the R/V *Hakuho-maru* (ORI, Univ. of Tokyo). Fish eggs and another plankton patches were detected at some frontal areas.

11AM2002 S1-015 Oral
A NEW APPROACH TO FISHERIES OCEANOGRAPHY WITH ADVANCES IN ELECTRONIC TAGS

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In recent years considerable advances in our understanding of the oceanic habitats of large marine animals have been achieved by sending out fleets of animals instrumented with electronic tags. For example, Argos-linked transmitters attached to sea turtles and archival tags attached to elephant seals have identified specific migration pathways and foraging habitats and strategies. However, until fairly recently tags required that the animal spend time at the surface for position determination and required that they be recaptured to recover the archived data. Now the newest generation of tags use a light sensor to estimate location from day length and time of sunrise and sunset. Further for animals that are unlikely to be recaptured, a tag that detached, floats to the surface and transmits archived data via satellite has been developed. These latest developments in electronic tags are still an emerging technology. Recent applications of these tags will be presented. Their potential and current limitations discussed.

11AM2002 S1-016 Invited
BUILDING A GLOBAL OCEAN OBSERVING SYSTEM WITH PROFILING FLOATS

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Most of what is known about the circulation of the world ocean on large scales comes from shipboard measurements of temperature and salinity collected during the past century. These observations are not of uniform quality, and they are not synoptic. At large spatial scales, observations from satellites can alleviate these problems and provide a useful global ocean observing system, as long as only the upper few centimeters of the ocean are considered. In order to observe the ocean globally and synoptically at greater depths, a different observing system is required. In this talk, profiling float technology, which can be used to build a global observing system capable of making synoptic measurements of both the shallow and deep ocean, will be discussed. The use of this technology will be discussed in the context of Argo, a multi-national project presently deploying 3000 floats over the world ocean during the next 5 years, and other recent profiling float experiments.

11AM2002 S1-017 Oral

DEVELOPMENT OF COASTAL OCEAN OBSERVATORIES FOR SYNOPTIC OCEANOGRAPHY

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The Ocean Sciences Decadal Committee of the United States in laying out future efforts suggested "The very few existing time-series stations paint a compelling picture of important oceanic changes in physics, chemistry and biology. Yet these stations capture the time domain at only a single point. New strategies for observing the appropriate spatial correlation are required." The question confronting the community is how do we get there? Key enabling technologies are opening the door. These include: (1) long-duration moorings or cabled observatories for subsurface time, (2) high-frequency RADARs providing real-time surface current maps over shelf scales, (3) a growing international constellation of high-resolution ocean color satellites, and (4) an emerging class of long-duration remotely-controlled Autonomous Underwater Vehicles (AUVs). The flight patterns of the AUVs will be directed by real-time satellite imagery, providing high resolution maps maps of fronts/slicks, and onboard theoretic decision-making software allowing the AUVs to analyze their own environmental data. Data from the AUVs will be transported back to shore on an hourly basis allowing for vicarious calibration of satellite imagery and adaptive sampling using ships. These real-time data streams are used to feed data assimilative nowcast/forecast models. This observationally rich environment changes the relationship between models and observation. In the well-sampled ocean, forecast errors are dominated by uncertainties in the model formulations or boundary conditions, and ensemble forecasts with differing parameterizations can be compared to observations so as to improve our understanding of errors associated with various model assumptions.

11AM2002 S1-018 Invited

OCEAN INFORMATION TECHNOLOGY: SOME NEW OPPORTUNITIES FOR MARINE DATA MANAGEMENT

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Through the last twenty years, oceanography and the marine environmental sciences have drawn great benefit from advances in technology. This Symposium will hear of several of these, particularly those associated with innovative autonomous observation platforms and novel instrumentation. Elsewhere we will see evidence of the impact of computers and models and new insight afforded by data assimilation. PICES, like many other groups, is drawing great benefit from these advances but it also shares a common, significant challenge: How to ensure these data and advances reach their optimum potential within their own community and, perhaps just as important, are made available to the broader community. The management of data and products, though recognized as fundamental, has not enjoyed the benefits of technological advances to the same degree as the areas mentioned above and is, to some extent, still working to the modes and methods established several decades ago. Many things have changed in that time, not the least being the revolution in information technology. Though we are now starting to see some impacts of this technology, this impact still falls well short of the potential and, more importantly, far short of the need. Among other things, the community needs (i) telecommunications that will permit all data from remote and autonomous platforms to be communicated to laboratories in real-time; (ii) data communication and exchange mechanisms that will allow data and associated products to be shared quickly and easily; (iii) adoption of protocols and formats that are open and widely used, greatly easing the difficulty of access; (iv) recognition of methods and practices that improve quality and add value, and a methodology for representing and retaining that value; (v) data and products servers that provide rapid and functional access for the specialists and, equally, for the itinerant or opportunistic users; (vi) generalized ocean customer and user interfaces that facilitate imaginative and novel use (ocean data "wizards"); and (vii) a community approach that recognizes the value and advantage of ocean information technology and one that demands and values a close working relationships between the scientists and data managers. All of this is within reach *now*. Data managers and scientists within the ocean community have accepted that immediate action is required and have agreed to develop a joint Ocean Information Technology Pilot Project to ensure all of the above needs are fully satisfied before this decade ends. The initial sponsors mostly derive from the global ocean community, with a strong focus on operational activities. However it is also

emphasized that the Project must embrace less conventional data derived from interdisciplinary observations and novel instruments. The Project recognizes that there is considerable strength within regional communities such as PICES and ICES and that it will be important to develop strong partnerships. This paper will discuss the prospects for this Project and actions already underway to deliver the required enhancements. It will note the great potential benefits that could be unlocked by this community approach to data management and discusses some options for PICES involvement.

11AM2002 S1-019 Poster
TRACE ELEMENT ANALYSIS FOR THE STOCK IDENTIFICATION OF CHUM SALMON (*Oncorhynchus keta*) IN KOREA

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To distinguish chum salmon stocks in Korea chemical compositions in otolith and natal stream were examined. Waters from three major streams (Namdae, Maeup and Wangpi) in the eastern coast of Korea were sampled for trace elements twice in October 2001 and March 2002, and otoliths were collected from adult salmon returned in October and hatchery-reared fry in March. Concentrations of trace element were determined using inductively coupled plasma mass spectrometry (ICP-MS) and laser ablation ICP-MS. The chemical compositions of stream water were distinctly different from each other, and chemical composition within a stream did not significantly vary through study period. Some trace elements such as Sr, Ba, and Mn in ambient stream water seemed to be well reflected in otolith of salmon fry, though the absolute concentrations were different. Furthermore, the examination on core portion of adult otolith revealed a similar pattern in microchemistry with that from salmon fry. Therefore salmon stocks might be identified by comparing components of otolith and stream water. Based on results above, considering October and March as the time for homing of spawners and releasing of fry, respectively, we may infer that unique chemical composition of each stream be the one of key factors for salmon homing through odour imprinting.

11AM2002 S1-020 Poster
TECHNIQUE OF A COMBINED RESEARCH OF NEAR-SURFACE FISH FORMATIONS BEHAVIOUR AND STRUCTURE WITH THE HELP OF SONARS AND ECHOSOUNDERS

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From the 1980s to the start of the 1990s in the summer-autumnal period, TINRO research vessels investigated the behaviour and spatial- temporal aggregations of fish schools in the Japan Sea and Pacific Ocean with the help of special hydroacoustic instrument complex, perfected for this purpose. The complex consist of hydroacoustic and navigational gears: circular electronic scanning FSS-32B sonar with the situational display SPD-102P (Japan), CVS-881B sounder (Japan), echointegrator (Norway), Sargan sonar (Russia), Sargan sounder (Russia), MF 220 Log (Japan), SKOL-1200 fishing gear control device (Russia), CVA-017 tape unit (Japan), EY-M scientific sounder (Norway), ADEL Dopler sounder (Russia) and MEIST magnetoelectric meter of a velocity of currents (Russia). A system of agreeing, switching and synchronizing these instruments for the purpose of automating research, elimination of mutual parasites and for simultaneous registration of fish aggregations was developed.

The mode of reminder and repeating map of a situation "FIX" of the display SD-102R and matrix method of copying of an information was used for definition of distribution, sizes of fish schools and other objects, their distances of detection, distances between schools and groups of schools, parameters of movement and form of schools. The statistical characteristics of detection distance distribution are determined: a minimum distance – 100 m, maximum – 1272 m; average - 665 m; a standard error – 18.2 m. Structure of a fish aggregation as a cellular formation was studied with the help of superpositions of a grid with the certain pitch. The observations of the sardine aggregations in evening time permitting to conclude about an irregular densities of schools and even about appearance of their thin structure are executed also. These heterogeneities observed with the help of colour sounder, probably testify to existence of elementary shoals (with force hydrodynamic relations formed in natural conditions),

was studied on capelin, bream and herring (Zaferman, 1995). It executed the measurements of parameters of more, than 500 schools of sardine by sonars during one hydroacoustic survey. In addition, the technique of definition of horizontal and vertical sizes of schools is developed for an effective using of this kind of horizontal echodetection being available on vessel single-beam sonars.

11AM2002 S1-021 Poster

POTENT: THE PACIFIC OCEAN TRACKING & EVALUATION NETWORK DESCRIPTION & APPLICATIONS IN MARINE SCIENCE

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The Census of Marine Life is sponsoring a planning phase to develop new ocean technology. One initiative involves "POTENT", a continental scale acoustic array that would be placed long-term on the seabed off the entire West Coast of North America. Potential capabilities of the array in fisheries would include providing detailed information on the timing and movements of individual fish for periods ranging from 5 months to 7 years. From an oceanographic perspective, the establishment of an acoustic array for fish tracking would provide a strategic resource: the data transmission and power supply backbone needed to host many other instruments. For example, the temperature and salinity sensors of ARGO profilers could be placed on the seabed nodes, providing detailed gridded fields of the changes in bottom temperature and salinity over time. Current plans for the array involve the eventual development of up to 30 cross-shelf monitoring lines spaced from Baja to the Bering Sea, each consisting of autonomous seabed nodes spaced at roughly 1 km down to (perhaps) 1,000m depth. It is anticipated that the array could be deployed and run at an annual cost of perhaps $10M shared between all users. If built, the array will provide a tool for marine scientists equivalent to that of the Hubble Space Telescope in astronomy, enabling scientists to "see" into the ocean in a way never before possible and to obtain extensive oceanographic and fisheries data for the entire shelf and slope region off the West Coast of North America.

S2 BIO/MEQ Topic Session
Food web dynamics in marginal seas: Natural processes and the influence of human impacts

Co-Convenors: Paul J. Harrison (Canada) and Hideaki Nakata (Japan)
Thursday, October 24, 2002 08:30-17:30

Marginal seas are often one of the most productive regions of the world's oceans. They are sites of abundant natural resources and fisheries. In some cases, nutrients and production are transported offshore, enriching these areas. Human impacts are evident in some areas of these marginal seas and these anthropogenic inputs including excessive nutrients, heavy metals and various organics, have altered various foodwebs. Sometimes changes in the phytoplankton species have resulted in changes in higher trophic levels including fisheries. Excessive nutrients may lead to over production of phytoplankton which are not eaten by zooplankton, and the decomposition of the bloom at depth may result in hypoxic or anoxic bottom waters with significant effects on the benthos. We need to understand these changes and their causes, if we are to better manage our marginal seas. Contributed talks and posters on the influence of excessive anthropogenic inputs on food web dynamics are encouraged.

08:30-08:35	**Session Introduction**
08:35-09:10	**R. Eugene Turner, Nancy N. Rabalais, Quay Dortch, Dubravko Justic** (invited) Variations in nutrient ratios and aquatic food webs (S2-030)
09:10-09:30	**Shang Chen, Mingyuan Zhu** Modeling response of marine pelagic ecosystem to phosphate enrichment (S2-289)
09:30-09:50	**Nianzhi Jiao, Shujiang Zhao, Zhiliang Shen, Yulin Wu** Causes and consequences of changes in nutrient structure in a typical coastal waterbody, with special reference to silica-limitation of phytoplankton (S2-027)
09:50-10:10	**Nelson Sherry** Predicting the influence of episodic physical events on longer term and/or larger scale estimates of biomass and production at lower trophic levels (S2-307)
10:10-10:20	**Questions**
10:20-10:40	**Coffee/tea break**
10:40-11:00	**Paul J. Harrison** Phytoplankton species competition: What determines which species will become dominant? (S2-025)
11:00-11:20	**Ruixiang Li, Mingyuan Zhu** The competition between two HAB species a diatom and a dinoflagellate - mesocosm experiment (S2-108)
11:20-11:40	**Atsushi Tsuda, H. Saito, J. Nishioka, T. Ono** Mesozooplankton responses during the Subarctic Ocean enrichment and ecosystem dynamics study (SEEDS 2001) (S2-275)
11:40-12:00	**Yanhui Yang, Nianzhi Jiao** Effects of iron enrichment on picoplankton cell abundances in the South China Sea: A result from deck experiment (S2-282)
12:00-12:10	**Questions**
12:10-13:30	**Lunch break**
13:30-14:05	**Kazuo Iseki** (invited) Continental margin carbon fluxes in the East China Sea (S2-026)

14:05-14:25 **Jinhui Wang, Xiuqing Huang**
Harmful algal bloom and nutrient overenrichment of East China Sea (S2-115)

14:25-14:45 **Nianzhi Jiao, Yanhui Yang, Hiroshi Koshikawa, Masataka Watanabe**
Coupling of hydrographic conditions and picoplankton distribution in the East China Sea, a marginal sea of the Northwest Pacific (S2-104)

14:45-15:05 **Jintao Li, Dengfeng Yang, Weihong Zhao**
Studies of influence of nutrients on growth of red tide plankton in the East China Sea by field experiment (S2-107)

15:05-15:10 **Questions**

15:10-15:30 **Coffee/tea break**

15:30-15:50 **Joseph S. Paimpillil, Jaime C. Si**
Nutrient enrichment in Yanbu (Red Sea) waters - impacts on coral health, algal growth, biomass and coral fish diversity (S2-112)

15:50-16:10 **Hui Huang, Renlin Zou, Sheng Liu**
Impacts of warm effluent from the Daya Bay nuclear power plant on stony coral community (S2-315)

16:10-16:30 **Bangqin Huang**
Alkaline phosphatase activity and utilization of dissolved organic phosphorus by algae in subtropical coastal waters (S2-296)

16:30-16:50 **Olga Podgurskaya, V.Ya. Kavun, O.N. Lukyanova**
Accumulation and subcellular distribution of cadmium in the digestive gland and kidney of the mussel *Crenomytilus grayanus* from upwelling region (S2-029)

16:50-17:10 **Olga N. Lukyanova**
Molecular biomarkers in the marine organisms of various trophic level influenced of human impact (S2-028)

17:10-17:30 **Questions and session summary**

11AM2002 S2-289 Oral

MODELING RESPONSE OF MARINE PELAGIC ECOSYSTEM TO PHOSPHATE ENRICHMENT

Shang **Chen** and Mingyuan Zhu

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How does marine pelagic ecosystem respond to eutrophication? It is not only the key to discover the occurrence mechanism of HAB but also the basis to determine the carrying capacity of marine organisms. To answer this question, two *in situ* experiments with adding phosphate were conducted in suspended mesocosms outside of the unique Yangtze River Estuary in Oct. 1997 and May 1998. Based on above experiment, more than 30 ecological parameters were quantified and one model was developed to simulate the change of pelagic ecosystem after adding phosphate. The model considers both microbial food chain and classical food chain, consists of 9 variables: diatom, dinoflagallete, mesozooplankton, protozoan, heterotrophic bacteria, detritus, dissolved inorganic nitrogen, phosphate and silicate. The model results consisted with the observed data quite well in mesocosms, esp. in biomass of diatom and dinoflagallete and nutrients concentration. It also shows there are diel fluctuations in standing stock of diatom and dinoflagallete and nutrients concentration. The model works better for the ecosystem change in phosphate-enriched mesocosm than in control, and better for the blooming process of diatom, dinoflagallete, mesozooplankton, protozoan and heterotrophic bacteria than their decaying process. But the model cannot simulate the short-term change (e.g. less than two days) of ecosystem. Model results show more energy flows into microbial food chain from classical food chain during algal blooms. The ratio of energy flowing into between microbial food chain and classical food chain should be kept in a certain range for one healthy ecosystem. But this ratio is not easy to be quantified without further studies.

11AM2002 S2-025 Oral

PHYTOPLANKTON SPECIES COMPETITION: WHAT DETERMINES WHICH SPECIES WILL BECOME DOMINANT?

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Dominance of certain species is mainly a function of accumulation rates and loss rates. Accumulation rates are largely governed by growth rates which are regulated by physical, chemical factors such as light, temperature, and nutrients (concentration, flux and ratios). Loss rates are generally determined by biological factors such as grazing and sinking. This presentation will review these factors which determine the outcome of species competition and show how factor interaction allows some species to unexpectedly dominate.

11AM2002 S2-296 Oral

ALKALINE PHOSPHATASE ACTIVITY AND UTILIZATION OF DISSOLVED ORGANIC PHOSPHORUS BY ALGAE IN SUBTROPICAL COASTAL WATERS

Bangqin **Huang** and Huasheng Hong

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Alkaline phosphatase activity (APA) and availability of dissolved organic phosphorus (DOP) by marine algae were determined in Xiamen Bay and in algal batch culture systems. Results showed that APA changed with seasons, it increased to the highest value in summer and decreased to the lowest in autumn and spring in Xiamen Bay. Test of natural population of planktonic algae and bacteria community showed that algae were mostly responsible for DOP utilization, while bacteria may not uptake DOP compounds. Results from algal batch cultures also supported the above conclusion. Relationships between APA and environmental factors indicated that APA was negative with phosphorus level such as phosphate and small molecular DOP, and APA played an important role in utilization of DOP by algae. All the results emphasized the ecological significance of DOP in subtropical coastal waters, the relationship between phosphorus and HAB will also be discussed.

11AM2002 S2-315 Oral

IMPACTS OF WARM EFFLUENT FROM THE DAYA BAY NUCLEAR POWER PLANT ON STONY CORAL COMMUNITY

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The hermatypic coral in Daya Bay is located at the northern edge of the global coral reef zone. Considering the warming-up caused by environmental factors such as the warm effluent from the nuclear power plant and global climate change and so on may lead its community succeed. We set up fixed surveying and drawing sections on the Dalaja and Xiaolaja to inspect the covering degree of corals alive, the community constitution and the size of individuals in July of 2002. 12 species of the stony coral were found in shallow water areas and the dominated species was *Porites lutea*. The total cover rate was 35% and that of *Porites lutea* was 9.5%. Based on data of hermatypic coral community in 1960s, 1980s and 1990s and data of water temperature in Daya Bay, the reasons and dynamics of ecosuccession and recovery of the coral community in Daya Bay were analyzed.

11AM2002 S2-026 Invited

CONTINENTAL MARGIN CARBON FLUXES IN THE EAST CHINA SEA

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As a part of Japanese JGOFS study, Marginal Sea Flux Experiments in the West Pacific (MASFLEX) was performed in the East China Sea during 1992-97. Its main goal was to clarify a role of marginal and coastal seas in the biogeochemical cycles of carbon, nitrogen and other substances relating to the global change issue. We have conducted particulate flux studies using sediment traps on the shelf, slope and the Okinawa Trough. On the inner shelf, particulate fluxes were large and rapidly increased near the bottom throughout the year, probably due to resuspended bottom sediment and suspended particles from the Changjiang, forming a bottom turbid layer (BTL). At the Okinawa Trough, particulate fluxes at 600m depth were extremely low but increased noticeably with depth (800m and 50m above the bottom). The flux generally peaked from late autumn to early spring and was lowest during summer. Considering that there is no strong seasonality of the primary productivity and phytoplankton biomass in the surface layer at the Trough, we hypothesize that the seasonality of particle fluxes at the deep waters of the Trough is linked to seasonal events in shelf waters. Downwelling and seaward bottom flow induced by the northeast monsoon in winter favor the offshore transport of particles in the BTL. Near-bottom transport may be a key process for shelf-to-deep sea export of biogenic/lithogenic particles, and the continental slope and the Okinawa Trough may play an important role as a carbon sink for the East China Sea.

11AM2002 S2-027 Oral

CAUSES AND CONSEQUENCES OF CHANGES IN NUTRIENT STRUCTURE IN A TYPICAL COASTAL WATERBODY, WITH SPECIAL REFERENCE TO SILICA-LIMITATION OF PHYTOPLANKTON

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Long-term variation of nitrate and ammonium (N), phosphate (P), and silicate (Si) concentrations and the nutrient structure in a typical coastal waterbody, Jiaozhou Bay, China, was followed during several periods: 1961-1963 (except for Si), 1981-1986, 1991-1994 and 1997-1998. The concentration of dissolved inorganic nitrogen increased 2.4-fold from the 1960s to the 1980s and another 0.6-fold in the following decade. Phosphate increased about 1.4-fold from the 1960s to the 1980s and 2.7-fold in the early 1990s, but decreased in recent years to a level slightly higher than that in the 1960s. The concentration of Si declined continuously from the middle 1980s to the late 1990s, resulting in a 2-fold decrease overall. Thus, the nutrient structure has changed greatly in the recent past. The

atomic ratio of ammonium and nitrate to phosphate (N/P) increased about 2.1-fold in the past 40 years with mean values of 9.21, 20.05, and 33.92 in the 1960s, 1980s and 1990s, respectively. The ratios of silicate to nitrate plus (Si/N) and to phosphate (Si/P) were 0.35 and 8.97 in the 1980s and 0.21 and 5.03 in 1990s, respectively; both decreased substantially.

Multiple regression analysis among nutrients and ecological and socioeconomic data from the area surrounding Jiaozhou Bay showed that the long-term variation of nitrate concentration in the seawater was basically controlled by agricultural activities (including fertilization), precipitation, population in the greater Qingdao area and drainage from Qingdao City. That of ammonium was less related to rainfall but more to anthropogenic factors such as shipping activities, population and city drainage as well as agricultural activities. Less of the variation of phosphate was explainable, but it was associated with shipping capacity, gross agricultural production, population and chemical fertilization. Si was correlated with precipitation and farming area.

Stoichiometric calculations indicated that the nutrient structure in Jiaozhou Bay has become more and more unbalanced with regard to phytoplankton requirements. There has been almost no possibility for nitrogen to be a limiting factor since the 1980s, on a large temporal and spatial scale. The probability of P limitation increased and could have occurred occasionally in autumn and summer; it was less likely to occur in spring and winter. The probability of Si-limitation increased dramatically from the 1980s to the 1990s. Seasonally, Si-limitation could have almost certainly occurred in spring and winter, although seldom in summer and autumn in the past decade.

Phytoplankton species composition in Jiaozhou Bay has changed remarkably as a consequence of the changes in nutrient structure. The firmly decreasing trend in diversity index and increasing trend in dominancy index, and the inverse correlation between the two indices clearly showed that the stability of the netplankton assemblages is decreasing. Thus, we speculate that the likelihood of certain species blooming is increasing. Since the total Chl-*a* level has remained roughly unchanged at around 3.55 μg/L on an annual basis for the past few decades, it is likely that smaller species have taken the niche vacated by larger species. Changes in phytoplankton size and species composition as a result of Si depletion may ultimately lead to various functional and structural changes at the system level.

11AM2002 S2-104 Oral

COUPLING OF HYDROGRAPHIC CONDITIONS AND PICOPLANKTON DISTRIBUTION IN THE EAST CHINA SEA, A MARGINAL SEA OF THE NORTHWEST PACIFIC

Nianzhi (George) **Jiao**[1], Yanhui Yang[1], Hiroshi Koshikawa[2] and Masataka Watanabe[2]

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Dynamics of *Synechococcus*, *Prochlorococcus*, pico-eukaryotes and heterotrophic bacteria populations along with physical and chemical conditions in the East China Sea, a marginal sea of Northwest Pacific, were investigated in July, 1998. *Synechococcus*, pico-eukaryotes and bacteria were ubiquitous with averaged abundance at the order of 10^4, 10^2 and 10^5 cells ml^{-1} respectively. *Prochlorococcus* was present at most locations beyond the 50m isobath at the level of 10^4 cells ml^{-1}. Responses of these picoplankters to the hydrographic conditions in the sea were recognized in both vertical and horizontal distributions. The following seemed to be typical ecological features of the marginal sea different from the situations of oceanic waters. 1) Water masses are the basic factors affecting the distribution of picoplankton. 2) Light availability played an important role in regulating picoplankton distribution patterns in the river plume. 3) *Prochlorococcus* were largely associated with oceanic water currents although they could be found in the majority of the sea; Sudden changes in cell abundance often occurred within a relatively short distance. Water temperature and salinity thresholds for *Prochlorococcus* to be present in the study period were >26°C and >30‰ in the surface mixed layer, and > 16°C and >33.4‰ in the deeper layer respectively. The *Prochlorococcus* nutrient thresholds are: TIN <3 μM and phosphate < 0.4μM. 4) No pronounced subsurface peak in *Prochlorococcus* abundance depth profiles were recorded in the oceanic warm currents although *Prochlorococcus* outnumbered *Synechococcus* at least an order of magnitude there. 5) *Synechococcus* was most abundant in the coastal area associated with high nutrient level. Pico-eukaryotes usually developed very well in the front areas on the continental shelf in addition to other high abundance zones in the coastal waters. Along offshore directions, pico-eukaryotes often centered farther from the shore and deeper in water column than did *Synechococcus*. 6)

Heterotrophic bacteria showed the least variation in abundance, but distinctly decreased from the coast to offshore, following an overlaid biomass pattern of pico-eukaryotes and *Synechococcus*. 7) Relationship between *Prochlorococcus* and bacteria was negative along gradients in the marginal sea.

11AM2002 S2-107 Oral
STUDIES OF INFLUENCE OF NUTRIENTS ON GROWTH OF RED TIDE PLANKTON IN THE EAST CHINA SEA BY FIELD EXPERIMENT

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An *in situ* experiment was carried out at 3 spots in East China Sea. The experiment was conducted in 5 L-bottles using the surface water. The culture time was 7 days. The experiment showed that nutrients influenced on growth of red tide plankton and absorption dynamics parameter of nutrients were obtained. Different phytoplankton species responded to different ratios of nutrients. And species of phytoplankton would change with the change of the ratios of nutrients. The *in situ* experiment of R01 illustrated the influence of nutrients on growth of red tide plankton during the process of decline of red tide.

11AM2002 S2-108 Oral
THE COMPETITION BETWEEN TWO HAB SPECIES A DIATOM AND A DINOFLAGELLATE - MESOCOSM EXPERIMENT

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Skeletonema costatum and *Prorocentrum dentatum* are two common HAB species in the East China Sea, especially *Prorocentrum* is responsible for most HAB events in the Spring since the late 90s. The HAB caused by *Skeletonema* usually occur during June to August. However, these two species will not bloom at the same time. Two mesocosm experiments were conducted in East China Sea in May 1998 and May 2002. In the experiment of May 1998, the cell number of *Prorocentrum dentatum* and *Skeletonema costatum* accounted for about 85% and 11% of total cell number of phytoplankton respectively at the beginning of the experiment. In control mesocosm, *Prorocentrum dentatum* dominated the community during the whole experiment. In phosphate enriched mesocosm, however, *Skeletonema costatum* showed a high competition capability. In May 2002, there were 4 bags in the mesocosm experiment. At the beginning of the experiment, the cell number of *Prorocentrum dentatum* accounted for 55~66% of the total. *Skeletonema costatum* accounted for 32~42. During the experiment, the growth of *Skeletonema costatum* was faster than that of *Prorocentrum dentatum*. The higher nutrient concentration was, the faster *Skeletonema costatum* growth. On the 2nd day, the cell number of *Skeletonema costatum* exceeded that of *Prorocentrum dentatum*. It seems that under high nutrients conditions, *Skeletonema costatum* grow better than *Prorocentrum dentatum*. But, under nutrients limited conditions, *Prorocentrum dentatum* could survival better than *Skeletonema costatum*.

11AM2002 S2-028 Oral
MOLECULAR BIOMARKERS IN THE MARINE ORGANISMS OF VARIOUS TROPHIC LEVEL INFLUENCED OF HUMAN IMPACT

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The structure and functions of the ocean food web depend on complex of abiotic and biotic factors. The anthropogenic pollution strongly influences these processes. It is well known that pollutants are accumulated via the food chain, so the main physiological functions of the marine organisms of various trophic levels are disordered. The high coefficients of the pollutant accumulation like the heavy metals and organic compounds occur in the marine mollusks and echinoderms, which are the important components of the marine food web.

The molecular biomarkers are the most sensitive stress indices that allow the first disruption in the animal metabolism to be revealed. Specific and non-specific molecular biomarkers in some species collected in Peter the Great Bay (the Sea of Japan) were studied. Specific biomarkers, namely the metal-binding proteins, or metallothioneins, were analyzed in the scallop *Swiftopecten swifti* and limpet *Collisella cassis* sampled from the Rudnaya Bay in the mine region. Data obtained show that these proteins are very important for the metal detoxification under the chronic technogenic pollution.

The most general non-specific integral indices of adaptive processes occurring in the marine invertebrates are the energetic metabolism parameters, for example the adenylate energetic charge (AEC) and the carotenoid concentration. Under the unfavourable conditions, AEC reflecting the main metabolic pathways decreases due to the extended energetic expenditures of an organism. It mainly occurs under the short-term influences. Under the long-term anthropogenic pollution, the marine mollusks and sea urchins are adapted to situation and can maintain their metabolism at a high level, with the AEC value near to 0.9.

The carotenoid concentration could be used for estimation of the marine invertebrate tolerance to the pollution effects. In the contaminated areas, the sustainable species, for example *Mytilus trossulus*, have a high carotenoid content in their organs. The sea urchin *Strongylocentrotus intermedius* as a non-resistant species has a low content of these pigments.

The oxidative stress usually arises in the marine organisms in polluted areas. It means that balance of the pro- and antioxidant systems are disrupted. One of the indices of the pro-oxidant system activity is the lipid peroxidation (LP) of cellular membranes that results in the metabolism disturbances. LP level was significantly higher in mussels collected near Vladivostok (the Ussuriisky Bay) in comparison with that in mussels from the Far Eastern State Marine Preserve area (the Reinike and Bolshoi Pelis Islands). The tripeptide gluthathione is very important component of the anti-oxidant system. Both the aquarium experiments and studies carried out on mussels from chronically polluted areas near Vladivostok shown that the glutathione concentration increase is one of the initial cell reactions to hazardous effects, which strengthens the animal resistance. The gluthathione content was found to be higher in organs of mussels from polluted area in comparison with this content in mussels from "unpolluted" sites that displays the mobilization of the organism defence systems under the unfavourable conditions.

Changes in metabolism of the marine organisms of various food chains at the molecular level could be determined before disruption displayed in tissues, organs, organisms and ecosystems. It allows not only to control, but also to predict the animal condition in populations influenced of human impact.

11AM2002 S2-112 Oral

NUTRIENT ENRICHMENT IN YANBU (RED SEA) WATERS - IMPACTS ON CORAL HEALTH, ALGAL GROWTH, BIOMASS AND CORAL FISH DIVERSITY

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The extensive mangrove stands north of Tropic of Cancer and the well developed coral reefs off Yanbu coast (Red Sea) had survived and adapted to the high salinity and extreme temperature. They had experienced destruction by the industrial development along the coast as evident in coral form changes from the branching to the massive form. The effluents from the highly efficient industrial waste treatment plant are discharged into Red Sea. Though a high degree of operational efficiency was attained by IWTP, the concentration of nitrate and nitrites had shown an increase during the effluent treatment, but were below the national pollution limit. The coastal waters in the coral reef had violations of TSS, PO_4 from regional pollution standards. The impact of excessive sediment and nutrient loads on the reduction of coral recruitment and live coral coverage, excessive growth of filamentous algae, changes in biomass and in population diversity of coral reef fishes were also highlighted. The low coral cover and high algal growth clearly indicated that the removal of live coral was not the only negative effect of industrial stresses but also had reduced the number of associated species proportionately. The poor coral health condition at the reef sites was attributed to nutrient enrichment resulting from the treated industrial wastewater, occasionally exceeding the prescribed safe discharge limits. The competition for living space due to the excessive growth of filamentous algae triggered by the supply of dissolved nutrients had restricted the coral development. The low species diversity of the

butterfly fish and the high damselfish association at the coral sites stressed by industrial impacts indicated them as coral health and water quality indicators.

11AM2002 S2-029 Oral

ACCUMULATION AND SUBCELLULAR DISTRIBUTION OF CADMIUM IN THE DIGESTIVE GLAND AND KIDNEY OF THE MUSSEL *Crenomytilus grayanus* FROM UPWELLING REGION

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Cadmium is one of the most toxic and widespread trace metals found in the marine environment. Bivalves in general are survivors in marine ecosystems contaminated with heavy metals owing to detoxification mechanisms within the cells. Metal-binding proteins called metallothionein-like proteins MTLP (about 10-12 kDa) play an important role in the detoxification of cadmium. A number the studies have revealed the subcellular distribution of cadmium under experimental conditions or in areas high contaminated by human activity. However, there is local elevated level of cadmium in seawater due to natural causes. For example, for Pacific Ocean the correlation of high levels of dissolved Cd with upwelling has been established. The aim of the present work was to study subcellular distribution of Cd in the digestive gland and kidney of mussel *Crenomytilus grayanus* from upwelling region. Mussels were collected in June – August 2001 from three sites. Sites 1 (Reineke Island) and 2 (Bolshoy Pelis Island, Far East State Marine Preserve - FESMP) were in Peter the Great Bay, Japan Sea. Site 3 (Prostor Bay) was on Okhotsk coast of Iturup Island, Kuril Islands. Levels of dissolved Cd in the selected sites are not affected by anthropogenic activity. Upwelling is known to occur during summer in the FESMP. There is Middle-Kuril upwelling in Prostor Bay. Site 1 is control area. The distribution of Cd among the different molecular weight ranges of compound in the cytosols of the digestive gland and kidney was studied by gel filtration chromatography. Cd concentrations in those organs and in fractions collected from gel filtration chromatography were determined with Hitachi 180-70 flame atomic absorption spectrophotometer. The Cd concentrations in the mussel digestive gland from selected sites varied as follows: site 3 > site 2 7>> site 1 (25.2 ±25.9 > 1.93 ± 0.6 >> 1.61 ±1.45 mkg/g dry weight respectively). The cadmium concentrations in the mussels kidney from selected sites varied as follows: site 3 > site 2 > site 1 (1780.0 ± 732.0 > 119.0 ± 22.0 > 84.0 ± 25.0 mkg/g dry weight respectively). MTLP are known to bind the most of Cd under constant high levels of the metal in surrounding waters. It was observed for studied organs of mussels from sites 2 and 3. Gel filtration chromatography showed two absorbance peaks in cytosols of digestive gland and kidney from all sites, a high molecular weight HMW peak (> 60 kDa) and low molecular weight LMW (< 10 kDa). However, MTLP peak was found in the elution profiles of mussels kidney from site 3. Consequently, increased Cd accumulation in kidney and digestive gland of mussels from site 3 compared to other sites and significant induction of MTLP reflect Middle-Kuril upwelling influence on level of dissolved Cd in Prostor Bay. Earlier no MTLP peaks were observed in mussels from natural clean areas. In mussels kidney from sites 2 and 3 most of the cytosolic Cd was found in the MTLP fraction and minor quantities of Cd were in fraction HMW and LMW. In control mussels, only traces of Cd eluted with HMW, MTLP fraction and LMW. In mussels digestive gland from sites 3 significant amounts of Cd were eluted at the same retention time as MTLP and traces of Cd were in fraction HMW and LMW. In mussels digestive gland from sites 2 Cd was found in MTLP fraction only. In control mussels, minor quantity of Cd was only eluted with the HMW compounds. Results obtained show upwelling significantly effect on dissolved Cd level in surface seawaters. This is result in MTLP induction in digestive gland and kidney of mussels. When MTLP induction is not enough Cd sequestered by HMW.

11AM2002 S2-307 Oral

PREDICTING THE INFLUENCE OF EPISODIC PHYSICAL EVENTS ON LONGER TERM AND/OR LARGER SCALE ESTIMATES OF BIOMASS AND PRODUCTION AT LOWER TROPHIC LEVELS

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Eddies, upwelling fronts, and other temporary and physically dynamic features account for a disproportionate amount of the variability we observe in biological measurements, while generally accounting for only a small proportion of the samples we collect. While this sampling discontinuity in both time and space has been widely recognized, sampling and thus quantifying these events and their regional influence is logistically difficult and often impractical. Has this bias in sampling significantly biased our estimates and/or predictions of regional production and biomass? What opportunistic or high resolution sampling strategies have been used to successfully measure the influence of these episodic events? This presentation will review some recent literature in the context of these two questions.

11AM2002 S2-275 Oral

MESOZOOPLANKTON RESPONSES DURING THE SUBARCTIC OCEAN ENRICHMENT AND ECOSYSTEM DYNAMICS STUDY (SEEDS 2001)

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Mesoscale iron-enrichment experiment was carried out in the western subarctic Pacific during 2001 summer (8x10km, Fe 0.4nM). The iron-patch was traced until 14 days from the fertilization (D14). The maximum differences between outside and inside of the iron patch were 19.5 mg m^{-3} in chlorophyll-*a*, and 11.7 μM in nitrate. The rapidly increased phytoplankton in the iron-patch was large-sized (>10mm), centric diatom, mainly *Chaetoceros debilis*. Dominant zooplankton species in the upper 200-m depth were *Neocalanus plumchrus* (C3), N. cristatus, *Eucalanus bungii* (C3-5) and *Metridia pacifica*. Gut-pigment contents of dominant copepods (*Neocalanus* spp. *E. bungii* and *M. pacifica*) in the patch increased 4 to 18.4 times and the maximum values were observed in D11. Any changes of vertical distribution and diel vertical migration were not observed for all species and stages of mesozooplankton throughout the observation period. Mesozoplankton biomass (wet weight) did not changed significantly in the patch. However, first copepodite stages of *N. plumchrus* and *E. bungii* increased several times only in the patch from D9. The increases of both species are considered to be brought from lowered mortality during the egg and nauplius stages, because spawning of *N. plumchrus* take place at depth using lipid storage, while spawning of *E. bungii* take place in the surface layer with grazing. Then, these facts suggest that the relative importance of copepod juveniles to diatoms decreased in the patch by the diatom blooming.

11AM2002 S2-030 Invited

VARIATIONS IN NUTRIENT RATIOS AND AQUATIC FOOD WEBS

R. Eugene **Turner**[1], Nancy N. Rabalais[2], Quay Dortch[2] and Dubravko Justic[1]

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The dissolved Si:dissolved inorganic nitrogen (DSi:DIN) atomic ratios of riverine and coastal waters have been declining in many areas of the world to near a DSi:DIN ratio of 1:1, primarily because of land use practices affecting nitrate concentrations. These changes will profoundly affect coastal food webs. Diatoms, for example, begin the algae-zooplankton-fish food web and have an intracellular DSi:DIN ratio of 1:1. Also, the regeneration of DSi and DIN in the worlds ocean is approximately 1:1. This led Redfield and others (e.g., Redfield 1934, 1958) to postulate the existence of stoichiometric and physiological limits to phytoplankton growth. Results from field and laboratory studies have suggested that the lack of silica relative to nitrogen can control phytoplankton community

composition, and Elser et al. (1996) have shown how nutrient ratios (commonly discussed in terms of nitrogen:phosphorus ratios) constrain organism organization at the cellular, organismal and community level.

If the minimal DSi:DIN proportion of 1:1 for diatoms is not met, then an alternative phytoplankton community composed of non-diatoms may be competitively enabled. Officer and Ryther (1980) argued that as the DSi:DIN ratio fell below 1:1, the fisheries web would re-form and be composed of less desirable species. It turns out to be a correct prediction for the Louisiana shelf near the Mississippi River delta. Thus important fisheries could be affected by the relative quantities of nutrients being loaded into the receiving waters.

11AM2002 S2-115 Oral
HARMFUL ALGAL BLOOM AND NUTRIENT OVERENRICHMENT OF EAST CHINA SEA

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Based on the monitoring data in East China Sea since early 1980s, nutrient over-enrichment intensified and spread widely along the East China Sea coastal environment, this has often had devastating effects on the fisheries, biodiversity and services provided by coastal ecosystems. Increased downstream and point source nutrients from anthropogenic and agricultural developments into the ecosystems of the East China Sea may ultimately be a direct link to additional outbreaks of harmful algal bloom. The HAB incidents in East China Sea have the tendency of increase with a manifold every 10 years, more than 30 and 20 of which were recorded in 2001 and up to now in 2002 separately. The major HAB caused species shifted from *Trichodesmium sp.* during 1960s and 1970s, *Noctiluca sintilance* and *Skeletonema costatum* during 1980s and 1990s to *Prorocentrum sp.* recently. This article conduct retrospective analysis of temporal and spatial extent of HAB occurrences associated with nutrient loading in East China Sea, compare HAB events in 10 important estuary and bay (including Changjiang estuary, Xiangshan Bay, Hangzhou Bay, Xiamen Bay, etc.) under varying conditions of eutrophication.

11AM2002 S2-282 Oral
EFFECTS OF IRON ENRICHMENT ON PICOPLANKTON CELL ABUNDANCES IN THE SOUTH CHINA SEA: A RESULT FROM DECK EXPERIMENT

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An iron (Fe) enrichment experiment was carried out on board the investigation vessel at station 508 (6.3°N, 110°E) in the South China Sea. Cell abundances of the main groups of picoplankton *Synechococcus* (Syn), Prochlorococcus (Pro), picoeukaryote (Euk) and heterotrophic bacteria (Bact) were traced during the experimental course by flow cytometry (FCM). Results showed that picoplankton responded rapidly to iron enrichments of nano mole. However, high concentrations of iron enrichment benefited pico-autotrophs in long-term incubation course. Within the picoplankton community, Syn required higher concentration of Fe than other picoplankton did. When chlorophyll *a* biomass was considered, quota of nanoplankton (2~20 μm) increased with the increasing of enriched Fe concentration. Extremely high concentration of iron enrichment shifted the community from pico-phytoplankton dominant to nano-phytoplankton dominant at the end of the experiment.

S3 BIO/POC/FIS Topic Session
The importance of biophysical coupling in concentrating marine organisms around shallow topographics

Convenors: Richard D. Brodeur (U.S.A.), John F. Dower (Canada), David L. Musgrave (U.S.A.) and Orio Yamamura (Japan)
Tuesday, October 22, 2002 08:30-12:30

Dense aggregations of organisms have been reported in the boundary zone between the coastal and offshore waters of many marine ecosystems, including shelf-breaks, submarine canyons, and shallow banks. Similar aggregations have been detected around topographic features such as seamounts and oceanic islands, which often generate eddies, re-circulating currents, and high biological productivity. These high biomass concentrations are utilized by marine predators, including pelagic and demersal fishes, cephalopods, marine mammals and seabirds. The transfer of oceanic energy to shallow regions may thus represent an important and largely unappreciated flux that affects the production in these ecosystems. Papers related to understanding the biophysical mechanisms underlying these aggregations and their trophic implications are encouraged.

Selected papers from this session will be published in a Special Issue of Journal of Marine Systems (Elsevier).

08:40-09:10	**Amatzia Genin** (invited) Trophic focusing: the role of bio-physical coupling in the formation of animal aggregations in the sea (S3-037)
09:10-09:30	**Jack A. Barth, Stephen D. Pierce, Timothy J. Cowles** The influence of Heceta Bank, Oregon, on the coastal ecosystem (S3-032)
09:30-09:50	**Susan E. Allen** Canyons and euphausiids: Trapping and aggregation mechanisms (S3-031)
09:50-10:10	**Armando Trasvina, G. Gutierrez de Velasco, A. Valle-Levinson, R. González-Armas, A. Mulhia, M.A. Cosio** Dynamics of the flow in the vicinity of a shallow seamount top in the Gulf of California (S3-046)
10:10-10:30	**John F. Dower, Sonia D. Batten, William R. Crawford** Biophysical coupling and the maintenance of dense rockfish populations on shallow seamounts in the Northeast Pacific (S3-036)
10:30-10:50	**Coffee/tea break**
10:50-11:10	**Chris D. Wilson, George W. Boehlert** Ocean currents and diel migrators at a seamount in the central North Pacific (S3-033)
11:10-11:30	**Kohei Mizobata, Sei-ichi Saitoh** Impact of eddy field on phytoplankton distribution along the shelf edge in the southeastern Bering Sea 1998-2000 using SeaWiFS and TOPEX/Poseidon time series data sets (S3-040)
11:30-11:50	**David L. Mackas, Mark Trevorrow, Douglas R. Yelland, Mark Benfield** Aggregation of macrozooplankton and fish at a fjord sill (S3-039)
11:50-12:10	**Michael P. Seki, George W. Boehlert** Species composition and assemblage patterns of oceanic micronekton at a central North Pacific Seamount. (S3-044)
12:10-12:30	**Anne B. Hollowed, Chris Wilson, Phyllis Stabeno, Sigrid Salo** Effect of ocean conditions on the cross-shelf distribution of walleye pollock (*Theragra chalcogramma*) and Capelin (*Mallotus villosus*) (S3-038)

12:30-12:50 **Evelyn Brown, Martín Montes, James Churnside, Anne B. Hollowed**
Effects of topography and storm events on nekton and plankton structure in near surface waters of western Gulf of Alaska (S3-035)

Posters:

Keith L. Bosley, Richard D. Brodeur, W. Waldo Wakefield, Robert L. Emmett, Kara Rehmke
Food-web dynamics in Astoria Submarine canyon off the Oregon coast (S3-034)

Vyacheslav B. Lobanov, V. Zvalinskiy, S. Zakharkov, P. Tishchenko, A. Salyuk, A. Salomatin, S. Ladychenko, Y. Zuenko, V. Nadtochiy, T. Orlova
Physical causes and biological consequences of cross-shelf water exchange intensification along Primorye coast, Japan Sea in the fall season (S3-290)

Evgeny Pakhomov
"Life-support systems" of sub-Antarctic archipelago and seamounts: physical and biological coupling mechanisms (S3-042)

Vadim F. Savinykh, Vladimir A. Shelekhov, Vladimir B. Darnitsky
Biology of the lightfish Maurolicus imperatoricus and the importance of physical processes on the dominance of this species over the Emperor Seamounts (S3-043)

Phyllis J. Stabeno, E.D. Cokelet, N. B. Kachel, C. A. Mordy, S.A. Salo
Mixing over Portlock Bank, Alaska (S3-045)

11AM2002 S3-031 Oral

CANYONS AND EUPHAUSIIDS: TRAPPING AND AGGREGATION MECHANISMS

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Coastal submarine canyons are regions of enhanced cross-shelf transport and strongly three-dimensional flow. Deep within the canyon the flow usually forms a cyclonic eddy. Recent observations and theoretical arguments show that an eddy at rim-depth (100-200 m) is also common. This eddy occurs at about the day-time depth of *Euphausia pacifica.*

In this presentation we will present the criteria for a rim-depth eddy to form over a canyon during summer upwelling-favourable flow. We will describe the role of the eddy in trapping zooplankton. Finally, the results of simple numerical models will show the role of canyons in aggregating euphausiids into patches.

11AM2002 S3-032 Oral

THE INFLUENCE OF HECETA BANK, OREGON, ON THE COASTAL ECOSYSTEM

Jack A. **Barth**

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The presence of submarine banks on otherwise relatively straight continental shelves has a profound influence on coastal circulation and hence the local ecosystem. The bank topography can disrupt or redirect strong alongshore coastal jets, create regions of weaker flow in their "shadow" and lead to enhanced mixing. Recent field work off central Oregon has documented the influence of Heceta and Stonewall Banks on the coastal upwelling ecosystem. The Banks rise to over 50% of the surrounding water column depth on the continental shelf off central Oregon (44 20' N). The Banks extend about 100 km in the alongshelf direction and widen the shelf to 60 km from the relatively narrow, straight 25-km wide shelves both to the north and south. In the summers of 1999-2002, high-resolution hydrographic, bio-optical and velocity surveys were conducted over the Banks and surrounding coastal waters. We present results from these surveys together with surface drifter trajectories and satellite SST imagery. The midshelf, southward coastal upwelling jet follows the Bank topography as it widens offshore. The jet reaches the southern end of the Bank, where the shelfbreak turns almost 90 degrees back toward the coast. A pool of high-chlorophyll (in excess of 10 mg m^{-3}) water is found in the low-velocity "lee" region created by the presence of the Bank. When southward upwelling favourable winds relax, northward flow is found on the inshore side of the Bank allowing potential recirculation around the entire Bank system.

11AM2002 S3-034 Poster

FOOD-WEB DYNAMICS IN ASTORIA SUBMARINE CANYON OFF THE OREGON COAST

Keith L. **Bosley**[1], Richard D. Brodeur[2], W. Waldo Wakefield[2], Robert L. Emmett[1] and Kara Rehmke[3]

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Astoria Canyon lies directly off the mouth of the Columbia River along the northern Oregon coast. There are several potential sources of energy available to the ecosystem in this large submarine canyon, from the discharge of the vast Columbia River Basin into the Pacific Ocean over the canyon, to the highly productive shelf waters along the coastal margin, to the transfer of oceanic energy by the advection of nutrient-rich water up the canyon floor. During the summer of 2001, an interdisciplinary team of scientists mapped and documented the physical, chemical, and biological systems of the canyon. Bioacoustic transects were conducted across the canyon using a towed multifrequency echosounder to map aggregations of fish and zooplankton. Invertebrates such as shrimp, crabs, euphausiids, and squid, as well as pelagic and demersal fish, were collected from midwater (Isaacs-Kidd Midwater Trawls) and demersal (bottom trawls) habitats for species identification, gut content analysis, tissue sample collection for stable isotopic analysis, and for validation of the acoustics. Particulate organic matter was also

collected at various depths from CTD casts that were conducted along the axis of the canyon as well as across the canyon at several sites. This paper examines species distribution patterns and food-web dynamics in Astoria Canyon as indicated by stable carbon and nitrogen isotopes, gut content analysis, and the trawl and acoustics data, with a view towards determining the relative contribution of the many sources of energy that flow into this highly productive ecosystem.

11AM2002 S3-035 Oral

EFFECTS OF TOPOGRAPHY AND STORM EVENTS ON NEKTON AND PLANKTON STRUCTURE IN NEAR SURFACE WATERS OF WESTERN GULF OF ALASKA

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The main research question addressed concerned the effects of fishing and oceanographic structure on prey fields for Steller sea lions. Our goal was to examine the effects of topography and storm events on biological structure and associated oceanography in the upper 50 m over the continental shelf. The study was closely coordinated with a companion shipboard study, focusing from 20 m to the bottom, in an area with high concentrations of pollock, capelin, marine mammals and sea birds. During August 2001, multiple day and night cross-shelf aerial surveys were conducted using remote sensing tools including lidar, a radiometer, and thermal and digital imagers. Measurements included ocean color, light penetration depth, sea-surface temperature, backscatter from plankton and nekton, and diurnal distributions of foraging sea birds, whales, and sea lions. Temporal variability in physical and biological spatial structure was determined and compared to satellite-derived imagery, bottom topography, and oceanographic results from the companion study. Prior to a storm event, thick plankton layers and aggregations of juvenile pollock, and chlorophyll minimums were concentrated over the center of gullies bisecting the shelf. Chlorophyll maximums and large capelin aggregations were concentrated at edges of gullies and over the shallower parts of the shelf within the 100 m contour. After a storm event, the plankton layers were greatly reduced, spatial structure in plankton and chlorophyll disappeared, and fewer fish aggregations and sea bird foraging flocks were observed. Frequency of storm events probably has significant impacts on spatial variability of prey fields for apex predators.

11AM2002 S3-036 Oral

BIOPHYSICAL COUPLING AND THE MAINTENANCE OF DENSE ROCKFISH POPULATIONS ON SHALLOW SEAMOUNTS IN THE NORTHEAST PACIFIC

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Dense aggregations of rockfish (Sebastes spp.) exist on numerous shallow seamounts in the NE Pacific. It has never been clear, however, whether these apparently isolated populations are indeed self-sustaining, or whether they depend on larval recruitment from the BC coast (since adult rockfish are not usually found in offshore waters). Here we investigate the potential for Haida eddies and other offshore-directed filaments to play a role in the offshore transport of larval rockfish. There are approximately 45 seamounts shallower than 1000m in the NE Pacific. Since 1992, eleven Haida eddies have passed over at least one (sometimes as many as three) shallow seamounts in the NE Pacific. In the summer of 2000, one such eddy became "stuck" to Bowie Seamount for almost two months. Using TOPEX-Poseidon sea-surface altimetry, data from a Continuous Plankton Recorder survey, as well as an oceanographic survey conducted at Bowie Seamount in August 2000 we will demonstrate that these physical oceanographic features can (and do) transport coastal species offshore and into the vicinity of shallow NE Pacific seamounts.

11AM2002 S3-037 Invited

TROPHIC FOCUSING: THE ROLE OF BIO-PHYSICAL COUPLING IN THE FORMATION OF ANIMAL AGGREGATIONS IN THE SEA

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Growth, production and recruitment of many marine predators depend on their ability to find aggregations of prey. Some predators need more than the average concentration of their prey to survive. For that dependency to have evolved, the occurrence of prey aggregations should have been somewhat predictable in time and space - a phenomenon typical to shallow seamounts, banks, canyons, sills and shelf breaks. What are the mechanisms generating aggregations of animals over shallow topographies? Unlike "conventional" eutrophication, of which the foundation is enhanced primary production, the accumulation of plankton, fish and predators over shallow topographies is usually (but not always) unrelated to phytoplankton and primary production. A common feature of the aggregation mechanisms appears to be the interaction between physics (advection by currents) and biology (swimming behaviour). One example is the pre-dawn entrapment and accumulation of descending zooplankters over abrupt topographies following their advection over the shallow topography during the preceding night. Another mechanism is the accumulation of zooplankters when they retain their depth against vertical currents. Such aggregations occur over shelf breaks, sills and sloping bottoms that induce upwelling or downwelling flows. Another mechanism is related to the substantial intensification of currents over abrupt topographies. Strong currents augment the flux of plankton and, therefore, the productivity of benthic suspension feeders. Enhanced benthic productivity can maintain rich populations of topography-associated micronekton and fish.

Shallow topographies are "hot spots" of trophic focusing and subsidy, maintained by the interactions between currents and animals. In most cases, animals, rather than primary producers, form the base of the local food webs. The role of shallow topographies in oceanic biology is yet to be fully understood.

11AM2002 S3-038 Oral

EFFECT OF OCEAN CONDITIONS ON THE CROSS-SHELF DISTRIBUTION OF WALLEYE POLLOCK (*Theragra chalcogramma*) AND CAPELIN (*Mallotus villosus*)

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Acoustic trawl surveys were conducted in 2000 and 2001 as part of a multi-year, multi-disciplinary experiment off the eastern coast of Kodiak Island in the Gulf of Alaska. The spatial distribution of walleye pollock (*Theragra chalcogramma*) and capelin (*Mallotus villosus*) differ and appear to be related to differences in habitat preferences. Pelagic habitats are characterized by a variety of physical measures. Drogued satellite drifters and moored current meters revealed that flow through submarine troughs is steered by the topography, with inflow along the upstream, eastern edge and outflow along the downstream, western edge of the troughs. Barnabas trough is broader than Chiniak which allows slope water to intrude further into the trough. Continuous underway sea surface temperature samples and water column profiles collected in 2000 and 2001 showed the presence of a sharp shelf break front in Chiniak trough and a mid-trough front in Barnabas trough. Surface water temperature was cooler in Chiniak trough than Barnabas trough, whereas, subsurface waters at 75 m were cooler in Barnabas trough than Chiniak trough. At distances less than approximately 12 nm from shore, the water column was well mixed, whereas a well-defined mixed layer was detected beyond approximately 12 nm from shore. In stratified regions, the mixed layer depth was approximately 15m and 18m in Barnabas and Chiniak troughs respectively. Water column properties in both troughs were influenced by a storm event in 2001. The storm event weakened stratification and cooled surface water temperature by 1.6-2.1°C. Satellite data taken before the storm event revealed low chlorophyll-*a* concentrations that were probably associated with nutrient depletion in the surface waters. Wind mixing associated with the storm event mixed subsurface chlorophyll-*a* to the surface and enhanced nutrients in the surface waters. These events resulted in a surface production event that was limited to regions inside the mid-trough front in Barnabas trough and throughout Chiniak trough.

Acoustic survey data identified four acoustic sign types: age-1 pollock, adult pollock, capelin and capelin-age-0 pollock mix. The spatial distribution of these three sign types appears to be influenced by the oceanographic and topographic features of the two troughs. In Chiniak trough, adult pollock were broadly distributed throughout the trough. In Barnabas trough, adult pollock were aggregated on the coastal side of the frontal systems in regions where summer wind events produce high levels of production. In 2000, capelin was mixed with age-0 pollock. In Chiniak trough, capelin were most abundant along steep topographic gradients at the edges of the trough and a deep region near Cape Chiniak. In Barnabas trough, capelin-age-0 mix (2000) or capelin (2001) concentrations were observed in slope water intrusions over the outer to middle shelf. Results suggest that habitat preference of walleye pollock and capelin are controlled by different processes. Capelin distributions appear to be associated with cool slope water intrusions and topographic gradients while walleye pollock appear to select habitats based on the availability of prey. Our findings suggest that in the month of August in the Gulf of Alaska, capelin may have a narrower temperature tolerance than pollock.

11AM2002 S3-290 Poster

PHYSICAL CAUSES AND BIOLOGICAL CONSEQUENCES OF CROSS-SHELF WATER EXCHANGE INTENSIFICATION ALONG PRIMORYE COAST, JAPAN SEA IN THE FALL SEASON

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Abrupt changes of water properties along Primorye coast, northwestern Japan Sea are usually observed in fall season and are associated with upwelling events during transition period of monsoon winds. Two consecutive surveys of hydrographic, chemical, biological and acoustical observations implemented during PICES cruise on board r/v Professor Gagarinskiy in October-November 2000 allow to examine details of this process. Under wind stress change during three weeks interval between first and second survey of the cruise a structure of Primorye Current had drastically modified and transformed into a chain of anticyclonic eddies located along the slope. Coastal upwelling areas and off shore tongues of cold water were associated with increase of phytoplankton biomass at surface layer. Re-circulation process had generated extended on shore intrusion of high nutrient open seawater over the shelf in a bottom layer. Distribution of biochemical parameters, plankton and fish concentration is discussed here. Location and number of the eddies and associated intrusions demonstrate inter-annual variations which should explain dynamics of coastal ecosystem observed in different years.

11AM2002 S3-039 Oral

AGGREGATION OF MACROZOOPLANKTON AND FISH AT A FJORD SILL

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We examined aggregation of zooplankton and fish by tidal currents over the Knight Inlet fjord sill, using a combination of high frequency acoustics, an instrumented multiple net zooplankton sampler, a CTD/rosette, ADCP current meters, and a high resolution underwater digital camera. The advantages of Knight Inlet as an experimental system are that the physical oceanography is well described, current interactions with the sill topography vary predictably on a tidal cycle, and the zooplankton acoustic scatterers are a relatively low-diversity mix of euphausiids, amphipods and large copepods. During both flood and ebb phases of the tidal cycle, aggregations of zooplankton and fish accumulate against the tidally 'upstream' rim of the sill. This aggregation produces a km scale maximum of macrozooplankton density in the immediate vicinity of the sill, which is in turn embedded within a broader (10-20 km scale) minimum, probably caused by enhanced predation pressure by planktivorous fish.

11AM2002 S3-040 Oral

IMPACT OF THE EDDY FIELD ON PHYTOPLANKTON DISTRIBUTION ALONG THE SHELF EDGE IN THE SOUTHEASTERN BERING SEA 1998-2000 USING SeaWiFS AND TOPEX/POSEIDON TIME SERIES DATA SETS

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Using satellite data of sea surface height anomaly (SSHA) from TOPEX/POSEIDON and chlorophyll *a* concentration (Chl-*a*) from SeaWiFS L3, the Bering Slope Current (BSC) eddy field was seen to impact phytoplankton distribution along the shelf edge in the southeastern Bering Sea during 1998-2000. We also used the velocity of eddy propagation, the eddy kinetic energy extracted from SSHA, and primary production (calculated using SeaWiFS Chl-*a*, PAR and AVHRR sea surface temperature) to understand details of interaction between Bering Sea eddies and biological conditions along the shelf edge.

In the summer of 1998 and 1999, relatively low Chl-*a* was observed along the shelf edge. In particular, low Chl-*a* (almost under 1.0mg m^{-3}), primary production (20gC m^{-2} $month^{-1}$) and low eddy kinetic energy occurred simultaneously after the spring bloom of 1999. The velocity of eddy propagation along the shelf edge was 0.43~0.54 cm^{-1}. In the summer of 2000, however, satellite data showed large fluctuation of SSHA, relatively high Chl-*a* concentration (almost over 1.0mg m^{-3}) and primary production (more than 25gC m^{-2} $month^{-1}$) along the shelf edge. Moreover, the velocity of eddy propagation along the shelf edge increased (1.0 cm^{-1}).

These results indicate that relatively strong BSC and eddy-topography interactions resulted in an increased number of eddies with baroclinic instabilities and the nutrient supply to the subsurface layer in 2000. Thus, the occurrence of mesoscale eddies with baroclinic instability may play an important role in maintaining high productivity along the shelf edge in the southeastern Bering Sea.

11AM2002 S3-042 Poster

"LIFE-SUPPORT SYSTEMS" OF SUB-ANTARCTIC ARCHIPELAGO AND SEAMOUNTS: PHYSICAL AND BIOLOGICAL COUPLING MECHANISMS

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The uniqueness of the Prince Edward Island (PEI) ecosystem is a result of a close marine-terrestrial interaction, which provides the food for the entire community of numerous seabirds and mammals on the islands. The "life-support mechanism" is thought to function as a long-term alternation between two components, an inshore (autochthonous) component, which is of crucial importance for only a few land-based top predators, and an offshore (allochthonous) component, which supports most of the top predators on the PEI. The issue of climate change, which is as fast as 1.2 degrees increase in temperature and 600 mm decrease in mean annual rainfall over the last 50 years on the PEI, is also visited. Much of this change is a consequence of the shifts in regimes of the major oceanic fronts (Antarctic Polar Frontal Zone, Sub-Antarctic Front, and Subtropical Convergence) and these re-emphasize the tight link between the land and sea in this region. Changes in frontal properties are not only affecting pelagic invertebrate communities, but also the foraging success of the seabirds and seals that rely on these species, and consequently their population trends, setting up new population limits. The "life-support system" of seamounts Ob and Lena is also summarized to understand the role of oceanographic features (water trapping and specific vertical structure of the water column) in the distributional patterns of zooplankton and its effect on bottom-dwelling fish populations.

11AM2002 S3-043 Poster

BIOLOGY OF THE LIGHTFISH *Maurolicus imperatoricus* AND THE IMPORTANCE OF PHYSICAL PROCESSES ON THE DOMINANCE OF THIS SPECIES OVER THE EMPEROR SEAMOUNTS

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Two species of Lightfish, *Maurolicus japonicus* and *M. imperatoricus*, dominate the pelagic species over several of the Emperor Seamounts, including Colahan, Milwaukee, Kinmei. The first species is distributed mainly over the continental slope of the Japanese Islands. Penetration of this species into the Central North Pacific results from passive migration in an eastward direction in the Kuroshio and North Pacific Current. The second species is endemic to the Emperor Seamounts and recorded only in this region. Both species have very close biological features, but the contribution of *M. japonicus* to the total biomass of the area is insignificant. Lightfish are short-lived species. We measured daily otolith rings (from the sagittal otolith) for Lightfish age determination. The maximal age recorded was 433 days, but most individuals lived about one and half year. The spawning period of Lightfish occurred in spring and summer with peak activity in March-April. Oceanic copepods and (rarely) euphausiids predominated in the Lightfish stomachs.

We suggest that there are two reason of isolation *M. imperatoricus* around the Emperor Seamounts. The first is temperature limitation. This subtropical species inhabits only subtropical and transformed subtropical waters. The second is the current system. In our studies, Taylor columns were registered sporadically (year-round) over the Emperor Seamounts. This is likely the main mechanism for retaining eggs and larvae over Seamounts. At times, there are high volumes of biogenic elements blocking over and around the seamounts. On the another hand, the North Pacific Current brings a large quantity of oceanic zooplankton that accumulate on the outer part of the Seamount shelf. Thus, there are very good conditions for planktivorous fishes feeding around Seamounts. Most micronekton species are only passing through, and only Lightfish is the dominant species of this area due to the possibility of concentration inside Taylor columns.

11AM2002 S3-044 Oral

SPECIES COMPOSITION AND ASSEMBLAGE PATTERNS OF OCEANIC MICRONEKTON AT A CENTRAL NORTH PACIFIC SEAMOUNT

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At the northern end of the Hawaiian Ridge, Southeast (SE) Hancock Seamount rises nearly 5 km from the ocean floor to a summit depth of 265 m near the ocean surface. Positioned near the center of the North Pacific subtropical gyre at 29°47'N lat. 179°04'E long., the water column in the vicinity of the seamount is typically well stratified with a permanent thermocline that limits vertical enrichment of the euphotic zone through most of the year. As a result, these oligotrophic waters are characteristically recognized as some of the least productive waters found in the world oceans. Nevertheless, like other seamounts located along the southern Emperor-northern Hawaiian Ridge, SE Hancock seems to offer an enhanced feeding habitat and has supported unusually large populations of commercially exploitable demersal fishes and aggregations of transient pelagic species such as tunas and squid.

Isaacs-Kidd Midwater Trawl (IKMT) surveys at SE Hancock Seamount conducted during summer 1984 and winter 1985 have shown that the midwater micronekton community includes both a unique resident faunal assemblage as well as a component advected from adjacent waters; these resources are likely key components of the ecosystem forage base and energy transfer to higher level predators. The resident community, composed primarily of the sternoptychid fish, *Maurolicus muelleri*, and the mysid, *Gnathophausia longispina*, forms a dense sound scattering layer (SSL) at night over the seamount and along the flanks during crepuscular periods yet are virtually absent away from the seamount. We present here a detailed examination of the species composition and assemblage patterns of the midwater micronekton from these surveys conducted over the seamount summit and at reference sites ranging from 2 to 20 km off the seamount. Micronekton at the reference stations comprise a highly diverse assortment of euphausiids (e.g., *Euphausia gibboides*, *Thysanopoda orientalis*, and *T. monocantha*), penaeid shrimps (e.g.,

Gennadas spp.), and fishes (e.g., *Vinciguerria* spp., myctophids). The physical and biological interactions between these species, the communities, and their environment are examined with respect to concurrent oceanographic conditions. Because SE Hancock is seasonally influenced by the thermal manifestation of the Subtropical Frontal Zone (STFZ) system, we discuss the impact of the STFZ on the faunal characterization.

11AM2002 S3-045 Poster
MIXING OVER PORTLOCK BANK, ALASKA

Phyllis J. **Stabeno**[1], E.D. Cokelet[1], N.B. Kachel[2], C.A. Mordy[2], P. Proctor[1], D. Righli[2] and S.A. Salo[1]

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Satellite imagery of ocean chlorophyll distributions from late mid to late summer indicate higher productivity near Kodiak Island, Alaska compared to lower production in surface waters over the remainder of the Gulf of Alaska. The bathymetry to the south and east of Kodiak Island is characterized by multiple banks and troughs. Hydrographic transects during four cruises in 2001 and 2002 focused on Portlock Bank, a shallow (~50m), broad plateau to the east of Kodiak Island. These hydrographic casts revealed a well-mixed water column with significant concentrations of nutrients. Some of the satellite-tracked drifters (drogued at 40m depth) deployed in the region were trapped over the bank during much of the summer and were advected off the bank only when strong storms began in the fall. The significant concentrations of nutrients over the bank indicate a continual replenishment of nutrients. Nutrients are transported far onto the shelf in two nearby troughs, Amatouli and Stevenson. This deep water in the troughs is likely the source of nutrients observed on the bank and are introduced to the bank through bottom processes up the sloping sides of the troughs.

11AM2002 S3-046 Oral
DYNAMICS OF THE FLOW IN THE VICINITY OF A SHALLOW SEAMOUNT TOP IN THE GULF OF CALIFORNIA

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An interdisciplinary study of the EBES seamount in the Gulf of California leads to a number of conclusions on interactions between the physical dynamics and the biology on a shallow seamount. A variety of processes are capable of locally enhancing productivity (shear-induced entrainment, three-dimensional tidal advection, upwelling induced by impinging large-scale currents). Larval fish diversity is high, with 104 different species having been identified. This is attributed to both enhancement of productivity by local processes and to 'external' influences coming from the Bay of La Paz and from the Gulf of California. This seamount acts as shallow substrate inserted into the biologically active surface layer of an oceanic region. The abrupt bathymetry produces a large variety of dynamic phenomena at a wide range of time scales. Some are local and of short time scales (e.g. tidal amplification). Others have larger length and time scales, typical of oceanic regions, but altered by the topographic obstacle (upwelling due to impinging currents). On such a seamount both oceanic and coastal conditions coexist and are capable of locally enhancing the productivity. The high diversity of species is due to its specific geographical location. Processes such as the outflows of the Bay of La Paz promote the higher diversity of species by carrying larvae and zooplankton from regions biologically different to the EBES seamount.

11AM2002 S3-033 Oral

OCEAN CURRENTS AND DIEL MIGRATORS AT A SEAMOUNT IN THE CENTRAL NORTH PACIFIC

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Seamounts are often characterized by unique faunas, including vertically migrating micronekton species. The two dominant seamount-associated micronekton at Southeast Hancock Seamount on the northern Hawaiian Ridge are the sternopthychid fish *Maurolicus muelleri* and the lophogastrid mysid *Gnathophausia longispina.* Distribution patterns for both species, based on midwater trawl and acoustic data, were compared with ADCP-measured ocean currents during four research cruises in 1987 and 1988. Populations of both species, resident on the seamount slope during daylight hours, migrated above the seamount nightly. The distributions of these two species over the seamount summit were regulated by a combination of behavioural and physical processes. Ocean currents affected the localized nighttime aggregations over different regions of the summit within and between cruises. Currents over the summit had the potential to advect animals an average of 6-7 km per night during the first two cruises and about 2 km per night during the last two cruises. Net and acoustic results indicated that *G. longispina* and *M. muelleri* were displaced to the downstream side of the summit through the night. Vertical current shear on one cruise complicated the interpretation of these distributions.

Both *G. longispina* and *M. muelleri* appeared to resist advective loss from the seamount, although the short-term distributional patterns of the two species were subject to current-mediated influences. Very few specimens were taken 5 and 10 km from the summit or above 100 m depth. Behaviour patterns apparently facilitated the maintenance of these populations at this isolated seamount.

S4 BIO/FIS/CCCC Topic Session
Responses of upper trophic level predators to variation in prey availability: An examination of trophic level linkages

Co-convenors: Hidehiro Kato (Japan), Elizabeth A. Logerwell (U.S.A.) and Gordon A. McFarlane (Canada)

Tuesday, October 22, 2002 13:30-17:30

Predators respond to changes in prey resources in a variety of ways over the range of ecological organizations from individuals to populations to species. There is increasing interest in this topic as evidence of the impact of physical forcing on prey resources accumulates over a wide range of temporal and spatial scales. Understanding these responses is important for gauging the usefulness of predators as indicators of ecosystem change. In addition, ecosystem management strategies require defined inter-specific relationships and an understanding of the role of predation in the regulation of marine populations. We invite presentations on the responses of seabirds, mammals and fishes at the individual (behavior, physiology), population (reproductive performance, mortality) or species (evolution) level. Dimensions of prey availability could include quantity, spatial and temporal distribution or quality. We are particularly interested in papers that discuss predator response as an indicator of ecosystem change, predator-prey relationships in the context of ecosystem management strategies or predation as a regulator of marine populations. This topic session compliments the BIO/POC/FIS session 'The importance of biophysical coupling in concentrating marine organisms around shallow topographie', which focuses on the mechanisms producing high biomass concentrations that are utilized by many marine predators and may represent an important flux affecting the productivity of many ecosystems.

13:30-13:55 **Alexander S. Kitaysky** (invited)
Are top-predators breeding in the Bering Sea food-limited? (S4-051)

13:55-14:20 **Tsutomu Tamura** (invited)
Diet variability of common minke whales in relation to changes in food availability (S4-059)

14:20-14:40 **Kerim Y. Aydin**
Where do predator/prey anomalies come from in the eastern Bering Sea (S4-047)

14:40-15:00 **William J. Sydeman, K.L. Mills, C.A. Abraham, J.A. Thayer, P. Warzybok**
Marine birds of the southern California Current ecosystem: Demographic and foraging consequences of variation in prey availability and quality (S4-057)

15:00-15:20 **Douglas F. Bertram, B. Smith, A. Harfenist, A. Hedd**
Contrasting adult survival of Cassin's Auklet on colonies in different oceanographic domains within British Columbia: 1994-2000 (S4-049)

15:20-15:30 **Discussion**

15:30-15:50 **Coffee/tea break**

15:50-16:10 **George L. Hunt, Jr., Lucy Vlietstra, Jaime Jahncke, Kenneth O. Coyle**
Feathered oceanographers: The foraging ecology of marine birds (S4-050)

16:10-16:30 **Andrew W. Trites, David A.S. Rosen**
Responses of marine mammals to variability in prey availability (S4-060)

16:30-16:55 **Richard J. Beamish, Gordon A. McFarlane** (invited)
Predation and other beliefs and speculations (S4-048)

16:55-17:15 **Akinori Takasuka, Ichiro Aoki, Isamu Mitani**
Is a slower growing larval Japanese anchovy actually removed by predation at a given moment in the sea? (S4-058)

17:15-17:30 **Discussion**

Posters:

Jae-Bong Lee, Yeong Chull Park, Dong Woo Lee, Doo Hae Ahn, Hyung Kee Cha, Seok Gwan Choi, Chang Ik Zhang
Predation by yellow goosefish, *Lophius litulon*, on yellow croaker, *Pseudosciaena polyactis*, in the East China Sea of Korea (S4-052)

Bernard A. Megrey, Robert A. Klumb, Francisco E. Werner, Kenneth Rose, Douglas Hay, Shin-ichi Ito, Michio J. Kishi
Application of a nutrient-phytoplankton-zooplankton-fish bioenergetics trophodynamic simulation model (NEMURO.FISH) to Stocks of Pacific Herring and Pacific Saury in the North Pacific (S4-053)

Sue E. Moore, Janice M. Waite
Distribution of mysticete whales along the Alaskan coast: Southeast Alaska to Bristol Bay (S4-054)

Ilyas N. Moukhametov
Feeding habits of Pacific halibut *Hippoglossus stenolepis* from the southern Kuril Islands (S4-055)

Svetlana V. Naydenko
The role of pacific saury in trophic structure in the epipelagial in the south Kuril Islands (S4-056)

Alexei M. Orlov
Summer diets, feeding habits and trophic relations of the most abundand elasmobranchs in the western Bering Sea (S4-303)

Yasuhiro Ueno, Mitsuyuki Namiki
Function of the gill-raker of the major pelagic fishes and the density effect (S4-061)

Yutaka Watanuki, Tomohiro Deguchi, Akifumi Nakata
Effects of Tsushima current on annual variation of diet and chick production in surface and sub-surface foraging seabirds breeding at Teuri Island, northern Hokkaido (S4-062)

11AM2002 S4-047 Oral

WHERE DO PREDATOR/PREY ANOMALIES COME FROM IN THE EASTERN BERING SEA?

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A simple large-scale (annual, population-level) functional response between predator and prey almost never holds up in reality, perhaps due to shifts in distribution, foraging conditions, climate, or due to the ephemeral nature of specific predator/prey communities when measured on an ecosystem scale. However, such simple predator/prey models may serve as a starting point for examining causality on the scale of an ecosystem. I present the results of attempts to fit single- and multi- species functional responses to 20 years of diet and survey data from multiple fish, invertebrate, bird, and mammal data the eastern Bering Sea, with a particular focus on predation of juvenile fish. These functional responses are used to examine whether long-term shifts in the amount of food "demanded" by predators on each trophic level has changed over time, and whether this provides evidence that the amount of total biomass "supported" by production in the eastern Bering Sea has changed. Further, I examine the temporal signals in the functional response anomalies to approach the question: are the predator/prey relationships governed by particular types of control through regime-scale shifts, or does control bounce from player to player as anomalies move through the system?

11AM2002 S4-048 Invited

PREDATION AND OTHER BELIEFS AND SPECULATIONS

Richard J. Beamish and Gordon A. McFarlane
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A principal in ecology is that the abundance of plants and animals that produce large numbers of seeds or babies is regulated by the available habitat and not the numbers of seeds or babies. Most fish produce large numbers of babies and it is expected that the juveniles surplus to the available habitat will perish. There is no question that some of these deaths result from predation, but in some studies of early marine mortality, predators are difficult to find. There also is evidence of large variability in estimates of predation-based mortality. We use our studies of natural regulation of the abundance of two marine species, coho salmon and sablefish, to propose that recruitment to the adult population is determined in the first marine year by two distinct mortalities. Early marine mortality (EMm) is dominated by predation, and mortality during the first marine winter is growth - based. The growth - based mortality is a function of marine productivity and thus is termed carrying capacity mortality (CCm). Therefore, total mortality (Tm) in the first year = early marine mortality (EMm) + carrying capacity mortality.

11AM2002 S4-049 Oral

CONTRASTING ADULT SURVIVAL OF CASSIN'S AUKLET ON COLONIES IN DIFFERENT OCEANOGRAPHIC DOMAINS WITHIN BRITISH COLUMBIA: 1994-2000

Douglas F. Bertram[1], B. Smith[2], A. Harfenist[2] and A. Hedd[3]
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We report on the survival of resident adult Cassin's Auklets (*Ptychoramphus aleuticus*) from two breeding colonies in British Columbia: Triangle Island, influenced by the California Current ecosystem, and Frederick Island, influenced by the Alaska Current ecosystem. We captured and banded birds at both colonies from 1994 to 2000 and analyzed the recovery data with Program MARK. Local adult annual survival was significantly lower on Triangle Island (0.42-0.80) than on Frederick Island (0.82-0.93, except 1997-1998). In 1998, the year of a large scale ENSO event, significantly fewer birds were breeding on both islands than in previous years. Adult survival was also markedly lower from 1997-1998 (0.54-0.61) than in other years for Frederick Island, though both islands

experienced depressed survival from 1997-1998. Our results are consistent with the hypothesis that ocean climate during the 1990s was generally a greater survival challenge for Cassin's Auklets breeding on Triangle Island (California Current ecosystem) than for those breeding on Frederick Island (Alaska Current ecosystem). We offer explanations for our observed differences in adult survival in the context of the availability of zooplankton prey, and also of reproductive performance and nestling diet collected concurrently on both colonies.

11AM2002 S4-050 Oral
FEATHERED OCEANOGRAPHERS: THE FORAGING ECOLOGY OF MARINE BIRDS

George L. **Hunt, Jr.**[1], Lucy Vlietstra[1], Jaime Jahncke[1] and Kenneth O. Coyle[2]
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Marine birds on average require prey equivalent to between 40 and 60 percent of their body mass each day. Marine birds improve the odds of meeting their energy needs through taking advantage of situations in which prey are predictably concentrated by the interaction of physical processes and the behavior of prey organisms. These include Langmuir circulation cells, fronts, tide-rips and interactions of currents with bathymetry. In this presentation, we review several studies from the Southern Ocean, eastern North Pacific Ocean, Bering Sea and Aleutian Islands to provide examples of ways in which physical processes result in foraging opportunities that support aggregations of marine birds. These aggregations would not persist in the absence of these prey-concentrating mechanisms. Marine birds also forage at schools or swarms of prey that result from the social or defensive behaviors of the prey. However, our ability to identify the importance of the spatial and numerical relationships between seabirds and their prey is scale-dependent. When regional stocks of prey are high, small-scale correlations between marine birds and their prey may be weak, whereas, when regional stocks are low, local matches between predators and their prey may be strong. These studies point to the importance of examining the patchiness of resources and the "landscape" within which patches occur. Variance in the abundance of prey at very small scales may be more important for trophic transfer than mean values, thus presenting a challenge to those wishing to understand the foraging ecology of top predators in the marine environment.

11AM2002 S4-051 Invited
ARE TOP-PREDATORS BREEDING IN THE BERING SEA FOOD-LIMITED?

Alexander S. **Kitaysky**
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During the past three decades population declines occurred among some seabird and marine mammal species in the Northern Pacific. It has been hypothesized that declines in food availability and abundance of high-quality forage fish resulted in food-related stress. Traditional methods of detecting food-related stress in free-living marine top-predators are not always effective. Therefore, we applied an additional tool that directly relates variations in food availability to physiological condition of animals: The measure of stress hormones in seabirds and Steller Sealions breeding in the south-eastern Bering Sea and eastern Aleutian Islands. In seabirds, food stress was assessed by measuring concentrations of the stress hormone corticosterone in the blood of undisturbed individuals (indicate current stress), and the rise in blood levels of corticosterone in response to a standardized stressor: capture, handling and restraint (indicate recent nutritional history). In sea lions, food stress was assessed by using the non-invasive method of measuring corticosterone metabolites in feces. We found that seabirds breeding in the southeastern Bering Sea were food-limited during late-spring and early summer, but were not food-limited during mid- to late-summer. We also found a positive relationship between fecal corticosterone concentrations in sea lions breeding on rookeries in the eastern Aleutian Islands during summer of 2000 and rates of population declines at those rookeries during 1976-2000. These results suggest that sea lion's rookeries that have experienced the highest rates of decline were also the most food-limited in 2000.

11AM2002 S4-052 Poster

PREDATION BY YELLOW GOOSEFISH, *Lophius litulon*, ON YELLOW CROAKER, *Pseudosciaena polyactis*, IN THE EAST CHINA SEA OF KOREA

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The yellow croaker (*Pseudosciaena polyactis*) is the most important prey item for the stock of Korean yellow goosefish (*Lophius litulon*) in the East China Sea of Korea. Yellow goosefish smaller than 30cm consumed yellow croaker, which represented over 50% of the total prey numbers except February and August during the period of 1994-1997. However, there was no clear selectivity in food size with the body size of yellow goosefish, probably due to the relatively large mouth size to the body length (27%) of yellow goosefish. Based on the predator-prey relationship between yellow goosefish and yellow croaker, the Korean stock of yellow croaker was assessed using a modified spawner-recruitment model. Ecosystem considerations and management of yellow croaker are discussed.

11AM2002 S4-053 Poster

APPLICATION OF A NUTRIENT-PHYTOPLANKTON-ZOOPLANKTON-FISH BIOENERGETICS TROPHODYNAMIC SIMULATION MODEL (NEMURO.FISH) TO STOCKS OF PACIFIC HERRING AND PACIFIC SAURY IN THE NORTH PACIFIC

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NEMURO (Northpacific Ecosystem Model Understanding Regional Oceanography), a nitrogen-based lower trophic level (LTL) marine ecosystem model, was developed in 2000 by the PICES CCC Model Task Team. It was recently coupled to a higher trophic level (HTL) fish bioenergetics model and applied to two pelagic fish stocks in the North Pacific, Pacific herring (*Clupea harengus pallasi*) and Pacific saury (*Cololabis Saira*). The coupled model was called NEMURO□FISH (NEMURO For Incorporating Saury and Herring).

In this presentation, we describe the fish bioenergetics mode and its coupling to the LT and HTL model. First we present the formulation of important environment-dependent biological processes of the bioenergetics governing equation and a multi-prey functional response submodel which allows the fish to choose their prey from a multispecies prey assemblage (provided by NEMURO). Next we describe the way in which the model was customized to accommodate species-specific and location-specific environmental characteristics and two approaches to coupling the LTL to the HTL model. Finally, we present comparisons of simulated growth patterns to observed size-at-age data for single and multi-cohort simulations and discuss future potential applications. Results of the simulation modeling show very good agreement between simulated annual growth patterns compared to those observed from actual field data. Also the influence of changing interannual environmental conditions is apparent in growth trajectories of different cohorts underscoring the importance of climate-change-induced environmental variability in modulating fish growth. Future plans are discussed including refinement of the model and its application to examining regime shifts and large-scale climate changes on fish growth as well as coupling the model to a spatially-explicit basin-scale.

11AM2002 S4-054 Poster

DISTRIBUTION OF MYSTICETE WHALES ALONG THE ALASKAN COAST: SOUTHEAST ALASKA TO BRISTOL BAY

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Line transect aerial surveys were conducted for cetaceans in Southeast Alaska (1997), the eastern Gulf of Alaska (1998) and along the south coast of the Alaskan Peninsula and in Bristol Bay (1999) for the purpose of estimating population size of small porpoise that frequently entangle in fishing gear. Surveys were conducted from late May through July each year using a DeHavilland Twin Otter flown at 150 m and 185 km/h. Primary observers searched waters port and starboard of the survey track through bubble windows, with a third observer guarding the trackline through a belly window. Sightings of all cetaceans were recorded during each survey, but data on large whales were not initially analyzed. Four species of mysticete (baleen) whales were seen, each demonstrating strong geographic clustering of sightings. Humpback whales (*Megaptera novaeangliae*) were the most common, with sightings clustered in Southeast Alaska, around Kodiak Island and in northern Bristol Bay. Fin whales (*Balaenoptera physalus*) were common near Kodiak Island and offshore Prince William Sound, but were not seen in Southeast Alaska nor Bristol Bay. With the exception of one gray whale (*Eschrichtius robustus*) seen near Yakutat Bay, all gray and minke whales (*Balaenoptera acutrostrata*) were seen in Bristol Bay, predominantly along the north coast of the Alaska Peninsula. While these data are simply composite snapshots of mysticete whale distribution, determining their geographic pattern over such a broad scale provides insight to areas of localized productivity. Because mysticete whales must find dense assemblages of prey to feed efficiently, their distribution can provide clues to biophysical coupling that structure marine communities.

11AM2002 S4-055 Poster

FEEDING HABITS OF PACIFIC HALIBUT *Hippoglossus stenolepis* FROM THE SOUTHERN KURIL ISLANDS

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Pacific halibut *Hippoglossus stenolepis* is abundant in coastal waters near southern Kuril Islands. Stomach contents of Pacific halibut captured during September 2000 bottom trawl survey in waters off the southern Kuril Islands were analyzed. 102 stomachs were examined. Of these, 82 contained prey items. Halibut ranged from 28-106 cm (SL) in length, and 1-10 years in age. The diet of Pacific halibut consisted mostly of fish (frequency of occurrence in stomachs (FO) 49.0% and 57.3% by weight (W)) and cephalopods (24.4% and 40.2%, respectively). Of fish in the diet, halibut consumed mainly arabesque greenling *Pleurogrammus azonus* (FO 6.1%, W 30.0%), walleye pollock *Theragra chalcogramma* (FO 4.9%, W 3.7%) and flatfishes (FO 4.9%, W 1.6%). Most conspicuous prey from fishes (FO 8.5%) were fry of rockfishes and sculpins, but only 0.5% by weight. Squid *Todarodes pacificus* (FO 12.2%, W 17.2%), and unidentified octopi (FO 13.4%, W 23.0%) represented cephalopods. Other dietary components consisted of crabs, shrimps and worms – FO 29.3%, 28.1%, 2.4% and W 6.4%, 1.8%, 1.7%, respectively. Small crustaceans and starfishes were relatively unimportant in stomach contents. With increasing size halibut consumed mainly fishes and cephalopods. Differences in diet compositions were detected at various depths. It is possible, that differences in diet composition between males and females related to their sizes. Males were shorter than females: 48.8 vs. 53.8 cm.

11AM2002 S4-056 Poster

THE ROLE OF PACIFIC SAURY IN TROPHIC STRUCTURE IN THE EPIPELAGIAL IN THE SOUTH KURIL ISLANDS

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Waters of southern Kuril islands (both off Okhotsk and Pacific coast) are a major feeding ground for many subtropical fishes in summer. The most abundant of them are saury (*Cololabis saira*), sardine (*Sardinops*

melanostictus) and anchovy (*Engraulis japonicus*). The biomass of saury during a period of high abundance of the sardine was 19% of all epipelagial fishes (depth 0-50) in coastal Okhotsk waters and 14% in Pacific waters. The abundance of sardine has significantly decreased in this area since 1991. Because of this, the % of saury increased to 48% of total fish biomass in coastal Okhotsk waters and to 24% in Pacific waters. The role of saury changed in the trophic structure of epipelagial communities in these areas.

In summer the feeding spectrum for saury comprised at least 10 taxa. The four dominant prey taxonomic groups were copepods, euphausiids, amphipods, and fishes (larvae). However, saury consumed better copepods and euphausiids in coastal Okhotsk waters and amphipods and larvae fishes (probably larvae *Pleurogrammus azonus*) in Pacific waters.

The consumption of the feeding hydrobionts by saury was 112.5 thousands tons per season in coastal Okhotsk waters and 143.5-286.3 thousands tons per season in Pacific waters. The % of hydrobionts in the diet of all fishes in the epipelagial (depth 0-50) increased from 10-13% in 1991 to 33-65% in 1996. Thus, saury is one of the main consumers of the feeding hydrobionts in the summer season in the waters of southern Kuril islands during period of low abundance of the sardine (since 1992).

11AM2002 S4-303 Poster

SUMMER DIETS, FEEDING HABITS AND TROPHIC RELATIONS OF THE MOST ABUNDANT ELASMOBRANCHS IN THE WESTERN BERING SEA

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Benthic skates and Pacific sleeper shark play an important role in ecosystems of the North Pacific basin. They are a significant element of food webs in benthic communities. Elasmobranchs consume commercially important species, such as salmons *Oncorhynchus* spp., rockfishes *Sebastes* spp., Atka mackerel *Pleurogrammus monopterygius*, walleye pollock *Theragra chalcogramma*, popeye grenadier *Coryphaenoides cinereus*, arrowtooth flounder *Atheresthes stomias*, flathead sole *Hippoglossoides elassodon*, yellowfin sole *Pleuronectes asper*, southern rock sole *Lepidopsetta bilineata*, Pacific cod *Gadus macrocephalus*, Pacific herring *Clupea pallasii*, Tanner crabs *Chionoecetes* spp., cephalopods and shrimps (Livingston and deReynier 1996; Orlov, 1998; Yang and Page, 1998). These species themselves have some commercial importance. For example, skates are processed into fish meat jelly and dried skate wing (Ishihara 1990). Pacific sleeper shark does not support a fishery now (Osipov, 1969; Compagno, 1990). In 1930s this shark have a slight commercially importance in California waters (Walford, 1935). During 1970s the Japanese fishermen taken Pacific sleeper shark in the North Pacific Ocean in insignificant number (Zolotova, 1978).

The diets of some northern Pacific skates are described in several papers of Mito (1974), Brodeur and Livingston (1988), Orlov (1998), and Dolganov (1998). Diet of the Gulf of Alaska Pacific sleeper shark was presented in paper of Yang and Page (1998). Feeding habits and trophic relations of elasmobranchs inhabiting the western Bering Sea were never previously considered.

Stomach contents of elasmobranchs brought aboard Japanese trawler Kayomaru No. 28 during summer 1997 were analyzed. The stomach samples were selected without known bias from bottom trawl hauls carried out around the clock in the western Bering Sea between 170°E and 178°W. Stomachs examined and those with food were as follows: 125/102 Pacific sleeper shark *Somniosus pacificus*, 139/123 Aleutian skate *Bathyraja aleutica*, 19/18 Matsubara skate *B. matsubarai*, 68/58 whitebrow skate *B. minispinosa*, 113/86 Alaska skate *B. parmifera*, and 189/179 Okhotsk skate *B. violacea*.

The diet of predatory elasmobranchs (Pacific sleeper shark, Alaska skate, Aleutian skate, Matsubara skate, and whitebrow skate) consisted of large crustaceans, cephalopods and fishes. Benthophage elasmobranchs (Okhotsk skate) consumed mainly worms, amphipods and shrimp.

Diets of male and female elasmobranchs differed, probably due mostly to the effect of size.

The consumption of worms and crustaceans (especially small) in diets of predators declined with increasing their size, whereas proportion of cephalopods and fishes in diet increased. The consumption of worms and small crustaceans by benthophage Okhotsk skates declined with increasing skate size while consumption of crabs and squids increased.

Among the species examined, three elasmobranch pairs had a medium level of dietary similarity: Aleutian and Alaska skates, Alaska and whitebrow skates, and whitebrow and Okhotsk skates. Diets of other species differed considerably.

11AM2002 S4-057 Oral
MARINE BIRDS OF THE SOUTHERN CALIFORNIA CURRENT ECOSYSTEM: DEMOGRAPHIC AND FORAGING CONSEQUENCES OF VARIATION IN PREY AVAILABILITY AND QUALITY

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We studied community, population, demographic, and foraging responses of breeding marine birds to short and long-term changes in ocean climate and prey availability in the central California upwelling system over the past 32 years, 1971-2002. Our research has revealed responses to variability in ocean climate and prey on interannual and interdecadal time scales. Prey availability to breeding birds was assessed by NOAA/NMFS conducting mid-water trawls for juvenile fishes and oceanographic measurements in the vicinity of the Farallon Island seabird colony for 17/32 years. Seabird diets, and for certain species, productivity, has undergone persistent change concurrent with an increase in ocean temperature and a decrease in seabird prey biomass (e.g., juvenile rockfish, *Sebastes* spp.) in the Gulf of the Farallones, particularly during the period 1989-2000. Juvenile rockfish re-appeared as the dominant diet item in 2001 and again in 2002. Functional relationships between prey availability and marine bird productivity varied by species (linear to logistic). Species with apparently higher costs of foraging (i.e., those with more aggressive reproductive strategies and/or those feeding in neritic habitats) were most responsive to climate and prey variations. Species-specific response to climate and forage fish variability provides new information on the potential role of marine birds as biological indicators and monitors of ecosystem change.

11AM2002 S4-058 Oral
IS A SLOWER GROWING LARVAL JAPANESE ANCHOVY ACTUALLY REMOVED BY PREDATION AT A GIVEN MOMENT IN THE SEA?

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Is a fish larva with lower growth rates actually removed by predation at a given moment in the sea? If so, is the mortality size-dependent? We demonstrated direct effects of growth rates on vulnerability to predation for postlarval Japanese anchovy *Engraulis japonicus*, by examining actually dead larvae by predation, in field research. Postlarval anchovy and their sympatric predatory fish species were simultaneously captured by a trawler in Sagami Bay, Japan. Otolith microstructure analysis was employed to compare the growth rates between the larvae from the stomach contents of their predators (predated larvae) and the larvae from the population of origin (control larvae). The mean growth rates of the predated larvae were significantly lower than those of the corresponding control larvae, presenting the first evidence for selective predation on individuals with lower growth rates at a given moment in the sea. Comparisons of back-calculated growth histories indicated that such differences were generally consistent from right after hatching to each encounter with a predator. The survivorship of higher growth larvae was not explained by size-selective predation but by growth variations at the same larval sizes. Therefore, the growth rates themselves directly affected vulnerability to predation. We propose a "growth-selective predation" hypothesis (mechanism), which would be independent of and synergistic with the existing hypotheses based on size (negative size-selective mortality) and time (stage duration). In addition, the growth rates of the predated larvae differed among predatory species, such as barracuda, jack mackerel, and round herring, suggesting that the "growth-selective predation" could be predator-specific.

11AM2002 S4-059 Invited

DIET VARIABILITY OF COMMON MINKE WHALES IN RELATION TO CHANGES IN FOOD AVAILABILITY

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The common minke whale *Balaenoptera acutorostrata* is widely distributed in the world. In the western North Pacific two stocks have been recognized: one in the Sea of Japan - Yellow Sea - East China Sea (J stock) and the other in the Okhotsk Sea – West Pacific (O stock). The abundance of common minke whales was estimated to be 19,209 animals in the Okhotsk Sea and 5, 841 animals in the Northwest Pacific during August and September in 1989 and 1990.

In the western North Pacific, common minke whales are opportunistic feeders with a broad diet and with flexible feeding habits. Previous reports indicate they consume several fish species and the prey consumption of minke whales is huge.

JARPN, the Japanese Whale Research Program under Special Permit in the western North Pacific was conducted between 1994 and 1999 with two main objectives related to population structure and feeding ecology of common minke whales. Taking into account the results of the Review Meeting, a two-year feasibility study of the second phase of JARPN (JARPN II) was conducted in the years 2000 and 2001.

In this study, geographical and seasonal changes of prey species were examined based on the forestomach contents of common minke whales collected by JARPN and JARPNII from spring to autumn since 1994. The diet variability of common minke whales is considered in relation to changes in food availability around Japan.

11AM2002 S4-060 Oral

RESPONSES OF MARINE MAMMALS TO VARIABILITY IN PREY AVAILABILITY

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Marine mammals require energy and nutrition for reproduction, growth, basal metabolism and daily activity. Reductions in the quantity or quality of prey available to marine mammals can lead to responses ranging from changes in an individual's behaviour, physiology (including blood biochemistry) and morphology (i.e., decreases in body size)—up to changes that directly affect the population (e.g., decreased birth rates and increases in the mortality rates of newborns and juveniles). Observations of seals and sea lions faced with acute short-term (1-3 y) reductions in prey quantity (e.g., during El Niño events) have shown that they increase the length of their feeding trips and may abort fetuses or give birth to underweight pups. In contrast, chronic long-term (10-30 y) declines in prey quality (e.g., a regime shift that favors the survival of low fat gadids over fatty forage fishes) likely affects the growth rates, body size and survival of independently feeding young, but is unlikely to affect the length of forage trips or the size of pups at birth. As K-selected species, adult marine mammals buffer the effects of decreases in quantity and quality of prey better than young animals. As such, young marine mammals are sensitive barometers of ecosystem change and a potentially useful age group to monitor both acute and chronic changes in prey availability.

11AM2002 S4-061 Poster

FUNCTION OF THE GILL-RAKER OF THE MAJOR PELAGIC FISHES AND THE DENSITY EFFECT

Yasuhiro **Ueno** and Mitsuyuki Namiki
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To clarify the function of the gill-rakers of pelagic fishes, we examined (1) the structure of the gill rakers of seven major pelagic species (*Oncorhynchus nerka*, *O. keta*, *O. gorbuscha*, *O. kisutch*, *O. tschawytscha*, *Sardinopus melanostictus*, *Engraulis japonicus*, and *Cololabis saira*) distributed in the Northwestern Pacific Ocean, (2) the size

compositions of the prey species in their stomach contents, and (3) the size compositions of zooplankton of the environment. The minimum sizes of the prey organisms in their stomachs were clearly limited by the spacing of the gill-rakers. When the spacing exceeded 2-2.5mm, the stomach contents changed from zooplankton to fishes or squids. This study confirmed that the gill-raker functions as a filter for taking zooplankton. Based on the results of this study, we concluded that the efficiency of the filter feeding is high for zooplankton larger than the spaces of the gill-rakers and is low for zooplankton smaller than the spaces. If the density of the fish were extremely high, the fish would capture the majority of larger zooplankton in the environment. In such a case, the fish would switch to feeding on smaller zooplankton. Since this causes decrease of the efficiency of the filter feeding, the profit that the fish gains decreases. This decrease of the profit causes a decrease in the growth rate of the fish. This mechanism could be one of causes of the density effect in offshore pelagic species.

11AM2002 S4-062 Poster

EFFECTS OF TSUSHIMA CURRENT ON ANNUAL VARIATION OF DIET AND CHICK PRODUCTION IN SURFACE AND SUB-SURFACE FORAGING SEABIRDS BREEDING AT TEURI ISLAND, NORTHERN HOKKAIDO

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In the Japan Sea along the western coast of Hokkaido, the strength of warm Tsushima current is known to affect marine ecological processes. We monitored diet and chick production of Black-tailed Gulls (surface foragers), Rhinoceros Auklets (midwater foraging divers) and Japanese Cormorants (bottom foraging divers) breeding at Teuri Island (northern part of this current system) in 1984-2001. From 1984-1987, both gulls and auklets foraged sardines and sandlance, then switched to anchovy after 1992, reflecting the crash of the sardine stock in the late 1980s. In the 1990s, the annual variation (%mass) of anchovy in the diet of these three species showed similar patterns, though anchovy occupied greater %mass in the diet of auklets than those of gulls and cormorants. This diet change was presumably affected by the annual variation of the strength of warm Tsushima current, which may induce the availability of anchovy. In years when auklets foraged less anchovy, they produced less chicks, while cormorants maintained chick productivity by foraging alternative prey in coastal waters. Occurrence of anchovy and sandlance in the diet did not affect chick productivity in gulls.

S5 FIS Topic Session
Comparison of the productivity of marginal seas with emphasis on the western Pacific (Japan/East Sea, Yellow Sea and East China Sea) with a focus on small pelagics

Co-convenors: Vladimir Belyaev (Russia), Suam Kim (Korea), Hideaki Nakata (Japan) and Qi-Sheng Tang (China)
Wednesday, October 23, 2002 08:30-12:30

This session of invited and contributed papers will review and compare the productivity of three major western Pacific ecosystems: Japan/East Sea, Yellow Sea and the East China Sea. The emphasis will be on understanding and comparing factors affecting the production of small pelagic fishes and zooplankton among the three ecosystems. The session is particularly interested in analyses of existing time-series data. Also encouraged are new and innovative approaches, especially those that focus on decadal-scale changes in productivity and shifts in species dominance that have occurred in these three ecosystems. Such contributions could consider the processes that link changes in fish productivity with zooplankton dynamics and ocean and climate changes. Other papers could describe the economic implications of the shifts in species dominance. This session will contribute to promoting the regional activities of GLOBEC-SPACC in East Asia.

08:30-08:55 **Chang-Ik Zhang, Jae Bong Lee, Young Il Seo, Sung Il Lee, Man Woo Lee, Sun Kil Lee, Sang Chul Yoon, Kyum Joon Park, Yeong Gong** (invited)
Productivity of small pelagics in Korean waters (S5-080)

08:55-09:10 **Young Shil Kang, Ginger A. Rebstock**
A comparison of three marine ecosystems surrounding the Korean peninsula: Responses to climate change (S5-073)

09:10-09:25 **Qi-Sheng Tang, Xianshi Jin**
Long-term variability in the ecosystem productivity of the Bohai Sea and control mechanisms (S5-286)

09:25-09:40 **Motomitsu Takahashi, Yoshiro Watanabe**
Growth of larvae and early juvenile Japanese anchovy, *Engraulis japonicus*, and environmental condition in the Kuroshio-Oyashio transition region (S5-077)

09:40-09:55 **Hee-Yong Kim, Shingo Kimura, Takashige Sugimoto**
Transport of jack mackerel (*Trachurus japonicus*) eggs and larvae inferred from the numerical experiment in the East China Sea (S5-074)

09:55-10:10 **Jae-Bong Lee, Yeong Gong, Chang Ik Zhang**
Relationship between the abundance of Pacific saury, *Cololabis saira* (Brevoort) and biological productivity in the East Sea (S5-075)

10:10-10:30 **Coffee/tea break**

10:30-10:55 **Svetlana V. Davydova** (invited)
Factors affecting the production of small pelagic fishes in the Japan/East Sea (S5-068)

10:55-11:10 **Vladimir A. Belyaev, V.B. Darnitzkiy, S.Yu. Shershenkov**
Dynamic processes in the fish community of the Japan Sea epipelagial (S5-065)

11:10-11:25 **Alexey A. Baytalyuk**
Contemporary stock status, distribution, place and role of Pacific saury in the Japan Sea/East Sea (S5-064)

11:25-11:40 **Jun Yamamoto, Yasunori Sakurai, Tsuneo Goto**
Does pycnocline depth affect the hatching success of Japaenese common squid paralarvae from pelagic egg masses? (S5-078)

11:40-11:55 **Xuewu Guo, Zhinan Zhang**
Zooplankton in the near bottom layer of the Yellow Sea in summer (S5-069)

11:55-12:10 **Xian-Shi Jin, Binduo Xu, Zhenlin Liang**
Changes in the fish community structure in the Yellow Sea (S5-072)

Posters:

Ichiro Aoki, Tetsu-ichiro Funamoto
Comparison of reproductive patterns of inshore and offshore spawning populations of Japanese anchovy *Engraulis japonicus* around Japan (S5-063)

Vladimir A. Belyaev, V.B. Darnitskiy, S.Yu. Shershenkov
Abundance dynamic of Japanese mackerel in the Japan Sea (S5-066)

Seok-Gwan Choi, Jin-Yeong Kim, Soon Song Kim, Young Min Choi, Kwang Ho Choi
Biomass estimation of anchovy (*Engraulis japonicus*) by acoustic and trawl surveys during spring season in the Southern Korean Waters (S5-067)

Nianzhi Jiao, Yanhui Yang, Koshigawa Horoshi, Masataka Watanabe
Distribution patterns of autotrophic picoplankton and heterotrophic bacteria and their affecting factors in the East China Sea (S5-070)

Nianzhi Jiao, Yanhui Yang
Ecological studies on *Prochlorococcus* in China Seas (S5-071)

Olga Moukhametova
Some peculiarities of fish eggs and larvae distribution in northern Japan Sea (S5-076)

Yanhui Yang, Nianzhi (George) Jiao
Distribution of virioplankton in the Kuroshio Current and the adjacent area in the East China Sea as determined by flow cytometry measurements (S5-079)

11AM2002 S5-063 Poster

COMPARISON OF REPRODUCTIVE PATTERNS OF INSHORE AND OFFSHORE SPAWNING POPULATIONS OF JAPANESE ANCHOVY *Engraulis japonicus* AROUND JAPAN

Ichiro Aoki and Tetsu-ichiro Funamoto
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The reproductive patterns of Japanese anchovy were compared among four spawning populations: three inshore spawning populations of Sagami Bay (Pacific coast), Wakasa Bay (Japan Sea coast) and Osaka Bay (Seto Inland Sea), and offshore migrant population off the Pacific coast of eastern Honshu. The last offshore spawning migrants occur characteristically during the period of high stock levels of Japanese anchovy.

Spawning of the three inshore populations occurred commonly at water temperature higher than 15°C and were subject to nutritional conditions, though each spawning season differed to some extent. The size at maturity varied from 5.8 to 8.5 cm BL among the inshore populations. It is worth notice that in Sagami Bay the anchovy spawned first at 5.8 cm BL during autumn and winter of the year of their birth. Spawning frequencies were correlated with water temperature in the same manner both for small and large fish.

In contrast, offshore migrant anchovy matured first at 10 cm BL that was larger than inshore anchovies. This suggests that energy is allocated to growth rather than maturation even at the maturity size for inshore anchovies. Furthermore they spawned at water temperature lower than 15°C with lowest of 5.0°C. Spawning frequency and batch fecundity had positive correlation with water temperature, while egg size was negatively related to water temperature. At the same water temperature batch fecundity of offshore anchovy was higher than that of inshore ones. Offshore migrant anchovy represent the reproductive ecology that is adapted to lower temperature and long distance migration.

11AM2002 S5-064 Oral

CONTEMPORARY STOCK STATUS, DISTRIBUTION, PLACE AND ROLE OF PACIFIC SAURY IN THE JAPAN SEA/EAST SEA

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Number and biomass of saury were estimated by results of the visual observation at light stations. Saury biomass changed from 12 to 24 thousand tons, number of population increased from 118 to 237 million individuals during 1977-2001. The minimal indices were during of 80s of the last century. According to trawl data sardine dominated in catches but saury were met rarely in these years. In autumn of 1997 and 2001 saury biomass made 7 and 21 thousand tons and it was low then of squids – *T. pacificus* and *W. scintilans*.

In the last years mass approaches of saury to Russian coast, including south of Primorie, were marked in June – July. Saury almost continuously distribute in the all EEZ of Russia to southern part of the Tatar Strait in the beginning of autumn. Large fishing grounds of adult saury consider with waters of southern and northern Polar front, juveniles distribute in interfrontal waters. Intensity of fish penetration to the north of the Japan Sea and a northern border of penetration depend on intensity of streams of subtropical waters and distribution of Primorsky current.

The food spectrum of saury includes some dozens of species of zooplankton. Adult saury consume large species of zooplankton (copepoda, amphipoda, pteropoda), juveniles consume small species (small copepoda, early stages of zooplankton). The saury are food for large pelagic fishes and squid.

11AM2002 S5-065 Oral

DYNAMIC PROCESSES IN THE FISH COMMUNITY OF THE JAPAN SEA EPIPELAGIAL

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Over last twenty years (1980-2000) the proportion of dominant species in the Japan Sea epipelagial fluctuated. Fluctuations in the proportion of dominant species were analyzed based on materials of trawl surveys of the north-western Pacific (200-miles zone of Russia and Korea) and also based on data of fishing and biological statistics represented by Japanese and Korean scientists.

Until 1989 Japanese sardine *Sardinops melanosticta* predominated and accounted 90%. From 1991 anchovy *Engraulis japonicus* was a dominant species (70%), in 1995 mackerel *Scomber japonicus* was the most occurred species and made up about 45%. Thus, since 1995 in the Japan Sea sardine fell, the abundance of anchovy decreased a few, and the abundance of mackerel increased. With this, it should be noted that in 1997 Pacific squid was dominant among nekton species, saury and Japanese anchovy predominated among fishes. In 2001 the situation was the same. Other species including mackerel occurred single. Populations of these species, inhabiting the Japan Sea have covered areas that is why it is difficult to determine the cause of changes in ecosystem at the moment. At the same time these changes were observed in the epipelagial of the Japan Sea earlier.

Usually specialists associate changes in the marine ecosystems with changes of oceanological processes (thermal regime of waters in different layers, course, velocity of main streams), where climatic and antropogenic factors are major. In the Japan Sea there are two large-scale areas differing by thermal and hydrodynamic conditions. The cold zone with three main eddies, cyclonic by nature is located further south than Pole front (the northern frontier of transformed subtropic waters). In the warm southeast zone of sea where the Tsusima Current and its branches are the main area, anticyclonic eddies predominate near the Yamato Bank. The significant meridianal magnitude of the Japanese Sea and also features of bottom topography determine the difference of hydrological processes in southern and northern zones. Whereas the oceanological regime in both zones has the significant seasonal and interannual changeability of characteristics as thermal as dynamic.

The southern zone of sea is the main reproduction and wintering area of saury mackerel, sardine, anchovy, and other thermophilic fishes and squids. In the northern zone of sea these fishes and squids feed within a warm season. So, the southeast zone is a area to form generations of mass pelagic fishes whereas the northern zone influences on the fish preparation to spawning.

With due regard that the total biomass and abundance of species which substituted sardine in feeding areas is less, and food base of waters at the end of 1980s is on the same level, we can suppose that the essential area influencing on the abundance fluctuations of mass epipelagic fishes (mainly sardine, mackerel and anchovy) is a south-east zone of sea. However, interannual changes in the proportion of these species reveal dynamic processes occurred in the epipelagial ecosystem of the Japan Sea.

11AM2002 S5-066 Poster

ABUNDANCE DYNAMIC OF JAPANESE MACKEREL IN THE JAPAN SEA

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Japanese mackerel *Scomber japonicus* is one of mass species in the epipelagial of the Japan Sea. During periods of the high abundance mackerel spread along the continental shore and through the center of Japan Sea and migrates northward. Within this period mackerel were caught near the shore of Primorie and in the 200-mile economic zone of Russia.

The fishing of Japanese mackerel by Russian fishermen in waters of Primorie began in 1908 in the Amursky and the Ussuriisky Bays. The annual catch did not exceed 250 tons (1913, 1924 and 1926). Due to the sardine fishing, the catch of mackerel declined gradually and almost stopped in 1931. Thanks to the development of purse-seining in 1937-1940, the catch of mackerel for one cast was more than 20 tons. From the 1940s the abundance growth of mackerel, migrating to waters of Peter the Great Bay, led to organization of the special fishery. From that time the

catch of mackerel became commercial and increased until 1953 then the catch over the whole fishing season was 12 thousand tons. To 1958 the run of mackerel to Peter the Great Bay decreased as significantly as the fishing of this species stopped. The decline of the mackerel abundance occurred at the end of 1950s in the Southern Primorie while the catch of mackerel in Korea and Japan was high, can be explained not only by the abundance decline, but also by the transformation of mackerel migration ways. Whereas the total decrease of the spawning area over a long period led to decrease of mackerel inhabiting the Japan Sea. The growth of sardine abundance from the end of 1970s to 1990s led to decrease of total abundance of mackerel because of the interspecies competition of two species in spawning and feeding areas.

At present the fishing of mackerel in the Japan Sea is of interest and needs the stock assessment of mackerel. We try to estimate its abundance and biomass over last 30 years based on data of Japanese and Korean and fishing over previous years.

Some growth of mackerel abundance of the Japan Sea population was observed in 1972-1977. Then the catch began decreasing until 1982, next after a little increase of abundance it fell. According to our estimations in 1960-1970s the maximal biomass of mackerel was in 1976-1977 (1.3 million tons), the maximal abundance was in 1976. The minimal biomass (174 thousand tons) and abundance (182.2 individuals) fell at 1965. This information concerns the whole Japan Sea, and there are no data on stock assessment of population in the northwest part of the Japan Sea, so we can use data on complex ecosystem surveys from 1985.

The changeability of mackerel occurrence in catches of trawl surveys is worth to consider. The occurrence ranged from 2.2% in 1990 to 13% in 1995. In that period the number of fish in catch increased. In September 1995 mackerel occurred within a relatively small area (39 thousand km^2), the abundance was 445.3 mln. individuals and biomass was 51 thousand tons. The base of population is represented by fishes of age +2 accounting for 95%, and if the total mortality coefficient is 0.4 the number of fish of age +2 is 267,2 mln. individuals. The average weight of third-year fish is 300 g, the biomass of population migrating to 200-mile zone of Russia can be 80 thousand tons. The total allowable catch of mackerel is 25-30%. Accounting relatively low abundance and using the minimal coefficient the total allowable catch is 20 thousand tons. Whereas over last years (1996-2002) mackerel occurs in the 200-mile zone only single. Probably it is connected with the reduction of area (decrease of population abundance) and absence of favourable hydrological conditions in the northwest Japan Sea.

11AM2002 S5-067 Poster

BIOMASS ESTIMATION OF ANCHOVY (*Engraulis japonicus*) BY ACOUSTIC AND TRAWL SURVEYS DURING SPRING SEASON IN THE SOUTHERN KOREAN WATERS

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Spatial distribution characteristics and biomass of Pacific anchovy, *Engraulis japonicus*, in the southern Korean waters during spring season were estimated by the hydroacoustic, trawl and oceanographic surveys in April~May 2000 and March 2001. Pacific anchovy appeared high-density schools in the coastal waters with the range of 12-15°C sea surface temperature and 33.6~34.5 sea surface salinity from Pusan to Yeosu and low-density in the western part of Cheju Island during spring season, 2000 and 2001. Biomass of Pacific anchovy by echo integration and trawl survey was estimated to be 198,970 tons in 2000 and 117,740 tons in 2001. The fact that Pacific anchovy distributed with high density in coastal waters of southern part of Korea during spring season identified this region as main habitat of Pacific anchovy stock migrating northward from over wintering ground.

11AM2002 S5-068 Invited

FACTORS AFFECTING THE PRODUCTION OF SMALL PELAGIC FISHES IN THE JAPAN/EAST SEA

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To understand how factors interact with each other three data categories were analyzed.
1. Biological - maximum stock assessment of saury, sardine, anchovy, and scomber in Japan/East Sea during 20th century, mean absolute fecundity, maximal life span, main spawning areas, spawn ecology, and peculiarities of species development during early ontogeny.

2. Hydrological - "type of year" (warm or cold), mean winter and summer SST anomalies, Kuroshio intensity, warm water distribution toward Tsushima Current of East-Korean Current.
3. Feeding - peculiarities of feeding for each species, seasonal dynamics of zooplankton biomass and number in the Japan/East Sea.

Having analyzed the interaction of these components, the scheme based on a suggestion that each species fluctuates according to peculiarities of population structure and reproduction was developed. Interspecies relationships overlap intrapopulation processes. They become especially actual in feeding. The most important factors in this aspect are match/mismatch spawning periods of the fishes (larvae appearing) and zooplankton bloom. These processes are determined by thermal condition in the winter period and feeding migrations of pelagic fishes and lead to aggravation or relaxation of relations in early ontogeny. According to this scheme changing trends in the pelagic fish population abundance have been forecast. Sardine and scomber population abundance is expected to increase dramatically if raising winter and summer temperatures forecast after 2003-2004 are confirmed. If this trend fails and thermal conditions are developing as in 1950s, increasing sardine number will stop and the saury reproduction will be successful.

11AM2002 S5-069 Oral

ZOOPLANKTON IN THE NEAR BOTTOM LAYER OF THE YELLOW SEA IN SUMMER

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The zooplankton in the near bottom water layer (NBL) were studied at seven stations along a transect from Qingdao to Jeju-do island in August 1999 and at ten stations around 35°N, 120°E in July 2001 in the Yellow Sea. By means of a midi-corer, a large quantity of zooplankton was discovered in the NBL. Its maximum abundance, about 180 thousand of individuals including 162 thousand of *Paracalanus parvus* per cubic meter of water, was found at the station located in the cold water-mass in the middle Yellow Sea. This implies that *Paracalanus parvus* might be summering there. Numerically, the NBL zooplankton were dominated by meso- and micro-zooplankton occupied more than 95% in abundance. The variation in species composition in sequential sampling conducted day and night at stations around 35°N, 120°E exhibits distinct diel vertical migration of the NBL zooplankton: up to the upper layer from 17:30 to 2:00 decreased the abundance to 5.5~7.6′10^3 ind./m^3 in the NBL, and down to the NBL from 3:00 to 15:00 increased the abundance to 12.4~19.8′10^3 ind./m^3.

11AM2002 S5-070 Poster

DISTRIBUTION PATTERNS OF AUTOTROPHIC PICOPLANKTON AND HETEROTROPHIC BACTERIA AND THEIR AFFECTING FACTORS IN THE EAST CHINA SEA

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Dynamics of *Synechococcus* (Syn), *Prochlorococcus* (Pro), picoeukaryotes (Euk) and heterotrophic bacteria (Bact) populations in the East China Sea were investigated by flow cytometry in February 1997 and July 1998. Syn was ubiquitous with an average depth-integrated abundance (concentration here after) of 0.11~0.54 x 10^4 cells ml^{-1} in winter and 1.0 ~ 4.2 x 10^4 cells ml^{-1} in summer. Pro was absent in the coastal areas. In winter, it was confined to the Kuroshio and Taiwan warm-currents areas and in summer it was present at most locations beyond the 50 m isobath at typical concentrations of 3.8 to 4.4 x 10^4 cells ml^{-1}. Euk concentrations were 2.8-5.8 x 10^3 cells ml^{-1} in winter and about an order of magnitude less in summer. Bacterial concentrations were nearly constant in both seasons ranging from 3 x 10^5 cells ml^{-1} near the coasts to 5 10^5 cells ml^{-1} offshore area in winter with a reversal of the gradient in summer. Two *Synechococcus* types (Syn1 and Syn2, based on their phycoerythrin content) were located mostly in coastal or oceanic waters respectively. Syn1 seemed to require high nutrient concentrations and sustained at lower temperatures than Pro, while Syn2 was more similar to Pro in geographical distribution. However due to the ability of Pro to grow at low light levels it peaked below Syn2 in most water columns. Pro correlates inversely with Bact and disappeared toward the coast. They seemed to vary in abundance between the various waters. As indicated by water temperature and nutrient level, water masses and currents seemed to be the main factor controlling the distribution of Pro on large scale. Nitracline, water column characteristics and even biological interactions were likely to play important roles in regulating Pro's distribution on small scale.

11AM2002 S5-071 Poster

ECOLOGICAL STUDIES ON *PROCHLOROCOCCUS* IN CHINA SEAS

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Prochlorococcus, a tiny oxygenic photosynthetic picoplankton with unique pigment composition has been found to be ubiquitous and abundant in the world oceans, and been recognized to be closely related to living resources and environmental issues. It has been attracting interests of marine biologists since its discovery, and field data on it over global oceans have been accumulated rapidly in the past 10 years. In China, we have studied *Prochlorococcus* for 8 years and basic ecological understandings are achieved. The presence of *Prochlorococcus* in China Seas, marginal seas of the west Pacific, was confirmed, and its distribution patterns were also brought to light. *Prochlorococcus* is very abundant in the South China Sea and the offshore regions of the East China Sea; it is seasonally present in the southeast part of the Yellow Sea and absent in the Bohai Sea. Temporal and spatial variations of the abundance of *Prochlorococcus* and their affecting factors, physiological and ecological characteristics of *Prochlorococcus* and their relationships to the other groups of picoplankton, as well as the importance of *Prochlorococcus* in total biomass and possible roles in living resources and environmental problems were discussed. In the future, isolation of different *Prochlorococcus* strains from China seas and their physiological characteristics, genetic diversity, phylogenies and gene exploiture, etc. are important issues to be addressed.

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CHANGES IN THE FISH COMMUNITY STRUCTURE IN THE YELLOW SEA

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Based on the data collected from bottom trawl surveys conducted in the autumn of 1985 and 2000, the temporal and spatial changes in the fish community structure in the Yellow Sea are analyzed. The results show that there is an

increase in biomass percentage of pelagic fish which is higher than that of demersal fish. The proportion of biomass of pelagic fish in the southern parts is higher than that in the northern and central parts of the Yellow Sea. The temporal and spatial variations in the composition of dominant species are also examined. The similarity of species composition between the north parts and central parts is relatively high, however, the indices between southern part and northern and central part is lower. The similarity between 1985 and 2000 is relatively low, which only amounts to 0.429. The species diversity decreases from the north to the south. Changes in the integrated community size spectra in the Yellow Sea are also found, which illustrate an increase of the numbers of small-sized species or small size individuals and a decrease in the numbers of large size individuals as well as a diminishing length range. The analysis on the length composition of some commercially important species show that there is a decreasing tendency in the dominant length class or abundance percentage in the length class, as reflected in the increase of numbers of small individuals. The small-sized individuals increase and large ones decrease from the north to the south with regard to the regions.

11AM2002 S5-073 Oral

A COMPARISON OF THREE MARINE ECOSYSTEMS SURROUNDING THE KOREAN PENINSULA: RESPONSES TO CLIMATE CHANGE

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This study uses a comparative approach to examine responses of marine ecosystems to climatic regime shifts. The three seas surrounding the Korean peninsula, the East/Japan Sea, the East China Sea and the Yellow Sea represent three contiguous but distinct ecosystems. Sampling has been carried out by the National Fisheries Research and Development Institute of South Korea since 1965, using the same methods in all three seas. Sampling was generally synoptic. Amplitude time series of 1st EOF modes for temperature, salinity, zooplankton biomass and concentrations of four major zooplankton taxa were used to determine whether the three marine ecosystems respond in a similar manner to climate. Temporal patterns of the variables were strongly similar among the three seas at decadal time scales, but very weakly similar at interannual scales. All three seas responded to a climatic regime shift in 1989. Temperature, zooplankton biomass and copepod concentrations increased in the late 1980s or early 1990s in all three seas. Concentrations of amphipods, chaetognaths and euphausiids also increased in the East/Japan Sea and the East China Sea, but not the Yellow Sea. The Yellow Sea ecosystem differs strongly from the other two seas, and water exchange between the Yellow Sea and the East China Sea is much weaker than that between the East China Sea and East/Japan Sea. Spatial patterns of zooplankton determined by the EOF analysis were closely related to currents and fronts in each of the three seas.

11AM2002 S5-074 Oral

TRANSPORT OF JACK MACKEREL (*Trachurus japonicus*) EGGS AND LARVAE INFERRED FROM THE NUMERICAL EXPERIMENT IN THE EAST CHINA SEA

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Using an advection and diffusion model for particle tracking in three dimensions, transport process of eggs and larvae for spring-spawning population of jack mackerel in the East China Sea was investigated. Results by the numerical experiment from four spawning areas showed differences of transport path by location of spawning grounds and the Kuroshio front. By applying physical environmental conditions (optimum water temperature and salinity) in relation to the development stage of jack mackerel to the advection and diffusion model, it became explicit that the Kuroshio frontal eddy area west of Kyushu had good hydrographic conditions for nursery ground of jack mackerel larvae. At west of Kyushu, a transport experiment by sea surface advective velocity field computed using Maximum Cross Correlation method (MCC) showed that jack mackerel larvae from the Kuroshio region southwest of Kyushu were transported into the nursery ground west of Kyushu by the Kuroshio frontal eddy, which is of benefit for the larvae to recruit to fishery resources. Trajectories of Argos buoys released both inside and outside of the Kuroshio front showed a remarkable transport difference by two current systems (the Kuroshio and

the Tsushima Warm Current). These trajectories of buoys and larval distribution between two current systems, combined with the results of numerical experiment, suggest that eggs have to be spawn very narrow area between the continental shelf water and the Kuroshio front to be transported into the nursery ground west of Kyushu.

11AM2002 S5-075 Oral

RELATIONSHIP BETWEEN THE ABUNDANCE OF PACIFIC SAURY, *Cololabis saira* (BREVOORT) AND BIOLOGICAL PRODUCTIVITY IN THE EAST SEA

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The relationship between the regional difference in the biological productivity and the abundance of Pacific saury, *Cololabis saira* (BREVOORT) in the East/Japan Sea was studied in relation to the production mechanism and to the ocean-size specific migration pattern suggested by Gong *et al.* (1983). It was postulated that the continuous winter-spring primary production led to the aggregation of different size groups of saury spawners along the frontal zone in the western central East/Japan Sea under normal oceanic conditions. Based on the ratio of critical depth (Dcr) to mixed layer depth (MLD) during winter and spring seasons, ecological boundary was determined around the longitude of 131–133°N line in the East/Japan Sea. The abundance of Pacific saury in the western (toward Korean coast) side was higher than the eastern East/Japan Sea (toward Japanese coast) because of the higher primary productivity, shorter migration distance, and larger number of length classes due to aggregation. The sharp decline in the abundance of the Pacific saury inhibited the Tsushima Warm Current system was attributed to the disturbance of high production zone by the climate-driven oceanic shift around 1976-1977 in the East/Japan Sea.

11AM2002 S5-076 Poster

SOME PECULIARITIES OF FISH EGGS AND LARVAE DISTRIBUTION IN NORTHERN JAPAN SEA

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Ichthyoplankton were collected near west Sakhalin between 48°N and 49°N by ichthyoplankton conical net (mouth 0.1 m^2, length 1.0 m) in July 1999, in Chihacheva Bay (51°27' N 140°05' W) and Nevelskogo Strait (52°05' N 141°30' W) by conical net IKS-80 (mouth 0.5 m^2, length 3.0 m) in September 2001. The sampling was made by total captures from bottom to surface or by 5-minutes surface horizontal towing. Eggs and larvae were sorted and preserved by standard methods. Data from Nevelskogo Strait were obtained with financial support of «Transstroymost Ltd».

The maximum of species diversity and larvae density were found in near-shore waters of west Sakhalin on the stations near capes, where many closed little bays with algae *Cystoseira crassipes, Laminaria japonica, L. cichorioides, Alaria* sp. were placed. 7 species of eggs and larvae, belonged to 7 families were carried out here on the 0.3 – 0.6 m depth (Table 1). The species list includes *Engraulis japonicus, Hexagrammos octogrammus, Arctoscopus japonicus, Rhodomenichthys dolichogaster, Stichaeopsis nana, Myoxocephalus jaok, Blepsias cirrhosus, Limanda aspera.*

The sea-surface temperature varied from 15.8 to 19.6°C. The eggs and larvae frequency of occurrence was not high (14.3 % for each species). Occurrence of *Hexagrammos octogrammus* larvae amounted to 28.6%. Fish eggs belonged to *Engraulis japonicus* with average catches 0.31 specimen per 1 m^3 and *Limanda aspera* with average catches 0.06 specimen per 1 m^3.

The ichthyoplankton complex of Chihacheva Bay consisted of 2 species *Engraulis japonicus* and *Limanda aspera*, but density of fish eggs and larvae was significantly higher. The number of *Engraulis japonicus* eggs increased to 4.52 specimen per 1 m^3. Larvae abundance was lower and reached 0.36 per 1 m^3. It composed 7.96% of eggs. Percent number of eggs of different developmental stages was as follows: I – 57.94%, II – 23.18%, III – 6.01%, IV – 0.43%. The part of dead, non-fertilized and deformed eggs composed 12.45%. The depth of eggs occurrence

varied from 6 to 19.3 m. The depth of larvae occurrence ranged from 6 m and 13 m. Temperature was stable - 16.3 - 16.9°C.

The number of *Limanda aspera* eggs was also high. It was 2.06 eggs per 1 m^3 in average. The larvae quantity composed 4.13% of eggs abundance. 64.21% of eggs were with developed embryos (53.68% - III stage, 10.53% – IV stage). 9.12% of eggs were on the I stage of development, 20.0% were on the II stage. The number of dead and defective eggs was 6.67%. Depth of eggs captures changed from 5.7 to 17.8 m, sea-surface temperature was 16.3 – 16.9°C. Larvae were sampled above 5.7 – 17.8 m depth and surface temperature 16.3°C.

Nevelskogo Strait characterizes by very variable conditions and strength stream. Larvae of only 2 species *Engraulis japonicus* and *Salangichthys microdon* were collected here. The depth of captures was changed from 11.4 to 17.5 m, sea-surface temperature varied from 14.9 to 16.2°C. It is necessary to mark that anchovy eggs and larvae extended wide near west and east cost of Sakhalin in September-October 2001. They spread to 52°N in the northern Japan Sea and to 54°N in the Okhotsk Sea in Sakhalin waters. Probably, anchovy at early stages of development can spread further to the north. Studying their real distribution was impossible by the cause of a limited exploring region.

Table 1: Species list, distribution and abundance of fish eggs and larvae (Northern Japan Sea, 1999 – 2001)

Location	Species	Size, mm, range mean	Frequency of occurrence, %	Number, per 1 m^3
Engraulidae				
20 m from mouth of Ichara River, West Sakhalin	*Engraulis japonicus* eggs	1.25-1.56 X 0.65-0.74 1.386 X 0.704	14.3	0.31
Chihacheva Bay, West shore of Tatarskiy Strait	Eggs	1.18-1.6 X 0.58-0.8 1.384 X 0.706	85.71	4.52
	larvae	3.0 – 9.1 5.05	42.86	0.36
Nevelskogo Strait	larvae	15.0 – 24.8 20.68	50	0.18
Salangidae				
Nevelskogo Strait	*Salangichthys microdon* larvae	34.8 – 55.1 45.29	16.7	0.17
Hexagrammidae				
Lamanon Cape, West Sakhalin	*Hexagrammos octogrammus* larvae	13.3-14.8	28.6	0.10
Trichodontidae				
Lamanon Cape, West Sakhalin	*Arctoscopus japonicus* fry	25.5	14.3	0.03
Pholididae				
Lamanon Cape, West Sakhalin	*Rhodomenichthys dolichogaster* fry	45 – 55	14.3	0.09
Stichaeidae				
Izilmentieva Bay, West Sakhalin	*Stichaeopsis nana* larvae	14.8	14.3	0.04
Cottidae				
Stukambis Cape, West Sakhalin	*Myoxocephalus jaok fry*	28.3 – 38.6 33.7	14.3	0.14
Lamanon Cape, West Sakhalin West Sakhalin	*Blepsias cirrhosus* larvae, fry	14.4 – 55 35.8	14.3	0.11
Pleuronectidae				
20 m from mouth of Ichara River, West Sakhalin	*Limanda aspera, eggs*	0.8	14.3	0.06
Chihacheva Bay, West shore of Tatarskiy Strait	*eggs*	0.75-0.92 0.824	100	2.06
	larvae	2.2 – 3.9 2.822	28.57	

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GROWTH OF LARVAE AND EARLY JUVENILE JAPANESE ANCHOVY, *Engraulis japonicus*, AND ENVIRONMENTAL CONDITION IN THE KUROSHIO-OYASHIO TRANSITION REGION

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Growth rates during early life stages of fishes are influenced by water temperature and prey density. The objective of this study is to evaluate the effects of environmental condition on the early growth of Japanese anchovy, *Engraulis japonicus*, in the Kuroshio-Oyashio transition region. We collected early juvenile *E. japonicus* (25–45 mm SL) by subsurface trawl hauls and zooplankton by vertical plankton tows in the transition region. Sea surface temperature (T, 15.3–19.0°C) at the sampling stations with positive juvenile collection was higher in the southwestern waters than in the north or eastern waters in the survey waters. Food availability (F) of early juveniles was defined as the density of copepod with prosomal width < 600 mm, which was equivalent to 42% of the esophagus diameter of 35 mm SL juveniles, was higher in the western waters than in the eastern waters. The mean recent growth rate (Gr) of the early juveniles caught in each trawl haul ranged from 0.54 to 0.96 mm d^{-1}. Gr was faster in the southwestern waters than in the northern or eastern waters in the Kuroshio-Oyashio transition region, and positively correlated with T and F, except for the northwestern waters with complicated mixing of the warmer water derived from the Kuroshio with the cooler water derived from the Oyashio. These results suggest that the southwestern waters in the transition region have suitable condition for the growth of *E. japonicus* larvae.

11AM2002 S5-286 Oral

LONG-TERM VARIABILITY IN THE ECOSYSTEM PRODUCTIVITY OF THE BOHAI SEA AND CONTROL MECHANISMS

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Decadal-scale variability in the ecosystem productivity of the Bohai Sea was described using the survey data of 1959/60, 1982/83, 1992/93 and 1998, in which the chlorophyll *a*, photosynthetic production, phytoplankton abundance, zooplankton biomass and fishery relative abundance have been considered as indices of the ecosystem productivity. The results indicate that the productivities of the various trophic levels were greatly changeable. Primary production and top production decreased from 1959 to 1998, for example, phytoplankton in 1992 and 1998 were only about 1/4 of 1959 and 1982, fishery abundance in 1998 were particularly low, only about 5% of 1959. Second production (Zooplankton) also appeared to decrease from 1959 to 1992, but very high in 1998 with 3.4 folds of 1959 and 1982, and 6 folds of 1992. No single theory can well explain the causes of the variability in the ecosystem productivity of the Bohai Sea, and a multi-control mechanism of the Bohai Sea ecosystem has been discussed.

11AM2002 S5-078 Oral

DOES PYCNOCLINE DEPTH AFFECT THE HATCHING SUCCESS OF JAPANESE COMMON SQUID PARALARVAE FROM PELAGIC EGG MASSES?

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Ommastrephid squids generally produce large numbers of small eggs encapsulated in gelatinous egg masses. No egg masses have been observed in the natural habitat, but they are thought to occur within the pycnocline, where developing embryos within the egg masses are thought to be relatively safe from predation and mechanical damage that might occur at the surface. However, embryos could also be damaged if the mixing depth layer reaches the sea bottom, causing the egg masses to come in contact with the bottom. The objective of the present study is to determine if the depth of the pycnocline relative to the sea bottom affects the hatching success of Japanese common

squid (*Todarodes pacificus*) paralarvae. Paralarvae were collected during four autumn surveys (1991-94) in the southwest Sea of Japan. The distribution of the paralarvae smaller than 1.0 mm mantle length (hatchlings) was used to infer areas where successful hatching occurred, and the mixing layer depth (MLD) was defined as the depth of the pycnocline. Hatchlings occurred at 42-61% of the sampling stations in each survey. Temperatures at the MLD were within the ideal temperature range (15-23°C) for embryonic development, suggesting temperature does not directly affect the distribution of hatchlings. Hatchlings were collected at stations where the MLD was shallower than the bottom depth, but few were collected at stations where the MLD occurred at or near the bottom. These results suggest that successful hatching from egg masses is higher when the MLD is shallower than the bottom depth.

11AM2002 S5-079 Poster

DISTRIBUTION OF VIRIOPLANKTON IN THE KUROSHIO CURRENT AND THE ADJACENT AREA IN THE EAST CHINA SEA AS DETERMINED BY FLOW CYTOMETRY MEASUREMENTS

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Distribution of one group of marine viral particles was investigated using flow cytometry for the first time along the Kuroshio Current and the adjacent area in June 1998. Position of this group of virioplankton in flow cytometry plots was identical to the V-I group reported by Marie *et al.* (1999). Abundance of this group of virioplankton in the surface water ranged from 3.4×10^5 to 2.3×10^6 ml^{-1} in the investigating area. Horizontal distribution of the virus correlated positively the most significantly with that of heterotrophic bacteria ($r=0.85$, $p<0.01$), then with that of *Synechococcus* ($r=0.65$, $p<0.01$) and that of pico-eukaryotes ($r=0.52$, $p<0.05$), but negatively with that of *Prochlorococcus* ($r=-0.60$, $p<0.01$). Its distribution did not correlate with bulk chlorophyll *a* or size-fractionated chlorophyll *a* biomass. However, its vertical distribution correlated positively with those of the *Prochlorococcus* and *Synechococcus*, but not with those of pico-eukaryotes or bulk or size-fractionated chlorophyll *a* biomass. Possible explanations were discussed.

11AM2002 S5-080 Invited

PRODUCTIVITY OF SMALL PELAGICS IN KOREAN WATERS

Chang Ik **Zhang**, Jae Bong Lee, Young Il Seo, Sung Il Lee, Man Woo Lee, Sun Kil Lee, Sang Chul Yoon, Kyum Joon Park, and Yeong Gong

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The annual fisheries production of small pelagics ranged from 210,000 mt in 1960s to 780,000 mt in 1980s during the last four decades in the Yellow Sea, the East China Sea and the East/Japan Sea of Korean waters. The proportion of the production of small pelagics to the total production has increased from 37% in 1960s to 53% in 1990s in Korea. The major small pelagic species were anchovy, common mackerel, common squid, filefish, Pacific sardine, Pacific saury, and horse mackerel in order of catch amount. The changes in productivity and shifts in species dominance were identified. In 1960s common squid was the most dominant, followed by anchovy and Pacific saury. But in late 70s and 80s filefish became the most dominant species, followed by anchovy and common mackerel in the 70s and anchovy and Pacific sardine in the 80s, respectively. However, anchovy occupied the most dominant position, followed by common squid and common mackerel in the 1990s. The fluctuations in the production and abundance of major species such as, common mackerel, Pacific sardine, and horse mackerel were analyzed in relation to oceanographic environmental factors. Also, the geographical distributions of the major species and their habitat overlaps were studied. Finally, the tropho-dynamic structures of the three marine ecosystems were preliminarily constructed and the role of small pelagics in the organization and structure of each ecosystem was evaluated.

S6 FIS Topic Session
Physical forcing of walleye pollock life history and population structure: New approaches to identifying critical temporal and spatial scales

Co-Convenors: Martin Dorn (U.S.A.), Akira Nishimura (Japan) & Mikhail Stepanenko (Russia)
Thursday, October 24, 2002 08:30-12:30

Walleye pollock occupy diverse habitats in the North Pacific Ocean, ranging from semi-enclosed fjords to large oceanic basins. For some pollock populations, an annual migration between spawning and foraging habitats can be identified; in other populations, a gradual ontogenetic shift in distribution seems most prevalent. Although evidence of fine-scale population structure in walleye pollock is equivocal, pollock spawning aggregations are highly consistent in timing and location. This session will explore new approaches to studying the life history and population structure of walleye pollock, a key species ecologically, and the target of major fisheries in the North Pacific. Papers and posters in this session will have a meta-analytical orientation, in which population characteristics such as life history traits, per unit carrying capacity, migratory patterns, responses to physical forcing or commercial fishing, and decadal trends in abundance, are contrasted.

08:30-09:10 **James N. Ianelli** (invited)
Patterns in the abundance of pollock in the Bering Sea: an integrated view of stock structure issues (S6-084)

09:10-09:30 **Yasunori Sakurai, Akifumi Suzaki, Jun Yamamoto, Tomonori Hamatsu, Tsutomu Hattori, Yukio Mihara**
Effect of variations in the flow of the coastal Oyashio Current on the year-class strength of walleye pollock in northern Japan (S6-092)

09:30-09:50 **Tsuneo Nishiyama, T. Tazaki, D. Takasaki, K. Kidokoro, S. Katakura, B.N. Kotenev**
Changes in body size, maturity, feeding condition, and age of walleye pollock during spawning period in the west coast of Kamchatka Peninsula, the Okhotsk Sea, in 1995~2001 (S6-090)

09:50-10:10 **Kyung-Mi Jung, Suam Kim, Sukyung Kang**
Ecological characteristics of walleye pollock eggs in the southeastern Bering Sea during the 1970s regime shift period (S6-085)

10:10-10:30 **Coffee/tea break**

10:30-10:50 **Anatoly V. Smirnov**
Spatial and temporal spawning patterns and interannual variability of walleye pollock in the Sea of Okhotsk (S6-093)

10:50-11:10 **Akira Nishimura, Takashi Yanagimoto, Kei-ichi Mito**
Rise and fall of pelagic walleye pollock resources in the Aleutian Basin (S6-089)

11:10-11:30 **Alexander I. Glubokov, Boris N. Kotenev**
Spatial – temporal distribution of Alaska pollock *Theragra chalcogramma* in the Northern Bering Sea (S6-305)

11:30-11:50 **Hiroya Miyake**
Population structure of the North Japan Sea walleye pollock stock (S6-087)

11:50-12:10 **Mikhail Stepanenko**
Structure of eastern Bering Sea pollock (*Theragra chalcogramma*) spawning aggregations and its functional composition (S6-094)

12:10-12:30 **Discussion and summary**

Posters:

Gennady V. Avdeev
Parasitism by indicator species as evidence of walleye pollock redistribution in the Okhotsk Sea (S6-081)

Alexandr Buslov
The use of vertebrae for walleye pollock age estimation (S6-082)

Alexandr Buslov
Growth of walleye pollock during the first year of life (S6-083)

Elena N. Kuznetsova
Geographic variability of the growth rate of walleye pollock from different regions of the northwest Pacific (S6-086)

Alexander V. Nikolaev, M.Y. Kuznetsov, M.A. Stepanenko, L.A. Boretz
Abundance and distribution monitoring of walleye pollock (*Theragra chalogramma*) in the north-western Bering Sea by echo integration surveys (1997-2001) (S6-088)

Michael C. Palmer, Brenda L. Norcross
Environmental forcing of walleye pollock, *Theragra chalcogramma*, growth in the southeastern Bering Sea (S6-091)

Alexandr I. Varkentin, N.P. Sergeeva
Walleye pollock size-age composition in the eastern Sea of Okhotsk (S6-095)

Alexandr I. Varkentin, N.P. Sergeeva
Walleye pollock survival in the eastern Sea of Okhotsk (S6-096)

Anatoly F. Volkov, Konstantin M. Gorbatenko
Diet of walleye pollock in the Okhotsk Sea during the spawning period (S6-097)

Takashi Yanagimoto, Akira Nishimura
Genetic variation in the walleye pollock, *Theragra chalcogramma* by PCR-RFLP and sequencing analysis of mitochondrial DNA (S6-098)

Oleg G. Zolotov, Pavel A. Balykin
Walleye pollock eggs and larvae drift in waters off Kamchatka Peninsula (S6-099)

11AM2002 S6-081 Poster
PARASITISM BY INDICATOR SPECIES AS EVIDENCE OF WALLEYE POLLOCK REDISTRIBUTION IN THE OKHOTSK SEA

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Walleye pollock in the Okhotsk Sea are parasitized by helmints larvae: *Anisakis simplex, Contracaecum osculatum* (Anisakidae), *Pyramicocephalus phocarum, Diphyllothrium* sp. (Diphyllobothriidae), and the copepod *Haemobaphes diceraus*. Parasitism by indicator species differs from areas of the Okhotsk Sea, but also shows interannual variability in areas with high infection rates.

The gradual increase (and decline) in the infection rate of the strong 1988 year-class by larval Anisakidae in Western Kamchatka was apparently due to an influx of uninfected young pollock from other regions of the Okhotsk Sea. The spatial distribution of age-3 pollock in 1991 suggests that juvenile pollock do not perform long migrations, and that the source of juvenile pollock was the adjacent region to the west.

The normal increase in infection rate with age was interrupted by a size range of fish comprising the strong 1988 and 1989 year-classes. During 1994-1997, there was a shift to larger sizes of this drop in infection rate. Based on the characteristics of parasite infection in various areas, and on changes in spawning stock and population size on the main spawning grounds of the Okhotsk Sea, it was concluded that the drop in infection of western Kamchatka pollock in the 1990s was caused by the uninfected individuals of strong year-classes migrating from the western areas of the Okhotsk Sea for first spawning.

11AM2002 S6-082 Poster
THE USE OF VERTEBRAE FOR WALLEYE POLLOCK AGE ESTIMATION

Alexander V. **Buslov**
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Determining fish age correctly is an urgent problem, particularly for valuable fishery species. Walleye pollock age is usually estimated using otoliths. However, counting annuli of this structure is not always straightforward. We attempt to estimate walleye pollock age using vertebrae. The annuli seen along the whole surface of vertebra are clearer than otolith annuli, a characteristic which simplifies age determination. Comparative age readings from vertebrae and otoliths demonstrates nearly equivalent results. The annuli seen in both structures are concluded to be informative analogs. The correlation between body length and vertebra radius can be approximated by a linear function that allows back calculation of body length. The growth curve obtained using this procedure correlates closely ($r=0.99$) with length-at-age data from otolith readings. Vertebrae are considered a useful structure for simplified age determination of walleye pollock; however the new method, while promising, is in need of further development.

11AM2002 S6-083 Poster
GROWTH OF WALLEYE POLLOCK DURING THE FIRST YEAR OF LIFE

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Extensive observations and published estimates of the body length of walleye pollock during the first year of life were analyzed. The relationship between age and body length during the first year of life shows a S-shape that can be described by a logistic function. Qualitative changes in the growth of walleye pollock occur after the larval stage (growth acceleration), and at the start of winter (slowing growth). The growth curves for various populations in the Sea of Okhotsk, Bering Sea, Japan Sea and adjacent waters were modeled with a logistic function. Growth rates during the first year of life are similar to all populations, except that walleye pollock in the south are larger due to earlier spawning and hatching of larvae.

Multifactor cluster analysis, using mean length in September, the average latitude of spawning, and the month of the peak larval hatch, demonstrates a significant difference between the southern and the northern pollock populations. The cluster of southern populations includes eastern Korean Bay, Peter the Great Bay, the waters adjacent to the Vancouver Island, the Pacific coast of Hokkaido Island, and the southern Kurils. The length in September for these populations was 94-103 mm. Walleye pollock populations from the eastern and northern Sea of Okhotsk, the eastern and western Bering Sea, and Navarinsky Bay belong to the northern cluster. For northern populations, length in September was 57-65 mm. Intermediate between the northern and southern clusters are pollock populations from Tatarsky Straight, western Gulf of Alaska, and Pacific coast of Kamchatka. The length in September for these populations was 70-80 mm.

11AM2002 S6-305 Oral

SPATIAL – TEMPORAL DISTRIBUTION OF ALASKA POLLOCK *Theragra chalcogramma* IN THE NORTHERN BERING SEA

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A study was conducted in the area encompassing the Koryak shelf zone, and waters off Cape Navarin and Anadyr Bay. The area was surveyed between 1998 and 2001 as follows: nine bottom trawl surveys during the spawning, post-spawning, feeding, pre-wintering and wintering periods; six surveys of juveniles during the post-spawning and pre-wintering and wintering periods; and three echo integration surveys. Data obtained for each year and season were used to estimate the total biomass and abundance of pollock using a spline approximation technique. The abundance of individual year classes was also estimated. The overall spatial distribution of pollock and spatial distribution of recruits by year class were mapped. The spatial-temporal movement of pollock in the northern Bering Sea was analyzed using all year classes, and separately for the 1999 and 2000 year classes as examples. The paper shows dependence of migration routes on the seasonal water dynamics in the region. The formation and duration of spawning, feeding and wintering distributions are influenced by annual oceanographic conditions.

11AM2002 S6-084 Invited

PATTERNS IN THE ABUNDANCE OF POLLOCK IN THE BERING SEA: AN INTEGRATED VIEW OF STOCK STRUCTURE ISSUES

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The dynamics of pollock stocks throughout their range are poorly understood. While some geographic barriers make management stock-units reasonably well defined, other stock definitions are often based on historical precedence and convenience. Definitions based on biological characteristics such as differences in growth are often open to interpretation, particularly if there are distinct ontogenetic migrations involved. Recently, evidence of geographically distinct year-class characteristics for the Eastern Bering Sea pollock raises a number of interesting questions. For example, to what extent are these patterns due to different distinct spawning groups? How important are environmental conditions in developing these distribution patterns? To what extent might interactions between population structure and the environment affect these observations? As fisheries management becomes increasingly concerned with fine-scale fishing patterns (*e.g.*, out of concern for Steller sea lion needs) issues of stock structure and spatial dynamics are critically important. We developed a multi-area population dynamics model for analyses of Bering Sea pollock to examine alternative hypotheses on stock structure for comparison with ontogenetic, environmentally affected movement. Since our observations indicate that the abundance and timing patterns on the main spawning grounds are consistent between years, it seems likely that stock structure issues is relatively minor and that environmental conditions during pre-recruit stages affect pollock distribution in the Bering Sea. We propose that new directed data-collection programs may provide additional observations to support or refute this hypothesis. One such program involves opportunistic hydro-acoustic data logging designed to evaluate temporal and spatial dynamics of pollock abundance patterns.

11AM2002 S6-085 Oral

ECOLOGICAL CHARACTERISTICS OF WALLEYE POLLOCK EGGS IN THE SOUTH-EASTERN BERING SEA DURING THE 1970S REGIME SHIFT PERIOD

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To investigate the environmental effects on the early life history of walleye pollock, we examined the patterns of distribution and abundance of pollock eggs in south-eastern Bering Sea (SEBS) during the 1970s regime shift period. Ichthyoplankton surveys were conducted in the SEBS during spawning time over the 1976-1979 period; May 1976, April-May 1977, March 1978 and June-July 1979. Eggs were sampled using Bongo net from around 200 m or near bottom to surface, and developmental status of eggs was categorized by 6 age-groups in a laboratory. The distribution of age-group 1 (<1-day old) representing a spawning ground appeared over the deep basin and continental slope in early-mid March. Walleye pollock moved along the intrusion of warm water mass to the outer shelf area in April. Peak of the spawning intensity usually found at stations (100m depth) in the north of the Unimak Island where strong thermocline divided two water mass (*i.e.*, cold one in upper layer, and warm one in lower layer). In May, the spawning intensity decreased rapidly, and pollock spawners moved to northwest toward the Pribilof Islands. Pollock eggs were slowly advected (5-10 cm/sec) to the northwest according to current over the outer shelf. Sea-ice edge, which might influence on spawning location and timing, was extensively developed in 1976, and sea-ice covered pollock spawning ground in SEBS until late March. The southern boundary of sea-ice moved toward the north since 1976, so that minimal sea-ice coverage was found in 1979.

11AM2002 S6-086 Poster

GEOGRAPHIC VARIABILITY OF THE GROWTH RATE OF WALLEYE POLLOCK FROM DIFFERENT REGIONS OF THE NORTHWEST PACIFIC

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The growth of walleye pollock in length and weight was analyzed using data collected from the most important areas of Russian fishery: West Kamchatka (the east Okhotsk Sea stock), the Pacific waters off the North Kurils (the east Kamchatka stock), and the Navarin and Olutory areas of the Bering Sea.

Females of the East Kamchatka stock at age 2-8 years had the largest body size. The minimum length for this age range was found for the East Okhotsk pollock. The female growth rate of Olutory and Navarin areas west of 174°E was similar. The growth of pollock from all regions with the exception of East Okhotsk approaches an asymptote at age 9+. For the Navarin stock inhabiting areas east of 174°E, asymptotic growth was not as pronounced compared to the western Bering Sea areas. For the East Okhotsk pollock, the growth rate even showed an increase with age. As a result, individuals of older age groups from this stock had a larger size compared to other pollock stocks.

The East Kamchatka stock was characterized by the maximum body weight of young fish. Minimum body weights were characteristic of the East Okhotsk stock. The growth in weight of Olutory and Navarin (west of 174°E) stocks was very similar for all ages. The growth in weight in these regions approaches an asymptote at age 9+. The growth in weight of pollock from the Navarin region east of 174°E approaches an asymptote at age 12+. The East Okhotsk pollock had quite different characteristics of growth in weight. Younger fish of this stock were characterized by the slowest growth rate, which then increased at age 8 and 9, and there was no clear slowing in growth for the older fish. As a result, the average weight of older pollock from East Okhotsk stock was larger compared to other pollock stocks. Males of different stocks had similar rates of growth in length and weight as the females.

The observed differences between populations may be due to different environmental conditions. The growth rate of fish less than 9+ may be associated with ambient temperatures. The East Kamchatka pollock inhabit the ice-free ocean all year, and their growth rate is the highest. The East Okhotsk pollock live in the severest temperature conditions, and in the same age range have the minimum growth rate. Olutory and Navarin (west of 174°E) areas have similar climatic conditions, and, thus, pollock growth rates in these areas are identical.

Food composition and availability may be the main factor resulting in differentiation of growth rates of older fish. The high growth rate of older fish of the East Okhotsk pollock may be explained by the high availability of nekton food.

11AM2002 S6-087 Oral
POPULATION STRUCTURE OF THE NORTH JAPAN SEA WALLEYE POLLOCK STOCK

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Acoustic assessments of walleye pollock off western Hokkaido Island have been conducted since 1996. These surveys determined the distribution pattern of this stock in the late feeding season. Pollock were more abundant in the southern part of this survey area than in the northern part. Moreover, younger fish were dominant in the northern part, but adults were mainly caught in the southern part. These results support the current hypothesis that walleye pollock grow in the northern part, and then migrate into the southern part to reproduce. However, these surveys found fewer young individuals than adult fish, an inconsistency in relative abundance.

In early 1990s, catches of walleye pollock decreased in the Japan Sea, the southern Okhotsk Sea, and the Nemuro Strait. We found a correlation between catch trends in the northern part of the Japan Sea and the southern Okhotsk Sea. Recently, it has been reported that larval and juvenile walleye pollock are transported to the southern Okhotsk Sea from the Japan Sea. The pollock stocks of the Japan Sea, the southern Okhotsk Sea, and the Nemuro Strait around Hokkaido Island may all be affected by the Tsushima Warm Current, and may be responding to common physical forcing. On the other hand, there has been an absence of large fluctuations in walleye pollock catch in the Pacific Ocean since 1975, and catches increased in late 1990s, an inverse trend relative to the Okhotsk area. The catches from off southwestern Hokkaido were similar to Funka Bay and the Pacific Ocean. It is suggested that these fish may be related not only to the population in the northern part of the Japan Sea, but also to the Funka Bay and Honshu populations.

11AM2002 S6-088 Poster
ABUNDANCE AND DISTRIBUTION MONITORING OF WALLEYE POLLOCK *(Theragra chalogramma)* IN THE NORTH-WESTERN BERING SEA BY ECHO INTEGRATION SURVEYS (1997-2001)

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Pacific Fisheries Research Center (TINRO-Center) employs acoustics extensively for fisheries investigations. Since 1996, TINRO-Centre has used the Simrad EK-500 scientific echo sounder to conduct acoustic surveys of pollock and other fishes. A new processing system for acoustic data, called FAMAS (Fisheries Acoustic Monitoring and Analyses System), has been developed. At present, FAMAS provides the following primary functions: visualization and accumulation of acoustic data in real time; secondary processing and analysis of acoustic images; organization and maintenance of a database of acoustic and biological measurements; estimation of large zooplankton with a two-frequency algorithm. Processing acoustic data is combined with the information from the biological database to provide estimates of biomass and numbers at length and age. FAMAS algorithms allow echosign assignment in mixed species situations and provide for characterization of spatial features throughout the survey area and through the water column.

Application of FAMAS occurred during acoustic surveys of walleye pollock in the Bering Sea in 1997-2001. Estimates of abundance and biomass of pollock, data on spatial distribution, and interannual variability of these estimates in the north-western Bering Sea were derived. In 1997, which was the warmest year, all age groups of pollock were much wider in distribution compared to subsequent years. Pollock from the 1996 and 1995 year classes were dominant in abundance. In 1998, the total number decreased by one-half and total biomass decreased to 120 thousand tons of mostly pelagic aggregations of juveniles from the 1996-1997 year-classes. In the cold year

of 1999, the number and biomass of near bottom aggregations of pollock decreased, and were mostly 3-year-old pollock from the 1996 year-class and middle-aged pollock. The downward trend in abundance 3-year-old and older fishes, forming a base of stock exploited in the Russian zone was confirmed by echo integration surveys in 2000 and 2001. One-year old pollock of 1999 year-class were the most numerous age group in 2000 (68%) and again in November 2001 (49%).

In summary, the abundance of mid-water pollock decreased by a factor of 6, and biomass by a factor of almost 8, during last 5 years in the northwestern Bering Sea. Abundance and biomass of mid-water pollock declined by almost 70% during one year (2000-2001). This may be a result of changes in spatial distribution and a reduction of feeding migrations of pollock to the Russian zone due to variation of oceanographic conditions and favorable feeding conditions on the eastern Bering Sea shelf.

11AM2002 S6-089 Oral

RISE AND FALL OF PELAGIC WALLEYE POLLOCK RESOURCES IN THE ALEUTIAN BASIN

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Walleye pollock is a species with a very broad ecological niche. Adult walleye pollock are described as demersal fish on the continental shelf and slope area, however they are strictly pelagic in the Aleutian Basin area. Significant abundances of pelagic pollock were found in the basin in the late 1970s, and a mid-water trawl fishery developed rapidly in the 1980s. Pollock harvest was especially high during the late 1980s, and has been closed since 1993 as a result of a rapid decrease in abundance. Reanalysis of historical catch data of pollock fishery in this area showed rapid increase in CPUE after 1985. Ageing results indicated that the extremely strong 1978 year-class sustained a huge biomass during the mid to late 1980s. Prior to 1985, with only limited immigration of young fish from 1978 year-class, considerable pollock catch occurred in the southeastern part of the Aleutian Basin. On the other hand, immigration to the basin area has been very low in the 1990s, despite strong year classes in adjacent waters. Though the immigration system to the basin area is still unclear, there may be considerable variability in recruitment and migration mechanisms between 1970-80s and 1990s. Climate-ocean variability might affect habitat and/or migration in the Bering Sea.

11AM2002 S6-090 Oral

CHANGES IN BODY SIZE, MATURITY, FEEDING CONDITION, AND AGE OF WALLEYE POLLOCK DURING SPAWNING PERIOD IN THE WEST COAST OF KAMCHATKA PENINSULA, THE OKHOTSK SEA, IN 1995~2001

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The walleye pollock population inhabiting the west coast of Kamchatka, the Okhotsk Sea, is characterized to spawn in cold water. We compare body size (FL), maturity (GSI), feeding condition (FC) and other parameters during spawning period from March to May, based on the available samples caught by Japanese fishing vessels for the seven-year-period from 1995 through 2001. The pollock were trawled with mesh size of 90 mm at the cod-end along the west coast of Kamchatka between 51°N and 55°N (60~100 m depth). Sample sizes and the data available for analysis varied by year due to arbitrary fishing operations and fishing regulations imposed.

When combined for whole spawning season, the FLs were larger in 1998 (330~510 mm) and previous years, but became smaller in 1999 and subsequent years (270~420 mm). The FL range changed by month. In 2000, the fish of 350~400 mm FL prevailed in March and April, but were replaced by smaller size of 250~350 mm FL in May. In 2000, the dominant ages were 4 to 6, but age 4 gradually became dominant as the season progressed. A similar trend was also detected in 2001. The female GSIs were high in March, but varied widely in April and May,

indicating the mixture of the pre-spawning and post-spawning individuals. The FCs remained smaller in early season, but increased in the late season. The seasonal changes in GSI and FC suggest that the feeding activity after spawning would commence in April and May. Since the ambient water temperature is low, the growth of walleye pollock appears to be slower than that reported in other regions. This is reflected in the length-at-age curves.

11AM2002 S6-091 Poster

ENVIRONMENTAL FORCING OF WALLEYE POLLOCK, *Theragra chalcogramma*, GROWTH IN THE SOUTHEASTERN BERING SEA

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Growth of walleye pollock, *Theragra chalcogramma*, in the southeastern Bering Sea was explored by assessing the contributions of potential growth control factors. We examined three hypotheses of growth control: (1) growth increases with enhanced secondary production associated with reduced ice cover; (2) growth increases with increasing water temperature; and (3) growth increases with a decreasing population. Yearly growth for the years 1982 to 2000 was calculated as the difference in the mean length-at-age of the particular year and that of the next older age class in the following year. Mean length-at-age data was obtained from NMFS bottom trawl surveys. A corresponding 19-yr data series of three predictor variables were used to explain the growth response of walleye pollock. The predictor variables used were, percent anomaly of February sea ice cover, summertime shelf bottom temperature and NMFS pollock abundance model estimates (fish numbers). Stepwise multiple linear regression was used to develop best fit growth models. Results suggest that variations in pollock growth were related to the two physical environmental variables, but not pollock density.

11AM2002 S6-092 Oral

EFFECT OF VARIATIONS IN THE FLOW OF THE COASTAL OYASHIO CURRENT ON THE YEAR-CLASS STRENGTH OF WALLEYE POLLOCK IN NORTHERN JAPAN

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In southern Hokkaido, Japan, walleye pollock spawn mainly in January and February near the mouth of Funka Bay. Transport of eggs and larvae in this region depends largely on the coastal Oyashio current, which flows generally southward along the eastern coasts of Hokkaido and Honshu. This study examines the effect of annual variation in the extension of the coastal Oyashio on the survival of walleye pollock eggs and larvae spawned near Funka Bay. First, we estimated the optimum temperature range for survival of eggs and larvae to be 2-7°C based on samples collected during 1984-99. Then, we examined how annual variations in sea surface temperature around the spawning and nursery areas affected the distribution and abundance of the eggs and larvae, and compared these data to estimates of year-class strength based on abundance and catch data from different age classes during 1976-99. Our results show that when the coastal Oyashio flowed near shore along southeastern Hokkaido and northeastern Honshu (*e.g.*, in 1989 and 1995), larval survival was enhanced, and year classes were strong. However, when this flow occurred further offshore (*e.g.*, in 1991 and 1992), survival decreased and year classes were weak. We conclude that survival of walleye pollock larvae is higher when they remain in inshore waters.

11AM2002 S6-093 Oral

SPATIAL AND TEMPORAL SPAWNING PATTERNS AND INTERANNUAL VARIABILITY OF WALLEYE POLLOCK IN THE SEA OF OKHOTSK

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Spawning grounds of walleye pollock in the Okhotsk Sea are rather wide. It is characterized by complicated structure and consists of several reproductive areas, where a peak spawning varies considerably in time. Western Kamchatka and northern Okhotsk Sea spawning grounds are the largest and most stable in time. Shelikhov Bay and eastern Sakhalin shelf areas also play significant part in walleye pollock reproduction. During periods of high abundance, several minor spawning groups of walleye pollock are formed in the north-western part of the sea. As a rule, spawning of walleye pollock takes place on the lower edge or on the central shelf in areas with mesoscale eddies. Exceptions are Shelikhov Bay, where spawning occurs at depths over 200 m, and Lebed Bank, where a small walleye pollock aggregation spawns in the mezopelagic layer over depths 500-700 m.

In the 1980s, under comparatively stable oceanographic conditions and high abundance of spawners, spawning grounds of walleye pollock did not change significantly in terms of position and spawning time. During the last decade, enhanced hydrodynamics was a characteristic of the Okhotsk Sea area. A warm period with a peak in 1997 gave way to period with cold winters, especially 2001. This led to corresponding changes in water dynamics, temperature regime, and a shift in productive zones and production processes. In 1997, walleye pollock began to spawn almost one month earlier than usual, and in 2001 - one month later. In warm years, the northern Okhotsk Sea spawning ground shifted to the north-west, the western Kamchatka spawning ground to the northeast, to lower depths and colder waters. In cold winters, walleye pollock spawn in deeper areas over all spawning regions. Notwithstanding the observed interannual changes in location and time of spawning, walleye pollock spawning sites together with areas with developing eggs, larvae, and juveniles are well isolated.

11AM2002 S6-094 Oral

STRUCTURE OF EASTERN BERING SEA POLLOCK *(Theragra chalcogramma)* SPAWNING AGGREGATIONS AND ITS FUNCTIONAL COMPOSITION

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Reproduction of eastern Bering Sea pollock takes place at diverse habitats of the shelf and deep water. Ecological differentiation of pollock habitats during the spawning period is potentially beneficial for reproduction and recruitment. The main pollock spawning centers are on the shelf off the Pribilof Islands and Unimak Island, and in deep water in the Bogoslof Island area, and off central Aleutian Islands (Kanaga Sound). Pollock spawning stocks are differentiated spatially and temporally. The ecological function of each pollock reproductive stock occurs at a discrete level. There are four ecological components to the Bogoslof Island spawning stock, which differ by age and habit during the feeding period: 1) 7-12 year old fish, with a feeding habit off the eastern Aleutian Islands; 2) 7-12 year old fish, with a feeding habit in the Aleutian Basin; 3) 7-9 year old fish, with a feeding habit over the eastern and northwestern Bering Sea continental slope; and 4) 5-8 year old fish, with a feeding habit on the eastern and northwestern Bering Sea shelf. The recruits (5-6 years old) for the Aleutian Basin pollock spawning stock migrate from shelf to deep water in late winter and spring (February-March), principally in the Bering, Zhemchug and Pribilof canyons. There are different functional components among shelf spawning pollock. The oldest pollock (9-12 years old) spawns annually in coastal waters off the Pribilof Islands in second half of March. The 7-12 year old pollock spawn in coastal water off Amak Island late January-February. The shelf pollock spawning grounds off Unimak Island and off eastern side of Pribilof Islands (40-50 miles offshore) are primarily first spawning and middle-age fish. The 6-7 year old pollock primarily spawn off Unimak Island in second half of March and the young and middle-age pollock (3-7 years old) spawn off the eastern side of Pribilof Islands in second part of March and early April. Functioning of various ecological components of the spawning pollock stocks depends on the abundance of the population and relative year-class strength.

11AM2002 S6-095 Poster
WALLEYE POLLOCK SIZE-AGE COMPOSITION IN THE EASTERN SEA OF OKHOTSK

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One of the largest walleye pollock populations reproduces in the eastern Sea of Okhotsk. Russian fishing operations have been begun since 1963. Annual yield varied from 15 (1963) to 1340 (1974) thousand tons, and, on average, was 727 thousand tons. In 1972-2001 walleye pollock length (AC) varied from 6.1 to 72.0 cm, age from 1 to 16 (scale ages). Pollock of 38-46 cm in length and ages 5-7 were dominant. Interannual dynamics of walleye pollock size-age composition depends principally on year-class abundance: the relative number of young fish increases and the relative number old fish decreases with strong recruitment, and conversely with weak recruitment. Young fish are relatively less common in the catches of bottom long-line and bottom trawl vessels than in catches of pelagic trawl vessels.

11AM2002 S6-096 Poster
WALLEYE POLLOCK SURVIVAL IN THE EASTERN SEA OF OKHOTSK

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The walleye pollock stock that reproduces in the eastern Sea of Okhotsk is a valuable fishery resource. Stock biomass varies from year to year depending on year-class variability, the cause of which is not well understood. Data for 1972-1995 have been analyzed to calculate survival coefficients for walleye pollock year-classes from eggs (ichthyoplankton survey data) to age 6 considering the fishery. Survival coefficients varied from 1.66'10-6 (1992) to 47.87'10-6 (1978), and, in average, was 13.60'10-6. Year-classes in 1972, 1974-1975, 1981-1988, 1991-1995, were characterized with low survival (less than 10.00' 10-6), and in 1976-1979, 1990 - high survival (greater than 20.00'10-6). In 1972-1995, walleye pollock survival in the eastern Sea of Okhotsk was inversely related to spawning ($r=-0.57$; $p<0.01$) and total ($r=-0.62$; $p<0.01$) biomass. In addition, walleye pollock survival coefficients were higher in years when Okhotsk Sea ice cover was extensive (cold years), than when it was low (warm years) ($r=0.3$; $p>0.05$).

11AM2002 S6-097 Poster
DIET OF WALLEYE POLLOCK IN THE OKHOTSK SEA DURING THE SPAWNING PERIOD

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Samples were taken in spring (April - May) 1998-2002 in waters off Western Kamchatka, the northern shelf and the transition zone. Samples sizes ranged between 30 and 50 cm. Despite a three-fold reduction in biomass, the diet of adult walleye pollock (> 40 cm) is still dominated by zooplankton (primarily euphausiids): in the Southern Kuriles - 100%; the waters off Western Kamchatka -60-80%; the northern shelf -30-45%. The diet of immature walleye pollock was primarily euphausiids and copepods, with the fraction increasing as fish size decreased. In waters off Western Kamchatka, benthic species were 1-6% of the diet, and nekton, 5-18%; and in northern shelf area, 10-45% and 18-49%, respectively.

The daily diet of walleye pollock was highest for juveniles (8-12%), and decreased for immature fish (2-6%), and spawning fish (0.5-4.3%). The feeding intensity of spawning fish depends not only on physiological condition, but also on the availability of food. Although pollock reduce their movement before spawning and remain constantly near the bottom, they do not lose a potential need for forage. The walleye pollock also consumed their own eggs, generally feeding on eggs for during the spawning period (from 0.3% up to 4.2% depending on the area).

Fat reserves, as measured by the hepatosomatic index, were highest for immature fish of 35-40 cm, while for spawning fish it was reduced to 20-40 %.

Zooplankton forage in both the epi- and mesopelagic part of the Okhotsk Sea was lowest in 1998 (6.9), but was high and stable in 1999-2002 (25-28), suggesting that the Okhotsk Sea forage base is in good condition.

11AM2002 S6-098 Poster

GENETIC VARIATION IN THE WALLEYE POLLOCK, *Theragra chalcogramma* BY PCR-RFLP AND SEQUENCING ANALYSIS OF MITOCHONDRIAL DNA

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Walleye pollock, *Theragra chalocogramma*, is one of the most important species in the North Pacific and Bering Sea ecosystems. However, the amount of genetic population structuring of walleye pollock is uncertain. In the present study, genetic variation of walleye pollock collected in spawning areas ranging from the Japan Sea to the Gulf of Alaska was investigated through mitochondrial DNA analysis. Three regions of the spacer and control region (Conrol region), the NADH dehydrogenase complex (ND5 and ND6 region), and the ribosomal DNA complex (ND1 and 16S rRNA region) were amplified using the polymerase chain reaction (PCR). Restriction fragment length polymorphism (RFLP) was conducted on PCR products and composite haplotypes were calculated. In addition, DNA sequences of entire control region (820 bp) were determined.

No significant genetic differences were detected among sequences of the control region. In RFLP analyses, the distribution of haplotypes from the control region and ND5-6 region showed a few differences among the three regions (No statistically significant test). Composite mtDNA haploptype frequencies were different between the eastern and western Pacific and Bering Sea, and these results are concordant with previous studies using allozymes. Based upon these results, mtDNA haplotypes are not partitioned geographically, refuting the hypothesis that different spawning aggregations form genetically distinct populations. Future studies using more highly polymorphic loci may be able to resolve the weak genetic differentiation characterizing large marine fish populations such as walleye pollock.

11AM2002 S6-099 Poster

WALLEYE POLLOCK EGGS AND LARVAE DRIFT IN WATERS OFF KAMCHATKA PENINSULA

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Since 1971, the abundance and distribution of walleye pollock pelagic eggs in waters around Kamchatka Peninsula have been monitored by means of ichthyoplankton surveys with the main purpose to estimate the number of spawning pollock. As a rule, only one survey in each area was conducted annually, however for several years the surveys were repeated 2-4 times during spawning season. We applied these data to estimate the direction and velocity of drifting eggs.

The spawning period of walleye pollock in the surveyed areas lasts generally from February to July, with a peak in April (western and southeastern Kamchatka stocks) or May (southwestern Bering Sea). The greatest drift of eggs was recorded for Pacific coast of Kamchatka, where the Eastern-Kamchatka Current is influential. Velocity in the southwestern direction varied from 3 km/day (1987) to 18 km/day (1978). In the eastern Sea of Okhotsk, aggregations of eggs can drift in southern direction, as occurred in 1974 and 1997, however, northward transport was observed more often (1975, 1980, 1984, 1985, 1986). Average velocity in this area ranged from 0.5 km/day (1985) to 3 km/day (1974). Any noticeable drift of pollock eggs in the southwestern Bering Sea (Karaginsky and Olutorsky Gulfs) was not observed.

S7 MEQ Topic Session
Eutrophication, harmful algal blooms and nutrients

Co-Convenors: Edward Black, Maurice Levasseur (Canada) & Ming-Jiang Zhou (China)
Friday, October 18, 2002 08:30-12:30

There is growing evidence that the incidence of harmful algal blooms (HABs) has increased on a global scale in recent years. The role of macro- and micro-nutrients in the initiation, propagation and toxicity of HABs is an area of active research. There is also increasing evidence that eutrophication is associated with the initiation and propagation of HABs, although the mechanisms are not fully understood. Determining when and how eutrophication affects bloom dynamics is central to developing effective mitigation strategies that reduce the effect of anthropogenic nutrients on these blooms. Moreover, better knowledge of the natural role of nutrients in HAB events is essential if we are to understand the effects of climate and oceanography. Papers on these issues were solicited.

08:30-08:55 **Isao Kudo** (invited)
Spring diatom bloom dynamics and nutrient cycles in subarctic coastal region (S7-106)

08:55-09:20 **Patricia M. Glibert** (invited)
Nutrients and harmful algal blooms: The importance of nutrient quality as well quantity (S7-103)

09:20-09:35 **Edward Black**
The role of nutrients in toxic blooms of *Heterosigma akashiwo* (S7-100)

09:35-09:50 **Xiulin Wang, Xiaoyong Shi, Feng Shi**
The dynamic and flux in the nutrient-sediment interface of East China Sea (S7-116)

09:50-10:10 **Question period**

10:10-10:30 **Coffee/tea break**

10:30-10:45 **Michael G. Foreman, Barbara Hickey, Vera Trainer, Amy MacFadyen**
Ecology and oceanography of toxic *Pseudo-nitzschia* in the Pacific Northwest Coastal Ocean (S7-102)

10:45-11:00 **Chunlei Fan, Patricia M. Gilbert**
The importance of reduced nitrogen in a Prorocentrum minimum bloom – a model approach (S7-101)

11:00-11:15 **Baodong Wang, Xiu-lin Wang, Run Zhan**
Excess nitrogen in the Yellow Sea and East China Sea (S7-114)

11:15-11:30 **Yury I. Zuenko, Marina Selina, Inna Stonik**
On conditions of phytoplankton blooms in coastal waters of the northwestern Japan Sea (S7-118)

11:30-11:45 **Xiaoyong Shi, Xiulin Wang, Xiurong Han**
Nutrient distribution in a high frequency area of red tides in the East China Sea (S7-113)

11:45-12:15 **Question period**

12:15-13:15 **Lunch**

13:15-13:30 **Rencheng Yu, Qingchun Zhang, Yunfeng Wang, Jun Li, Tian Yan, Mingjiang Zhou**
Growth and toxin production of *Alexandrium minutum* with organic and inorganic nitrogen sources (S7-117)

13:30-13:45 **Su Mei Liu, J. Zhang**
Character of nutrient regeneration from sediments in the Bohai, Yellow Sea and East China Sea (S7-109)

13:45-14:00 **Jia-Yang Lu, Da-Zhi Wang, Hua-Sheng Hong, Bang-Qin Huang**
Nitrate reductase activity of phytoplankton population in mesocosm experiments (S7-110)

14:00-14:15 **Question period**

14:15-15:00 **Session review and formulation of recommendations**

15:00-15:20 **Coffee/tea break**

Posters:

Bingzhang Chen, Huasheng Hong
Alkaline phosphatase activity and utilization of dissolved organic phosphorus by algae in subtropical coastal waters (S7-297)

Nianzhi Jiao, Jinjie Yang, Heyang Li, Yanhui Yang
Viability of bacterioplankton in the Chinese coastal waters and west Pacific (S7-105)

Jia-Yang Lu, Dazhi Wang
Nitrate reductase of red tide algae in controlling ecosystem (S7-314)

Lingjian Ou, B. Huang, H. Hong, D. Wang
Induced algal bloom by phosphate addition in mesocosm - variation of alkaline phosphatase activity (S7-111)

11AM2002 S7-100 Oral

THE ROLE OF NUTRIENTS IN TOXIC BLOOMS OF *Heterosigma akashiwo*

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Understanding the role of nutrients in the development of large toxic blooms of the Raphidophyte alga *Heterosigma akashiwo* may be important in understanding shifts in trophic regimes in coastal inland seas. This species toxicity affects what is perhaps the broadest range of marine organisms of any of the harmful marine phytoplankton. *H. akashiwo* has been reported world-wide although toxic blooms of this species have only been reported around the globe in northern and southern temperate zones.

In 1989, a toxic bloom of this species occurred in the Strait of Georgia on Canada's west coast. At that time a number of researchers were studying this water body and as a consequence we have a complete record of the bloom from excystment, through growth, to toxic effects on aquaculture, and to final encystement. A combination of laboratory and field studies helped to elucidate the role of environmental factors including nutrients in the creation and maintenance of the toxic bloom.

This presentation will document how changing nutrient concentrations in the Strait of Georgia parallel experimental conditions used to create toxic cultures of this species. The role of timing and quantities of available nutrients in the level of toxicity expressed in blooms in nature and in laboratory cultures will also be discussed.

11AM2002 S7-297 Poster

INFLUENCES OF ENVIRONMENTAL FACTORS ON *Prorocentrum dentatum*

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An investigation conducted in the northern East China Sea from April to May this year, found that the main breed of most red tides was *Prorocentrum dentatum*. A dispute still exists whether it is *dentatum*. Some scientists say it is a new breed and name it *donghaiense*. Despite of it, more and more evidences have shown it is very important. However, scarce researches have been carried out on it.

Environmental factors, for example: temperature, sanlity and depth, etc, are considerable to many phytoplankton species including *Prorocentrum dentatum*. I am trying to discover its optimize factors and connection between its external and internal factors. In order to do this, I must scrutinize its life cycle.

Some experiments have been done to find out its rivalry against some other species like *Skeleton costatum*. They are expressed in Prof. Zhu Mingyuan and Prof. Li Ruixiang's articles.

11AM2002 S7-101 Oral

THE IMPORTANCE OF REDUCED NITROGEN IN A *Prorocentrum minimum* bloom – A MODEL APPROACH

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In the late spring and early summer of 1998, an extensive *Prorocentrum minimum* bloom developed in the Choptank River of Chesapeake Bay, U.S.A.. A series experiments were conducted to determine the physiological characteristics of *P. minimum* in relation to its bloom development. These physiological characteristics in term of nitrogen uptake were applied toward the development of a simulation model of *P. minimum* bloom dynamics. Several scenarios were tested with this model to demonstrate the importance of some key ecological and physiological processes in the development and maintenance of *P. minimum* blooms. Model results suggested the initial pulse of sufficient nitrogen from river flow was essential for the bloom initiation. However, the bloom was sustained by reduced nitrogen sources after its establishment. The physiological preference for reduced nitrogen uptake by *P. minimum* therefore plays an important role in bloom maintenance, with reduced nitrogen representing

more than 90% of total nitrogen uptake in bloom peak period. The model further suggested that the ability of maintaining a significant uptake of nitrogen by *P. minimum* under low light or dark conditions would be advantageous in its bloom development.

11AM2002 S7-102 Oral

ECOLOGY AND OCEANOGRAPHY OF TOXIC *Pseudo-nitzschia* IN THE PACIFIC NORTHWEST COASTAL OCEAN

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Recent studies suggest that the Juan de Fuca Eddy, a seasonal nutrient-rich retentive feature off the Washington and British Columbia coasts, may be an initiation site for the toxigenic phytoplankton *Pseudo-nitzschia (PN)* that impact shellfish along the Washington coast. A five-year project funded by the Ecology and Oceanography of Harmful Algal Blooms program has just started to determine: a) the physical/biological/chemical factors that make this eddy more viable for growth and sustenance of toxic *PN* than the nearshore upwelling region; b) the combination of environmental factors that regulate the production, accumulation, and/or release of domoic acid from *PN* cells; c) possible transport pathways between domoic acid initiation sites and shellfish beds along the coast. This work will be a collaboration with the Olympic Region Harmful Algal Bloom (ORHAB) partnership, a project that monitors when and where blooms occur on the Washington coast. This talk will outline preliminary findings of the ORHAB project and field, laboratory, and modeling studies planned over the duration of the ECOHAB project.

11AM2002 S7-103 Invited

NUTRIENTS AND HARMFUL ALGAL BLOOMS: THE IMPORTANCE OF NUTRIENT QUALITY AS WELL QUANTITY

Patricia M. **Glibert**

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The role of nutrients in the development of many harmful algal blooms is increasingly recognized. Yet, there is much uncertainty regarding the relationships between nutrient supply and the development of specific species or species groups. Some success has been achieved in applying nutrient ratios, such as N:P or N:Si, in predicting shifts from diatoms to dinoflagellates. Considerable insight has recently been gained into several physiological relationships which further our ability to link specific nutrients with species groups. First, the rate at which inorganic nutrients are assimilated depends on the total quantity of those nutrients and their relative composition. Diatoms are often associated with the flux of nitrate, whereas flagellates are often associated with ammonium or urea supply. Furthermore, nutritional preferences vary strongly with temperature, due to the nature of the enzymes that are involved in assimilation. Nitrate uptake decreases with temperature over the range from 10-20°C, while the uptake of reduced N correspondingly increases. Many harmful species also have alternate mechanisms, including feeding and extracellular pathways, to acquire particulate and organic nutrients and energy. The ratio DOC:DON has been correlated with the outbreak of some bloom species. Thus, similar nutrient loadings delivered during different seasons, or to regions of differing physical dynamics, may not have the same effect on phytoplankton abundance or composition. The ultimate success of a given species will depend on the ability to exploit both quantity and quality of available nutrients, the timing and intensity of the nutrient supply, and the interaction of other environmental factors and competitor or consumer species.

11AM2002 S7-105 Poster

VIABILITY OF BACTERIOPLANKTON IN THE CHINESE COASTAL WATERS AND WEST PACIFIC

Nianzhi (George) **Jiao**, Jinjie Yang, Heyang Li, Yanhui Yang
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Flow cytometry and epifluorescence microscopy were employed in determination of bacterial cells stained with 4',6-diamidino-2-phenylindol dihydrochloride (DAPI), 5-cyano-2,3-ditoyl tetrazolium chloride (CTC) and propidium iodide (PI) as total cell counts, cells with respiration viability and dead cells in the Yangtze River Estuary areas, Taiwan Strait, and the west Pacific and the warm pool areas. Total counts of bacterioplankton varied with environmental conditions ranging from 10^5 cells/ml to in the open ocean to 10^6 cells/ml in the coastal waters. The ratios of the respiration active cells to the total varied from 21-87%, and ratios of dead cells to total ranged from 1-48%, suggesting a considerable part of "live" but inactively respiring bacterioplankton existed in the natural seawater in the investigation areas. The possible affecting factors were discussed.

11AM2002 S7-106 Invited

SPRING DIATOM BLOOM DYNAMICS AND NUTRIENT CYCLES IN SUBARCTIC COASTAL REGION

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Spring diatom bloom generally occurs in temperate and subarctic coastal areas. Before the bloom, nutrients are abundant due to replenishment of nutrients in winter time. The bloom consumes large amounts of nutrient and much of the annual new production occurs because nitrate is a major N source. In Funka Bay, Japan spring diatom bloom occurs in March. Nitrate and silicate presented about 10 and 20 μM at surface before the bloom and were consumed at a molar ratio of 1:1. Thus, nitrate depletion terminated the bloom in the Bay. However, silicate was also depleted two weeks after the nitrate depletion due to the increase in Si:N consumption ratio of diatom. Phosphate remained after the bloom and continued to decrease until summer. River discharge increased due to spring thaw after the bloom and river water contains quite higher silicate and nitrate content than the surface seawater. In the deeper layer (90 m deep) nutrient concentration increased after the bloom due to re-mineralization of organic material produced at the bloom. This regenerated nutrients contribute to the surface production in summer through diffusion and advection. Floral shift from diatom to dinoflagellate or picoplankton was observed after the bloom. Bloom of *Alexandrium tamarense*, a HAB species causing paralytic shellfish poisoning, was reported often in summer. This species is known to utilize dissolved organic nitrogen (DON) when inorganic N is low in the environment. Thus, the nutrient consumption and regeneration dynamics of the spring bloom may affect the appearance of *Alexandrium tamarense*.

11AM2002 S7-109 Oral

CHARACTER OF NUTRIENT REGENERATION FROM SEDIMENTS IN THE BOHAI, YELLOW SEA AND EAST CHINA SEA

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The Bohai, Yellow Sea and East China Sea are characterized as a river-dominated region and surrounded by a land region of rapid population rise and economic advances in China. The field observations were carried out in September-October 1998 and April-May 1999 in the Bohai, October 2000 and May 2001 in the Yellow Sea and East China Sea, and April-May 2002 in the East China Sea. The benthic fluxes of nutrient species were determined by incubating the sediment core samples with *in situ* water bubbled with air and/or nitrogen. The depth profiles of nutrient concentrations in sediment pore waters were examined before and after incubations.

The exchange fluxes of nutrients at sediment-water interface varied with elements, season, site, and redox condition. The NO_2^-, NH_4^+, PO_4^{3-}, dissolved organic nitrogen, total dissolved nitrogen, dissolved organic phosphorus and total dissolved phosphorus showed a net exchange flux from water to sediment, while the NO_3^-, DIN (DIN= NO_3^- +NO_2^- +NH_4^+) and SiO_3^{2-} were released from sediment to the seawater in the Bohai. The net result of sediment-water exchange is to induce the further increase of DIN and reduce the phosphorus load in the Bohai. The release of silicate from sediment to the overlying seawater will reduce the potential limitation mechanism of silicate as the result of the decrease of the riverine discharge. While regeneration of nutrients increased the nutrient load of silicate, but reduced DIN and phosphate in the Yellow Sea and East China Sea. The nutrient concentrations in pore waters changed in incubation experiments. The accumulations of nutrients calculated by integrating the profiles of nutrient concentrations with depth before and after incubations were obviously higher than the diffusion fluxes of nutrients as the physical factors influence. The main influence factors (*e.g.* nitrification and denitrification) on diffusion fluxes of nutrients have been discussed by two-layer diagenetic equations in this study. The benthic fluxes of nutrients were compared to riverine input and atmospheric deposition of nutrients. The ecosystem of these regions has been modified by anthropogenic activities. The regeneration of nutrients from the sediments is responsible for significant flux of nutrients to the waters of the seas, which may further lead to ecosystem of the seas change obviously. The present study also illustrated that concentrations and composition of nutrients in water column be affected by sediment resuspension.

11AM2002 S7-314 Poster
NITRATE REDUCTASE OF RED TIDE ALGAE IN THE CONTROLLING ECOSYSTEM

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Within living organisms, there are several distinct proteins that reduce nitrate to nitrite and are thus termed nitrate reductases (NR). Research on NR has been going on for more than half a century. We are going to research the nitrate reductase of red tide algae in the controlling ecosystem for three years. In the first year, we will collect enough papers to analyze, culture three or four algae in order to be researched in future, establish right methods, and so on. We want to find different vigor of NR in different terms through changing the concentration of nitrate. Then we could make further research in NR.

11AM2002 S7-110 Oral
NITRATE REDUCTASE ACTIVITY OF PHYTOPLANKTON POPULATION IN MESOCOSM EXPERIMENTS

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Nitrate reductase (NR) is an inducible enzyme in phytoplankton, which catalyzes the reduction of nitrate (NO_3^-) to nitrite (NO_2^-). NR activity responses to the internal cellular concentration of nitrate rather the ambient water concentration. In this study, nitrate reductase activity of phytoplankton population was investigated in mesocosm experiments with enriched phosphate and different N/P ratio. The preliminary results showed that two algal blooms, *Skeletonem costatum* and *Prorocentrum dentatum*, were induced, NR activity varied with N/P ration and population fluctuation. NR activity was also influenced by environmental factors. This paper also discussed enzyme basis of nitrogen metabolism in two red tide algal species.

11AM2002 S7-111 Poster

INDUCED ALGAL BLOOM BY PHOSPHATE ADDITION IN MESOCOSM - VARIATION OF ALKALINE PHOSPHATASE ACTIVITY

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Phosphorus is one of the limiting factors for marine phytoplankton. It has been suggested that low phosphorus concentration limits phytoplankton growth. It will often cause harmful algal bloom when phosphorus concentration increases suddenly.

Alkaline phosphatase is one kind of ectoenzymes in aquatic environment. As a specific enzyme induced on hydrolyzing phosphate monoester, alkaline phosphatase is produced within algal or bacterial cells and is actively secreted to the outside of the cell when phosphorus is scarce in the aquatic environment and intracellular phosphorus pool. The increase of alkaline phosphatase will cause algae and bacteria making use of dissolved organic phosphorus and inorganic polyphosphorus as phosphorus source to sustain their growth.

Alkaline phosphatase activity (APA) was measured during the cruise in Yangtse River Estuary in April-May 2002. Mesocosm experiment was carried out for induced algal bloom by phosphate addition. Result showed that, for mesocosm, APA was generally low in the beginning of experiment when phosphate was high. APA increased with time while phosphate was depleted. Diurnal variation of APA was detected within difference types. The variation of dissolved APA was smaller than that of total APA. The relationships between APA, phosphate, dissolved organic phosphorus, algal biomass, N/P ratio and other environment factors were discussed.

11AM2002 S7-113 Oral

NUTRIENT DISTRIBUTION IN A HIGH FREQUENCY AREA OF RED TIDES IN THE EAST CHINA SEA

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The first China HAB research cruise, the 973 Project of China, was carried out in the East China Sea, which located from 29°00′N~32°00′N and 122°00′E~124°00′E, April 27 to May 27, 2002. In the field survey, nutrient and sources distribution in a high frequency area of red tide in the East China Sea were studied. It shows that in different depths the average concentration of phosphate, nitrate, nitrite, ammonia and silicate is 0.49 to 0.56, 12.8 to 22.9, 1.28 to 1.46, 1.74 to 1.92 and 11.8 to 15.9 μmol/dm^3, respectively. In general, the concentration of nutrients in coast area is much higher than that in the open sea. The highest concentration is above 0.8, 50, 1.8, 3.0 and 45 μmol/dm^3 for phosphate, nitrate, nitrite, ammonia and silicate, respectively, which was found near the Changjiang Estuary except nitrite and ammonia. It is found that the concentrations nutrients in the survey area have a tendency to increase, comparing with the literature.

Furthermore, it is also found that there has a negative correlation between salinity and nutrients (SiO_3:R=0.89, P<0.001; NO_3: R=0.81, P<0.001; PO_4: R=0.84, P<0.001). It indicates that the sources of nutrients in the survey area come mainly from Changjiang River diluted water and Hangzhou Bay. That is, the discharge of excessive nutrients from municipal and industrial waste water, urban and agricultural runoff leads to the enrichment of nutrients in the survey area.

11AM2002 S7-114 Oral

'EXCESS NITROGEN' IN THE YELLOW SEA AND THE EAST CHINA SEA

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Based on the Redfield ratio (Si:N:P=16:16:1) at which three essential nutrients are utilized by marine phytoplankton, the Si/N ratios and the 'excess dissolved inorganic nitrogen' relative to phosphate were calculated and studied for the upper water of the Yellow Sea and the East China Sea. The results indicated that the Si/N ratios were very high. It suggests that silicate is not the limiting factor for the growth of phytoplankton in the Yellow Sea and the East China Sea. However, under the influence of terrestrial runoff, especially the Changjiang River runoff, which is rich in combined nitrogen and has very high N/P ratios, 'excess DIN' occurred in the Changjiang estuary and its adjacent areas such as the south and southwest of the Yellow Sea, the inshore area of the East China Sea and the area east of the Changjiang estuary in four seasons. These regions cover about one third to three fourths of the Yellow Sea and the East China Sea. As a result, in contrast to general open marine systems, the systems in these areas resemble estuarine ones rather than typical marine ones. The primary production in a considerable portion of the Yellow Sea and the East China Sea may be limited by phosphate rather than nitrogen.

11AM2002 S7-116 Oral

THE DYNAMICS AND FLUX IN THE NUTRIENT-SEDIMENT INTERFACE OF THE EAST CHINA SEA

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As the base of marine primary production and food chain, the nutrient exchange in the sediment-water boundary is acting as an important position to the marine nutrient budget as well as the nutrient dynamics. Here in the first China HAB cruise, 973 Project of China, surveyed in the East China Sea, April 27 to May 27, 2002, *in situ* culture experiments were carried out with pore sediments for the primary investigation of the nutrients dynamics and flux in the sediment-water interface. In addition, a continuous function method was used to calculate the exchange rate and the flux as well.

It is found that silicate shows positive transfer from sediment to water column for all the experimental stations in the East China Sea, the exchange rate is in the range of 1.26 to 25.4 $\mu mol \times m^{-2} \times d^{-1}$. The phosphate also shows positive transfer in the boundary for most experimental stations and the exchange rate is about -0.22 to 0.018 $\mu mol \times m^{-2} \times d^{-1}$. But for ammonia, nitrite and nitrate, there have different results with various sediments, the results imply that the exchange rate is -0.69 to 1.40, -0.028 to 0.56 and -0.78 to 1.33 $\mu mol \times m^{-2} \times d^{-1}$, respectively.

In addition, the nutrient flux in the sediment-water boundary of various sediment type in East China Sea were calculated, and it indicates, in the East China Sea, the net flux from sediment to water column is approximately $2.28' 10^{12}$ $\mu mol \cdot d^{-1}$ for silicate, $1.77' 10^{9}$ $\mu mol \times d^{-1}$ for phosphate and $7.99' 10^{9}$ $\mu mol \times d^{-1}$ for dissolved inorganic nitrogen (DIN), respectively.

11AM2002 S7-117 Oral

GROWTH AND TOXIN PRODUCTION OF *Alexandrium minutum* WITH ORGANIC AND INORGANIC NITROGEN SOURCES

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The effects of nutrients on growth and toxin production of toxic algae have been well studied in the last decade. However, most of the researches concentrate on the effects of inorganic nutrients like phosphate and nitrate. Effects of organic nutrients, which should also play an important role in growth and toxin production of toxic dinoflagellate

in highly eutrophic sea area, are often ignored. In this study, the status of growth and toxin production of *A. minutum* with different nitrogen sources, including nitrate, ammonium, urea and extract of yeast, were compared. The results showed that addition of nitrate and yeast extract after N depletion could promote the growth of *A. minutum*. High concentration of ammonium at the time of nutrient addition showed toxicity on growth of *A. minutum*, however, the toxic effects disappeared after 8 days and algae started to grow in a high rate comparable to that with nitrate or yeast extract. The effect of urea on the growth of *A. minutum* was much less than the other three nutrients. However, urea could make the algae to sustain in a relatively stable concentration compared to the rapid declination of blank, where no nutrient was added. The addition of all, the four nitrogen sources after N depletion could promote the toxin production in *A. minutum*. Similarly, the effect of urea was much weaker than the other three nutrients. Nitrate and ammonium promoted the toxin production more directly than yeast extract and urea, since the toxin content per cell increased quickly with nitrate and ammonium after nutrient addition. All of the four nutrients had little effects on toxin composition of *A. minutum*.

11AM2002 S7-118 Oral

ON CONDITIONS OF PHYTOPLANKTON BLOOMS IN COASTAL WATERS OF THE NORTHWESTERN JAPAN SEA

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Seasonal changes of abundance of the main phytoplankton groups of species (diatoms, dinoflagellates, small flagellates and cryptomonads, chrysophyta) and a set of environmental parameters were investigated in coastal and pre-estuarine waters of Peter the Great Bay (Japan Sea) in May-October 1998 and 1999. Three periods of mass development were revealed: spring, summer and autumn blooms. The spring bloom in the coastal zone is prolonged and finishes in late May - early June by mass development of Chrysophyta in the layer of seasonal pycnocline. Seasonal increasing of fresh water discharge in June after monsoon rains lead to the summer cycle of phytoplankton succession begins by diatoms bloom, the most intensive at sea surface. The sharpening of stratification in the middle of summer forces to change the diatoms bloom to flagellates bloom, and in a short period of the strongest stratification (in August) there could be no blooms of any group of algae. New source of nutrients as upwelling starts with monsoon winds change in early September, and the autumn bloom of diatoms begins. It is supposed to be controlled by a light limitation in conditions of thick mixed layer depth. Later, the diatoms bloom is succeeded by flagellates bloom in conditions of thicker mixed layer.

The blooming conditions of each group of species were determined as combinations of favourable SST and MLD. Driving mechanisms of succession include nutrients transport through seasonal pycnocline by turbulent mixing, terrestrial nutrients supply by monsoon floods, nutrients supply by upwellings, light control by the thickness of upper mixed layer. Summer succession could be analysed by a simple SST-MLD diagram similar to Pingree S-kh diagram with SST as indicator of stratification (S) and MLD as indicator of optical depth (kh).

S8 POC/FIS Topic Session
S8 Detection of regime shifts in physics and biology

Co-Convenors: Jacquelynne R. King (Canada) & James E. Overland (U.S.A.)
Thursday, October 24, 2002 08:30-17:30

Regime shifts are an organizing principle in North Pacific systems. Physical systems might act as a broad-banded oscillator driven by external forcing or internal feedbacks, or as a stochastic system driven by multiple scale processes. Biological systems can act as filters for the noisy physical system. The responses of individual species will vary with life history strategies and trophic level. Some species respond to extremes in interannual variability while others appear tuned to decadal scales. In keeping with the overall PICES XI theme, retrospective and numerical models that describe the nature of regimes or the early detection of regime shifts are encouraged. Conceptual models on the underlying mechanisms of regime shifts in physical and biological systems or the mechanisms connecting physical dynamics to biota are also invited.

Selected papers from this session will be published in a Special Issue of *Journal of Marine Systems* (Elsevier).

08:30-09:00	**Shuhei Masuda, Kazunori Akitomo** (invited) A model of regime transitions in the North Pacific (S8-129)
09:00-09:20	**Kerim Y. Aydin, Gordon A. McFarlane, Jacquelynne R. King, Bernard A. Megrey** Signatures of biotic regime shifts and their propagation through trophic webs – historical data and food web models in the eastern and western subarctic Pacific gyres (S8-120)
09:20-09:40	**Sayaka Yasunaka, Kimio Hanawa** Regime shifts found in the Northern Hemisphere SST field (S8-143)
09:40-10:00	**Andrei S. Krovnin, George Moury** Variations in Pacific and Atlantic salmon stocks in association with recent climate changes in the northern hemisphere (S8-124)
10:00-10:20	**Coffee/tea break**
10:20-10:50	**Gordon Swartzman** (invited) To shift or not to shift: Biological response to the 1997-1998 regime shift in the California Current Ecosystem (S8-291)
10:50-11:10	**William T. Peterson, Franklin B. Schwing** Recent changes in climate and carrying capacity in the northern California Current shelf waters suggest a regime shift was initiated in July 1998 (S8-131)
11:10-11:30	**Brian J. Pyper, Milo D. Adkison, Steve Ignell** Comparison of alternative measures of salmon productivity for quantifying spatial and temporal scales of climate-induced variation (S8-133)
11:30-11:50	**James R. Irvine, D.G. Chen, J.R. King** Regime shifts and British Columbia salmon – linkages between physical processes and ocean survival (S8-123)
11:50-12:00	**Morning summary**
12:00-13:00	**Lunch**
13:00-13:20	**Viktoria A. Platonova, L.N. Vasilevskaya, N.I. Savelieva** Connection of the cold periods in the east of Russia with the centers of atmospheric action (S8-132)

13:20-13:40 **Yongjun Tian, Yasuhiro Ueno, Maki Suda, Taturo Akamine**
Decadal variability in the abundance of Pacific saury and its response to climatic/oceanic regime shifts in the northwestern subtropical Pacific during the last half century (S8-140)

13:40-14:00 **Chuanlan Lin, Jilan Su, Yian Lin, Bingrong Xu**
Changes of the ecological environment in the Huanghai Sea during 1976-2000 (S8-126)

14:00-14:20 **Akihiko Yatsu, Hideaki Kidokoro**
Coherent low frequency variability in biomass and in body size of Japanese common squid, *Todarodes pacificus*, during 1964-2000 (S8-144)

14:20-14:40 **Konstantin A. Rogachev, Eddy C. Carmack**
Rapid thermohaline transition in the western subarctic Pacific: evidence for the role of freshwater flux in the variability of coastal currents and fresh-core eddies (S8-138)

14:40-15:00 **Coffee/tea break**

15:00-15:20 **Daniel Lluch Belda**
Scales of interannual variability in the California Current System: associated physical mechanisms and likely ecological consequences (S8-127)

15:20-15:40 **Ruben Rodríguez-Sánchez, D. Lluch-Belda, H. Villalobos, S. Ortega-García**
Large-scale low-frequency response of small pelagic fishes in the California Current system to major regime shifts (S8-137)

15:40-16:00 **Francisco P. Chavez, John Ryan, Salvador Lluch-Cota, Miguel Niquen C.**
Multi-decadal climate variations, fish abundance, oceanic productivity, and atmospheric carbon dioxide (S8-122)

16:00-16:20 **Nicholas A. Bond, James E. Overland**
Is the marine ecosystem of the Bering Sea Shelf driven by episodic weather events? (S8-121)

16:20-16:40 **Carol Ladd, George L. Hunt, Jr., Phyllis J. Stabeno**
Climate, mixing, and phytoplankton on the southeast Bering Sea shelf (S8-125)

16:40-17:00 **Muyin Wang, James E. Overland, Nickolas A. Bond**
Is the climate of the Bering Sea influenced by hemispheric teleconnections? (S8-142)

17:00-17:30 **Day summary**

Posters:

James E. Overland, Donald B. Percival, Harold O. Mofjeld
A model of North Pacific atmospheric variability on scales of 1 – 100 years (S8-130)

Brian J. Pyper, Randall M. Peterman, Milo D. Adkison
Use of the Kalman filter and state-space models of stock and recruitment to estimate trends in productivity of 120 stocks of Pacific salmon (S8-134)

Brian J. Pyper, Randall M. Peterman, Milo D. Adkison
Multi-stock state-space models for estimating trends in stock-recruit parameters of Pacific salmon (S8-135)

Jake Schweigert
Detecting the effects of regime switching on Pacific herring in British Columbia (S8-139)

Elena I. Ustinova, G.V. Khen, Yu.D. Sorokin
Large-scale fluctuations in physical oceanography at Far-Eastern seas of Russia in the late 1900s (S8-141)

11AM2002 S8-120 Oral

SIGNATURES OF BIOTIC REGIME SHIFTS AND THEIR PROPAGATION THROUGH TROPHIC WEBS – HISTORICAL DATA AND FOOD WEB MODELS IN THE EASTERN AND WESTERN SUBARCTIC PACIFIC GYRES

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Concurrent large-scale changes in the biomass of multiple species in an ecosystem may arise either through dominant climatic frequencies affecting each species independently, or through cascading effects beginning with key species and propagating outwards. In the subarctic Pacific gyres, historical data, especially from Pacific salmon (*Oncorhynchus* spp.) strongly suggest that biotic regime shifts have occurred. However, as salmon migrate through multiple connecting regions and coastal areas, it is not clear whether the measured changes represent a direct relationship between salmon and physical conditions, or arise as the result of trophic cascades. We present the results of a series of modeling workshops held by the PICES Basin Ecosystems Task Team (BASS), and examine and compare the eastern and western subarctic Pacific gyres by integrating food web models (ECOPATH), with lower trophic level models (NEMURO) and historical data. In particular, we examine whether the observed salmon patterns could be better explained by the propagation of bottom-up signals from primary/secondary production, or whether a direct relationship between climate and salmon moves both upwards and downwards through the trophic web.

11AM2002 S8-121 Oral

IS THE MARINE ECOSYSTEM OF THE BERING SEA SHELF DRIVEN BY EPISODIC WEATHER EVENTS?

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Climate variability on decadal time scales is generally recognized as having had substantial influences on high-latitude marine populations. Our recent work in studying air-sea interactions in the Bering Sea suggests that the slow manifold in climate variability is important through its modulation of the frequencies and magnitudes of weather events on times scales of a season and less. We hypothesize that it is these weather events that directly impact the marine ecosystem of the Bering Sea shelf.

The linkages between the event-scale weather and the ecosystem are illustrated here using three examples: walleye pollock, tanner crabs and coccolithophorid blooms. Regarding walleye pollock, we hypothesize that the strong recruitment that occurred in 1978, 1982 and 1996 can be attributed in part due to the anomalously strong storms that occurred in the early summer of those years. We expect that this caused greater mixing of nutrients into the euphotic zone, enhanced plankton production after the spring bloom, and possibly, better feeding conditions for pollock larvae and their competitors. With regards to tanner crabs, recruitment was particularly strong for year classes at the larval stage in 1980 and 1984. These years had strongly anomalous winds from the east along the Alaska Peninsula during the previous winter. Such winds promote flow through the Aleutian passes, and hence an enhanced Aleutian North Slope Current, and potentially, transport of tanner crab larvae to favorable habitat. Finally, a prominent coccolithophorid bloom occurred over the Bering Sea shelf in the summer of 1997. This summer featured much lighter winds and greater solar insolation than usual, and hence a very warm, nutrient-poor upper mixed layer, which put the traditional phytoplankton community at a disadvantage.

In summary, while slow variations in the overall aspects of the physical environment may be important for setting the stage, we propose that the major multi-year adjustments in the marine ecosystem of the Bering Sea shelf is more directly linked to air-sea interactions on time scales of a season and shorter.

11AM2002 S8-122 Oral

MULTI-DECADAL CLIMATE VARIATIONS, FISH ABUNDANCE, OCEANIC PRODUCTIVITY, AND ATMOSPHERIC CARBON DIOXIDE

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Landings of small pelagic populations of anchovies and sardines fluctuate at periods of around 40-50 years and provided early evidence for variability on these time scales. Since then this multi-decadal climate variability has been uncovered throughout the North and South Pacific. The signature of this variability is evident in the productivity of ecosystems, including coastal and equatorial upwelling systems, the central gyre and the northwestern Pacific. Productivity along the equator and the eastern boundaries appears out of phase with productivity in the central gyres and the western Pacific. The Mauna Loa CO_2 time series, which integrates global scale fluctuations, was also found to fluctuate on similar time scales. In the mid-1970s, the Pacific changed from a cool equatorial and eastern boundary "anchovy regime" to a warm equatorial and eastern boundary "sardine regime". Recent observations suggest that a new shift in state has occurred with a return to a 1960s-like condition. Its persistence still needs to be confirmed and may depend on other natural or human-induced climate changes. Better understanding of these climate-driven ecosystem changes could lead to more skilful management of ocean resources and is needed to accurately assess climate change.

11AM2002 S8-123 Oral

REGIME SHIFTS AND BRITISH COLUMBIA SALMON – LINKAGES BETWEEN PHYSICAL PROCESSES AND OCEAN SURVIVAL

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Correlations between oceanographic indices and salmon catch data frequently break down when stock specific data are examined. Restricting ourselves to a time series analysis of data of high precision, we investigated linkages between various physical processes associated with regime shifts and survival patterns for Pacific salmon populations from northern and southern British Columbia. Correlations between recruits per spawner and broad oceanographic indices were weak. Nevertheless, when stock recruit data were partitioned into "positive" and "negative" regimes and a fuzzy logic approach was used to analyze the results, differences in stock recruitment relationships were evident. Patterns varied among species, and among areas within species. Salmon survivals were often more closely related with physical conditions near the point of sea entry than with broad oceanographic indices. Our results corroborate findings that the processes that control marine survival for salmon vary among species, and frequently operate on regional scales. A proper understanding of the conceptual mechanisms connecting physical dynamics associated with regime shifts to salmon survival requires an understanding of the distribution and life history of salmon as well as physical oceanographic conditions.

11AM2002 S8-124 Oral

VARIATIONS IN PACIFIC AND ATLANTIC SALMON STOCKS IN ASSOCIATION WITH RECENT CLIMATE CHANGES IN THE NORTHERN HEMISPHERE

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The paper is based on the results of studying the structure of winter climate in the North Atlantic and North Pacific during the last 40 years and the revealed climatic connections between them. The well-pronounced four-pole structure in sea surface temperature anomaly variations (SSTA) was found in the North Atlantic. It is clearly associated with the manifestation of the North Atlantic Oscillation (NAO): the correlation coefficient between the first EOF of the above four-pole structure and the index of the NAO is 0.90. In the North Pacific, the climate system is characterized by two independent spatial patterns.

Four distinct decadal climatic regimes were identified in the North Atlantic during the 1957-2002 period. The last regime established in 1989 continued through the 1990s and possibly ended in 2001. In the North Pacific the

climatic regime established in the second half of the 1970s continued till 1998-1999. The 1990-1999 decade was the warmest in both oceans compared with the previous three decades.

Climatic variations in the North Atlantic during the last 40 years were characterized by the second, interdecadal, mode of variability. The situation in the North Pacific was more uncertain.

To consider if there are any relationships between the observed climatic variations and the recent trends in Atlantic salmon and Far East (Pacific) pink, chum and sockeye salmon stocks, we applied PC analysis to isolate the patterns of common variability in the 40 physical and 37 biological time series characterizing the Atlantic and Pacific salmon stocks. The time series of PC1 (25.5%) illustrates an abrupt shift from negative to strongly positive values in 1987. High loadings ($r>|0.4|$) on PC1 occur for 6 of 9 time series for Pacific salmon stocks and for most time series of Atlantic salmon. All the Pacific salmon time series are positively correlated with PC1, while most Atlantic salmon stocks show the negative association with PC1. This indicates on the inverse reproductive patterns of the Pacific and Atlantic salmon stocks that may be explained by the revealed features of climate variations in the oceans under consideration. PC2 (12.6%) shows three distinct regimes from 1971 to 1998, with abrupt shifts in 1977 and 1989 which are similar to climatic regimes defined in the North Atlantic. However, only few biological time series have high loadings on PC2, indicating on positive correlation between fluctuations of East Sakhalin pink salmon stock and Atlantic salmon stocks in Labrador and Newfoundland areas. Some proposals regarding the situation with the salmon stocks in both the oceans in the nearest future were made.

11AM2002 S8-125 Oral
CLIMATE, MIXING, AND PHYTOPLANKTON ON THE SOUTHEAST BERING SEA SHELF

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Using the results from a series of one-dimensional mixed layer model runs, variability in timing of the spring bloom, water temperature during the spring bloom, summer stratification and mixing was explored. The model was evaluated using a seven-year time series of temperature, salinity, and fluorescence obtained from a mooring on the southeast Bering Sea shelf. During these seven years, the mixed layer model reproduces the observed temperature structure, heat content, and timing of mixing events during the summer months well, confirming the one-dimensionality of the system. Using NCEP Reanalysis sea surface temperature to initialize the model each spring, and windstress and heat fluxes to force the model, a series of summer model runs is executed covering the period from 1951 to 2001. In the absence of ice, the timing of the spring bloom is influenced by both the wind mixing and the heat fluxes during the spring. In addition, the North Pacific climate pattern, related to storminess over the Bering Sea, is correlated with the spring bloom date. The water temperature on the bloom date is influenced by the timing of the bloom and by the initial winter water temperature. Summer stratification is primarily driven by the winds and heat fluxes earlier in the spring. The strength of the stratification then influences the amount of entrainment that can occur during the summer. Stratification formed during the spring tends to decouple entrainment from summer wind events. Variability on interannual timescales is strong while evidence for regime-like behaviour is weak.

11AM2002 S8-126 Oral
CHANGES OF THE ECOLOGICAL ENVIRONMENT IN THE HUANGHAI SEA DURING 1976-2000

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Changes of the ecological environment in the Huanghai Sea during 1976-2000 were studied using a set of seasonally monitored data along a section at 36°N maintained by State Oceanic Administration. The data included the ocean temperature (T), salinity (S), and biogenic elements (dissolved oxygen (O_2), phosphate (PO_4-P), silicate (SiO_3-Si), the dissolved inorganic nitrogen (DIN).

The annual mean, summer and winter values, respectively, of these elements all showed significant changes. Time series of T, S, DIN and N:P all showed positive trends. During the twenty-five years between 1976 and 2000, the annual mean T and DIN of the Huanghai Sea have increased their values by 1.7°C and 2.95μmoll^{-1}, respectively. Time series of O_2, P and Si, however, showed negative trends. During the twenty-five years between 1976 and 2000, the annual mean O_2, P and Si of the Huanghai Sea have decreased their values by 5.26,0.1 and 3.925μmoll^{-1}, respectively. During 1980s, especially between 1983-1989, the values of P and Si dropped to near the critical value for essential growth of diatoms. The ratio of N:P were changed from 4 in 1984 to over 16 in 2000. The rise of the ratio of N:P may be attributed to the reduction of P and the increase of N in the Huanghai Sea. The climate-trend coefficiant R_{xt} of these time series were all over 0.34 and were significant at the 99% level. The increases of T were consistent with the recent warming in northern China, the Bohai Sea and the East China Sea. The reduction of O_2 may be attributed to the increases of T in the Huanghai Sea.

The results indicated that the changes of the elements have some important effects on the Huanghai Sea ecosystem. Those effects include the experience of the nutrient limitations in the Huanghai Sea ecological environment, the dramatic decrease of the amount of phytoplankton abundance, in spring season from 1986 to 1998, the decrease of percentage of *Bacillariophyta* in the total amount of the phytoplankton abundance, the increase of the percentage of *Coscinodiscus* in the total amount of phytoplankton abundance, and other ecosystem improper sign.

11AM2002 S8-127 Oral

SCALES OF INTERANNUAL VARIABILITY IN THE CALIFORNIA CURRENT SYSTEM: ASSOCIATED PHYSICAL MECHANISMS AND LIKELY ECOLOGICAL CONSEQUENCES

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Inter-year variability has been recognized at the California Current System essentially in three scales: the high frequency, usually associated to ENSO events; the decadal-bidecadal one that has been mostly detected in alternating warm and cold periods, particularly in the northeast Pacific and the very low frequency allied to the regime variation most evident in small pelagic fishes population abundance large scale changes. The comparison between reported physical effects of the variation at the three scales give insight of what similarities and differences may exist between them. On the other hand, the differences in duration of the states of change from each of the scales are prone to result in discernable ecological impacts, some of which have already been reported or may be inferred from previous information.

11AM2002 S8-129 Invited

A MODEL OF REGIME TRANSITIONS IN THE NORTH PACIFIC

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The mechanism of the decadal climate variability in the North Pacific is investigated using a simple non-linear model, a four-variable low-order model in which one ocean variable is added to the three-variable model for the atmospheric general circulation by Lorenz. Three factors, which are implied to be essential for the decadal variability in the atmosphere by observational data, are included in the forcing term. Those are decadal and ENSO-scale variations of sea surface heat flux (or its meridional gradient) and ENSO-scale variation in the atmosphere. Former two factors are controlled by the ocean variable in this model. Two stable states in the atmosphere are realized as a periodic solution with strong Westerlies and a steady solution with weak Westerlies in the model. During having each solution, the atmosphere compels the ocean to act as a "restoring force" for the atmospheric state on a decadal time scale, and the transition occurs when the "restoring force" exceeds a threshold. The transitions can occur without the modeled ENSO variability. However, the interval of the transitions is modified by it since the variation due to the ENSO event causes the "restoring force" of the ocean to exceed a threshold temporarily. Time changes of the model variables are consistent with the decadal variability in the real climate,

which implies that this variability is a kind of transition phenomenon between two stable states in the atmosphere and the ocean plays an essential role in its transition.

11AM2002 S8-130 Poster
A MODEL OF NORTH PACIFIC ATMOSPHERIC VARIABILITY ON SCALES OF 1 – 100 YEARS

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We present time series models for winter-averaged Aleutian Low surface pressures (North Pacific Index), Sitka air temperatures and the Pacific Decadal Oscillation. Each model is a weighted combination of up to three submodels: a first-order autoregressive (AR) process, a fractionally differenced (FD) or "long-memory" process, and a pentadecadal square wave oscillation (SWO) with white noise. Each submodel focuses on a different aspect of the climate record. The AR describes interannual variability, the FD captures a range of variation on decadal scales, and the SWO focuses on regimes of about a quarter of a century. Each depends on three parameters, so they are equally simple and are therefore weighted equally. Additional information and physical arguments support the idea of several time scales in the combined model. The FD process suggests multiple physical processes contributing to a broad banded response on decadal to interdecadal time scales. While the SWO has small amplitudes, the combination of the AR, FD, and SWO submodels produces large but short-lived episodic events with roughly decadal scales, that could lead to regime-like reorganizations in the ecosystem. The combined model leads to a practical scheme for forecasting these North Pacific time series and for forming predictive confidence intervals.

11AM2002 S8-131 Oral
RECENT CHANGES IN CLIMATE AND CARRYING CAPACITY IN THE NORTHERN CALIFORNIA CURRENT SHELF WATERS SUGGEST A REGIME SHIFT WAS INITIATED IN JULY 1998

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In July 1998, a large La Niña event occurred in the North Pacific Ocean, weakening winds in the Gulf of Alaska and strengthening upwelling winds over the California Current. This event led to a cooling of the coastal waters of the Gulf of Alaska and California Current by several degrees. Since 1998, fundamental changes in the productivity of the northern California Current have increased the carrying capacity of the ecosystem: coastal upwelling has increased, nutrient concentrations are higher, zooplankton biomass has doubled, zooplankton species composition has switched to a dominance of boreal neritic species, baitfish such as smelt and anchovy numbers have increased by factors of two to four, and survival of coho and Chinook salmon has increased by 500%. It has now been four years since the La Niña was initiated, an unusually long period. Based on persistent changes in both the Pacific Decadal Oscillation and in ecosystem structure in the California Current, we suggest that the La Niña conditions have given way to a climate regime shift, similar to regime shifts that occurred in 1925, 1947 and 1976.

11AM2002 S8-132 Oral
CONNECTION OF THE COLD PERIODS IN THE EAST OF RUSSIA WITH THE CENTERS OF ATMOSPHERIC ACTION

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For revealing dependence of duration of the cold periods on a condition of centers of atmospheric action (CAA), daily average air temperatures at 10 stations of the East of Russia and monthly average parameters of a condition of the Siberian High and Aleutian Low (CAA) during the 20th century were investigated. As the cold period between

steady dates of transition of air temperature through 0 degrees on the spring and the autumn was accepted, the extremely cold period with negative temperatures below -15°C was considered. Parameters of condition of CAA geographical coordinates and pressure in the centre baric formations determined for monthly average fields of northern hemisphere atmospheric pressure are referred.

The basic statistical characteristics of air temperature transition dates through the appropriate limits aside downturns and rises, and also durations of the mentioned above periods were designed. The greatest variability dates of transition through 0°C and -15°C. About aside downturn of temperature (their factors of a variation (Cv) make 0.5) and also duration of the coldest period with temperatures is lower-15°C (Cv=0.8).

Inertia of processes in the cold period of year was investigated. The narrowness of communications of various dates of transition and durations was estimated. It was revealed, that quite informative it is possible to count dates of transition through 0°C, -15°C about aside downturn of temperature. On them it is possible to judge duration of the cold period, about the ending of the period with temperatures is lower -15°C.

Dynamics of the cold periods and conditions CAA was investigated with the help of the curve saved up anomalies of the appropriate characteristics. The correlation analysis of these curves has shown significant communication between duration of the cold period (with temperatures below 0°C) and condition CAA in the majority of points (factor of correlation near 0.70). Dependence of duration of the extremely cold period (with temperatures are lower-15°C) with condition CAA is marked only at separate meteorological stations.

11AM2002 S8-133 Oral

COMPARISON OF ALTERNATIVE MEASURES OF SALMON PRODUCTIVITY FOR QUANTIFYING SPATIAL AND TEMPORAL SCALES OF CLIMATE-INDUCED VARIATION

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Identifying the spatial and temporal scales over which environmental processes affect fish recruitment is critical for generating and testing appropriate hypotheses regarding mechanisms. It is therefore important that inferences concerning scales of climate-induced variation be based on measures of fish productivity that best reflect these scales.

Recent comparisons of trends in climatic conditions and aggregate catches of salmon provide evidence that broad, decadal-scale processes are a key determinant of salmon production in the Northeast Pacific. In contrast, however, analyses of survival rates across numerous stocks suggest that salmon productivity is primarily driven by more regional-scale processes that exhibit greater modes of interannual variation. Both catch and survival-rate data are potentially confounded by factors such as measurement error and changes in spawner abundance. Which is a better measure of productivity? Under what circumstances?

To address these questions, we compared catch and survival indices using empirically-based simulations that explored numerous scenarios of climate-induced variation in salmon productivity. We also examined novel state-space formulations of stock-recruit relationships that provide promising models for simultaneously estimating low-frequency (*e.g.*, decadal-scale) and high-frequency (*e.g.*, interannual) modes of variation. We discuss the implications of our results for interpreting past studies, drawing inferences regarding mechanisms, and the potential role of decadal-scale trends in spawner abundances as a key determinant of historic trends in salmon production.

11AM2002 S8-134 Poster

USE OF THE KALMAN FILTER AND STATE-SPACE MODELS OF STOCK AND RECRUITMENT TO ESTIMATE TRENDS IN PRODUCTIVITY OF 120 STOCKS OF PACIFIC SALMON

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A recent development in modeling stock-recruit relationships is the use of state-space formulations in which parameters are estimated via Kalman filtering. For example, formulating the Ricker model with an explicit time-varying parameter provides a flexible framework for simultaneously estimating low-frequency (e.g., decadal-scale) trends in stock productivity (*i.e.*, survival rates or offspring produced per unit spawning biomass) amid high-frequency variation in survival rates. If important sources of climate-induced variation follow slowly changing, decadal-scale patterns, such state-space models offer potentially valuable tools for reconstructing historical trends in productivity of fish stocks and for rapidly detecting future shifts in productivity.

To examine the utility of state-space models of stock and recruitment for salmon populations, we developed four state-space representations of the Ricker model and applied them to 120 data sets of pink, chum, and sockeye salmon in the Northeast Pacific. In particular, the models differed by which Ricker parameter – a (density-independent changes in productivity) or b (density-dependent changes) – was assumed to vary over time and by the form of that time-varying process (either a random walk or an AR(1) process). We found that across data sets, the state-space model with a random-walk a parameter clearly performed the best in terms of model-selection criteria, statistical properties, and usefulness of results for management. In addition, many stocks showed large trends in historical productivity, as measured by time series of the a parameter, during the last 40 years. These trends help to characterize decadal-scale influences of climatic forcing and have important implications for management strategies.

11AM2002 S8-135 Poster

MULTI-STOCK STATE-SPACE MODELS FOR ESTIMATING TRENDS IN STOCK-RECRUIT PARAMETERS OF PACIFIC SALMON

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Growing evidence suggests that fish populations, especially those from similar geographical regions, may be subject to shared, decadal-scale trends in productivity (*i.e.*, survival rates or offspring produced per unit spawning biomass). For example, previous research has shown that eight stocks of Bristol Bay sockeye salmon experienced rapid and persistent increases in productivity concurrent with the mid-1970s regime-shift in climatic conditions. Multi-stock models of stock and recruitment that allow for such consistent trends across stocks may improve estimates of productivity parameters of individuals stocks as well as low-frequency (*e.g.*, decadal-scale) trends in productivity shared among stocks. The latter may assist in rapid detection of regime-shifts caused by abrupt transitions in regional-scale climatic forcing.

We therefore developed several multi-stock state-space models, which are extensions of the Ricker stock-recruit relationship, and examined their potential utility using simulations. Parameters for these models were estimated via Kalman filtering. For various scenarios of shared, climate-induced trends in productivity, we found that multi-stock models provided better estimates of parameters and trends than either single-stock state-space models or the standard Ricker model. The benefits of using multi-stock models were greatest for short (*e.g.*, 20-year) data sets in which there was considerable stock-specific interannual variation. In addition, we compared the fit of our different multi-stock models using data for eight stocks of Bristol Bay sockeye salmon.

11AM2002 S8-137 Oral

LARGE-SCALE LOW-FREQUENCY RESPONSE OF SMALL PELAGIC FISHES IN THE CALIFORNIA CURRENT SYSTEM TO MAJOR REGIME SHIFTS

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The distribution of live-bait catch by tuna baitboats operating off California and Baja California during 1931-1997 is analyzed together with available SST data. We provide a view of long-term changes in the abundance of small pelagic fish on a large geographical scale.

During the regime shift of early 1940s, sardine (*Sardinops caeruleus*) abundance declined in northern areas as a first sign of ocean-climate and population interaction, with lower changes in the south. Changes in southern areas were observed a decade later. Similarly, after the regime shift of mid-1970s, sardine abundance changes in northern areas occurred a decade later than changes in the south.

An empirical relation between SST and sardine abundance is evident only at the beginning and the end of the sardine population movement (1930s and 1970s). No such relationship is apparent when sardine abundance is shifting (1940s-1960s and 1980s-1990s). Those early changes at the extremes of the sardine distribution are a confident indicator of a major regimen shift affecting the California Current system (CCS).

Preliminary reports suggest a regime shift around 1997 in the North Pacific. If the physical environment changes are of such magnitude to imply biological regime changes within the CCS, then according with our results, sustained changes of sardine abundance at the north end of its distribution should be observed first. There was no alteration in the trend of sardine population growth or in its northward movement around 1988-1989, suggesting that a regime shift in those years affected the dynamic of the species.

We also discuss the spatial-temporal variability of northern anchovy (*Engraulis mordax*) and other tropical species during the complete collapse-outburst sardine cycle previously described.

11AM2002 S8-138 Oral

RAPID THERMOHALINE TRANSITION IN THE WESTERN SUBARCTIC PACIFIC: EVIDENCE FOR THE ROLE OF FRESHWATER FLUX IN THE VARIABILITY OF COASTAL CURRENTS AND FRESH-CORE EDDIES

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During the past decade significant temporal variability has been observed in the western subarctic Pacific (Rogachev, 2000) prompting a comparison to the Pacific's 1976-1978 "regime shift" (cf. Ebbesmeyer *et al.*, 1991) and to the Atlantic's "great salinity anomaly" (cf. Dickson et al., 1988). We here (a) describe an analogous thermohaline transition in the Kamchatka Current and Oyashio regions during 1990-1997 as reflected in both the strength and freshwater content of coastal currents and the structure of fresh-core anticyclonic eddies and (b) suggest links to atmospheric forcing.

Strong interannual variability (~ 50 cm) is noted in the pressure-adjusted sea level difference between stations in the subarctic Pacific off East Kamchatka (at Petropavlovsk) and the Sea of Japan off Hokkaido (at Wakkanai). This sea level variation is argued to be a steric effect associated with the freshwater content of coastal currents. A comparison of years with low and high transport of the Kamchatka Coastal Current, as revealed by CTD sections, shows seasonal and interannual variability in dynamic height of over 30 cm in association with increased fresh water content and a deeper pycnocline. Coincident with changes in coastal sea level, observations during the past decade have revealed large variability in the horizontal scale and dynamic topography of Kamchatka and Oyashio eddies.

Variability in the western boundary current domain is also accompanied by concurrent trends in other climatological indicators, the duration of winter (sub-zero temperatures), and the Arctic Oscillation index. This correlative evidence for the rapid thermohaline transition points toward a link with the timing of regional freshwater fluxes and, ultimately, the Arctic Oscillation index. These results suggest that the transport and distribution of freshwater components critically influence climate variability in high latitudes of western subarctic Pacific.

11AM2002 S8-139 Poster

DETECTING THE EFFECTS OF REGIME SWITCHING ON PACIFIC HERRING IN BRITISH COLUMBIA

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Changes in climate and ocean conditions are expected to impact primary and secondary production more quickly than in higher trophic levels. Pacific herring and other forage species should respond to the effects of climatic change and regime switching relatively rapidly. Consequently, changing regimes should result in impacts to herring recruitment almost immediately. In this study, I report the results of canonical and discriminant analyses of Pacific herring recruitment prior to and following the 1976 regime shift in relation to environmental indicators (sea surface temperature, salinity, ekman transport, river discharge, ENSO, atmospheric forcing index, Pacific decadal oscillation index, and others). British Columbia herring production was higher during the cool period prior to 1976 and lower during the more recent warm regime. The five major herring stocks responded differently to environmental conditions during the cool and warm periods but it was possible to identify the important indices related to herring recruitment during the different regimes. It appears to be possible to use the knowledge of the critical environmental indices and their recent trends to make short-term forecasts of Pacific herring recruitment. Trends in climatic conditions and ocean productivity should also be incorporated into fisheries management strategies.

11AM2002 S8-291 Invited

TO SHIFT OR NOT TO SHIFT: BIOLOGICAL RESPONSE TO THE 1997-1998 REGIME SHIFT IN THE CALIFORNIA CURRENT ECOSYSTEM

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Increasing physical-oceanographic evidence suggest that a regime shift in the Eastern Pacific Boundary Current region occurred following the 1997-98 El Niño. We expect the signal of this change in biota to be stronger in euphausiids than in pelagic fish because lower trophic levels are more directly responsive to changes in current flow, upwelling and primary production. Acoustic backscatter data from acoustic surveys in summer 1995, 1998 and 2001 suggested that significant changes in abundance and distribution of euphausiids and fish have occurred between 1995 and 2001. Graphical and statistical results show that the density of fish schools and euphausiid patches increased significantly south of Cape Blanco between 1995 and 1998-2001. North of Cape Blanco, although there was no consistent change in euphausiid abundance, both fish and euphausiid distributions in 2001 appeared to be shifted toward the shelf compared with the other years. Pelagic fish abundance distributions appear more closely linked to El Niño, with abundance shifted much farther north in 1998, an El Niño year, than in the other years, while 1995 and 2001 fish abundance distributions are similar to each other. This and other studies suggest shifts in the distribution, abundance and species composition of macro-zooplankton since 1997. The impact of these changes in zooplankton is likely to be strongest on small pelagic fish feeding largely over the continental shelf (*e.g.* juvenile salmon).

11AM2002 S8-140 Oral

DECADAL VARIABILITY IN THE ABUNDANCE OF PACIFIC SAURY AND ITS RESPONSE TO CLIMATIC/OCEANIC REGIME SHIFTS IN THE NORTHWESTERN SUBTROPICAL PACIFIC DURING THE LAST HALF CENTURY

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Pacific saury (*Cololabis saira*) is one of the most important small-sized pelagic fishes in the North Pacific. Using the correlation analysis and Principal Component Analysis (PCA), we examined the relationships between climatic/oceanographic indices (MOI, SOI, AOI, NPI, air temperature, wind velocity, Kuroshio current velocity, and SST) and Pacific saury abundance/biological indices (catch, CPUE, larvae density, condition factor, and body length) in order to detect the response of Pacific saury abundance to the recent climatic/oceanographic regime shifts

(1976/77, 1987/88, and 1997/98). The results of these analyses showed that the decadal-scale variation pattern of Pacific saury abundance well responded to the regime shifts of 1987/88 and 1997/98. Our results also showed that annual variation of Pacific saury abundance is significantly correlated with both the SST of the northwestern Kuroshio waters and the current velocity of Kuroshio in winter. These suggest that oceanographic environment in northwestern Kuroshio waters strongly affects the success of the recruitment of Pacific saury. Our oceanographic analysis showed a notable regime shift occurred in 1987/88 and 1997/1998 in northwestern Kuroshio waters while the same kind of regime shift was not clearly observed in 1976/77 there. These results indicate that only the regime shift that occurs in northwestern Kuroshio waters can affect Pacific saury abundance. We concluded that Pacific saury could be used as a bio-indicator of the regime shifts in northwestern Kuroshio waters.

11AM2002 S8-141 Poster
LARGE-SCALE FLUCTUATIONS IN PHYSICAL OCEANOGRAPHY AT FAR-EASTERN SEAS OF RUSSIA IN THE LATE 1900S

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Decade averaged ice cover area of the Sea of Okhotsk indicates that in the middle fifties of the twentieth century, change of two large-scale cycles has occurred for approximately 50 years. Two trends were mark out within the second cycle: cooling from the 50s to the 70s and warming in the 80s and 90s. Trend change has occurred all over the three seas in the late seventies and in the early eighties that complies with the known climatic shift in the atmosphere.

Since 1998 a strong cold snap has happened in all Far-Eastern Seas of Russia, which in the beginning linked to La-Niña only. But process of the cold snap lasted in current following 4 years, moreover each year it became more intensive that could be a consequence of a large-scale event as, for instance, a regime shift.

After 1998, the area of the ice cover increased, the area of the spreading cool winter water with negative temperature enlarged, the cool currents on surfaces became stronger, salinity of the near-bottom water on the continental shelf to account of the more intensive process of the shaping high-salt water in ice-hole increased, the area of the pacific structure of water decreased.

On the other hand, reinforcement of the water rotation was noted at last years between the Sea of Okhotsk and Pacific Ocean and corresponding to increasing of the temperature and salinity in the layer 500-1000 m was distinguished.

11AM2002 S8-142 Oral
IS THE CLIMATE OF THE BERING SEA INFLUENCED BY HEMISPHERIC TELECONNECTIONS?

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A spatial correlation pattern of the monthly mean Surface Air Temperature (SAT) anomaly over the Bering Sea with 500 hPa meridional wind and Sea Level Pressure (SLP) reveals that there is significant correlation between the selected fields. The fact that SAT is more strongly correlated with the 500 hPa meridional wind than with the zonal wind suggests the surface temperature is influenced primarily by variability in the nature and propagation of synoptic weather systems. This correlation is most obvious in the winter (JFM) season. The same pattern continues in spring (AM) with weaker amplitude, and is absent in summer (JA). This result can in part be attributed to the seasonal cycle of the standard deviation of the SAT: for the past 52 years (1950-2001) the standard deviation of winter season for a location at North Bering is 4.5C, while the annual value is 3.0C, and the summer season (JA) is only 1.1C. There is a lack of spatial correlation of the selected local variables with Northern Hemispheric teleconnection indices (PDO, Polar Vortex, AO, and NP). This low correlation supports the concept that climate variability of the Bering Sea is due to episodic weather events on time scales shorter than one month. A further study on the effects of the episodic weather on Bering Sea's climate need to be carried out using daily data.

11AM2002 S8-143 Oral

REGIME SHIFTS FOUND IN THE NORTHERN HEMISPHERE SST FIELD

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We investigated when regime shifts occurred and what was the difference in climatic states before and after the shifts, using the wintertime SST field in the Northern Hemisphere. Relationship between the regime shifts and the tropical SST variation was also examined. Analysis period is 97 years from 1901 to 1997.

SST averaging in the Niño 3.4 region is used as an index of the tropical SST variation. By subtracting the variations linearly responding to Niño 3.4 SST from the raw field, the residual SST field is obtained. An EOF analysis shows that the dominant variations in the residual field are the North Pacific mode and that corresponding to activities of the Arctic Oscillation.

5-year differences are calculated in the time series of original gridded SST data and those of the two dominant EOF modes and the change of Niño 3.4 SST obtained above. Regime shifts are defined when large changes are detected in both of the two, that is, the 1925/26, 1945/46, 1957/58, 1970/71, 1976/77 and 1988/89 shifts. All regime shifts have similar SST and atmospheric circulation pattern including the changes in an intensity of the AL and the corresponding SST change in the central North Pacific. While most of the regime shifts took place concurrently with the three dominant variations, the 1988/89 shift had no change of Niño 3.4 SST. This fact indicates that the regime shifts can be divided into the two groups: one is the regime shift closely linked with the tropical Pacific variation and the other is independent.

11AM2002 S8-144 Oral

COHERENT LOW FREQUENCY VARIABILITY IN BIOMASS AND IN BODY SIZE OF JAPANESE COMMON SQUID, *Todarodes pacificus*, DURING 1964-2000

Akihiko Yatsu[1] and Hideaki Kidokoro[2]

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Mean mantle length (ML) of *Todarodes pacificus* during August-October in the Japan Sea shifted from 24.6 to 22.4 cm in 1976/77, ML remained small until 1985, and abruptly increased from 21.2 to 23.5 cm in 1986, then became almost stable. A surplus production model was applied to catch statistics during 1964-2000 with high and low carrying capacity K corresponding to the above large and small ML regimes. The high K: low K ratio varied from 0.60 (2% annual increase in catchability coefficient q) to 0.76 (constant q). Coherent shifts in ML and K were discussed in relation to ocean/climate regimes and plasticity of squid somatic growth and extended spawning period. Possibility of body size as an indicator of new regime of an ecosystem was presented.

S9 PICES CCCC – GLOBEC Joint Topic Session
ENSO and decadal scale variability in North Pacific ecosystems

Convenor: R. Ian Perry (Canada)
Friday, October 18, 2002 a.m. (during GLOBEC OSM)

ENSO-scale (4-7 years) variability strongly influences North Pacific ecosystems, with perhaps the most marked effects having occurred in the 1990s. Decadal-scale variability has also been recognized to have major impacts on North Pacific ecosystems. It is unclear how processes on these two scales interact, and whether they are coupled somehow to amplify impacts (i.e. cause major changes, or "regime shifts") to marine ecosystems. This session will consider how ecosystems (with particular focus on the North Pacific) respond to variability on these scales, and whether some systems are structured so that they are resilient (or perhaps more susceptible) to such variability. Are there biological feedbacks to the coupled ocean-atmosphere system which might modify the characteristics of this variability? These issues will be considered in this session by invited papers. **NOTE:** This session will be convened in the GLOBEC Open Science Meeting.

11:00-11:30 **Kaoru Nakata**
Decadal scale variability in marine ecosystem in Kuroshio in winter (S9-024)

11:30-12:00 **Jin-Yeong Kim, Kangseok Hwang, Young-Sang Suh**
ENSO and decadal-scale variability of pelagic fish population in the southwestern North Pacific Ocean (S9-023)

12:00-12:30 **Anne B. Hollowed**
A comparison of hypotheses linking climate and marine fish production (S9-022)

11AM2002 S9-022 Invited

A COMPARISON OF HYPOTHESES LINKING CLIMATE AND MARINE FISH PRODUCTION

Anne B. **Hollowed**
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Statistical comparisons of temporal patterns of marine fish production and oceanographic forcing suggest that production is strongly influenced by the ocean. Numerous hypotheses have been introduced to explain the apparent coupling between marine fish production and ocean forcing. The scientific foundation for these hypotheses stems from retrospective studies and/or interdisciplinary process oriented studies. In Alaskan waters interdisciplinary process oriented studies include: Bering Sea FOCI (BSFOCI), Southeast Bering Sea Carrying Capacity (SEBSCC), Gulf Ecosystem Monitoring Program (GEM), Sound Ecosystem Assessment (SEA), Fisheries Oceanography Coordinated Investigations (FOCI), U.S. GLOBEC NEP, and Study of Environmental Arctic Change (SEARCH). Similar studies have established a scientific foundation for ecological indicators in regions along the U.S. west coast and other eastern boundary currents. This paper presents a synthesis of proposed mechanisms and provides an analysis of the support (or lack thereof) for these mechanisms. The synthesis suggests that marine fish production can be classified by the temporal signature of responses to ocean forcing. The ecological significance of this finding relative to the integrity of marine fish communities is discussed.

11AM2002 S9-023 Invited

ENSO AND DECADAL-SCALE VARIABILITY OF PELAGIC FISH POPULATION IN THE SOUTHWESTERN NORTH PACIFIC OCEAN

Jin-Yeong **Kim**, Kangseok Hwang and Young-Sang Suh
National Fisheries Research & Development Institute (NFRDI), 408-1 Shirang-ri, Kijang-up, Kijang-gun, Pusan, 619-902, Republic of Korea jiykim@nfrdi.re.kr

Variability of the pelagic fish population in the southwestern North Pacific Ocean was studied, relating to the environmental factors in ENSO and decadal-scale since 1970. Variations in the southern Oscillation index (SOI), indicating the magnitude and duration of El Niño events, tended to show negative values during 1-3 years, respectively, 2 times in every decade. Yearly catch of major pelagic fish, anchovy, mackerel and tuna species caught by Korea, China and Japan in the southwestern North Pacific Ocean had nearly significant relationships with SOI at lags of 1-3 years.

Monthly abundance of large purse seine and anchovy fisheries by Korean fishing vessels were used to analyze their spectrum of the variability, in accordance with hydrographic and biological data measured bimonthly by NFRDI in the southwestern area of the Jeju Islands as environmental factors. Monthly abundance of mackerel species, temperature and zooplankton biomass in the northern area of the East China Sea including southern waters of Korea fluctuated at intervals corresponding to the range of 2-3 and 4-5 year cycles of SOI.

Those results indicated that ENSO's teleconnections through meteorological and physical process affected variability of pelagic fish population and their tropho-dynamics in the southwestern area of North Pacific Ocean.

11AM2002 S9-024 Invited

DECADAL SCALE VARIABILITY IN MARINE ECOSYSTEM IN KUROSHIO IN WINTER

Kaoru **Nakata**
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It is well documented that the regime shift in sea and atmospheric systems occurred in the North Pacific at least twice (76/77 and 98/99) during the last three decades in the 20th century. Interannual variation of copepod biomass in winter during the period was examined in the Kuroshio off the Pacific coast of central Japan in relation to the regime shifts and ENSO events. Although there was not clear shift in the biomass trends for small copepods, three different states of biomass trend were identified for large copepods (prosomal length >1mm). The biomass trends of

large copepods before 1977 and after 1997 were characterized by significantly higher biomasses (Mann-Whitney, $p<0.001$) and grater variation ranges of their biomass than those in 1978 to 1996, and the shifts in the biomass trends almost concurred with shifts in sea and atmospheric systems. Prominent peaks in biomass of large copepods were found in 1971, 1976, 1977, 1997 and 1999 during the high biomass states, and the biomass was relatively high around 1987 and in 1993 during the low biomass state. These biomass peaks coincided with the winters with strong winds or ENSO events. Since significant positive relationships were found for biomass of large copepods in the Kuroshio and diatom abundance in the gut of the dominant copepods, both sea and atmospheric regime shift and ENSO events may have influenced interannual variation of biomass of copepods and their size composition through the effects on the new production.

S10 PICES CCCC – GLOBEC Joint Session
Coupled biophysical processes, fisheries, and climate variability in coastal and oceanic ecosystems of the North Pacific

Friday, October 18, 2002 13:30-17:30
Co-Convenors: Harold P. Batchelder (U.S.A.) & Makoto Kashiwai (Japan)

The past decade has shown renewed scientific investigations in coastal regions on both sides of the North Pacific. New interdisciplinary programs have foci ranging from phytoplankton and harmful algal blooms, recruitment of benthic invertebrate larvae, wind-driven cross-shelf exchange, and the mechanisms that regulate the success of holozooplankton and fish. These programs supplement established longer-term observation programs in both coastal and oceanic regions (KNOT, Stn. Papa) and examine the responses of coastal ecosystems to forcing over broad spatial and temporal scales. A common goal of these programs is to elucidate the biological-physical mechanisms responsible for correlative changes that have been observed in the North Pacific. This session will provide a forum for investigators from a number of disciplines -- climatologists, physicists, plankton biologists, and fisheries scientists -- to present recent findings from the North Pacific. We encourage presentations that link observations over multiple disciplines or datasets.

14:00-14:20 **Shoshiro Minobe** (invited)
Atmospheric circulation changes in 1998/99 over the North Pacific (S10-251)

14:20-14:30 **Poster previews**

14:30-14:45 **Ernesto A. Chávez Ortiz, José Luis Castro-Ortiz**
Impact of climate change on fisheries of the eastern Pacific Warm-temperate Transition Zone (S10-241)

14:45-15:00 **Jack A. Barth, Timothy J. Cowles, Stephen D. Pierce, William T. Peterson**
Mesoscale physical and biological variability in the northern California Current System (S10-236)

15:00-15:15 **Julie E. Keister, William T. Peterson**
Relationships between zooplankton communities and mesoscale physical features during two cruises off the Oregon coast USA during early and late summer 2000 (S10-248)

15:15-15:30 **Ya-Qu Chen, Zhaoli Xu, Yunlong Wang, Mei Jiang**
Study on change of zooplankton to biomass in passing 50 years in the East China Sea (S10-242)

15:30-16:00 **Coffee/tea break**

16:00-16:15 **Poster previews**

16:15-16:30 **Xian-Yong Zhao, Johannes Hamre, Fuguo Li , Xianshi Jin, Qi-Sheng Tang**
Recruitment, sustainable yield and possible ecological consequences of the sharp decline of the anchovy stock in the Yellow Sea (S10-262)

16:30-16:45 **Keita Kodama, Ichiro Aoki, Toru Taniuchi, Makoto Shimizu**
Long-term changes in the assemblage of demersal fishes and invertebrates in relation to environmental variations in Tokyo Bay, Japan (S10-249)

16:45-17:00 **Yoshioki Oozeki, Yoshiro Watanabe, Yutaka Kurita, Kaoru Nakata, Daiji Kitagawa**
Growth rate variability of Pacific saury *Cololabis saira* larvae in the Kuroshio Waters (S10-255)

17:00-17:15 **Fei Chai, M.-S. Jiang, R.T. Barber, R.C. Dugdale, Y. Chao**
Modeling ecosystem response to interdecadal climate variability in the Pacific Ocean (S10-240)

17:15-17:30 **Phyllis J. Stabeno, Nicholas A. Bond, Nancy B. Kachel, Calvin W. Mordy**
The response of the Alaska Coastal Current (ACC) to regional atmospheric forcing (S10-259)

Posters:

Richard D. Brodeur, T.W. Miller, D.C. Reese, R.L. Emmett

Community structure of surface nekton and plankton in the northern California Current in relation to oceanographic con (S10-239)

Steven J. Bograd, Ronald J. Lynn, John A. McGowan

Interdecadal physical-biological coupling in the southern California Current System (S10-237)

Louis W. Botsford, M.F. Hill, A. Hastings, K. McCann

Spatial and temporal scales of variability in California Current salmon and crabs (S10-238)

Miriam J. Doyle, Janet Duffy-Anderson, Susan J. Picquelle

Interannual trends in abundance of ichthyoplankton species in the Gulf of Alaska during spring, 1978 through 2000: Exploring linkages between pelagic ecosystem dynamics and the early life history of fish (S10-243)

Albert J. Hermann, D.B. Haidvogel, E.L. Dobbins, P.B. Stabeno

Interannual variability of SST and cross-shelf transport in the coastal northeast Pacific (S10-244)

George L. Hunt, Jr., Phyllis J. Stabeno, Kenneth O. Coyle

Energy flux to top predator in the eastern Bering Sea: The roles of climate change and biophysical coupling (S10-341)

Nianzhi (George) Jiao, Yanhui Yang

Ecological studies on prochlorococcus in China seas (S10-245)

Nianzhi (George) Jiao, Jinjie Yang, Heyang Li, Yanhui Yang

Viability of bacterioplankton in the Chinese coastal waters and west Pacific (S10-285)

Xian-Shi Jin

Yearly changes of community structure in the Bohai Sea (S10-246)

Yi'an Lin, Mingming Jin, Shengquang Gao, Renyou Tang, Jianming Pan

Cycling and regeneration of nitrogen and phosphorus as well as its significance on ecosystem environment of the Yellow Sea (S10-250)

Yuriy Mitrifanov, O.V. Demenok

Distinctions in biological indices and dynamics of growth of *Onchorhynchus keta* and *O. gorbusha* fry in some natural and bred populations (S10-252)

Xiuren Ning, Yuming Cai, Chenggang Liu, Fei Chai

Size-fractionated phytoplankton standing stock and primary production in Bohai Sea during late spring (S10-299)

Tsuneo Ono, Kazuaki Tadokoro, Takashi Midorikawa, Sanae Chiba, Toshiro Saino

Decadal oscillations of net primary production in the spring Oyashio region (S10-254)

William T. Peterson, Jaime Gomez-Gutiérrez, Tracy Shaw, Leah Feinberg

Abundances of eggs, brood size, molting rates and production by the euphausiids *Thysanoessa spinifera* and *Euphausia pacifica* in the northern California Current (S10-256)

Thomas C. Royer, Chester E. Grosch, Nandita Sarkar

Ocean climate conditions during GLOBEC Northeast Pacific Program (NEP) Long Term Observation Program (LTOP) (S10-257)

Norman Silverberg

Sediment trap information from San Lazaro and Alfonso Basins, off Baja California Sur (S10-258)

Kazuaki Tadokoro, S. Chiba, T. Ono, T. Midorikawa, and T. Saino

Interannual variations of *Neocalanus* copepod biomass in the Oyashio water, western subarctic North Pacific (S10-260)

Ernesto Torres-Orozco, A. Trasviña, A. Muhlia-Melo

Interannual variation of the yellowfin tuna catches (*Thunnus albacares*) at the entrance to the Gulf of California (S10-261)

Igor A. Zhigalov, V.A. Luchin

Interannual variability of the bottom water temperature on western Kamchatka Shelf (S10-263)

11AM2002 S10-236 Oral

MESOSCALE PHYSICAL AND BIOLOGICAL VARIABILITY IN THE NORTHERN CALIFORNIA CURRENT SYSTEM

Jack A. **Barth**, Timothy J. Cowles, Stephen D. Pierce and William T. Peterson
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During 2000 and 2002, mesoscale mapping cruises were carried out in spring and summer in the northern California Current System between 41.9 and 44.6N and offshore for 150 km. The primary measurement platform was a towed undulating vehicle equipped with a CTD, two fluorometers, a multi-wavelength light absorption and attenuation instrument, and a PAR sensor. A shipboard ADCP measured water velocities and a bio-acoustics instrument measured multi-frequency (38, 120, 200, 420 kHz) backscatter. Surface drifter trajectories and satellite SST imagery provide context for the mesoscale maps. Both strong upwelling and downwelling favorable winds were encountered. Flow-topography interactions are important in this region including the influence of a major submarine bank and a large coastal promontory. Early in the 2000 season the upwelling front and jet followed the bottom topography. There was cold water inshore of the shelfbreak all along the coast with pockets of elevated phytoplankton biomass (up to 4 mg/m^3) near the coast. Mesoscale activity was minimal. During the summer 2000 cruise, the upwelling front and jet were significantly more convoluted including major meanders offshore associated with Heceta Bank and Cape Blanco. High levels of phytoplankton biomass (in excess of 10 mg/m^3) were found over Heceta Bank and near the coast south of Cape Blanco. The large offshore meander near the Cape carried cold, nutrient-rich, high-phytoplankton biomass (2-4 mg/m^3) coastal water to over 100 km offshore. Comparisons between the physical circulation and ecosystem response in 2000 and 2002 will be made.

11AM2002 S10-237 Poster

INTERDECADAL PHYSICAL-BIOLOGICAL COUPLING IN THE SOUTHERN CALIFORNIA CURRENT SYSTEM

Steven **Bograd**[1], Ronald J. Lynn[2] and John A. McGowan[3]
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[2] *NOAA/NMFS/Southwest Fisheries Science Center, 8604 La Jolla Shores Drive, La Jolla, CA 92038, U.S.A.*
[3] *Scripps Institution of Oceanography, University of California, San Diego, 9500 Gilman Drive, La Jolla, CA 92093-0227, U.S.A.*

We summarize more than 50 years of physical and biological data in the southern California Current System (CCS) based on the California Cooperative Oceanic and Fisheries Investigations (CalCOFI) hydrographic, nutrient, and plankton record, 1949-2001. CalCOFI is the world's longest-running multi-disciplinary oceanographic field program, making it ideally suited for revealing the mechanisms of interdecadal physical-biological interactions in the coastal ocean. A particular focus of this study is to characterize the local signature of the large-scale North Pacific climate regime shifts in 1976-77 and 1998-99. Changes associated with the first shift include (1) significant upper-ocean warming and spatially heterogeneous changes in coastal salinity; (2) deepened density surfaces, increased stratification, and a reduction in the vertical transport of inorganic nutrients; (3) a spin-up of both the offshore California Current and nearshore California Undercurrent; (4) a large reduction in net plankton biomass, and corresponding higher trophic level responses; and (5) a cross-shore dichotomy in both the physics and biology, with the nearshore regime changes occurring primarily during the upwelling season and the offshore changes being impacted more strongly by low-frequency incursions of Subtropical Gyre waters. Profound changes were also evident following the 1998-99 climate shift, although they were not entirely symmetrical to those of the earlier shift. It is found that changes in water column structure are particularly important in determining the biological effectiveness of coastal upwelling. We put the interdecadal variability observed over the past half-century in the southern CCS in the context of regional and basin-scale variability throughout the North Pacific.

11AM2002 S10-238 Poster

SPATIAL AND TEMPORAL SCALES OF VARIABILITY IN CALIFORNIA CURRENT SALMON AND CRABS

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Catch records of the two dominant salmon in the California Current, chinook salmon (*Oncorhynchus tshawytscha*) and coho salmon (*O. kisutch*), and Dungeness crab (*Cancer magister*) indicate these populations respond differently to environmental variability. Coho salmon respond to annual fluctuations, while chinook salmon respond on a several year scale because of differences in age structure. Dungeness crab responds on a 10-year time scale because of the over-compensatory nature of their stock-recruitment relationship. Coho salmon and Dungeness crab are synchronous over several hundred km spatial scales, while chinook salmon vary on spatial scales of a hundred km. Coho salmon declined coastwide in response to the regime shift in the mid-1970s, while the similar congener, chinook salmon did not. Differences in spawning age distribution cause differences in persistence, but they are not sufficient to explain the difference in response to decadal scale variability. Metapopulation structure created by dispersing larvae and straying between spawning streams may explain some of these observations, and the individual salmon of the two congeners may respond to ocean conditions differently. These results underscore the fact that scales of variability in environmentally driven populations may not reflect the spatial and temporal scales of the forcing.

11AM2002 S10-239 Poster

COMMUNITY STRUCTURE OF SURFACE NEKTON AND PLANKTON IN THE NORTHERN CALIFORNIA CURRENT IN RELATION TO OCEANOGRAPHIC CONDITIONS

Richard D. **Brodeur**, T.W. Miller, D.C. Reese, R.L. Emmett
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In order to make better-informed management decisions, it is necessary to know the existing distribution of biological and habitat diversity, as well as quantify the amount of natural variability at different spatial and temporal scales. We conducted a comprehensive analysis of how zooplankton and nekton are distributed in the northern California Current, not only in space and time but also with reference to species assemblages, habitat characteristics, and environmental factors (e.g., depth, temperature, salinity, chlorophyll content) using a geostatistical approach. The community structure, spatial distribution patterns, and environmental associations of neustonic zooplankton and pelagic nekton species from June and August 2000 GLOBEC cruises were examined. Particular emphasis was placed on differences related to the regions north and south of Cape Blanco off Southern Oregon. Crab megalopae, hyperiid amphipods, euphausiids, and chaetognaths dominated the neustonic zooplankton community during both cruises. Nekton assemblages differed significantly between cruises. The June cruise was dominated by juvenile rockfishes, rex sole, and sablefish, which were almost completely absent in August. The forage fish community during June was comprised of Pacific herring and whitebait smelt north of Cape Blanco and surf smelt south of Cape Blanco. The fish community in August was dominated by Pacific sardines and other highly migratory pelagic species. To explore patterns in community structure, we applied cluster analysis, Indicator Species Analysis, and Nonmetric Multidimensional Scaling (NMS) ordination to both data sets. The cluster analyses differentiated the inshore and offshore taxa in the first division followed by latitude in the second division. Results from NMS confirmed the cross-shelf zonation of zooplankton and nekton, with SST the most consistent environmental parameter explaining the distributions. An offshore assemblage of zooplankton was entrained in an eddy and transported onto the shelf in August.

11AM2002 S10-240 Oral

MODELING ECOSYSTEM RESPONSE TO INTERDECADAL CLIMATE VARIABILITY IN THE PACIFIC OCEAN

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To improve our understanding of physical variability and the marine ecosystem response in the Pacific Ocean, especially on seasonal to decadal time scales, we have developed a physical-biogeochemical model for the Pacific Ocean. The lower trophic level ecosystem processes are linked with upper ocean carbon chemistry and embedded into a three-dimensional circulation model that is forced with observed the air-sea fluxes between 1950 and 2000. The improved physical-biogeochemical model produces a 50-year (1950-2000) retrospective analysis for the Pacific Ocean. The physical-biogeochemical model is capable of reproducing many observed features and their variability in the Pacific Ocean. Analyses of the modeled results are focused on two regions, the equatorial Pacific and the transition zone in the North Pacific. The physical-biogeochemical model captures the slowdown of the meridional overturning and decrease of the equatorial upwelling transport, which causes primary production and phytoplankton biomass decrease by about 10% after 1976-77 in the equatorial Pacific. In the central North Pacific, the modeled primary productivity and phytoplankton biomass in the transition zone (30N-45N) increase after the 1976-77 climatic shift. Elevated chlorophyll level in the central North Pacific expends the transitional zone and pushes the transition zone chlorophyll front (defined as surface chlorophyll = 0.2 mg/m^3) equatorward. Overall, the physical-biogeochemical model responds to the abrupt climate shift reasonably well, and the modeled results are consistent with the limited observations in the Pacific Ocean.

11AM2002 S10-241 Oral

IMPACT OF CLIMATE CHANGE ON FISHERIES OF THE EASTERN PACIFIC WARM-TEMPERATE TRANSITION ZONE

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General patterns of exploited stocks variability and their possible temporary relationship with the climate change in the Pacific basin are examined. Large synchronous variations in the scale of decades, were observed in several fisheries, therefore, variations in abundance do not seem to happen at random. Responses of fifteen exploited stocks of western Mexico are examined in the context of several indices of climate change. Nine of the species-groups examined are tropical; six others are of temperate affinity. Landing data were analyzed as normalized departures from mean values every year and some indices of climate change were analyzed also as normal deviations and compared with transformed landing data. High correlations were found in some cases, suggesting an influence of climate stronger than expected. Three main patterns of impact of the climate change are identified on the fisheries: 1. A response to the shift in the middle of the 70s (seven stocks). 2. A shift in 1989, approximately, characterized by a moderate negative response before the middle of the 80s, then an abrupt response leading to spectacular increases in catches afterwards (four stocks), and 3. Species that apparently respond to El Niño-La Niña events, well known as warm above normal temperatures followed by cold periods occurring every five to seven years (four stocks). Although a clear cause-effect relation of these changes is still to be discovered in most cases, the implication of these effects on fisheries management leads to suspect that climatic change may have stronger influence in some stock sizes than any management regulation.

11AM2002 S10-242 Oral

STUDY ON CHANGE OF ZOOPLANKTON TO BIOMASS IN PASSING 50 YEARS IN THE EAST CHINA SEA

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This paper deals with changes of zooplankton biomass in passing 50 years in the East China Sea. Based on analyzing results, it shows that highest plankton biomass appeared in 1950's and lowest biomass appeared in 1997-1999 years. In 1959 year, plankton biomass was 156 mg/m^3/Y and since 1970's plankton biomass gradually have been decreasing to 125 mg/m^3/Y due to impact by some environmental factors. In 1981 year, seasonal biomass of zooplankton was 64 mg/m^3/Y which shows obviously that biomass was decreasing sharply in the East China Sea. During 1997-1999 year, plankton biomass reached to 11.6 mg/m^3, 29.4 mg/m^3, 79.4 mg/m^3 and 25 mg/m^3 respectively in spring, summer, autumn and winter. It describes dynamic and distribution of zooplankton biomass in the East China Sea. It shows that most higher concentrations of zooplankton are located frequently at convergence zones of different currents such as coastal water Yellow Sea cold water mass, Taiwan warm current, Kuroshio warm current and diluted fresh water of Changjiang River, etc. Temperature, salinity, runoff, nutrients, phytoplankton and pollution elements etc. are important factors to affect changes in dynamics of zooplankton biomass in the East China Sea. Dominant species of zooplankton in the East China Sea are *Calanus sinices, Euchaeter concinna, Euchaeta plana, Eucalauus subcrassus, Euphausia pacifiea, Pseudeuphansia sinica, Sagitta nagae, Sagitta enflata. Themisto gracilipos, Undinula vulgaris* etc. which population control fluctuation of zooplankton biomass. Biomass of zooplankton also is an important factor in marine ecosystem, it related fluctuation of economic fisheries research and stability and location and moving of main fishes such as marchal etc. It shows obviously zooplankton biomass is really an important supplement of fishes in marine ecosystem.

11AM2002 S10-243 Poster

INTERANNUAL TRENDS IN ABUNDANCE OF ICHTHYOPLANKTON SPECIES IN THE GULF OF ALASKA DURING SPRING, 1978 THROUGH 2000: EXPLORING LINKAGES BETWEEN PELAGIC ECOSYSTEM DYNAMICS AND THE EARLY LIFE HISTORY OF FISH

Miriam J. **Doyle**, Janet Duffy-Anderson and Susan J. Picquelle
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Dramatic changes in species composition and abundance have been documented among adult fish populations in the Gulf of Alaska during the 1980s and 1990s. A shift in ocean climate during the late 1970s is thought to have triggered the observed, subsequent reorganization of community structure in this northeast Pacific ecosystem. Mechanisms linking the oceanographic and climate changes with the marine biota, particularly fish, are not well understood. Little is known about the affect of fluctuations in ocean conditions on the early life history dynamics of fish species in the Gulf of Alaska and whether "regime shift" effects are detectable in the ichthyoplankton. A time-series of spring ichthyoplankton data in the Gulf of Alaska, 1978 through the present, provides an opportunity to investigate such linkages by examining interannual trends in the early life history stages of fish, including eggs and larvae, in this region. Retrospective analyses of these data are being conducted to examine spatial and temporal patterns of ichthyoplankton in relation to environmental conditions. The hypothesis being addressed in this retrospective study is that environmentally induced fluctuations in Gulf of Alaska fish populations may be modulated through the early life history dynamics of these fish and reflected in temporal trends in abundance and distribution of ichthyoplankton species. There are three ongoing components to this investigation: 1) Interannual trends in springtime abundance of ichthyoplankton species, 2) Interannual trends in timing of spring production of eggs and larvae among fish species, 3) Interannual trends in springtime ichthyoplankton spatial patterns. For the purposes of this GLOBEC/PICES OSM session, we will focus on the first component and present results of our investigation of interannual trends in abundance of ichthyoplankton species in the Gulf of Alaska during spring. Initial analyses reveal that interannual trends in larval abundance reflect observed trends in adult biomass, associated with the late 1970s oceanographic "regime shift", for several species including Pacific cod, arrowtooth flounder, southern rocksole and flathead sole. Other species display interannual trends in larval abundance that appear unrelated to the decadal scale oscillation in the oceanographic regime but that may be linked to shorter term

variability in the pelagic environment. Special attention will be given to the observation that a new oceanographic "regime shift" may have occurred in the northeast Pacific in the late 1990s with an expectation of concomitant change in biological communities in the Gulf of Alaska.

11AM2002 S10-244 Poster
INTERANNUAL VARIABILITY OF SST AND CROSS-SHELF TRANSPORT IN THE COASTAL NORTHEAST PACIFIC

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The winter SST of the coastal Northeast Pacific exhibits strong interannual variability, and contributes to large-scale indices of climate change such as the Pacific Decadal Oscillation (PDO). Spatially nested primitive equation model hindcasts, forced with NCEP winds and heat fluxes for the years 1997-2001, have been used to diagnose this interannual variation. Patterns generated by the model for those years (e.g. warming around the coastal Gulf of Alaska and cooling in the deeper basin) relate directly to ENSO and PDO modes, compare favorably with observed SST patterns, and exhibit especially pronounced interannual differences between 1998 and 1999. Through float tracking and EOF analysis of model output, we explore the mechanisms for spatial downscaling of the regional circulation in different years, the interannual variability of cross-shelf transport, and how these effects could produce observed biophysical correlations in the region.

11AM2002 S10-341 Poster
ENERGY FLUX TO TOP PREDATORS IN THE EASTERN BERING SEA: THE ROLES OF CLIMATE CHANGE AND BIOPHYSICAL COUPLING

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We examine how coupling of physical and biological processes affects the production and transfer of energy to upper trophic-level species in the southeastern Bering Sea. During the 1990s, the Bering Sea experienced variability in the marine climate that was as great or greater than previous extremes recorded since the early 1970s. For example, in 1998, ice cover was minimal in extent and retreated early, but in 1999, it was unusually great and long-lasting. Likewise in 1997, sea surface temperatures were unusually high during late spring and summer, whereas in 1999, temperatures in spring and summer were unusually low. Data from a biophysical mooring deployed in the middle domain has shown the relationship between the timing of ice retreat and the occurrence of ice-edge vs. open-water spring phytoplankton blooms. When sea-ice remains until late March, an ice-edge bloom results, whereas if ice retreats prior to mid-March, an open water bloom occurs in May or June, depending upon when the thermocline sets up. The timing of the bloom and the temperature of the water in which it occurs have a significant impact on the fate of the production by influencing the production of small neritic copepods. The availability of copepods for consumption by the dominant fish, walleye pollock (*Theragra chalcogramma*) may in turn influence the extent to which the recruitment of pollock is influenced by top-down or bottom-up processes. When adult pollock are abundant, they may depress the productivity of other apex predators, such as black-legged kittiwakes (*Rissa tridactyla*), by competing for forage fish, including age-1 pollock.

11AM2002 S10-245 Poster
ECOLOGICAL STUDIES ON PROCHLOROCOCCUS IN CHINA SEAS

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Prochlorococcus, a tiny oxygenic photosynthetic picoplankton with unique pigment composition has been found to be ubiquitous and abundant in the world oceans, and been recognized to be closely related to living resources and environmental issues. It has been attracting interests of marine biologists since its discovery, and field data on it

over global oceans have been accumulated rapidly in the past 10 years. In China, we have studied *Prochlorococcus* for 8 years and basic ecological understandings are achieved. The presence of *Prochlorococcus* in China Seas, marginal seas of the west Pacific, was confirmed, and its distribution patterns were also brought to light. *Prochlorococcus* is very abundant in the South China Sea and the offshore regions of the East China Sea; it is seasonally present in the southeast part of the Yellow Sea and absent in the Bohai Sea. Temporal and spatial variations of the abundance of *Prochlorococcus* and their affecting factors, physiological and ecological characteristics of *Prochlorococcus* and their relationships to the other groups of picoplankton, as well as the importance of *Prochlorococcus* in total biomass and possible roles in living resources and environmental problems were discussed. In the future, isolation of different *Prochlorococcus* strains from China seas and their physiological characteristics, genetic diversity, phylogenies and gene exploiture, etc. are important issues to be addressed.

11AM2002 S10-285 Poster
VIABILITY OF BACTERIOPLANKTON IN THE CHINESE COASTAL WATERS AND WEST PACIFIC

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Flow cytometry and epifluorescence microscopy were employed in determination of bacterial cells stained with 4',6-diamidino-2-phenylindol dihydrochloride (DAPI), 5-cyano-2,3-ditoyl tetrazolium chloride (CTC) and propidium iodide (PI) as total cell counts, cells with respiration viability and dead cells in the Yangtze River Estuary areas, Taiwan Strait, and the west Pacific warm pool areas. Total counts of bacterioplankton varied with environmental conditions ranging from 10^5 cells/ml to in the open ocean to 10^6 cells/ml in the coastal waters. The ratios of the respiration active cells to the total varied from 21% ~ 87%, and ratios of dead cells to total ranged from 1% ~ 48%, suggesting a considerable part of "live" but inactively respiring bacterioplankton existed in the natural sea water in the investigation areas. The possible affecting factors were discussed.

11AM2002 S10-246 Poster
YEARLY CHANGES OF COMMUNITY STRUCTURE IN THE BOHAI SEA

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Yearly changes of community structure, biomass and biodiversity in the Bohai Sea were analysed based on four-year bottom trawl surveys in summer from 1959 to 1998. The results indicate that yearly changes in the community structure, including dominant species, size spectra and diversity have occurred in the Bohai Sea. Both spawning and recruitment stocks of many commercially important species have been collapsed recently. The relative biomass in 1998 declined to only 4.38% and 3.58% of those in 1982 and 1992, respectively. The indices of species richness, diversity and evenness have continuously decreased from 1982 to 1998, which might be caused by a combined effect of high fishing intensity and pollution.

11AM2002 S10-248 Oral
RELATIONSHIPS BETWEEN ZOOPLANKTON COMMUNITIES AND MESOSCALE PHYSICAL FEATURES DURING TWO CRUISES OFF THE OREGON COAST USA DURING EARLY AND LATE SUMMER 2000

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We conducted two cruises to study mesoscale variability in zooplankton communities during early (May/June) and late (July/August) summer 2000 as part of the U.S. GLOBEC Northeast Pacific program. These cruises were conducted in conjunction with two other vessels studying the physical oceanography and distribution of juvenile salmonids. We sampled zooplankton using a 202mm mesh, ½ m diameter plankton net lifted vertically from near-bottom (max. depth of 100m) to surface. Zooplankton were counted and identified to species when possible (mostly for copepods) or to genus or larger taxonomic groups such as chaetognaths, echinoderms, or medusae. We used

cluster analysis and Non-Metric Multidimensional Scaling (an ordination technique) to examine similarities in zooplankton communities among sampling sites and Indicator Species Analysis and Multi-Response Permutation Procedure to interpret the differences.

Satellite images of SST and CTD data collected during the cruises show that mesoscale physical activity was minimal during the early-summer cruise, but mesoscale features (e.g.-eddies and filaments) were well developed during the late-summer cruise. Strong differences in the zooplankton communities that appear related to mesoscale physical activity were apparent both between cruises and within each cruise. At the highest cluster level, the zooplankton communities present during the early-summer cruise separated completely from that found during the late-summer cruise. Within each cruise, communities North of Cape Blanco (a large cape on the Oregon coast that is presumed to be a faunal boundary) separated from communities South of Cape Blanco. The relative complexity of the physical system during the two cruises was reflected in zooplankton distributions: during early summer, cross-shelf differences were slight, whereas in late summer, cross-shelf differences in the zooplankton communities were strong and the pattern of community structure matched well with the complex physical features (primarily a large eddy) seen in the physical data and satellite images. Zooplankton communities present during these cruises will be compared to those studied as part of the U.S. GLOBEC Long-Term Observations Program to investigate possible implications of the seasonal differences to longer-term climate change issues such as differences among years of strong and weak upwelling.

11AM2002 S10-249 Oral

LONG-TERM CHANGES IN THE ASSEMBLAGE OF DEMERSAL FISHES AND INVERTEBRATES IN RELATION TO ENVIRONMENTAL VARIATIONS IN TOKYO BAY, JAPAN

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Tokyo Bay, in the central part of Japan, is a coastal region with high productivity. Long-term changes in the demersal assemblage, including both fishes and invertebrates, in the bay were examined by test trawl survey between 1977 and 1995. A total of 255 species were collected, of which 113 were regarded as representative in terms of occurrence. Multivariate analyses of the representative species showed fluctuations in the catch were related to three periods, namely, Period 1 (1977-1983), Period 2 (1984-1988) and Period 3 (1989-1995), which reflected changes in relative abundance and species composition. Relative abundance of the representative species in the Period 2 was higher than in other periods. In particular, mantis shrimp, *Oratosquilla oratoria* (de Haan), whipfin dragonet, *Repomucenus valenciennei* (Temminck & Schlegel), and marbled sole, *Pleuronectes yokohamae* (Günther), showed high dominance in Period 2. However, the total relative abundance declined dramatically in the Period 3, mainly due to decline in the three species. Discriminant analysis suggested that the demersal assemblage changed synchronously with environmental conditions: dissolved oxygen, precipitation, salinity and dissolved inorganic phosphorus. Causes of the temporal changes in the demersal assemblage in relation to variations in the environmental factors are discussed.

11AM2002 S10-250 Poster

CYCLING AND REGENERATION OF NITROGEN AND PHOSPHORUS AS WELL AS ITS SIGNIFICANCE ON ECOSYSTEM ENVIRONMENT OF THE YELLOW SEA

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On the basis of the data obtained by the field survey and experiments recently, we study the cycling and regeneration of nitrogen and phosphorus as well as its effect on ecosystem environment of the Yellow Sea. The distribution and temporal-spatial variation of concentration of species of N and P are described. The characteristic and influence factors of process of biogeochemical cycling and regeneration in the water column up and down the halocline of coastal waters and thermocline layer of cold-water mass region are discussed in particular. As a result of the effect by the coastal current and inputs from terrigenous runoff, a high concentration region of TIN was formed

in offshore area, and to add to ion exchange and desorption of inorganic P occurred on the surface of suspend particle and organic P was uncasing degraded into DIP, that can maintain primary productivity in a higher level in this area. In summer, while Cold Water Mass was formed in the middle of Yellow Sea and thermocline layer was intensified, there are two inversional biogeochemical action in water columns up and down the thermocline. The main action was photosynthesis where DIN and DIP were absorbed by plankton and transformed into PON and POP in the upper water column. Primary mineralization occurred when PON and POP were degraded and inverted into DON-DIM and DIP below the thermocline. Meanwhile a large quantity of the organic particles was aggregated and supported by the thermocline and there was a longer resident time for the DIP regenerating in the interface of thermocline that supplied the needs of primary production and caused DIN short relatively. Owing to retardation by the thermocline, the regenerated nutrients in the lower layer water was stagnated under the thermocline column and the Cold Water Mass becomes a nutrients storage tank. Until the thermocline disappears in the winter, water mass was mixed and diffused and nutrients was transferred up to upper water column. Hereto a long period cycle.

10AM2002 S10-251 Invited
ATMOSPHERIC CIRCULATION CHANGES IN 1998/99 OVER THE NORTH PACIFIC

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The atmospheric circulation anomalies occurred in 1998/99 over the North Pacific is examined using the circulation indices and analysis of wave activity fluxes. Minobe (2002) showed that the SLP changes in 1998/99 take an East Pacific pattern. Although the possibility that the 1998/99 change marks a regime shift has attracted large attentions, the previous major regime shifts in the 1920s, 1940s and 1970s are characterized by the prominent changes over the region of the climatological Aleutian lows. The analysis of wave activity fluxes of 200 hPa height indicates that the wave energy is mainly supplied over mid-latitudes and propagate toward the north and south. The influences from the tropics are not prominent. Therefore, the recent anomalous positive EP is forced over mid-latitudes, and is not governed by the tropical or polar variability. That is, the transition from the El Nino to La Niña in 1998/99 is not likely to be the main cause of the atmospheric circulation anomalies over the North Pacific.

The time series of the EP pattern exhibits energetic decadal variability in the last two decades, and appeared to leads the North Pacific Index and Pacific/North American pattern by about five years. Thus the EP pattern can be a harbinger of the possible weakening of Aleutian lows in a few years. However, it cannot be excluded the possibility that anomalous EP pattern back to normal without the occurrence of a long-lasting regime. Continuous efforts to understand the ongoing changes are necessary.

11AM2002 S10-252 Poster
DISTINCTIONS IN BIOLOGICAL INDICES AND DYNAMICS OF GROWTH OF *Oncorhynchus keta* AND *O. gorbusha* FRY IN SOME NATURAL AND BRED POPULATIONS

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It is known that the ability to survive and the viability of some Pacific salmon bred at fishery hatcheries are considerably lower than that of the natural populations. This is illustrated by a decrease in return of the bred young fish. Returns of chum and pink salmon bred at the old farms of Sakhalin Region are low. Methods of dry and semi-dry fertilization used at the hatcheries result in low-active sperms participating in fertilization along with the high-active sperms. Probably, this is one of the causes of the decrease in quality of salmon offspring at the fish hatcheries.

The given study was aimed at the following:

1. Development and trial of a new method for fertilization the eggs of salmon fish.
2. Comparisons of different populations of chum and pink salmon from the rivers of Sakhalin and Primorye, both natural and bred ones.
3. Investigation of dynamics in growth and weight of fry.

The paper presents studies of individuals of natural and artificial populations of chum and pink salmon. The material for studies was obtained at Barabashevsky Fish Hatchery (Primorsky Krai) and Sokolovsky Fish Hatchery (Sakhalin Region), as well as from the Rivers Melkaya and Tym' (Sakhalin Island) in 1988-1991.

At the fishery hatcheries the eggs were fertilized with the help of trivial dry method of fertilization (control). Besides, we received the posterity using the technique of spermal selection (SS) - selection of the most active part of sperms. In this case, before fertilizing the sperms were activated in the absence of eggs in definite conditions, and after that they were mixed with the eggs. Then the less active sperms were loosing their activity and didn't participate in fertilization.

As a criterion of ontogenesis stability and significance of heredity for the formation of some characteristic features in the studied populations it was chosen the level of fluctuating asymmetry (FA) of different features: number of pores of seismosensory channels, gill rakers, rays in pectoral fins and ventral fins, spots along the side line. The indices of viability, sex ratio, dynamics of change in size and weight were studied.

It is described the variability in the above features of the studied populations. It is established that the fish individual of each studied population was characterized by certain typical indices of the features and FA of the twin features.

11AM2002 S10-299 Poster

SIZE-FRACTIONATED PHYTOPLANKTON STANDING STOCK AND PRIMARY PRODUCTION IN BOHAI SEA DURING LATE SPRING

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During June 1997 cruise by R/V *Science No.1*, observations on temporal and spatial variations of size-fractionated phytoplankton standing stock and primary production were carried out in the Bohai Sea. Size-fractionated chlorophyll *a* and primary production, PAR (photosynthetically available radiation), as well as the related physico-oceanographic and zooplanktonic parameters were measured at five time-series stations represented sub-areas of the sea.

Results obtained shows that there were marked features of spatial zonation of chlorophyll *a* and primary production in the Bohai Sea. The values in Laizhou Bay, Liaodong Bay and Bohai Bay were high and appeared close relation with tidal fluctuations, *i.e.* high chlorophyll *a* concentration occurred during high tide in Laizhou Bay, and during low tide in Liaodong Bay and Bohai Bay. In the mouth and the central region of Bohai Sea, the values were relatively low and no relationship with tidal fluctuation could be found. Chlorophyll *a* concentration vertically decreased from surface to bottom in Liaodong Bay and Bohai Bay, while it increased in Laizhou Bay, the mouth and the central region of Bohai Sea, and the highest value were encountered at the bottom.

Size-fractionation results showed that nano- combining pico-plankton (< 20 mm) predominated in phytoplankton communities of Bohai Sea during late spring. The average contribution to total chlorophyll *a* in each station ranged 76~95% (mean=87%). The contribution of net (> 20 mm), nano- (2~20 mm) and picoplankton (< 2 mm) were 13%, 63% and 24% to total production, and 9%, 53% and 38% to total chlorophyll a, respectively. It proved the importance of nano- and pico-plankton in phytoplankton communities in the Bohai Sea ecosystems. In comparison with the previous observations, primary production has decreased significantly during the last decade.

The paper also discussed the factors, such as light intensity, zooplankton grazing pressure, etc. governing standing stock and production of phytoplankton in Bohai Sea.

11AM2002 S10-254 Poster

DECADAL OSCILLATIONS OF NET PRIMARY PRODUCTION IN THE SPRING OYASHIO REGION

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We analyzed a 30-year time series of chlorophyll-*a* concentration, zooplankton biomass, and net primary production in the spring mixed layer in the Oyashio region, and both linear decreasing trend and decadal oscillations were observed in all time series. The detail and cause of linear trends were introduced in the last PICES meeting and will be further discussed in this Meeting (Chiba et al., 2002). In the present paper, the decadal oscillations are characterized. Decadal oscillation signals were extracted from each time series by subtracting linear trend, and 5-y running average was then calculated to remove year-to-year variation. The net production time series showed a 13-y cycle oscillation with its maximum phase located in early 1970s and mid 1980s, and this signal correlated well to the 5-y running averaged SOI time series ($r^2 = 0.80$). However, its phase seemed to precede SOI by ~2y. Zooplankton time series showed similar oscillation with a good correlation to SOI ($r^2 = 0.82$), and its phase seemed coherent to SOI. Both time series also showed statistically significant correlation with 5-y averaged winter NPI time series, but correlation coefficient was lower than that of SOI case ($r^2 = 0.37$ for net production and 0.62 for zooplankton, respectively). These features contrasted with those of AOU time series in the Oyashio-subsurface, in which ~20y cycle oscillations coherent to the winter-NPI were characterized (Ono et al., 2001).

11AM2002 S10-255 Oral

GROWTH RATE VARIABILITY OF PACIFIC SAURY *Cololabis saira* LARVAE IN THE KUROSHIO WATERS

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Pacific saury *Cololabis saira*, one of the important small pelagic fishes in Japan, has been exploited with large fluctuation of stock size. Wide range of spawning activities has been observed seasonally and spatially, in the Kuroshio Waters (winter) and the Kuroshio-Oyashio Transitional Waters (autumn and spring). Spawning amount and vital parameters in early life stage have been thought as the major factors controlling the fluctuation of seasonal cohort size. Our previous studies revealed that the winter cohort of the saury larvae indicated the fastest growth, and that the growth and mortality rates were most stable in winter. Multiple regression analysis among recent growth rates estimated from otolith increment widths and environmental factors indicated that the sea surface temperature (SST), copepod concentration, and chlorophyll a concentration were key factors controlling the larval growth rate. Growth rate time series of the saury larvae were reconstructed from SST, chlorophyll *a* concentration and copepod biomass time series in the Kuroshio Waters from 1971 to 2000. Time duration from hatching to juvenile, one of the key factors deciding the mortality of larval stage, will be discussed comparing to the landing date sets of winter seasonal cohort.

11AM2002 S10-256 Poster

ABUNDANCES OF EGGS, BROOD SIZE, MOLTING RATES AND PRODUCTION BY THE EUPHAUSIIDS *Thysanoessa spinifera* AND *Euphausia pacifica* IN THE NORTHERN CALIFORNIA CURRENT

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Abundances of euphausiid eggs were estimated from 250 cruises made in 1969-1973, 1983 and 1996-2002, and fecundity and molting rates of two euphausiid species were estimated on more than 50 oceanographic cruises (July, 1999 to August 2002) in the coastal upwelling zone off central Oregon. Highest abundances of euphausiid eggs occurred in continental shelf waters in July and August and peaks in egg abundance were most often associated with upwelling events. Lowest abundances of eggs occur in El Niño years (1969, 1972, 1983, and 1998). Brood sizes (eggs per female) of females incubated for 24 h were similar for both species (overall average of 144.0 eggs per batch for *E. pacifica*; and 135.9 eggs per batch for *T. spinifera*). These values represent 8.2% and 4.0% of the female's body weight respectively. Highest brood sizes were observed in July and August. The average brood size for *E. pacifica* was similar among the four years for *E. pacifica* but brood size has increased for *T. spinifera* (from 45.6 eggs per female in 2000 to 139.1 in 2001, and 154.4 to date in 2002). Molting rates of juveniles and adults ranged from 2% per day in winter months to 10-30% during the summer upwelling season, and were similar among years. Maximum molting rates were observed at the height of the upwelling season in July-August. This is also the time of year when chlorophyll concentrations are highest, often reaching values in excess of 20 micrograms chlorophyll-a per liter. Our measured growth rates of 0.065 mm per day were similar to values estimated by Pearcy and Smiles in a study conducted from 1963-1967, and to values estimated by Dexter in a laboratory study conducted in 1976-1977. Secondary production of euphausiids will be calculated and compared to secondary production of copepods for the same time periods in order to determine the relative proportion of production contributed by these two taxa in an upwelling system.

11AM2002 S10-257 Poster

OCEAN CLIMATE CONDITIONS DURING GLOBEC NORTHEAST PACIFIC PROGRAM (NEP) LONG TERM OBSERVATION PROGRAM (LTOP)

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A 31 year time series of temperature and salinity versus depth to 250 m at the mouth of Resurrection Bay, Alaska (60 N, 149 W) (GAK 1) is used to establish the climatic conditions for the Northeast Pacific GLOBEC Long Term Observation Program (LTOP) and to determine whether the hydrographic conditions during the sampling are warmer, colder, fresher or saltier than normal. The surface temperature anomaly was about +1 C in fall 1997 but decreased to - 2 C in late spring 1999. It has returned to the normal with large, short period fluctuations. At 100 m, a record anomaly of more than +1.5 C occurred in 1998, followed by a decrease to nearly -1 C in late spring 1999. Since that time, the anomalies have generally been increasing to a near record high in late 2001. At 200 m, there was a similar pattern as was found at 100 m. In fall 1997, the surface salinity was below normal (- 3) increasing to more than + 3 in summer 1999. At 100 m the salinity anomaly increased from –0.3 in early 1998 to nearly +0.5.in early 2001. There was a larger change in the salinity at 200m where it increased from more than –0.5 in late 1997 to nearly 0.4 above normal in summer 1998. Wind, freshwater discharge and currents are potential driving mechanisms for these observed changes.

11AM2002 S10-258 Poster

SEDIMENT TRAP INFORMATION FROM SAN LAZARO AND ALFONSO BASINS, OFF BAJA CALIFORNIA SUR

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Results are presented from sediment traps moored in a basin on the Pacific margin, and some preliminary indicators from another on the Gulf of California.

The mass fluxes at 330m depth in San Lázaro Basin were 63-587 $mg.m^{-2}.d^{-1}$ between August and November, 1996. OrgC contents were 5.6 to 14.8%, yielding POC flux rates of 9-40 $mgC.m^{-2}.d^{-1}$. In December 1997 and January 1998, total mass and POC fluxes (47-202 $mg.m^{-2}.d^{-1}$ and 3-8 $mgC.m^{-2}.d^{-1}$, respectively) indicated unexpectedly comparable sedimentation during the height of the strong El Niño event. The February-June records, however, reveal sharply reduced fluxes of mass (1-6 $mg.m^{-2}.d^{-1}$) and POC (0.2-0.8 $mgC.m^{-2}.d^{-1}$).

Marine snow made up 20-80% of the material. Fecal pellet fluxes were low (18-2350 $m^{-2}.d^{-1}$), with ovoid forms dominating over rod-shaped pellets. Plankton remains indicated a shift from a mixed assemblage in late 1996 to a coccolith-dominated assemblage, during 1998. The POC collected in 1996 was predominantly autochonous ($\delta^{13}C$ = -22‰ ; C/N = 8). The variation in $\delta^{15}N$ (8.3 to 11.0‰) suggests an alternation of new and regenerated production, possibly associated with fluctuations in the intensity of deep mixing in the fall of the year. The relatively high organic matter fluxes in December 1997 appear to be associated with regenerated production. The average POM composition from February to June 1998 ($\delta^{13}C$ = -23.6‰; ^{15}N = 11.7‰; C/N = 10.5), suggests that the sediment trap had collected degraded material of marine origin. Regime changes within each of the trap collection periods are evidenced by concurrent shifts in most of the measured parameters (including trace metals).

T-S profiles, plankton and chlorophyll contents of the upper water column indicated that the large diatom bloom, normally associated with seasonal wind-induced upwelling along the Pacific coast of Baja, did not occur during spring of 1998. Similar mid-day primary production rates in December 1997 and April 1998 (about 0.6 $mgC.m^{-2}.d^{-1}$) are thus surprising. In spring local conditions favoured the dominance of nanoflagellates (94%) and apparently limited the export of particles from the photic zone.

11AM2002 S10-259 Oral

THE RESPONSE OF THE ALASKA COASTAL CURRENT (ACC) TO REGIONAL ATMOSPHERIC FORCING

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This study is assessing air-sea interactions important to the Alaska Coastal Current (ACC) using measurements being collected under the auspices of GLOBEC's Coastal Gulf of Alaska Program. Direct observations of the ACC have been inadequate for determining its interannual to decadal variability. This variability can be estimated indirectly, however, using the relationships between the atmospheric forcing and the ACC from the present study, in conjunction with the historical weather record that extends back to the late 1940s. These relationships are being established through analysis of the observations in 2001 and 2002 from the GLOBEC-sponsored mooring array.

The properties of the ACC of primary interest are along-shore transport, cross-shelf exchange, and vertical velocity and mixing. The along-shore transport is is measured directly using current meters from the moorings; the transport is moderately correlated with the along-shore component of the wind (R ~ 0.5). The circulation in the vertical cross-shelf plane is weaker and hence more difficult to determine than the alongshore transport, but some measures of that circulation are provided by the moorings. In particular, salinity is used as a tracer to estimate cross-shelf and vertical velocities, and the magnitude of mixing. Preliminary evidence indicates that these aspects of the flow are related to the winds, but not necessarily in a straightforward manner. For example, in many cases there has been a more coherent response to the cessation, rather than to the onset, of a strong forcing event. In addition, the sense and magnitude of the cross-shelf flow near the surface is not simply related to its counterpart at depth, even during periods of strong downwelling or moderate upwelling favorable winds. Nevertheless, our results suggest that the mooring observations can be used to provide useful and meaningful estimates of the ACC's response to atmospheric

forcing. These estimates will be updated as more data is collected, and will be compared with the results from the high-resolution numerical ocean models being run for the Gulf of Alaska.

11AM2002 S10-260 Poster

INTERANNUAL VARIATIONS OF *Neocalanus* COPEPOD BIOMASS IN THE OYASHIO WATER, WESTERN SUBARCTIC NORTH PACIFIC

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To clarify the interannual variations in biomass and species composition of Neocalanus copepods in spring and summer in the Oyashio water, we analyzed hydrographic data and zooplankton samples collected along the 'PH' monitoring line located offshore Hokkaido between 1972 and 1999. *Neocalanus flemingeri* and *N. plumchrus* were the predominant species in spring and summer, respectively, and their biomass showed different interannual variations between 1980 and 1999. In spring, biomass of *N. flemingeri* was about 40 mg/m^3 and did not vary significantly from 1980 to 1999. Although we did not have information on species composition before 1980, total zooplankton biomass decreased significantly from the mid 1970s to the late 1970s. We assumed that the decrease of the zooplankton biomass was chiefly due to the decrease of *N. flemingeri* since *N. flemingeri* usually dominates the zooplankton population in spring. Abundance of diatoms, important food resource of Neocalanus copepods, also decreased from the mid 1970s to the late 1970s. This deficiency in food availability might have caused the decreased *N. flemingeri* biomass. The cause of diatom decrease cannot be identified with the currently available data set, but it can be noted that the decrease coincided with the decreasing surface salinity in the western North Pacific. One possible explanation for the decrease in diatoms is that the diatom growth is limited by iron, and main source of iron is winter entrainment. In this case, iron availability of diatoms will be reduced by diminished winter entrainment, resulting in reducing vertical mixing due to increase density gradient. In summer, biomass of *N. plumchrus* was about 20 mg/m^3 in the 1980s and increased to 80 mg/m^3 in the 1990s. Diatom abundance also increased in the1990s, suggesting that high food availability caused the increase of *N. plumchrus* biomass during the period. Also, body size of *N. plumchrus* increased in the1990s. We observed water temperature increase during the period. As it is reported that water temperature has a negative relationship with body size of copepods, the observed size increase also implied that the food availability improved in 1990s. However we cannot clarify the cause of the diatom increase in the1990s.

11AM2002 S10-261 Poster

INTERANNUAL VARIATION OF THE YELLOWFIN TUNA CATCHES (*Thunnus albacares*) AT THE ENTRANCE TO THE GULF OF CALIFORNIA

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We examine capture data of yellowfin tuna for the period of 1990 to 1999, and for an area off the Gulf of California, in the northeastern tropical Pacific (18-24° N, 112-104° W). The data were extracted from a database gathered from logbook records of the Mexican tuna purse-seine fleet. Normalized catch-per-unit-effort in a zonal band of highest catches is highly correlated with El Niño-Southern Oscillation (ENSO) events. The latitudinal distribution of tuna catches increase from south to north for the 10-year period. Highest effort, and catches, concentrate between 22 and 23° N. The area accumulates 50% (81380 Tm) of the total capture and 52% (6079 sets) of total sets for the 10-year period. At least two periods of exceptionally high captures are found. They occur the springs following the ENSO events starting in 1991 and 1997 and for two consecutive years. Peaks are triggered by the arrival of positive anomalies of sea surface temperature (SST) to the area. A delay of 2 to 4 months is observed between the occurrence of maximum SST anomalies at the equator and the peaks of capture. Prior to these two events catches were extremely low and, at the same time, negative SST anomalies were the dominant feature in the study area.

11AM2002 S10-262 Oral

RECRUITMENT, SUSTAINABLE YIELD AND POSSIBLE ECOLOGICAL CONSEQUENCES OF THE SHARP DECLINE OF THE ANCHOVY STOCK IN THE YELLOW SEA

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Natural mortality, stock-recruitment relationships and the sustainable yield of the anchovy (*Engroulis japonicus*) stock in the Yellow Sea were calculated on the basis of acoustic stock estimates of the wintering anchovy in the period from 1987 to 2002. The possible ecological consequences of the sharp decline of the anchovy stock were examined in terms of the reduction in the biomass production of anchovy as food supply to the Yellow Sea ecosystem, and possible species interactions including predator-prey interaction and species competition were discussed.

11AM2002 S10-263 Poster

INTERANNUAL VARIABILITY OF THE BOTTOM WATER TEMPERATURE ON WESTERN KAMCHATKA SHELF

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Data obtained during oceanographic observations carried out regularly on western Kamchatka (WK) shelf in May-July from 1963 to 2001 are analyzed. Anomalies of bottom water temperature (ABWT) were determined to exclude the influence of seasonal variability. First multi-year average monthly temperatures were determined for 36 "squares" of 0.5′0.5° size. The latter was then calculated over all squares. Adjusted anomalies monthly temperatures made the temporal series for 1963-2001. Spectral analysis revealed 6.3- and 9.5-year periods in ABWT temporal series, also for the smoothed series (smoothing interval is 3 years), a 19-year period was revealed, whereas a linear trend was not significant.

Years of observations were also classified according to their thermic conditions. Based on the series length and guidelines of the general theory of statistics, the number of types was confined to five (extremely cold, cold, normal, warm, and extremely warm). This approach allowed finding extremely cold (1966, 1967) years in the thermic regime of western Kamchatka shelf. 1963, 1964, 1968, 1977, 1984, 1986, 1989, 1991, 1996 are referred to as warm years, while 1970, 1971, 1973, 1979, 1980, 1981, 1982, 1994, 1998, 1999, 2001 are cold years. Absolute maximum of the time range of cold years made up four years (1979-1982). From 1983 to 2001 only four years were cold. Percentage wise cold years-33%, warm years-28%.

Statistic correlations between ABWT and factors that influence the temperature field of near-bottom waters were determined. Correlation coefficients between ABWT and the factors mentioned below are higher of the critical value: ice concentration in January - February, distance to the north of the Eastern Channel at 154°E in March, distance to the ice edge towards Okhotsk in March, distance from Sakhalin island to the ice edge at 54°N in February - March, distance from Sakhalin island to the ice edge at 50°N in February, water temperature at the surface of Okhotsk Sea near the northern Kuril islands in January - March, average monthly pressure in the center of Aleutian Low in March, average position of Aleutian Low in February-March.

Critical correlation coefficient (based on the series length and 95% probability) equals 0.35. Results obtained show that the forecast may be made for a 3-4 month term.

S11 PICES CCCC - GLOBEC Joint Poster Session
Climate change and carrying capacity of the North Pacific: Recent results of GLOBEC and GLOBEC-like programs in the North Pacific

Co-Convenors: Harold P. Batchelder (U.S.A.) & Makoto Kashiwai (Japan)
Wednesday, October 23, 2002 17:30-20:30

The purpose of this session is to highlight recent results of GLOBEC and GLOBEC-like programs in the North Pacific. We seek papers that address how climate change affects ecosystem structure and productivity of coastal and oceanic populations. Posters on modelling, retrospective studies, observational programs and process-oriented research are appropriate. NOTE: This is a poster session only. It complements Day 4 (Friday, October 18, 2002) of the GLOBEC Open Science Meeting, which has oral sessions on (1) Fisheries, climate and biological-physical coupling in the north Pacific, and (2) ENSO and decadal scale variability in the North Pacific. For oral presentations, abstracts must be submitted to the GLOBEC OSM, rather than to PICES XI. GLOBEC and PICES are co-ordinating their efforts so that oral presentation requests which cannot be accommodated within the PICES CCCC - GLOBEC Joint Sessions, will be included as posters at the GLOBEC OSM and/or PICES XI.

A.I. Abakumov
Modelling of aquatic community as self-organizing system (S11-145)

David G. Ainley, L.B. Spear, C.T. Tynan, J. Barth, T. Cowles, S. Pierce
Biological and physical factors explaining occurrence patterns of seabirds in the California Current (S11-195)

Susan E. Allen, T. Bird, K.L. Denman, J.F. Dower, S. Harris, R.G. Ingram, R.S. Lee, R. Pawlowicz
Biophysical coupling in the Strait of Georgia (S11-207)

Valentina D. Budaeva, Vyacheslav G. Makarov, Valery P. Tunegolovets
Interannual variability of water regime in the Tatar Strait (S11-279)

Sanae Chiba, Kazuaki Tadokoro, Tsuneo Ono, Toshiro Saino
Has lower trophic level ecosystem changed in the western subarctic North Pacific? - a 30 year retrospective study (S11-205)

Hyo Choi
Response of sea temperature in fishing grouns to wind driven current induced by wind in the mountainous coastal sea (S11-197)

Valery I. Chuchukalo, Larisa N. Bokhan
Seasonal distribution of net plankton in the southern part of the Okhotsk Sea and the Kuril region of the Pacific Ocean (S11-284)

William R. Crawford, Sonia D. Batten
The influence of coastal- origin eddies on oceanic plankton distributions in the eastern Gulf of Alaska (S11-201)

Jaime Färber-Lorda, Ignacio Romero-Vargas, Cesar Almeda-Jauregui
Summer trophic conditions int the Southern California Current (S11-198)

Jaime Färber-Lorda, M.F. Lavin, M. Guerrero-Ruiz, J.M. Robles
Trophic conditions in the Gulf of Tehuantepec during wind forcing (S11-204)

Sergio Hernández-Trujillo, G. Esqueda-Escárcega, R. Pacheco-Chávez, A. Zárate-Villafranco, R. Avendaño-Ibarra
Seasonal abundance of Acartia clausi and Paracalanus parvus (Copepoda:Calanoida) in relation to hydrography in a subtropical lagoon of Mexico (S11-203)

Masahide Kaeriyama, R.R. Edpalina, R.V. Walker, K.W. Myers
Effects of long-term and temporal climate changes on the population dynamics and life history of Pacific salmon (S11-206)

Natalia V. Klovatch, O.F. Gritsenko
Self-regulation of Japan chum salmon abundance (S11-224)

Salvador E. Lluch-Cota, M.O. Nevárez-Martínez, D. Lluch-Belda, A. Parés-Sierra, D. Lluch-Cota
Towards and ecosystem status report for the Gulf of California (S11-128)

Juana López-Martínez, M.O. Nevárez Martínez, D.B. Lluch Cota, E. Herrera Valdivia, A.R. García
Effects of the interannual and long temporal variability, in the brown shrimp fishery in the Gulf of California, Mexico (S11-322)

Wieslaw Maslowski, Stephen R. Okkonen
The influence of mesoscale eddies on biophysical exchanges across the shelf break in the Aleutians and Bering Sea (S11-202)

Ludmila V. Milovskaya
The influence of climate changes on the ecosystem carrying capacity in Kuril Lake (S11-280)

Manuel O. Nevárez Martínez, G.I. Rivera Parra, E. Morales Bojórquez, J. López Martínez, D.B. Lluch Cota, E. Miranda Mier, C. Cervantes Valle
Effects of interannual environmental variability on the jumbo squid (*Dosidicus gigas*) fishery of the Gulf of California (S11-321)

Jun Nishioka, Shigenobu Takeda, Daisuke Tsumune, Takeshi Yoshimura, Isao Kudo, Kenshi Kuma, Atsushi Tsuda
Processes of iron limitation in the subarctic NW Pacific – higher particulate iron concentration than that in the subarctic NE Pacific (S11-281)

Takeshi Okunishi, Michio J. Kishi
A three dimensional ecosystem- physical model including sea ice effect in the Sea of Okhotsk (S11-208)

Olav M. Ormseth, Brenda L. Norcross
Interannual variability in the distribution of spawning Pacific cod in Alaska: The influence of ocean temperature (S11-278)

Chul Park, Chang Rae Lee
Variation in zooplankton assemblages in the Asan Bay, Korea during the last decade (S11-199)

R. Ian Perry, Stewart M. (Skip) McKinnell
PICES North Pacific Ecosystem Status Report: an update (S11-345)

Vladimir M. Pishchalnik, A.V. Leonov
Modelling of processes of biotransformation of organogenic substances in the La Perouse (Soya) Strait (S11-209)

S. Lan Smith, Yasuhiro Yamanaka, Michio J. Kishi
A version of NEMURO including C, N and P cycles applied to Station ALOHA: Impact of the microbial loop on organic matter stoichiometries and carbon export. (S11-200)

Yehui Tan
Assessing long-term changes in early summer zooplankton community construction of the Pearl River Estuary (S11-316)

Jia Wang, Meibing Jin
A 3-D coupled physical-biological model and its application to the spring plankton bloom of 1996 in Prince William Sound, Alaska (S11-298)

C.S. Wong, Liusen Xie, William Hsieh
Variations of nutrients and carbon due to regime shift in subarctic NE Pacific (S11-277)

Jie Zheng, Gordon H. Kruse, James D. Schumacher, Doug Woodby
Spatial and recruitment patterns of eastern Bering Sea crabs in relation to decadal oceanographic variability (S11-283)

11AM2002 S11-145 Poster

MODELLING OF AQUATIC COMMUNITY AS SELF-ORGANIZING SYSTEM

A.I. **Abakumov**

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Mathematical modelling of aquatic communities and aquatic ecological systems has a longtime history. We propose two variants of these models for aquatic community as self-organizing system. First variant describes the community in static conditions. Let x is vector of abundance of species in community, θ is vector of environmental condition. We determine a set $X(\theta) \subset R_+^n$ of possible conditions for vector x of abundance of species. The species of community may they purposes. We describe this fact with help the conditions

$$\Psi_J(x,\theta) \to_{x \in X(\theta)} \sup \qquad (1)$$

for some subsets J of set $I = \{1,2,...,n\}$. Here n is number of species in community. This model is applied for investigate of fish community of Khanka Lake.

Second variant describes the community in dynamic conditions. Mathematical model for dynamics of abundance of species in aquatic community is described with help of system of differential equations

$$\frac{dx}{dt} = f(t,x,\theta), \qquad (2)$$

where $t \in R_+$ is time-variable, $x = x(t) \in D \subset R_+^n$ is vector-function of abundance of species, θ is vector of environmental condition. Classical models (2) are based on analogy between biological systems and physical systems. This analogy is right in close field of modelling.

If abundance x depend on space-parameters, the system (1) is modified to system of equations

$$\frac{\partial x}{\partial t} = F(t,\alpha,x,\theta), \qquad (3)$$

where $x(t,\alpha)$ is some solution of equation (3). If self-organizing of species is allow, the function $x(t,\alpha)$ may has the form

$$x(t,\alpha) = \bar{x}(t) * \varphi(\alpha, q(t)). \qquad (4)$$

Here $\bar{x}(t)$ is general abundance of species, $\varphi(\alpha,q(t))$ is density of abundance on set A, $\int_A \varphi(\alpha,q(t))d\alpha = 1$.

Parameter q is control from species. Symbol "*" is denoted the multiplication "element-on-element" for vectors or matrices. Integration of system (2) on $\alpha \in A$ give

$$\frac{d\bar{x}}{dt} = G(t,\bar{x},q,\theta), \qquad (5)$$

where $G(t,\bar{x},q,\theta) = \int_A F(t,\alpha,x,\theta)d\alpha$. Parameters $q(t)$ is defined with help of some criteria of successful survival for species. It is described with help of equation

$$\frac{dq}{dt} = Q(grad_q G(t,\bar{x},q,\theta)), \qquad (6)$$

where operation of *grad* is apply for each element of vectors. Operator Q describes the level for self-organizing of the species.

The properties of solution in this model are investigated. The examples of the application of this method to investigate of aquatic communities of Okhotsk Sea and Khanka Lake are shown in this presentation. The different between of the "classical" method (2) and our methods (1), (4)-(5) is shown. Ours models on basis of formulas (1), (4) - (5) demonstrate more good character contrast to classical models (2).

Experimental data for aquatic communities show a good coordination with ours model's solutions in situations of changes for condition of environment.

11AM2002 S11-195 Poster

BIOLOGICAL AND PHYSICAL FACTORS EXPLAINING THE OCCURRENCE PATTERNS OF SEABIRDS IN THE CALIFORNIA CURRENT

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We investigated variability in the abundance and distribution of seabirds in the GLOBEC Northeast Pacific-California Current study area during two cruises in May-June and July-August 2000. Seabird densities were determined coincident with quantification of water-column properties using SeaSoar and hydroacoustic (multi-channel) sampling. Data were binned into approximately 1.5 nm segments. Greater than 60% of variability in distribution could be explained for specialist species such as Common Murre and Rhinoceros Auklet (fish predators), as well as storm-petrels (neuston feeders). Such a high degree of explained variability has rarely, if ever, been achieved before for seabird predators. The most important factors were depth and intensity of the chlorophyll maximum, characteristics of the mixed layer (sharp gradients), prevalence of potential prey, and distance to nearest breeding colony. Appropriately, the piscivores responded to prey detected by the lower acoustic frequencies, and the neustron feeders to the highest frequency. Explained variability in occurrence for generalist species (e.g., shearwaters) was much lower (20-30%). Results point out the complexity of attempting to answer questions pertaining to why marine predators concentrate where they do. It has more to do that merely the abundance of potential prey.

11AM2002 S11-207 Poster

BIOPHYSICAL COUPLING IN THE STRAIT OF GEORGIA

Susan E. Allen, T. Bird, K.L. Denman, J.F. Dower, S. Harris, R.G. Ingram, R.S. Lee, R. Pawlowicz
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The Strait of Georgia is a highly productive, semi-enclosed, marine ecosystem located between Vancouver Island and mainland British Columbia. In recent years the Strait has undergone considerable changes, many of which are tied to the rapid population growth. These changes have included increased usage of the Strait for both commercial and recreational purposes, reduced air-quality, and increases in sewage and other effluent. There have also been significant changes in the marine ecosystem. Surface water temperatures have warmed by about 1°C since the 1960s. Certain fish species have been fished virtually to local extinction. There are increased occurrences of red tides. Key zooplankton species are now arriving about a month earlier than they did historically. The public's attention was caught by the highly visible collapse of salmon stocks in the late 1990s.

To date there has been little recognition of the role played by natural physical variability in regulating biological production in the Strait. However, a growing body of evidence suggests that changes in the productivity and structure of this and other marine ecosystems are likely due to interannual variability in the linkages between physical and biological processes. Our research project STRATOGEM is an attempt to understand the links between the lowest levels of biological productivity and the physical dynamics of the system. The project will tie together a 3 year monitoring program with computer models of the circulation and biological dynamics. Monitoring began in April 2002. In this poster, we will present our scientific approach and some preliminary results.

11AM2002 S11-279 Oral

INTERANNUAL VARIABILITY OF WATER REGIME IN THE TATAR STRAIT

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The study deals with comparative analysis of interannual variability of water dynamics in the Tatar Strait (48-51°30N) for the years with differing thermal regimes. Water circulation structure, current fields, integral coefficients of the density structure, surface dynamic profile at 46°16 in March and August, as well as water thermal

anomaly in a 0-200 m layer are studied. Three-dimensional current fields are reconstructed using the linear baroclinic Ekman-type model (Budaeva & Makarov, 1999) with 10'10' horizontal resolution.

Dynamic regime of a "cold" year has been reconstructed using the data collected during oceanographic surveys of summer 1961 and 1971, the one of a "warm" year – using the data obtained in 1958 and 1962. The structure of currents in a 70-mile offshore zone of the southwestern Sakhalin is shown to produce influence on the type of water thermal regime in the southern deep part of the Tatar Strait. Great activity of the Tsushima Current was revealed in "warm" years, that was caused by "additional" advective inflow of heat in the subsurface layers (50-150 m) registered not only in the preceding summer, but winter as well (January 1956, 1958, 1962; February 1948, 1949, 1955; March 1974). On the contrary, "cold" years are marked with instability of southwestern Sakhalin shelf currents: an abruptly decreasing width and intensity of the main Tsushima Current flow to the west of Moneron Island. Surface currents in this case have a well-distinguished anticyclonic direction that is preserved to about 100-150 m layer. Drifting currents and their interaction with the sea bottom topography, as well as transport of residual winter water masses along the continent are shown to produce the greatest impact on the current dynamics in the northern Tatar Strait.

11AM2002 S11-205 Poster

HAS LOWER TROPHIC LEVEL ECOSYSTEM CHANGED IN THE WESTERN SUBARCTIC NORTH PACIFIC? - A 30 YEAR RETROSPECTIVE STUDY

Sanae **Chiba**[1], Kazuaki Tadokoro[1], Tsuneo Ono[1,2] and Toshiro Saino[1,3]

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Analyzing the time series data sets collected from 1970s to 1990s in the Oyashio Water, we observed a sign of alteration of physical, chemical and biological environments of the water column in the western subarctic North Pacific. Salinity, phosphate concentration and apparent oxygen utilization (AOU) in winter subsurface layer linearly increased for the 30 years. At the same time, salinity and phosphate of winter surface mixed layer decreased. Increase of density gradient between the surface and subsurface suggested that upper water column stratification be intensified to retard vertical water exchange during the period. Net community production, which was estimated from the phosphate consumption from February through August, also declined. Average springtime diatom abundance (cell number) decreased one order of magnitude while that of wintertime more than doubled during the 30 years, consistent with the multi-decadal decreasing trend of net community production. Nevertheless, no negative influence was observed in secondary production. Average maturity stages in spring increased in *Neocalanus cristatus* and *N. flemingeri*, and spring occurrence of *N. plumchrus* increased after the 80s. Our results suggested that attenuation of winter vertical water mixing limited nutrient supply to the level decreasing winter-summer net community production for these 3 decades. With the fact of doubled wintertime diatom abundance, it is speculated that earlier stabilization of the mixed layer might have enhanced phytoplankton production in winter. This condition might have allowed zooplankton to effectively utilize phytoplankton from earlier timing, resulting in the apparent early maturation.

11AM2002 S11-197 Poster

RESPONSE OF SEA TEMPERATURE IN FISHING GROUNDS TO WIND DRIVEN CURRENT INDUCED BY WIND IN THE MOUNTAINOUS COASTAL SEA

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Numerical simulation on marine wind and sea surface elevation was carried out using both three-dimensional hydrostatic and non-hydrostatic numerical models and a simple oceanic model from 0900 LST, August 13 to 0900 LST, August 15, 1995. As daytime easterly meso-scale sea-breeze from the eastern sea penetrates Kangnung city in the center part as basin and goes up along the slope of Mt. Taegulyang in the west, it confronts synoptic-scale westerly wind blowing over the top of the mountain at the mid of the eastern slope and then the resultant wind produces an upper level westerly return flow toward the East Sea. In a narrow band of weak surface wind within

10km of the coastal sea, wind stress is generally small, less than $1x10^{-2}$ Pa and it reaches 2×10^{-2} Pa to the 35km. Positive wind stress curl of 15×10^{-5} Pa m^{-1} still exists in the same band and corresponds to the ascent of 70cm from the sea level. This is due to the generation of northerly wind driven current with a speed of 11cm/s along the coast under the influence of south-easterly wind and makes an intrusion of warm waters from the southern sea into the northern coast, such as the East Korea Warm Current. Warm waters along the coast near Kangnung coastal sea induce the migration of warm water-fish tribes like squid from the South Sea of Korea.

On the other hand, even if nighttime downslope windstorm of 14m/s associated with both mountain wind and land-breeze produces the development of internal gravity waves with a hydraulic jump motion of air near the coastal inland surface, the surface wind in the coastal sea is relatively moderate south-westerly wind, resulting in moderate wind stress. Negative wind stress curl in the coast causes the subsidence of the sea surface of 15cm along the coast and south-westerly coastal surface wind drives alongshore south-easterly wind driven current, opposite to the daytime one. Then, it causes the intrusion of cold waters like the North Korea Cold Current in the northern coastal sea into the narrow band of the southern coastal sea. Cold waters following the narrow band of the coastal sea can also induce the migration of cold water species like the Alaska pollock. However, the band of positive wind stress curl at the distance of 30km away from the coast toward further offshore area can also cause the uprising of sea waters and the intrusion of warm waters from the southern sea toward the northern sea (northerly wind driven current), resulting in a counter-clockwise wind driven current. This counter-clockwise current induces the East Korea Warm Current toward north and then its further clockwise motion toward the open sea results in meandering of the wind driven current. Thus, wind driven current induced by windstorm under the orographic effects over coastal complex terrain and can make much change of sea surface temperature, which should give a great influence upon biological environmental system, such as fishing ground. Response of sea water temperature to wind driven current induced by wind was confirm by the comparison with GMS satellite pictures to model results.

11AM2002 S11-284 Poster

SEASONAL DISTRIBUTION OF NET PLANKTON IN THE SOUTHERN PART OF THE OKHOTSK SEA AND THE KURIL REGION OF THE PACIFIC OCEAN

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Phytoplankton and zooplankton biomass distribution over vast area off Kuril Islands (41-52°N, 144-159°E) is considered on the data of Jeday planktonic net tows from the layer 200-0 m or bottom-0 m (at shallows) collected in 1984-1997. Species and quantitative composition of the plankton was very changeable during a year. The following biological seasons are determined: winter (December–March), spring (April-June), summer (July–early September), and autumn (middle September-November). Phytoplankton vegetation proceeds about 8 months. Distribution of the phytoplankton biomass in winter and autumn periods is similar with rather low values (< 20 mg/m^3) predominating. In spring and summer the phytoplankton concentration is much higher with blooming (biomass > 1000 mg/m^3), in certain areas caused basically by diatoms. In summer, the average biomass of phytoplankton is identical (220 mg/m^3) on both sides of Kuril Islands. Phytoplankton concentration increases toward the Islands.

In spring and summer, the zooplankton abundance grows due to seasonal migration of bathypelagic species to upper layers, copepods reproduction, meroplankton appearance, and warm-water species transportation by warm currents. That is why the zooplankton biomass reaches its maximum (>1000 mg/m^3). In autumn and winter, the total zooplankton abundance is in 1.5-2 times less than in summer. Distribution of plankton in these seasons is a mosaic, with the range of biomass about 200-1000 mg/m^3. Concentration of large–size zooplankton is low because of seasonal sinking and grazing by predators. The southern part of the Okhotsk Sea has more abundant zooplankton, in comparison with the oceanic side of Kuril Islands, all the year round.

11AM2002 S11-201 Poster

THE INFLUENCE OF COASTAL ORIGIN EDDIES ON OCEANIC PLANKTON DISTRIBUTIONS IN THE EASTERN GULF OF ALASKA

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Mesoscale anticyclonic eddies that form along the eastern continental margin of the Gulf of Alaska in winter transport large quantities of coastal water to the open ocean. The Continuous Plankton Recorder (CPR) sampled repeated transects that passed close to, or through these eddies in 2000 and 2001. Neritic and shelf species of diatoms and calanoid copepods were recorded on CPR samples within, or in close proximity to eddies, and they persisted through the sampling period. Several oceanic taxa also showed an association with the eddies. Significantly reduced occurrences of shelf taxa on oceanic samples were seen in 2001 which coincided with a weaker eddy than observed in 2000. Images of ocean temperature and chlorophyll-*a*, prepared from satellite observations, reveal changes in offshore transport mechanisms by eddies between winter and spring, and between southern and northern eddies in this region. These effects may explain some of the seasonal and geographical variability in the CPR samples.

11AM2002 S11-198 Poster

SUMMER TROPHIC CONDITIONS IN THE SOUTHERN CALIFORNIA CURRENT

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Samples of particulate matter were collected by filtering water at 0, 20, 50 and 100m, during the IMECOCAL cruise of August 1999. Seston, total protein and total carbohydrates were studied, and were compared with zooplankton displaced-volume in the area, obtained with tows of a Bongo net (333μm). At the same stations, hydrographic data was obtained with a CTD.

Frontal areas were found in front of San Quintin and Punta Canoas, which were coincident with higher values of seston, the same coincidence was found in the area of Punta Eugenia and south of Punta Eugenia. In general these high values were present in the first 50m, with a considerable decline in deeper waters. The same trend was found for Particulate Organic Matter (POM), in this case protein +carbohydrates. No significant correlation was found between POM and zooplankton displaced-volume. Proteins and carbohydrates showed the same trend, high values associated with frontal areas. Significant differences were found among the four studied depths for: Protein, carbohydrates and POM.

A multiple linear regression between zooplankton displaced volume and POM for all four depths was performed; assuming that most zooplankters are vertical migrators, that all available particles are utilized by zooplankton and that the nutritional value of the particles is given by its biochemical composition. In this manner, the regression integrates the euphotic zone. A significant multiple linear regression was obtained between POM at the four depths and zooplankton displaced volume (r^2=0.399 n=46, P>0.05). Hydrography is currently studied to obtain a better separation of hydrographically different areas, which produced better results for other areas.

11AM2002 S11-204 Poster

TROPHIC CONDITIONS IN THE GULF OF TEHUANTEPEC DURING WIND FORCING

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Zooplankton and particulate matter samples were obtained to study the trophic conditions of the area in relation to hydrography. Protein carbohydrates and lipids of the particulate matter were studied, as well as the biochemical composition of euphausiids.

During winter, strong winds arriving from the Gulf of México, through a depression in the Tehuantepec Isthmus, arrive to the Gulf of Tehuantepec. Ekman transport and pumping raises the thermocline in the east and lower it in the west. In the center, strong vertical mixing brings cool, nutrient-rich waters to the surface. During our winter sampling, three sectors were separated following the hydrography of the area: east, center and west. Zooplankton biomass was higher in the central stations but there was not a significant difference between sectors. The western sector showed the higher POM, but no significant differences were found among the three sectors. Similarly, protein, carbohydrates and lipids did not show significant differences. A significant regression was obtained between lipids in krill and lipids in POM, and between lipids in euphausiids and POM. A separation of stations in time did show differences in biomass, a higher mean biomass was found in the stations sampled after a strong wind event, just before sampling started, than during a moderate wind event during our last two weeks of sampling in the area, showing significant differences, also, a significant difference was found among the two different periods of sampling, for the lipid content in euphausiids. These results show a response of the populations to wind forcing.

11AM2002 S11-203 Poster
SEASONAL ABUNDANCE OF *Acartia clausi* AND *Paracalanus parvus* (COPEPODA:CALANOIDA) IN RELATION TO HYDROGRAPHY IN A SUBTROPICAL LAGOON OF MEXICO

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Acartia clausi and *Paracalanus aculeatus* are important copepod species in Bahia Magdalena along the year, mostly by their high abundance, constant occurrence, and high rate egg production. *A. clausi* was more abundant than *P. parvus*, despite both occurring at similar SST intervals. This is related to the seasonal variability of the field wind, and blooms associated with turbulence that influencing the phytoplankton production. *A. clausi* was more abundant during summer-autumn, and *P. parvus* during winter-spring. There were seasonal consistency trend of both species abundance in relation to SST, chlorophyll *a*, and salinity.

11AM2002 S11-206 Poster
EFFECTS OF LONG-TERM AND TEMPORAL CLIMATE CHANGES ON THE POPULATION DYNAMICS AND LIFE HISTORY OF PACIFIC SALMON

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We investigated survival rate, somatic growth, and feeding ecology of Pacific salmon (*Oncorhynchus* spp.) in relation to the long-term climate change and the ENSO event. The relationship between the Aleutian Low Pressure Index (ALPI) in 11-year time lag and the survival rate of Hokkaido chum salmon (*O. keta*) population significantly indicated a positive correlation. The growth analysis back-calculated from scales showed that the population size negatively correlated with the individual growth after the second year in the Hokkaido chum salmon population. Results on carbon and nitrogen stable isotope and stomach content analyses reveals that the feeding ecology of Pacific salmon in the Gulf of Alaska was influenced by the ENSO (El Niño and La Niña events). These facts suggest that the long-term climate change (ALPI) and the temporal climate event (ENSO) will affect the population dynamics and the life history pattern of Pacific salmon, respectively. The population density-dependent effect may also be a factor affecting the somatic growth in the Pacific salmon.

11AM2002 S11-224 Poster

SELF-REGULATION OF JAPAN CHUM SALMON ABUNDANCE

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The rise in abundance of Japanese chum salmon in the first half of the 1990s resulted in appearance of density mechanisms. With the increase of abundance of Japanese chum salmon, their average size and weight decreased but the average age increased. The abundance of chum salmon in 1994-1996 apparently exceeded the carrying capacity of the North Pacific. Chums started to use the low-calorie food –gelatinous zooplankton. Their organisms did not receive the enough proteins that resulted in degeneration of muscles in many individuals. We found the maximum number of anomalous chums in 1996. They were mainly the immature fish, which should return for spawning in 1997-1998. We supposed that the abundance of Japanese chum salmon would begin to decline since 1997. That was a real situation with changes in chum salmon abundance. To study the mechanisms of abundance regulation we conducted the biochemical investigations of muscles, liver and gonads of females of normal and flabby chum. The contents of water, proteins, lipids, carbohydrates and nuclein acids were different that was indicative of change in the metabolism. This change obviously allows the flabby females to form oocytes, which have a good content of proteins and lipids, but reduced level of RNA as compared to the standard level. This indicates on a low condition of sexual products for flabby females. This resulted in a bad generation, which caused an increased death at the early stages of marine life period and a decreased in population abundance. Really, the returns of Japanese chum salmon gradually decreased despite the level of their release from the farms did not change over the last decades.

11AM2002 S11-128 Poster

TOWARDS AND ECOSYSTEM STATUS REPORT FOR THE GULF OF CALIFORNIA

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Several physical and biological evidences indicate a major change in the North Pacific environment since the late 1990s. The magnitude and consequences of this interdecadal change is still a matter of debate, and it is likely that a comprehensive picture could only result from the comparison of several regions and variables within the basin. PICES community is currently developing a North Pacific Ecosystem Status Reports based on 12 regions covering most of the PICES region, the Gulf of California not included. We believe that having information on such an important and special region will provide many elements to the proper basin scale vision; it is one of the only two inner seas in the north pacific, is located at the temperate-tropical transition of the eastern north Pacific, hosts important primary production, fisheries (including the two most important for Mexico in term of biomass and value, sardine and shrimp), marine birds and mammals. In this report we show biological evidences of a recent environmental change in the Gulf, specially those related to the catch composition of small pelagics, and we found indications of major changes in other components of the ecosystem (p.e. phyto and zooplankton, predators, etc.). Such changes seem to be undetected by physical parameters (temperature gradients, column water properties, winds, etc.) probably because data are not available or generated at all, and no systematic monitoring nor adequate organization efforts are taking place. We conclude by providing a strategic plan to develop the Gulf of California ERS in the future and an invitation to all interested contributors.

11AM2002 S11-322 Poster

EFFECTS OF THE INTERANNUAL AND LONG TEMPORAL VARIABILITY, IN THE BROWN SHRIMP FISHERY IN THE GULF OF CALIFORNIA, MEXICO

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It is recognized the fact that the fisheries based on the penaeids crustaceans present a high interannual variability in the catch, and diverse causes of that variation have been suggested. In this work, we explore the effect that the

interannual variation of the environment cause in key population parameters of the organisms with a short life cycle, using as reference the brown shrimp *Farfantepenaeus californiensis* of the eastern coast of the Gulf of California, and the effect that events of long spatial scale, as El Niño and La Niña, exercise on these processes. We worked with catch and biological databases for 1962-2002 period. The abundance, recruitment and individual growth time series showed that the brown shrimp population follows a long term trend and that El Niño and La Niña events induced changes in the individual growth coefficient, the recruitment (magnitude and pattern), the first age maturity and shift in reproductive period, works as a positive or negative feedback. All this changes can have important repercussions in the shrimp catches and in the regional economy, and they should be considered in the management proposal.

11AM2002 S11-202 Poster
THE INFLUENCE OF MESOSCALE EDDIES ON BIOPHYSICAL EXCHANGES ACROSS THE SHELF BREAK IN THE ALEUTIANS AND BERING SEA

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A regional, coupled ice-ocean model is used to study oceanic mass and property exchanges, including nutrient pathways from the Gulf of Alaska into the Bering Sea and further to the north and to investigate how the mesoscale eddy field influences these pathways. The model domain is configured at 9-km and 45-level grid and extends from ~30°N in the North Pacific across the Bering Sea, the Arctic Ocean, to ~45°N in the North Atlantic. This approach yields realistic predictions of the net northward transport through Bering Strait and consequently the oceanic circulation upstream in the Bering Sea and the Gulf of Alaska. Results for 1979-1999 are analyzed from the model integration forced with realistic daily atmospheric fields from the European Centre for Medium-range Weather Forecast (ECMWF) reanalysis and operational data. TOPEX altimeter measurements of sea surface height anomalies for 1993-1999 are used for validation of the model mesoscale eddy field. Two shelf-slope regions are chosen for model-data analyses: (i) the central Bering Sea and (ii) the eastern Aleutians/Alaska Peninsula. A wide shelf characterizes the former region whereas a narrow shelf characterizes the latter. Mesoscale eddies are found to strongly influence the position and strength of along-slope fronts and across-slope biophysical property transfers. Anticyclonic eddies displace the surface expression of the shelf break front seaward and promote compensatory onshore transport of oceanic water and properties within the bottom layer. Temporal and spatial eddy statistics are determined from the 20-year model integration, and these are compared against the available altimeter observations.

11AM2002 S11-280 Poster
THE INFLUENCE OF CLIMATE CHANGES ON THE ECOSYSTEM CARRYING CAPACITY IN KURIL LAKE

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Kuril Lake is nursery and feeding lake for largest sockeye salmon (*Oncorhynchus nerka* Walbaum) stock in Asia. Forage base condition depends on crustacean production, regulated by water temperature, and elimination, depending on the abundance of feeding juvenile. Smolt weight has been determined by food supply and active feeding seasonal duration. The tendency of average annual air temperature and precipitation volume increase has been revealed from 1980 to 2000. Since second half of 1980s average annual water temperature in the lake has decreased due to the absence of winter ice covering and wind cooling. For the first half of 1980s crustacean production has been higher than elimination. For the second half of 1980s crustacean productivity has been largest due to high water temperature. The elimination has been more than production during this period because abundance juvenile has been increased. For the first half of 1990s the most unfavourable changes occurred. Water temperature decrease and maximum abundance juvenile existed, as a result of the forage base depression have been observed. In the second half of 1990s the juvenile abundance was low, but lowest water temperature has been determinative factor, preventing forage base restoration. In general the trends of food supply and of smolt weight

demonstrate monodirectional character. The climate warming generated water temperature decline and carrying capacity decrease in Kuril Lake.

11AM2002 S11-321 Poster

EFFECTS OF INTERANNUAL ENVIRONMENTAL VARIABILITY ON THE JUMBO SQUID (*Dosidicus gigas*) FISHERY OF THE GULF OF CALIFORNIA

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The fishery of the jumbo squid *Dosidicus gigas* developed in the Gulf of California and occasionally in the western coast of the peninsula of Baja California, Mexico. The great abundance of the squid that was presented during 1994 in the region, motivated the development of the fishery that has shown as characteristic feature a high interannual variability in the catches. Unfortunately, it is also a resource that presents periods of greatly decreased catches. These variations are likely related to changes in the marine environment of the Gulf, and particularly those determined by El Niño events. The examination of such effects is further complicated for periods when catches are the only information available, since often catches are not related to the abundance of a population. However, in the last seven years detailed capture data and effort have been gathering, and we have made several prospecting cruises with the objective of obtaining estimates of abundance and distribution of the jumbo squid in the Gulf of California. The results (between May 1996 to May 1999) show significant variations in the biomass estimates, with a maximum value of biomass in 1996 and diminishing during 1997 and 1998. The population showed a recovery of the biomass during 1999. The same occurred with the distribution of the squid. Correlation analyses indicated a relationship ($r = 0.9$) to catches registered in Guaymas, one of the main locations for this fishery, and biomass estimates. In turn, the squid biomass was found to by closely related ($r = 0.9$) to the catches of small pelagic fishes, which in this region are the main prey for squid. Finally, a weak relation ($r = -0.27$) was found between the biomass squid and the anomalies of sea surface temperature. Based in this results, we propose that the fluctuations in the catch of jumbo squid are due to physical and biological changes in the habitat of the jumbo squid, particularly in terms of its prey, which in turn promote changes in the distribution and abundance of squid that ultimately affect their availability to the fishing fleet.

11AM2002 S11-281 Poster

PROCESSES OF IRON LIMITATION IN THE SUBARCTIC NW PACIFIC – HIGHER PARTICULATE IRON CONCENTRATION THAN THAT IN THE SUBARCTIC NE PACIFIC

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In the subarctic North Pacific, a meso-scale *in situ* iron enrichment experiment, SEEDS (Subarctic Pacific Iron Experiment for Ecosystem Dynamics Study), clearly demonstrated that iron is an important factor controlling the phytoplankton growth. Although previous studies reported that the subarctic North Pacific has strong longitudinal gradients in the flux of atmospheric iron deposition from west to east, there is little information available on the differences in iron concentration in seawater between the western and eastern subarctic North Pacific.

Here we report evidence for higher iron concentration in the western subarctic North Pacific than the eastern part and propose the processes of phytoplankton iron limitation in the western region even with the higher iron supply. Comparison of vertical size-fractionated iron profiles as background conditions between the western and the eastern regions clearly indicated higher labile particulate iron concentration in the western surface mixed layer and this result strongly supports the higher iron supply. Additionally, the results of the SEEDS experiment clearly showed

that artificially enriched iron in the dissolved fraction (mainly in colloidal fraction) was rapidly transformed to suspended labile particulate iron during phytoplankton growth and was retained in the surface layer. Probably, this rapid transformation process may occur in natural after sporadic iron supply and labile particulate iron is retained in the western region. Furthermore, this transformation process reduces dissolved iron concentration and its bioavailability. Therefore, the transformation process is a key how phytoplankton become iron limited and understanding the biogeochemical iron cycle in the western subarctic North Pacific.

11AM2002 S11-208 Poster
A THREE DIMENSIONAL ECOSYSTEM- PHYSICAL MODEL INCLUDING SEA ICE EFFECT IN THE SEA OF OKHOTSK

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A three dimensional ecosystem- physical coupled model including sea ice effect in the Sea of Okhotsk is constructed. NEMURO is used as an ecosystem model and MOM is used as a physical model. Thickness of sea ice is estimated from satellite data. The model was run through winter and spring in 1997 (the year with small ice-covered area) and in 2001 (the year with large ice-covered area). We parameterize the relationship between nutrient supply and the thickness of sea ice and discuss the effect of the sea ice on the spring bloom in the Sea of Okhotsk.

11AM2002 S11-278 Poster
INTERANNUAL VARIABILITY IN THE DISTRIBUTION OF SPAWNING PACIFIC COD IN ALASKA: THE INFLUENCE OF OCEAN TEMPERATURE

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Pacific cod (*Gadus macrocephalus*) are an important ecological and economic resource on both sides of the North Pacific Ocean. In Alaskan waters, Pacific cod are the target of a valuable commercial fishery, are major predators of fish and crustacean species and serve as prey for other fish and marine mammals. In the winter cod migrate, sometimes over long distances, to gather in large spawning aggregations. Factors that influence the timing, size, and location of these aggregations have important implications for cod ecology, the marine ecosystem, and commercial fishing activities, yet are not well understood. Some evidence exists to suggest that the distribution of cod during the spawning season is related to ocean temperatures. As a first step in describing the degree of variability in cod spawning distribution and the nature of that variability, we are conducting a retrospective analysis of commercial cod fishery catch-per-unit-effort (CPUE) in the Gulf of Alaska and eastern Bering Sea. The U.S. National Marine Fisheries Service Groundfish Observer program collects data on amounts and locations of commercial catch in Alaskan fisheries. These data are being used to construct yearly maps of relative cod fishery CPUE as a proxy for estimating centers of spawning aggregation. In addition, temperature data from research cruises and permanent moorings are being used to construct an index of winter bottom temperatures throughout the region on an annual basis. By combining these two datasets, we are exploring the connection between changes in ocean temperature and changes in cod spawning distribution.

11AM2002 S11-199 Poster

VARIATION IN ZOOPLANKTON ASSEMBLAGES IN THE ASAN BAY, KOREA DURING THE LAST DECADE

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Variation in zooplankton assemblages during the last decade was studied in the Asan Bay where many dykes were constructed. Total zooplankton abundance was the highest in spring and more abundant at inner bay area while the number of taxa living in this bay was the greatest in summer and more at outer part of the bay. The former showed marked decrease since 1998 while the latter showed opposite trend. After the construction of the Seokmoon dyke, one of the biggest dykes in this bay and most recently constructed one (in 1991), the number of living taxa in this bay decreased till 1997, and then recovered thereafter. However, total abundance showed a different trend. It decreased for two years, increased for next 4 years, and then decreased again thereafter. The patterns of annual variations in these two variates resulted in a sine curve pattern of the annual means of species diversities. From these results the followings were summarized and postulated; 1) dyke construction caused the reduction of both abundance and kinds of zooplankton for next two years, 2) for the following next four years, the kinds of zooplankton were still at poor level while the total zooplankton abundance was increased due to the opportunistic increase of the most abundant taxon *Acartia bifilosa*, 3) thereafter, the number of living taxa increased contrary to the decreased total abundance, 4) the forcing factor for the found annual pattern of zooplankton assemblages was believed to be the decreased food (phytoplankton) concentration due to the increased suspended substances caused by the strengthened flow field of seawater that was resulted by dyke construction.

11AM2002 S11-345 Poster

PICES NORTH PACIFIC ECOSYSTEM STATUS REPORT: AN UPDATE

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At its 10th Annual Meeting (2001) PICES resolved to develop a report on the marine ecosystems of the North Pacific Ocean. This report, which is to be prepared periodically but updated regularly, would identify: factors driving changes in the ecosystems of the North Pacific Ocean; the current status and recent trends of a number of characteristics of these ecosystems; and issues such as gaps in knowledge and data, significant concerns, *etc.* With the incorporation of models, it is expected to also include a look forward at potential future trends and concerns. This poster presents an outline of a pilot Ecosystem Status Report, which develops sample chapters for selected ecosystems in the eastern and western North Pacific. These chapters provide sections on background, factors driving change in that system; current status and recent trends of a variety of physical, chemical, and biological "themes"; identifies issues of understanding and concern; and recommends sources for more information. The main purpose of this draft report (http://www.pices.int/projects/projects.asp) is to crystallise the current format of the report, its component parts, and problems relating to flows of data and information. This report will also ultimately provide material for the joint PICES - Census of Marine Life project on "Marine Life in the North Pacific Ocean: the Known, Unknown, and Unknowable". Feedback from PICES (and other) scientists on the North Pacific Ecosystem Status Report is invited.

11AM2002 S11-209 Poster

MODELLING OF PROCESSES OF BIOTRANSFORMATION OF ORGANOGENIC SUBSTANCES IN THE LA PEROUSE (SOYA) STRAIT

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A hydroecological simulation model was applied for the study of transformation features of compounds of biogenic elements (N, P, Si, C) and transport of organic and mineral fractions of specified elements on a water area of the La

Perouse Strait. This model allowed us to calculate variations of substance concentrations and to study the conditions of transformation of dissolved organic and mineral components transformations (compounds of N, P and Si, dissolved organic C, suspended components (detritus and biomasses of hydrobiontes - heterotrophic bacteria, phyto- and zooplankton), as well as to evaluate internal substance fluxes, including transport of various substances by water masses. Long-term mean values of parameters of marine water environment were used as input data for the simulation model run. These parameters were estimated with the help of the electronic atlas of oceanographic data for the shelf zone of the Sakhalin Island. Whole water area of the La Perouse Strait was subdivided into four basins taking into account the hydrological and hydrochemical features of this water area and with a goal of determination of substance sizes and fluxes inside of the studied region and assessment of bioproductivity potential for separate trophic levels.

The simulation results show that the values of biomasses and their ratio considerably vary on seasons. It is connected primarily to the conditions of the input as biogenic substances as biomasses between separate water areas. Average ratio of production values (in nitrogen units) of bacteria, phyto- and zooplankton is 23.3 : 11.2 : 1. The least values are marked in the Aniva Bay and heaviest - in regions of intensive substance transport by the water masses. In total annual production of a phytoplankton the diatom contribution on different water areas prevails and makes 92-99% in the nitrogen units. Thus, the values of bioproductivity in dynamically active regions in a greater degree are determined by hydrological conditions (among which on the studied marine area the water exchange is dominated), than by intrawater body processes connected with internal circulation of biogenic substances. Waters of the West Sakhalin Current are richer on the content of mineral biogenic substances, and water of the Soya Current are richer on organic fractions. The heaviest concentration of biogenic substances characterize waters of East Sakhalin Current which are the basis of formation bioproduction for the Aniva Bay.

11AM2002 S11-200 Poster

A VERSION OF NEMURO INCLUDING C, N AND P CYCLES APPLIED TO STATION ALOHA: IMPACT OF THE MICROBIAL LOOP ON ORGANIC MATTER STOICHIOMETRIES AND CARBON EXPORT

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We have applied a one dimensional physical-biological model to simulate the production, recycling and export of organic matter at Station ALOHA, Hawaii. Our ecosystem model is a modified version of the NEMURO formulation developed by PICES, coupled to a one dimensional physical model. The major additions to the model are the Microbial Food Web (MFW), carbon and phosphorous cycles, and variable stoichiometries. The model assumes that the stoichiometries of all living organisms are constant (although differing significantly by the type of organism) and allows for variable stoichiometries for all non-living organic matter. We also include nitrogen fixation based on Fennel et al's [2002] model for Stn. ALOHA.

We compare our simulations to data from the Hawaii Ocean Time-series (HOT) for nutrients, DOM, particulate nitrogen, particulate organic matter (POM) fluxes, and primary production. By employing differential rates for the remineralization of C:N:P in DOM and POM, the model can simulate the observed mean stoichiometry of POM in traps at 150 meters depth and some of the observed variations with depth in the stoichiometry of DOM. We demonstrate how tuning the MFW formulation impacts the simulated export of POC by changing the amount and stoichiometry of POM. Where the model does poorly is in its inability to simulate the observed primary productivity (mean of 490 mg C m^{-2} d^{-1}). We present what may be a partial solution to this problem that centers on high uptake ratios of C:N by phytoplankton and especially diazotrophs. Even this, however, only allows the model to simulate about half of the measured primary production. We discuss reasons for this, including that the measurements may represent something closer to gross than net primary production, and uncertainties in measured fluxes of POM.

11AM2002 S11-316 Poster

ASSESSING LONG-TERM CHANGES IN EARLY SUMMER ZOOPLANKTON COMMUNITY CONSTRUCTION OF THE PEARL RIVER ESTUARY

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A summary of the early summer survey zooplankton data for June or July is presented for the years 1981-1996. Along with time-series information on sea surface temperature, we review the regional characteristics of zooplankton populations from distinct areas of the Pearl River Estuary and update the observations of dominant changes that have occurred during the past two decades. During the period presented (1981-1997), the Pearl River Estuary ecosystem has undergone very large changes in abundance of different zooplankton species. The midsummer abundance of *Temora turbinata*, which originally is advected into the estuary from the open ocean, fluctuated from 26 ind.m^{-3} copepods in 1981 to 1 ind.m^{-3} copepods in 1996, and at the same time the neritic zooplankton *Acartia spinicauda* increased from 104 ind.m^{-3}, accounting for 30% of total abundance in 1981 to 324 ind.m^{-3} for 43% in 1993. Long-term displaced volumes of zooplankton remained fairly stable although there were pronounced short-term fluctuations. Comparison of the zooplankton abundance 345 recorded in 1981 with that recorded in the past indicates that, in this estuary, the abundance and relative biomass of the species in 1996 have been the lowest ever recorded. Compared with the previous data, the biodiversity index H' declined. Over a seven-year period, abundance of most zooplankton genera was positively correlated with chlorophyll a concentrations and temperature. All zooplankton groups showed a long-term abundance decline from 1981 to 1996.

11AM2002 S11-298 Poster

A 3-D COUPLED PHYSICAL-BIOLOGICAL MODEL AND ITS APPLICATION TO THE SPRING PLANKTON BLOOM OF 1996 IN PRINCE WILLIAM SOUND, ALASKA

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A 3-D coupled biological-physical model of Prince William Sound (PWS) was developed to simulate the spring plankton bloom. The physical model is based on an existing 3-D circulation model developed from the SEA (Sound Ecosystem Assessment) project under forcing of monthly heat flux, freshwater discharge of a line source, daily wind, Alaska Coastal Current (ACC) inflow/outflow and tide. The biological model consists of four compartments: 1) (dissolved organic nitrogen + nitrite) DIN, 2) (phytoplankton) P, 3) (zooplankton) Z, and 4) (detritus) D. A mixed layer model is introduced to calculate vertical mixing caused by wind stirring and surface cooling.

The spring plankton bloom in 1996 was simulated using this coupled model. The model exhibited a spring plankton bloom, which is a feature of a steadily repeating annual cycle of phytoplankton population. The spring phytoplankton bloom starting and ending time and its magnitude compared well with field observations at several layers from 0 m to 50 m at a Station AFK in the sound. In the western sound, the bloom occurred earlier, but was less intensive, and the bloom depth was shallower than in the east. In the central, and eastern sound and Montague Strait, the plankton blooms occurred following the bloom in the western sound, but stronger and deeper. Thus, the phytoplankton bloom lasted longer. There was a shallower but higher phytoplankton concentration core related to an anticyclonic gyre in the eastern sound at the beginning of the bloom, and disappeared later as circulation changed.

11AM2002 S11-277 Poster

VARIATIONS OF NUTRIENTS AND CARBON DUE TO REGIME SHIFT IN SUBARCTIC NE PACIFIC

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Time series at Station P (50°N, 145°W) and along Line P (Fig.1) showed long-term changes of 8 oceanographic and chemical parameters-- sea surface temperature, salinity, oxygen, phosphate (PO_4), silicate (SiO_4), nitrate (NO_3), total carbon dioxide (TCO_2) and apparent oxygen utilisation (AOU). These parameters were affected by climate regime shifts. There were "step" changes of anomaly for nutrients and carbon in the subarctic Pacific in 1976 and 1989. The response of nutrient and carbon to regime shift was more prominent in 1976 than in 1989. The anomalies of salinity, PO_4, SiO_4, NO_3, oxygen and TCO_2 were positive during 1950-76 but became negative during 1976-96. The changes through the 1976 regime shift was significant (marked sign change), but the variations of the nutrients and carbon in 1989 were weak, barely showing small magnitude changes.

The effect of La Niña on nutrients and carbon exceeded that of El Niño in the subarctic NE Pacific. The variation in characteristics of nutrients and carbon increased progressively reaching a peak value after several El Niño events. The stronger La Niña events (1975 and 1989) caused sudden decrease in nutrients and carbon. Two possible regime shifts (1976 and 1990) occurred after the strong La Niña events in 1975 and 1989, as deduced from the atmospheric pressure and wind variations. Upwelling also plays an important role in causing variations in the carbon and nutrients, especially in coastal waters.

11AM2002 S11-283 Poster

SPATIAL AND RECRUITMENT PATTERNS OF EASTERN BERING SEA CRABS IN RELATION TO DECADAL OCEANOGRAPHIC VARIABILITY

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Red king (*Paralithodes camtschaticus*), Tanner (*Chionoecetes bairdi*) and snow crabs (*C. opilio*) are broadly distributed in the eastern Bering Sea and support important invertebrate fisheries in Alaska. During the last three decades, population abundances of these three stocks fluctuated greatly, driven by highly variable recruitments. In this study, we used the summer trawl survey data collected by the National Marine Fisheries Service to examine the spatial dynamics and recruitment patterns of these three stocks. Centers of distribution of mature females have shifted from southern Bristol Bay in the 1970s to the center and northern Bristol Bay in the 1980s and 1990s for red king crab, occurred more westward during the early 1980s than during the other periods for Tanner crab and have gradually moved to the northwest over time since the late 1970s for snow crab. Recruitment to these three stocks is periodic and strongly auto correlated. Red king crab recruitment trends were consistent with patterns of decadal climate shifts, periods of strong winter Aleutian Lows coinciding with periods of weak recruitment. Tanner crab recruitment shows decadal cycles with 13-14-year periodicity. Periods with strong and weak snow crab recruitments alternated every few years. We then mapped the temporal and spatial patterns of these three stocks with sea bottom temperatures and sea ice extent to examine relationships between changes in spatial distributions and environmental conditions. The implications of spatial distribution changes on crab recruitment success are discussed.

S12 TCODE Electronic Poster Session
Data systems to support technological advances in observation systems

Co-Convenors: Allen Macklin (U.S.A.), Igor I. Shevchenko (Russia) & Ling Tong (China)
Wednesday, October 23, 2002 17:30-20:30

This session demonstrates data systems that support technological advances in observing systems for marine scientific research. Electronic poster displays will focus on innovative data acquisition systems, web pages, databases and tools for data analysis and visualization. The goal of this electronic poster session is to improve awareness of new data sources and systems that work with new technologies to advance scientific activities conducted by PICES researchers.

Norio Baba
Data online service system at Japan Oceanographic Data Center through the Internet (S12-146)

Andrew V. Golik, Vitaliy K. Fishchenko
Development of geographic information system of Pacific Oceanological Institute of northwestern Pacific based on internet/intranet (S12-147)

Gabriel Gorsky, Philippe Grosjean, Marc Picheral, Caroline Warembourg
New methods for treatment of net samples and for underwater imaging of zooplankton (S12-148)

S. Allen Macklin
Planning a North Pacific Ocean observational array (S12-306)

Ron McLaren, Brian O'Donnell
The North Pacific Data Buoy Advisory Panel: An initiative of PICES and The Data Buoy Co-operation Panel (S12-304)

Nazila Merati, Tiffany C. Vance, Jason Fabritz, Mick Spillane, Jon Callahan, Don Denbo
Integrating oceanographic data into GIS – working with both *in situ* and gridded data (S12-320)

Georgiy Moiseenko
Monitoring of annual catch spatial distributions using GIS (S12-149)

Sachiko Oguma, Toru Suzuki
A construction of data inventory of CO2 related data in the North Pacific (S12-150)

Young Jae Ro, Yang Ho Choi
Web-based realtime monitoring of water quality conditions in the Korean coastal waters (S12-136)

Igor D. Rostov, V.I. Rostov, E.V. Dmitrieva, N.I. Rudykh
Development of a regional segment of the unified system of information on the world ocean state (ESIMO) in Russia (S12-151)

Igor D. Rostov, N.I. Rudykh, V.I. Rostov
Oceanographic atlas of the Bering Sea, Okhotsk Sea and Japan/East Sea. English version of CD-Rom (S12-152)

Vladimir I. Rostov, N.I. Rudykh, I.D. Rostov
Data base of archival observations of currents in the northern Pacific (S12-153)

Margaret E. Sullivan
Comparison of gridded temperature profiles and walleye pollock data from trawl surveys on the Bering Sea Shelf (S12-317)

Tiffany C. Vance, Nazila Merati
Processing and visualization of oceanographic data in 2.5 and 3D- Examples from the Bering Sea, Arctic and west coast of the United States (S12-319)

Ivan Vysotskiy
Website of PICES Technical Committee for data exchange (S12-154)

11AM2002 S12-146 E-poster

DATA ONLINE SERVICE SYSTEM AT JAPAN OCEANOGRAPHIC DATA CENTER THROUGH THE INTERNET

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Japan Oceanographic Data Center improved the JODC Online Data Service System (J-DOSS) in July 2002. J-DOSS was developed in 1994 in order to provide users with data retrieval service from the database system in JODC through the Internet with various keywords, such as location, data type, name of research vessel *etc.* JODC made a big improvement for J-DOSS in July 2002 in order to strengthen user service, for example, 3 million profiles of serial station data from 1984 to present, and 12 million points of ocean current data are provided from the system. The data and related information provided from the system are gathered from various research institutes through the International Oceanographic Data & Information Exchange (IODE) system promoted by IOC/UNESCO.

11AM2002 S12-147 E-poster

DEVELOPMENT OF GEOGRAPHIC INFORMATION SYSTEM OF PACIFIC OCEANOLOGICAL INSTITUTE OF NOTHWESTERN PACIFIC BASED ON INTERNET/INTRANET

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The technique and features of development of GIS based on internet/intranet of nothwestern Pacific and Far Eastern Seas are described. This spatial region is a primary target for investigation at Pacific Oceanological Institute of Far Eastern branch of Russian Academy of Science. This system developed in the Laboratory of complex analysis of oceanological data of POI FEB RAS and trial testing in common with other scientific institutes of FEB RAS. Also specific aspects of the system described in the field of oceanology, oceanography, objective data analysis, visualization of oceanological data, information systems based on internet/intranet (including geoinformation systems), authorized access to data store and services. Creation of integrated GIS that can consolidate activity and results of research work from various branches of oceanological investigations is paid much attention. Development of a mechanism for running complex computational tasks on supercomputers as a part of this system is open subject. In fact, the integral part of this work is careful design of user interface in accordance with modern advances in psychology of user interfaces and abilities.

11AM2002 S12-148 E-poster

NEW METHODS FOR TREATMENT OF NET SAMPLES AND FOR UNDERWATER IMAGING OF ZOOPLANKTON

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Three methods will be presented here.

1) A system for enumeration, measurement and identification of zooplankton from net samples named ZOOSCAN is designed for retrospective data acquisition. Historical or new zooplankton collections may be scanned using this non-destructive method and new databases can be rapidly compiled or existing ones completed.

2) The Underwater Video Profiler is used for *in situ* image acquisition of macroplankton, especially of fragile forms frequently damaged using net sampling. Macroplankton image files are acquired in quasi real time and can be used by expert systems or by specialists for species determination.

3) Creation of virtual holotypes is an important tool for gathering information concerning fragile organisms that may play a significant role in marine ecosystems. Because of their delicate nature, their identification is restricted to a small number of specialists. By the 3D reconstruction of sectioned organisms and wide diffusion of these virtual holotypes on the web we hope to enlarge the expertise and collect new information on insufficiently documented species.

11AM2002 S12-306 E-poster
PLANNING A NORTH PACIFIC OCEAN OBSERVATIONAL ARRAY

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Scientists have shown that ecosystems of the North Pacific Ocean and its marginal seas respond to decadal-scale climate change in measurable ways. The combined climate and ecosystem changes are called regime shifts. We do not fully understand the processes that transfer atmospheric climate changes to the ocean; we understand even less how climate change alters life in the sea; and we do not know how to forecast regime shifts.

Twenty years ago, scientists did not know what caused El Niño, nor could they forecast it. It was only by deploying the equatorial buoy system called the TAO array, and through the ensuing international research effort, that we gained knowledge leading to the first successful El Niño forecast in 1997.

An observational array for the North Pacific Ocean will provide a tool for understanding North Pacific climate changes and their effect on regional ecosystems and the rest of the world. The heart of the array will be a configuration of moored surface and subsurface buoys, each with physical and biological sensors transmitting in real time to a data center for dissemination to researchers. Ancillary information will come from other moorings, Argo floats and satellite-tracked drifters, remote sensing platforms, scheduled and ad hoc cruises and surveys from ships, etc. There are a number of large-scale, long-term, US research programs that would benefit from and could help fund part of the array. Additionally, the array can only be successful if Pacific-wide coverage is possible with the cooperation of other North American and Asian countries.

11AM2002 S12-304 E-poster
THE NORTH PACIFIC DATA BUOY ADVISORY PANEL: AN INITIATIVE OF PICES AND THE DATA BUOY CO-OPERATION PANEL

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Established in 1985, the Data Buoy Co-operation Panel, (DBCP) is an official joint body of the World Meteorological Organization (WMO) and the Intergovernmental Oceanographic Commission (IOC). The Panel consists of representatives of members of the WMO or member states of the IOC interested in participating in its activities. The most important task of the DBCP is to co-ordinate drifting and moored buoy programmes at the international level, with a view to increase the number of buoys deployed and maintain high quality archived and real time oceanic and atmospheric data.

PICES, the North Pacific Marine Science Organization, is an intergovernmental scientific organization that was established and held its first meetings in 1992. Its present members are Canada, People's Republic of China, Japan, Republic of Korea, Russian Federation, and the United States of America. The goals of PICES are to promote and co-ordinate marine research in the northern North Pacific and adjacent seas especially northward of 30 degrees North, advance scientific knowledge about the ocean environment, global weather and climate change, living resources and their ecosystems, and the impacts of human activities and to promote the collection and rapid exchange of scientific information on these issues.

The North Pacific has earned the dubious reputation of being the "Pacific data Void", particularly in the case of real time data availability. With the natural synergy of the goals of the two groups, DBCP and PICES, it seemed a logical step to combine efforts to further the aims of both organizations. The North Pacific Data Buoy Advisory Panel was formed within PICES in the fall of 2001 and the first meeting of the group was held in Victoria, June 5 & 6, 2002. The electronic poster presentation describes the formation of the Panel and the accomplishments over the past year since its inception at PICES X.

11AM2002 S12-320 E-poster

INTEGRATING OCEANOGRAPHIC DATA INTO GIS – WORKING WITH BOTH *IN-SITU* AND GRIDDED DATA

Nazila **Merati**[1], Tiffany C. Vance[2], Jason Fabritz[1], Mick Spillane[1], Jon Callahan[1] and Don Denbo[1]

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Ocean scientists are beginning to incorporate the use of GIS into data visualization, data management and analysis. At NOAA's Pacific Marine Environmental Laboratory (PMEL), software tools have been developed to help scientists select, process and convert their *in-situ* data sets into a GIS-usable format. EPIC is a tool that allows scientist to manage, display and analyze CTD, XBT, time series and bottle data. Access to PMEL's data repository is available via the World Wide Web. The EPIC Web Browser allows users to select data using various search criteria. Once data are selected, users may display the data and download the data for conversion to a GIS format. The conversion of data uses a JAVA application developed at PMEL. Csv2shp allows users to convert .csv files to an ESRI specified shapefile format independently of the ESRI software environment.

Climatologies and other gridded data sets are available for download from PMEL using the Live Access Server. The Live Access Server (LAS) allows users to connect to remote data servers using a seamless web interface. LAS interface allows users to select data by geographic region and by variable type. Data are available for download as either ascii text or ArcView Grid Format to add to ArcView or ArcMap sessions.

Ncbrowse is a software application developed at PMEL that allows users to browse netCDF files, subsetting the data and saving the data to a text file that can be converted to a shapfile. Ncbrowse allows GIS users to explore their data in 1and 2 d space.

In this presentation, we will create a GIS project using tools developed at PMEL and provide links to other research groups working to make oceanographic data accessible to the marine community.

11AM2002 S12-149 E-poster

MONITORING OF ANNUAL CATCH SPATIAL DISTRIBUTIONS USING GIS

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The objective of this work is to create the information system for monitoring of annual catch spatial distributions. The system is based on ArcView 3.2 by ESRI and RDBMS Oracle8i by Oracle. Russian fishing ships daily data from 1995 to 2001 are used to calculate spatial distributions of annual catch for any object of fishing. The Oracle8i database performs all calculations. By joining of two tables – one from ArcView and another from Oracle database – the polygonal themes are created. Their attribute tables contain records with the sum catches for each polygon and object of fishing. Resulting themes visualize the process of spatial evolution of annual catch from year to year. Some examples for the Okhotsk Sea are presented.

11AM2002 S12-150 E-poster

A CONSTRUCTION OF DATA INVENTORY OF CO_2 RELATED DATA IN THE NORTH PACIFIC

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As an interest to the greenhouse gases has increased, oceanic CO_2 observations have been actively done during many projects in the world, and lots of data analyses have suggested air-sea CO_2 exchange in various temporal and spatial scales. There are some difficulties of data exchange, however, not only for CO_2 data but also for other chemical oceanographic data. To share and fully open the data, an effective data management method has become

much important. For more active and free data exchange, a Japanese scientist group has established "Inventory for Chemical Oceanographic Data (IJCD)" since 2000. Main purpose of IJCD is to rescue scattered data in the institutes and to establish the inventory database system in order to encourage the exchange of the data among researchers, who interests in chemical oceanographic research. Another important activity of IJCD is to consult on the development of the data format of the chemical oceanographic data with meta-data, which contains items used for inventory. For efficient collection of data inventory, IJCD cooperates with national and international activities concerned. IJCD data inventory will be public via web site, and will be linked with real data, which can be fully opened.

11AM2002 S12-136 E-poster

WEB-BASED REAL-TIME MONITORING OF WATER QUALITY CONDITIONS IN THE KOREAN COASTAL WATERS

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This study is based on the operational real-time monitoring system for the water quality conditions in Korean coastal waters at two locations. To establish warning system for harmful algal bloom and other emergent episodes for local fishery farming, it is necessary to obtain very detailed information for abrupt change of water quality conditions. To make effective warning messages possible, such information is required on a real-time basis. This study developed a real-time monitoring system of oceanic conditions (current, sea level, salinity, dissolved oxygen, turbidity) in the Chunsu Bay and the Namhae Bay, western and southern coastal waters of Korea, respectively. The system consists of three major sub-systems of data loggers with sensor array in the seawater, to which wireless Internet data terminal such as pda is connected and a host computer is on the remote location. The system produces the database of oceanic conditions with sampling interval of 10 minutes continuously. Real-time monitored data can be browsed on the Internet web pages in terms of text and graphics with query function for the existing database. The display pages contain the time series plot of temperature and other conditions, statistics of data-based parameters, recall of the past parameters, etc. In this study, we will describe seasonal and high frequency variation of temperature as well as other oceanic conditions in terms of descriptive statistical parameters and spectral analyses. Results of multivariate analyses will be given with emphasis of regressing time series of dissolved oxygen to various oceanic processes. In particular, episodes of oxygen depletion in summer season will be highlighted and is attempted to forecast with a stochastic model.

11AM2002 S12-151 E-poster

DEVELOPMENT OF A REGIONAL SEGMENT OF THE UNIFIED SYSTEM OF INFORMATION ON THE WORLD OCEAN STATE (ESIMO) IN RUSSIA

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Considerable progress in sphere of oceanographic data management in Russia has been achieved at the expense of means concentration and efficient coordination of studies developed for the last 3 years in the frame of the Subprogram "Creating a Unified System of Information on the World Ocean State". It represents an important part of the Federal target program "The World Ocean" and is realized by organizations of different Federal Departments under 51 projects. Actually it is most significant National GLOBEC-like Program in the field of data management. In the bounds of the conception for the ESIMO construction, at the POI there has been created a sub-regional segment of the system. Main objectives of the studies are:

1. Formation of the information system fund. Development of the integrated oceanographic database.
2. Development of the special website "Oceanography and Marine Environment of the Far Eastern Region of Russia", located at <www.pacificinfo.ru>.
3. Realization of subject electronic information-reference textbooks and atlases for their distribution on CD-ROM and through Internet.
4. Realization of computing-model block. Construction of complex information-analytical system on marine environment of the Far Eastern Seas.

11AM2002 S12-152 E-poster

OCEANOGRAPHIC ATLAS OF THE BERING SEA, OKHOTSK SEA AND JAPAN/EAST SEA. CD-ROM VERSION IN ENGLISH

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The electronic Atlas presents a summary of many major aspects of the Far Eastern Seas (FES) regional oceanography presented as tables, pictures and text materials. CD-ROM contains a brief annotated description of data on the main physical-geographical characteristics, peculiarities of hydrological regime, water masses, tidal phenomena, water circulation and ice conditions in the FES. It is presented the vast graphic material (1600 color pictures) characterizing the large-scale background peculiarities of distribution and inter-annual variability of the seawater temperature, salinity, sound velocity, some hydrochemical elements and currents. It is given a list of the available databases of free access and the web sites containing additional operative and archived data on a wide circle of special and interrelated problems of studying and exploring the region. The system provides fast access to the specially selected data stored on CD-ROM, as well as to the other operative or generalized reference information scattered among various sources, and hence, limited for wide use. CD-ROM is distributed on a non-commercial basis. A copy of full version will be available through the Internet (www.pacificinfo.ru).

11AM2002 S12-153 E-poster

DATA BASE OF ARCHIVAL OBSERVATIONS OF CURRENTS IN THE NORTHERN PACIFIC

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New database of current observations by current-meters of moored buoy stations (MBS) is developed at the POI FEBRAS (DB "Ocean-3"). Data of 850 MBS obtained from the Russian NODC, POI archive and other organizations are assembled in the DB for the northern Pacific. Using the relational "Paradox" Data Management System allows us to organize direct access to all stored information and easily manipulate the data for the analysis and visualization. Executing various requests, it is possible to receive any information, which is presented at the DB to make various calculations, to build the diagrams and pictures illustrating outcomes of the requests and calculations. For the convenience of operating with the DB a special form for the survey and choice of necessary information is created. As a result of the research the electronic version of the DB "Ocean-3" on CD-ROM is created. Except for the Russian observations, it includes the J-DOSS/JODC data accessible through the Internet, and also the USA similar data for 1965-2000 years copied from CD-ROM, issued by OSU Buoy Group, Oregon State University.

11AM2002 S12-317 E-poster

COMPARISON OF GRIDDED TEMPERATURE PROFILES AND WALLEYE POLLOCK DATA FROM TRAWL SURVEYS ON THE BERING SEA SHELF

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Correlation of oceanographic and fisheries data is imperative for assessment of fisheries resources and climate-related ocean issues, and FOCI (Fisheries Oceanography Coordinated Investigations) is driven to study the effect of physical and biological environments on recruitment of various species. Walleye pollock is a vital species in the Bering Sea, and an important species commercially and ecologically. Trawl data as well as pollock CPUE data and temperature profiles have been collected annually over the Bering Sea shelf by the Alaska Fisheries Research Center (AFSC). This data resource has impressive potential for providing an areal depiction of fish habitat conditions. Water column temperature over a spatial grid will be developed from MicroBathythermograph (MBT) data collected during annual early-summer trawl surveys. A minimum of data has been prepared as temperature transects, allowing for 2D representation of temperature contours. The data set preparation will be expanded upon to create a larger 3D area of temperature information. Mixed-layer depths will be calculated. These two endeavors will

provide for development of 3D views of mixed-layer depth over the coverage area, and a view of cold pool movement across the extent. Once a spatial extent is established with temperature data, corresponding fisheries data for Walleye pollock will be used in conjunction with the 3D temperature grid. Calculations and data presentation will utilize web-based technologies.

11AM2002 S12-319 E-poster
PROCESSING AND VISUALIZATION OF OCEANOGRAPHIC DATA IN 2.5 AND 3D-EXAMPLES FROM THE BERING SEA, ARCTIC AND WEST COAST OF THE UNITED STATES

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NOAA's Pacific Marine Environmental Laboratory (PMEL) and Alaska Fisheries Science Center (AFSC), both in Seattle, collect a wealth of data about the physical and biological characteristics of the Bering Sea and the Gulf of Alaska. The data are stored in a variety of formats in a variety of data systems. AFSC makes extensive use of a GIS to store their data. PMEL has growing expertise in visualizing scientific data. Routines have been developed to take data from a variety of sources that have not previously been GIS compatible. ArcView GIS and ArcView 3D Analyst have been used to create a series of VRML visualizations of these data. Some of the VRML files have been created directly from 3D Analyst; others have required extensive postprocessing. The use of EVS, a geological software visualization package, to create true 3D visualizations will also be demonstrated.

11AM2002 S12-154 E-poster
WEBSITE OF PICES TECHNICAL COMMITTEE FOR DATA EXCHANGE

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The goal of this site is to provide a media for TCODE members for information exchange and communication.
At the moment, the content is divided into the following sections:

- Work plan including a description of progress for each entry;
- Annual reports;
- Metadata storage;
- News;
- Members info;
- Links to data and metadata resources.

The site is implemented as a virtual server on the web server of TINRO-Center (http://www.tinro.ru) and available at the URL http://tcode.tinro.ru. The server is created with use of the Apache web server, Perl scripting language and Oracle DBMS. All site pages have a similar structure and consist of the header, menu, workspace and footer. The pages are distinguished only by the contents of the workspaces.

Along with browsing, the server provides following services:

- Online search;
- Metadata updating;
- Members info updating;
- News updating.

The privileged users (TCODE members) may edit the contents of the members info and metadata sections. Before editing, the users must pass through the authentication procedure. Only a server administrator generates login/passwords and edits the news section.

POC Paper Session

Convenor: Kuh Kim (Korea)
Tuesday, October 22, 2002 14:00-17:30

14:00-14:20 **Hyo Choi**
Modification of air and sea temperatures in the coastal seas of the path of the East Korea Warm Current (POC-167)

14:20-14:40 **Pavel Ya Tishchenko, L.D. Talley, V.B. Lobanov, V.A. Luchin, A.P. Nedashkovskj, S.G. Sagalaev, R.V. Chichkin, E.M. Shkirnikova, I.A. Zhabin, V.I. Ponomarev, D. Masten, D.-J. Kang, K.-R. Kim**
Seasonal variability of hydrochemical properties of the Japan/East Sea (POC-188)

14:40-15:00 **Tatsuro Watanabe, Norinobu Ota**
A possible origin of Japan Sea intermediate water (POC-190)

15:00-15:20 **Akifumi Nakata, Mayumi Sawada, Tomomi Watanabe, Hideo Yoshida, Iori Tanaka**
Direct current measurements of the Tsushima Warm Current at the west to the Hokkaido in the Northern Japan Sea (POC-182)

15:20-15:40 **Coffee/tea break**

15:40-16:00 **Eung Kim, Young Jae Ro**
New opportunity for data assimilation in the circulation model in the East Sea with Argo float data (POC-174)

16:00-16:20 **Akira Kusaka, Shin-ichi Ito, Kazuyuki Uehara, Yasuhiro Kawasaki**
Seasonal variability of Oyashio velocity and volume transport, southeast of Hokkaido, Japan (POC-176)

16:20-16:40 **Shin-ichi Ito, Kazuyuki Uehara, Takahi Miyao, Tomoo Watanabe, Yugo Shimizu, Ichiro Yasuda**
Oyashio transport on OICE and comparison with altimeter SSHA data (POC-172)

16:40-17:00 **Zhe Liu, Hao Wei, Guangshan Liu, Jing Zhang**
Simulation of water exchange time in Jiaozhou Bay with the half-life time concept (POC-177)

17:00-17:300 **Discussion**

Wednesday, October 23, 2002 08:30-12:30

09:00-09:20 **Masahide Wakita, Shuichi Watanabe, Nobuo Tsushima, Tsuneo Ono, Yutaka W. Watanabe, Shizuo Tsunogai**
Temporal change in dissolved inorganic carbon content in the western North Pacific water (POC-189)

09:20-09:40 **Andrey G. Andreev**
Temporal changes in dissolved oxygen of the intermediate water in the subarctic North Pacific (POC-163)

09:40-10:00 **Ichiro Yasuda, Hiroaki Tatebe**
Possible impacts of North Pacific intermediate water on fronts and climate variability (POC-191)

10:00-10:20 **Tangdong Qu**
Mixed-layer heat balance in the western North Pacific (POC-343)

10:20-10:40 **Coffee/tea break**

10:40-11:00 **George V. Shevchenko, Gennady Kantakov, Valery Chastikov**
Measurements of currents and water parameters in Aniva Bay, southern Sakhalin (POC-187)

11:00-11:20 **Leonid Mitnik, Vyacheslav Dubina**
Satellite SAR characterization of oceanic dynamic features in the Japan/East Sea (POC-180)

11:20-11:40 **Konstantin A. Rogachev, Eddy C. Carmack, Igor Gorin**
Mass and freshwater transport by mesoscale eddies in the Kamchatka Current (POC-185)

11:40-12:00 **William R. Crawford, Josef Cherniawsky**
Observations of sea level anomalies in Bering Strait and surrounding seas using satellite altimetry observations (POC-004)

12:00-12:20 **Li Ren, Stephen C. Riser**
Examining large-scale variability in the Pacific Ocean using early data from the Argo array of profiling floats (POC-184)

Posters:

Tatyana Bogdanovskaya
Multi-year variability of AAC midpoint intensity and movement for the Asian Pacific region (POC-164)

Liqi Chen, Zhongyong Gao, Weiqiang Wang
Air-Sea Fluxes of CO2 in the Polar Ocean (POC-288)

Hyo Choi
Effects of atmospheric circulation and sea surface temperature on sea fog formation (POC-166)

Mikhail A. Danchenkov
Subarctic gyre in the Japan Sea and stationary eddy in its eastern part (POC-328)

Vladimir B. Darnitskiy, S.P. Bomko
The second bifurcation of the Kuroshio to east of Japan (part 1) (POC-168)

Vladimir B. Darnitskiy, S.P. Bomko
The second bifurcation of the Kuroshio to east of Japan (part 2) (POC-169)

Boris S. Dyakov
Possible correlation between atmospheric circulation in the northern hemisphere and water temperature in the northwestern Japan Sea (POC-170)

Larissa A. Gayko
Peculiarity of hydrometeorological conditions in the southeastern Peter the Great Bay in the Sea of Japan (POC-171)

Fedor F. Khrapchenkov, N.I. Rudykh
Seasonal variability of sound velocity field and acoustic waveguides of the northwestern part of Pacific Ocean (POC-173)

Valery V. Kobylyansky, M.M. Domanov, L.S. Vilentchik, I.G. Akhmetsafin
Transformation of sea water salt composition in process of "double diffusion" (POC-175)

Viatcheslav G. Makarov, Valentina D. Budaeva
Application of piecewise curve-fitting technique for reconstruction of the density CTD profiles near northeastern Sakhalin coast (POC-178)

Leonid Mitnik, Vyacheslav Dubina
Internal waves around Sakhalin: Preliminary mapping with ERS SAR (POC-179)

Valentina V. Moroz
Hydrological conditions of the Kuril Island zone and adjacent areas (POC-181)

Eugene V. Samko, V.M. Petruk
The characteristic of the Okhotsk Sea water dynamic near the western Kamchatka coast in 1996-2001 (POC-186)

Gennady Yurasov
New mechanism of deep water formation in the Peter the Great Gulf, the Sea of Japan (POC-192)

Igor A. Zhigalov, V.A. Luchin, V.V. Plotnikov
Estimation of the seasonal and interannual variability of the temperature waters in the Okhotsk Sea

Igor A. Zhigalov, Vladimir A. Luchin
Classification of the thermal conditions of the bottom waters on western Kamchatka Shelf (POC-194)

11AM2002 POC-163 Oral

TEMPORAL CHANGES IN DISSOLVED OXYGEN OF THE INTERMEDIATE WATER IN THE SUBARCTIC NORTH PACIFIC

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Using an approximately 50-year data set, the changes in dissolved oxygen (DO) on isopycnals in the intermediate layer of the subarctic North Pacific were analyzed. The temporal variations in DO on a decadal scale in the western subarctic Pacific display a negative correlation with those in the eastern subarctic Pacific. From 1950 to 2000 there is an average increase in the Apparent Oxygen Utilization (AOU) in the Western Subarctic Gyre and Alaska Gyre. The increase in AOU coincides with an increased temperature in the intermediate layer and decrease in surface-water salinity in the Bering Sea. It is hypothesized that the changes are correlated with the North Pacific Index (NPI), which fosters meridional transport of salt to the Bering Sea when it is high. The gradual decrease in NPI thus has caused a freshening and a subsequent decrease in the ventilation resulting in an AOU increase in the intermediate waters of the subarctic North Pacific.

11AM2002 POC-164 Poster

MULTI-YEAR VARIABILITY OF AAC MIDPOINT INTENSITY AND MOVEMENT FOR THE ASIAN PACIFIC REGION

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Climatic variability of atmospheric action centers (AAC) is assessed through an introduced factor that is called a midpoint (MP). MP position and intensity are calculated as the mean values of latitude, longitude and pressure of the four main AACs in the Asian Pacific region (North Pacific high, Aleutian low, Asian high, and Asian low). MP defines background pressure of the four AACs and their movement. Average monthly AAC parameters for the period from 1947 to 1994 were analyzed. Geographic position of MP and multi-year variability of its parameters (pressure, latitude and longitude) were studied.

Multi-year average location of MP is 42°N-151°E, MP intensity is 1014.8 gPa. In cold season located in the north-western part of the Pacific Ocean (about 44°N 166°E), while in warm season it moves to the Asian coast and is found in the Sea of Japan in June. This is connected with seasonal specificities of AAC movement.

Multi-year average data on atmospheric pressure reveals a distinct pressure change through the year, maximum pressure being registered during winter months and minimum pressure – in summer. Such a distribution of pressure testifies to the fact that during winter and summer months continental AACs produce the largest impact on background pressure.

Linear trends of AAC parameters were also studied. It can be noted that for the period of study the Asian Pacific region was characterized with the pressure decrease (in summer) and MP movement to the north and east.

11AM2002 POC-288 Poster

AIR-SEA FLUXES OF CO_2 IN THE POLAR OCEAN

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The data have been collected during Chinese Arctic and Antarctic Expeditions in the Southern Ocean and the Arctic Ocean respectively since 1980s for the study on the role of Arctic and Antarctic in Global Change.

The polar oceans show very significant areas in a study of global change especially for carbon cycling. Chinese polar researches in those areas reveal that the southern ocean and the Arctic Ocean would play a significant role in absorbing anthropogenic Carbon Dioxide. The CO_2 flux of air to sea is an average of 3.06 mol/(m^2·a) during austral

summer of 2000 between 80°W to 80°E in the Southern Ocean. There is 3.92 mol/(m^2·a) for total CO_2 fluxes in Chucki Sea in the Arctic Ocean during summer of 1999.

11AM2002 POC-166 Poster
EFFECTS OF ATMOSPHERIC CIRCULATION AND SEA SURFACE TEMPERATURE ON SEA FOG FORMATION

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POC PAPER

By three-dimensional grid point model with a complex terrain-following coordinate system (x, y, z*), numerical simulation on the formation of coastal and sea fogs for a 48 hour from 0900LST, May 19, to 0900 LST, May 21, 1998 was made through one-way double nesting technique from a coarse-mesh domain with a 20km grid size with 50 x 50 grid points to a fine-mesh domain with a 5 km, respectively. The study area on the fog formation is located in the Yellow Sea coast of Korea and stretches out to 250 km x 250 km. At 1800z, May 19 (0300LST, May 20), 1998, the center of high pressure system is located in the south-eastern part of Korean peninsula, synoptic-scale south-westerly wind prevails near Inchon city in the central part of Korean western coast. Divergence of wind fields occurs around the central part of the Yellow Sea and wind speed increases away from its center. North-westerly wind stretches out toward the inland side near Inchon city and it confronts an easterly wind combined with land-breeze from inland plain toward coast and mountain wind from mountain toward inland plain, resulting in a calm zone in the coastal sea and inland. Synoptic westerly wind of 2.5 m/s blows from the Yellow Sea toward the coast and becomes calm wind in the coastal region, because mountain wind of 2.5 m/s blows from the top of a mountain in the further inland side toward the basin and it is associated with land-breeze from the inland plain near Inchon city toward the Yellow Sea, suppressing the westerly wind and resulting in calm wind. Basically, moisture advection from the Yellow Sea toward the coast near Inchon city occurs under synoptic westerly wind and the moisture can be transported into further inland area by daytime westerly sea breeze from the coastal sea toward the inland plain, before sunset.

Early in the morning, 0600LST, moist air should be cooled down, due to maximum nighttime cooling of the ground surface and be condensed into fog, under calm wind state. Vertical turbulent diffusion coefficient of heat with a very small magnitude of 1 m^2 exists near the ground surface and indicates the occurrence of a thin shallow nocturnal surface inversion layer (NSIL) with a thickness of about 300 m. As mountain winds blowing from the top of the mountain toward the valley merges into the ground surface of the valley, adiabatic warming of air parcel is produced, due to downward motion of air from the mountain top into the valley and mountain wind interrupts cooling of the air on the ground surface of the valley, resulting in the thicker NSIL in the mountain than the coastal region. Otherwise, marine atmospheric inversion layer (MAIL) forms with 250 m thickness over the sea and its depth becomes slightly higher than one of the coastal inland NSIL of about 200 m, because the cooling of sea surface is smaller than that of the ground surface.

As cold waters from Han River of Seoul city into the Yellow Sea exists at 25 km ~ 50 km away from the coast, air parcel over a cool pool of 100°C water temperature should much cool down, showing relative humidity of 92% and inducing the formation of fog in the Yellow Sea and coastal sea near Inchon city. Small divergence of sensible heat flux generally causes the mountain surface to be more cooled down than the sea surface at night. As nighttime sea temperature is not much changed from daytime one, air temperature keeps 14°C near the sea surface. In the coastal sea of 14°C, dense fog is also detected with relative humidity of 92%. Thus, as air parcel on the sea surface with lower water temperature at the 25 km offshore should much cool down than air with higher temperature at the coast, slightly higher relative humidity can induces the formation of denser fog.

11AM2002 POC-167 Oral

MODIFICATION OF AIR AND SEA TEMPERATURES IN THE COASTAL SEAS OF THE PATH OF THE EAST KOREA WARM CURRENT

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The investigation on the modification of air temperature to sea temperature (or vice verse) in the upper layer of ocean from sea surface to 20 m depth in the coastal seas was undertaken by analyzing monthly averaged surface meteorological and oceanographic temperature data set at the observation points of the southern and eastern coastal seas of Korea in the path of the East Korea Warm Current (EKWC) and the North Korea Cold Current (NKCC). Oceanographic variables were acquired every other month (February, April, June, August, October and December) at the closest oceanographic station (here, four stations-Sokcho, Kangnung, Ulsan and Chungmu) from the coast on each serial oceanographic measurement line by National Fisheries and Development Agency, such as 107-01, 105-01, 208-01 and 206-01 lines, from 38.2°N to 34.6°N and from 128°12.6'E to 128°34.5'E. Meteorological data confined to the same months were obtained by coastal meteorological stations of Korean Meteorological Administration for ten years from 1981 through 1990.

In order to verify the effect of air temperature upon the modification of sea temperature, statistical methods were adopted to evaluate both correlation coefficients of air temperature to sea surface temperature and to make regression equations between sea and air temperatures. The regression equations every other month could inform us detail seasonal variation on the modification of air temperature on sea temperature, which is one of important physical system influenced on biological system. The deviations from sea temperature to air temperature at four stations from April through August had negative values with minimum in June, except for August in Ulsan coast, where upwelling frequently occurred, and the negative values described the heat gain to the sea, resulting from heat conduction across air-sea interface. On the other hand, October to February had positive values, which mean the heat loss from the sea. The correlation coefficients between air and sea temperatures at the coastal stations in the path of EKWC and NKCC showed good relationships of air and sea temperature at the sea surface, 10 m depth and even 20 m depth with 0.98 to 0.70, except for Ulsan coast at 20 m depth.

11AM2002 POC-004 Oral

OBSERVATIONS OF SEA LEVEL ANOMALIES IN BERING STRAIT AND SURROUNDING SEAS USING SATELLITE ALTIMETRY OBSERVATIONS

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We apply satellite altimetry methods (TOPEX/POSEIDON and ERS-2) to investigate changes in sea level in Bering Strait and surrounding seas. Altimetry observations provide global coverage of sea surface height unimpeded by cloud cover, thereby providing a method to determine links between flow through Bering Strait and oceanographic features far from this strait. Present models of sea ice in the Arctic lack information on this transport of heat and fresh water, and will be greatly improved with this information. Analysis of TOPEX/POSEIDON observations in Bering Strait reveals lower than normal sea levels during ice-free periods in 1999, and higher than normal sea levels in 1994, 1997 and 1998. Analysis of sea levels along 191.34W reveals these anomalies to extend southward of Bering Strait. We associate the 1998 and 1999 anomalies with El Niño and La Niña, respectively.

Bering Strait lies near the northern-most extent of the TOPEX/POSEIDON orbit, where tracks converge to provide more frequent observations in time. Future studies will examine cross-strait sea surface slope in Bering Strait during each satellite pass, and relate this slope to wind-driven currents set up by local storms and to remote forcing associated with basin-scale changes in sea level.

11AM2002 POC-328 Poster

SUBARCTIC GYRE IN THE JAPAN SEA AND STATIONARY EDDY IN ITS EASTERN PART

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It is known that Tsushima warm current intensifies north of 40°N. But the reason of it was unknown. Explanation of it was given on the base of drift of PALACE floats in 1999-2001. By this, data were founded two places of stationary eddies inside of Subarctic gyre. Subarctic gyre in the Japan Sea (Aubrey, Danchenkov, Riser, 2000) has on its southern border - East Korean warm current; on northern border - unnamed westward current from Hokkaido to Peter the Great Bay. Eddies inside gyre play an important role in redistribution of heat and salt. Eastern eddy was situated (8.1999-10.2001) in area between 41°N and 43°N, 136°5'E and 139°5'E. Inside upper part of this cyclonic eddy water salinity was low and inside lower part of it - high. The penetration of cold surface water and high saline water in lower part of Eastern eddy was traced in the winter.

11AM2002 POC-168 Poster

THE SECOND BIFURCATION OF THE KUROSHIO TO EAST OF JAPAN (Part I)

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The first bifurcation of the Kuroshio area to the south of Japan is the well known Idzu - Ogasavara ridge, near to which or above it meandering of the main Kuroshio flow occurs. The periods of existence of Kuroshio meandering have temporary scale, commensurable with ENSO cycles and were marked by many researchers of this area, since pioneer papers of Japanese oceanographers. The horizontal sizes of the Southern Cyclonic Meander of Kuroshio (SCMK) vary from tens up to hundreds miles (Darnitskiy, Bulatov, 2001). In a line of cases the Kuroshio jet after interaction with the ridge gets fan-shaped character (Pocoudov, Velayots, 1979).

The first well known anticyclonic Kuroshio meander east of Japan (FAMK) is investigated. The area of its generation is connected to a separation of Kuroshio from coast of Japan and turn of a jet in open ocean to the east. This meander gives a beginning of a northeast branch of Kuroshio. In our point of view the rigid localization of FAMK in space is caused by group of Kashima seamounts, located in latitudinal strike a direction between 35°30-36°15N 142° 20-144° 30E, finite relative heights of 3-5.5 km. Distance from Sioya cape up to a nearby seamount - about 90 miles (from c. Inubo - 80 miles). The seamounts are guided almost on normal to about Honshu by a double circuit by extent about 90 miles. The top of the highest seamount is located on 1500 m, and lowest (3 km height) on 4500 m depth (Map of Geological Survey of Japan, 1978).

Thus, these 6 seamounts cluster their influence on the currents in a range of depths from bottom (7.5 km) up to 1.5 km. About 3 km - range influence of top of seamounts in intermediate layers of ocean.

The difference in depths of a continental slope on western periphery of these seamounts makes 1.5-7.5 km. It appears, that the effect of influence of a bottom relief amplifies at the expense of a combination of an abrupt continental slope and contacting with it of the seamount cluster. And the sharp of depth differences of the continental slope in area of an arrangement of seamounts is directed by a ledge to the party of open ocean, *i.e.* in the party of underwater mountains.

It is represented to us, that such a combination of relief features is a primary factor of Kuroshio jet meandering to east of Japan with subsequent vorticity and eddies migration to the north or northeast. There is some oceanographic and space images information about that question.

11AM2002 POC-169 Poster

THE SECOND BIFURCATION OF THE KUROSHIO TO EAST OF JAPAN (Part II)

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The almost ideal circuit of such Kuroshio behaviour was observed from space images, on April 3-4, 1982 in N.V. Bulatov's interpretation. It is visible that a series of eddies originates at Kashima seamounts and has NE trajectory up to area to the east Hokkaido with the central coordinates of the northern eddy (42°30N 149°E), incorporating by the tail sectors as a vortical path. The double vortical pathes are also possible, as it was observed August 1, 197. The trajectory of larger eddies by a 120-180 miles diameter in this case had NNE direction, and the more southern trajectory of smaller eddies by a 60-100 miles diameters had NE direction. The second trajectory in this case was under managing influence of the following 5 underwater mountains cluster, 2-3.5 kms height located in a 37-38°N between 144°30-146°E square.

The similar space images are available and for northern trajectories of eddy moving from Kashima seamounts along the Japan coast. Thermohaline structure of separated eddies from Kuroshio is resulted in A. Tomosada (1978) work. The FAMK period has not been studied as against of Southern Kuroshio meander. However, there is preliminary information that the SCMK and FAMK systems have the various periods of existence at the expense of dividing influence of the Idzu ridge. The area of Kashima seamounts is characteristic by behaviour of a multimode Kuroshio jet near to them. In particular, in case of flow of seamount cluster runs from the south the basic flow on its left periphery gives a cyclonic vorticity type, *i.e.* the jet, separated from a main flow, back - in the western direction. Such cases were observed both on space images, and on oceanographic surveys, in particular, on one of surveys of the SECTIONS program. Others of polymodal structure currents variants near to underwater mountains will be submitted in the report.

This area (to east of Boso peninsula) is a key from the point of view of functioning the Kuroshio - SubArctic front ecosystem. One of spawning grounds situated for sardine - ivashi (*Sardinops sagaxs melanostica*) has settled down.

There are data that ivashi spawn with periodic changes in space. Japanese scientists have the information that the spawning grounds tend to move around the Japanese archipelago with 50-70 years periodicity (Watanabe 1981; Kuroda 1989). We have the fishery statistics for this area for the winter period 1981-1988, which is the second half-cycle of last flare of the sardine population. Spawning sites based on fishery statistics were observed during the whole specified period. Spawning sardine catch during 8 winter periods changed from 10.468 up to 123.170 tons, but the maximum catch made by the USSR fleet was 380.600 tons in 1983.

Probably in that year the ecosystem about Boso peninsula had more favourable conditions. One of the possible reasons for that it can be the minimal interaction influence of typhoon activity that year on all Kuroshio system 1982-1983. With agrees V.P. Tunegolovets (1998), investigating frequency of the typhoons which have left on area of Kuroshio current - 30°N. During 1957-1996 the average number of typhoons in this area was 13.6, with a low of 6 in 1983 and a high of 21 in 1966. Besides the other ecological reasons, on size located at Boso peninsula spawning of stock fishes and craft the quieter condition of all dynamic Kuroshio system, taking place in this year under the minimal external influence of an atmosphere. This question, however, requires attraction of other types of information for its acknowledgement that it is supposed to make to the report.

11AM2002 POC-170 Poster

POSSIBLE CORRELATION BETWEEN ATMOSPHERIC CIRCULATION IN THE NORTHERN HEMISPHERE AND WATER TEMPERATURE IN THE NORTHWESTERN JAPAN SEA

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This work investigates multi-year form recurrence variability of atmospheric circulation Vangengeim – Girs W, E, C, Z, M1, M2 in the northern hemisphere for 1950–2001. Data on water temperatures during 1965-2001 at the standard hydrological section «Sangarsky», with coordinates 42°30'N, 133°00'E - 41°50'N, 136°30'E to the northwest of the Japan Sea were used. The average temperature at this section for layers of 0–50, 50-200, 0-200 m was calculated and correlation between forms of atmospheric circulation in the northern and water temperature at

the standard section in the Japan Sea was determined. Changes of Pacific sardine and Japanese common squid abundance are marked in dependence on the gydrometeorologic conditions.

The research of perennial variability of atmospheric processes has shown. During 1975-1992 Pacific sardine abundance was high and Japanese squid abundance was low in the Japan Sea. It was observed in the atmosphere. The positive trend of recurrence of processes of the form W and Z, and negative - the form E as well as pressure in the center of the Siberian anti-cyclone were observed in the atmosphere. In 1989-2001, Pacific sardine abundance was low and Japanese squid abundance was high. It was marked the negative trend of variability of recurrence of atmospheric processes of the form W and Z, positive - forms E and C as well as pressure in the Siberian anti-cyclone. In 1975-1992 and 1989-2001 the marks of trends of variability of recurrence of atmospheric processes of the form C, M1, M2 varied from month to month.

The coefficient of correlation between interannual changes of the average water temperature in layer 0-200 m "Sangarsky" section in a northwest of the Japan Sea and recurrence of the forms of atmospheric circulation did not exceed 0.6. Thus the degree of correlation is higher in winter in comparison with summer. The dependence was in inverse proportion for the form W in August, and E - in February. The statistical correlation of water temperature and recurrence of the form E in August essentially enlarged in surface layer 0-50 m in comparison with subsurface 50-200 m. For the form Z the dependence was in inverse proportion in February and August, and the correlation coefficient increased by absolute value in a subsurface layer 50-200 m. For the form Ml the correlation was significant only in August in subsurface layer 50-200 m, and M2 - in February in layers 0-50 and 50-200 m, respectively. The dependence between water temperature off hydrological section and pressure change in the center of the Siberian anticyclone in a winter was in inverse proportion, correlation coefficient equalled -0.6 - -0.7.

POC PAPER

11AM2002 POC-171 Poster
PECULIARITY OF HYDROMETEOROLOGICAL CONDITIONS IN THE SOUTHEASTERN PETER THE GREAT BAY IN THE SEA OF JAPAN

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The research of climatic changes in separate regions is especially interesting for estimation of their possible aftermaths and impact on the environment and economy. In this connection, we discuss the interannual and intraannual fluctuations of water and air temperatures in the southeastern Peter the Great Bay. Vostok Bay and Nakhodka Bay are two bays second-order. This area is characterized with the strongly affected water temperatures fluctuations by advective factors. The temperature condition of waters in Peter the Great Bay is influenced both by climatic and advective factors. At the Vostok Biological Station of the Institute of Marine Biology, situated in Vostok Bay, the intense research is carried out. It is one of the most biologically studied regions in the Sea of Japan. Concerning the hydrometeorological conditions, Vostok Bay is poorly studied.

The regular hydrometeorological observations in Vostok Bay have not been carried out, there are only the separate isolated observation data. The authors of this paper were and carried out the expeditions in 1987-89 are to study hydrometeorological conditions in Vostok Bay. To define, in what measure the rating of distinctions the temperature condition on years on a basis of the so limited data can correspond to concept "interannual variability", important take into account conditions of formation of the temperature water condition per considered years. A number of observations are necessary for this purpose. The regular observations of the hydrometeorological conditions in this area are made in Nakhodka Bay for the hydrometeorological station (HMS) Nakhodka. Analysis of water and air temperature trends at HMS Nakhodka showed that from 1932 until 2000 the linear trend was positive, that is, air temperatures gradually increased. From August the trend was not revealed. A significant increase in water temperature was observed from December until March, that is winter became warmer. From May until September water temperature fluctuation tendency is also significant, but the water temperature is negative. The interrelation between the HMS Nakhodka data and materials of 1987-1989 is established. Advective factors significantly affect the water temperature distribution. It proves that significantly by negative anomalies at surface water temperature of a superficial layer of at positive anomalies of air temperature per separate months.

11AM2002 POC-172 Oral

OYASHIO TRANSPORT ON OICE AND COMPARISON WITH ALTIMETER SSHA DATA

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To estimate transport of the Oyashio which flows south caost of Hokkaido Japan, we set an intensive observation line along the T/P orbit 060. The observation line extends from the Cape Erimo to the southeastward (from the Oyashio region to the mixed water region) and we named this line as OICE (Oyashio Intensive observation line off Cape Erimo). On the OICE, we have been repeating CTD observations and maintaining the mooring systems.

We compare the SSHA derived geostrophic surface velocity anomaly with real velocity anomaly observed by the moored ADCP with various smoothing for SSHA data. The result showed that about 60 km Gaussian low-pass filter and the about 5 km distance between two point at which the SSHA was picked up brings the maximum correlation between the geostrophic surface velocity anomaly derived from SSHA and the one derived from ADCP. The geostrophic Oyashio transport was also compared with low-passed SSHA difference between 39-30N and 42-00N. These two components also showed good correlation. Using linear regression equation the Oyashio transport time series were estimated from SSHA difference between 39-30N and 42-00N. The time series showed both strong seasonal and interannual variability. Thought the SSHA derived Oyashio transport showed relatively good correlation with the southern limit latitude of Oyashio coastal intrusion, the interannual variability was not consistent with one of the Sverdrup transport derived from the wind stress curl west of the Emperor Sea Mount.

11AM2002 POC-173 Poster

SEASONAL VARIABILITY OF SOUND VELOCITY FIELD AND ACOUSTIC WAVEGUIDES OF THE NORTHWESTERN PART OF PACIFIC OCEAN

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Based on analysis of numerous sections the region from the Kamchatka Strait before the Oyashio - Kurosio current system were studied in different years and seasons. Areas almost uniform over temperature and salinity, which exist at the intermediate depths of 30-250 m on axes of the inshore part of the East-Kamchatka and Oyashio Currents are distinguished. These areas are bound by sound velocity isotaches in the field of sound velocity and relief of the continental shelf comprising a closed three-dimensional waveguide. Conditions of the sound velocity field and the three-dimensional acoustic waveguide origin and intensity are analyzed.

11AM2002 POC-174 Oral

NEW OPPORTUNITY FOR DATA ASSIMILATION IN THE CIRCULATION MODEL IN THE EAST SEA WITH ARGO FLOAT DATA

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The East/Japan Sea (hereafter, ES) attracts the attention of the international community from various scientific points of view. Particularly, its importance has been recognized as Miniature Ocean so that it provides a unique experimental natural laboratory to investigate the global warming problems, since it is fairly deep (average 1500 meters) compared to horizontal length scale of 1200 km with residence time of around 30 years. POM-ES (Ro 1999) was developed based on Princeton Ocean Model with the realistic bottom topography. Model configuration is designed with eddy-resolving grid resolution (1/10 deg), realistic bottom topography, boundary conditions (three open boundaries at Korea, Tsushima, and Soya Strait with 3 (Sv) seasonally varying transport), monthly surface forcings with wind stress and radiation. POM-ES was initially spinned up with monthly GDEM dataset by relaxing to 3-D climotological monthly T-S field. Production of new oceanographic dataset such as profiling Argo drifter

data will be a challenging opportunity for ocean modeling community. In this study, we try to blend hydrographic survey data and Argo drifter data into climotological T-S fields, which are then regridded for use in data assimilation for model run. Two schemes of data assimilation (nudging and adjoint) are used. The objectives of the study is to 1) evaluate the data assimilation schemes developed and 2) understand the responses of the model results to the assimilated datasets in terms of boundary currents variability and meso-scale eddy formation. All the results of modeling will be presented through animated movie loops.

11AM2002 POC-175 Poster
TRANSFORMATION OF SEA WATER SALT COMPOSITION IN PROCESS OF "DOUBLE DIFFUSION"

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Deviations from the constant sea salt composition were registered in the number of hydrochemical investigations in the ocean executed in mesoscales (B.P. Fabricand *et al.*, 1967; A.S. Bychkov, 1982; S. Tsunogai *et al.*, 1968; V.V. Anikeev *et al.*, 1985; M.M. Domanov, 1987). This effect had non-systematic nature and for a long time had not satisfactory explanation. Most of the scientists, who have marked in the measurements variability of salt composition supposed, that these deviations were due to properties of the different water masses.

The other view on variability of chloric ratios in the ocean was formulated by us in earlier published works on the basis of our experimental researches. Phenomenological association of chloric ratios variations and processes of the differential-diffusion convection was discovered. As a consequence from this, the time-space variability of chloric ratios should be like time-space variability of fine thermohaline structure of water masses of the ocean.

Three types of experimental methods were used for the investigation of this phenomenon:

a) Non-uniformity of salt composition in interlayers of fine thermohaline structure were investigated in the Atlantic Ocean on the sampling station with coordinates 4°17′ N 44°03′ W.
b) It is possible to use a direct registration of the 1.43 Mev spectrum line of K-40 isotope for obtaining reliable outcomes about concentration of potassium in a vertical probing across the fine thermohaline structure of water masses.
c) The experimental data (in laboratory conditions) demonstrate that during process of carry-over by salt fingers take place redistribution of ions of the main salt composition both in time and in space.

11AM2002 POC-176 Oral
SEASONAL VARIABILITY OF OYASHIO VELOCITY AND VOLUME TRANSPORT, SOUTHEAST OF HOKKAIDO, JAPAN

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We examined seasonal variability in velocity and volume transport of Oyashio from hydrographic data measured by CTD observation and mooring observation data in the vicinity of the main path of the Oyashio off southeast of Hokkaido, Japan. Furthermore, we estimated the integrated absolute volume transport flowing over the continental slope inshore of Kuril-Kamchatka Trench, referred to the velocity data measured by moored current meters.

The velocity in southwest components, nearly coincident with the direction of the Oyashio path, was fast in winter and spring of early-1990s. However, in summer this component velocity got remarkably fast in mid-1990s. The seasonal mean velocity in this component for over ten years was not so slow in summer, and was not so fast in winter and spring due to warm core rings persisting in late-1990s, near the mooring station.

On the other hand, we could observe the maximum absolute volume transport of Oyashio in winter (ca.26sv), and minimum in autumn (ca.11sv), although there was a little change in relative volume transport, suggesting intensification of atmospheric field in winter. In contrast, both relative and absolute volume transport in summer was not so as small as we had expected. This reason might be as follows: The "dome" in flat isopycnal surface,

where baroclinic structure does not develop, shifts offshore and the width of Oyashio spreads, and accordingly results in relatively much volume transport.

11AM2002 POC-177 Oral
SIMULATION OF WATER EXCHANGE TIME IN JIAOZHOU BAY WITH THE HALF-LIFE TIME CONCEPT

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A box model and a eulerian dispersion model are developed to simulate the exchange process of passive, dissolved and conservative matter between Jiaozhou Bay and Yellow Sea in order to estimate the self-purification water ability. The concept of half-life time is adopted to describe the water exchange time. There are two main modifications in our box model compared to the classical ones: 1) tidal water flux is replaced by the tidal elevation data through a simple transform; 2) the fact that outflow may be not completely assimilated by Yellow Sea is considered. The half-life time computed from the box model is about 9.38 days that is obviously longer than the results given by a previous study. The dispersion model is coupled with a three-dimension barotropic physical model, which provides the simulation of background flow field. Then half-life time both for the total amount and average concentration are calculated in the computation domain. As pointed out, the variation of total amount is negative correlated to that of average concentration in a tidal period and positive correlated in long term. The half-life time for total amount and average concentration are about 9.84 days and 22.53, days respectively for the whole bay in M_2 tide driven system. It shows that half-life time is quite different from less than 5 days in the deep water region near the straight to over 75 days in the northwest shallow coastal area due to tidal residual current field structure and the distance to Yellow Sea. The results are supported by the field observation data of salinity-recovery process and radium isotopes variation over a tidal period. Half-life time is mainly dominated by the semidiurnal M_2 tide and almost independent of the start time. The non-linear interaction of M_2, S_2, O_1 and K_1 seems not very important in exchange speed. In order to reveal the exchange process essence in detail, the bay is separated into four subsystems and then share ratio and contribution ratio are studied to describe the interactions among them. According to our simulation, Box IV is under heavy burden of accommodating the contaminant from other boxes while Box II is most active region for water exchange.

11AM2002 POC-178 Poster
APPLICATION OF PIECEWISE CURVE-FITTING TECHNIQUE FOR RECONSTRUCTION OF THE DENSITY CTD PROFILES NEAR NORTHEASTERN SAKHALIN COAST

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Researching the main features and properties of the vertical profile of oceanographic parameters (upper quasi-homogeneous layer, intensity and depth of the density jump, *etc.*) is an important component for the ocean water structure study.

Computational algorithm for data processing of the density vertical CTD profile was developed on the basis of an iterative least-square method. The technique was consisted of two stages. First, the profile was fitted to a broken line model with a given accuracy. A posterior specific analysis of this line allowed automatically detecting layers with the local maximums of density gradient and their quantity N. Then curve-fitting to the hyperbolic function was used within intervals between the upper limits of those layers. 3N parameters of this piecewise curve-fitting model of the density vertical structure represent layers boundaries, magnitudes of density gradients and asymptotic density values in deep waters for each of CTD profiles.

The above technique was used for analysis of CTD observations carried out during the international marine expedition (R/V *Khromov*, August 1998) near northeastern Sakhalin coast. 3D density structure in the region for the summer period was diagnosed based on individual processing of the whole profile set. The following features were revealed: (i) existence of the upper well-mixed 5-15 m wide layer and a strongly pronounced primary pycnocline below it, sometimes with the breaks within 30-150 m and, (ii) presence of the weak but visible local maximum of density gradient within 350-450 m that was occurred mainly at the continental slope.

11AM2002 POC-179 Poster
INTERNAL WAVES AROUND SAKHALIN: PRELIMINARY MAPPING WITH ERS SAR

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The ship observations and the results of modeling have shown that tides play the significant role in the oceanography of the Okhotsk Sea. Both diurnal and semidiurnal currents increase in shallow waters and in particular in proximity to Sakhalin. The interaction of tidal currents with shelf break and other topographic features generate the packets of nonlinear internal waves (IWs). Together with tidal currents, they contribute significantly to the vertical mixing. Relatively little is known about IWs spatial distribution and properties. Over 100 ERS-1/2 Synthetic Aperture Radar (SAR) images were collected to map the IWs around Sakhalin. They include both the full resolution and quick look images, which show only the high radar contrasts. The variable surface currents induced by the IWs modulate the small-scale sea surface roughness that, in turn, determines the intensity (brightness) variations on the SAR images. The IWs were detected on about 25% of all images taken during warm season. They were found along the eastern shelf Sakhalin, in the area between Sakhalin and Hokkaido, in the Tartar Strait and to the north of Sakhalin. The IWs parameters that can be evaluated from the images (the distance between the leading and the successive waves, number waves in a packet, length of crests, the distance between successive packets, *etc.*) and relevant data change in a broad range. These variations reflect in particular the variations of water properties on the Sakhalin shelf.

11AM2002 POC-180 Oral
SATELLITE SAR CHARACTERIZATION OF OCEANIC DYNAMIC FEATURES IN THE JAPAN/EAST SEA

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In the Japan/East Sea circulation patterns are spatially complex and seasonably variable. In the upper 200 m layer water properties are altered by lateral exchanges through several straits and vertical exchanges with the atmosphere. At the mesoscale (10-500 km), the upper column is known to be a complex of warm and cold currents, eddies and upwelling zones. At still lesser scales a significant contribution to the variability gives the narrow streamers, internal waves, river plumes, *etc.* Wind fields are also complex and affected by mountains and other land boundaries. SAR images from the ERS-1 and ERS-2 satellites allowed us to reveal the surface manifestations of the meso- and finescale oceanic dynamic features which were observed against the variable background induced by the surface wind variations. 136 precision images provided by the ESA and over 250 quick look images with reduced resolution were used in the study. The SAR images were taken in 1992-2002 and cover mainly the northwestern portion of the sea. The main attention was given to characterization of the eddy patterns in the subpolar frontal zone and upwelling phenomenon near the Primorie coast. Additionally, the coastal fronts, the packets of internal waves, ice eddies and other ice features were identified on the SAR images. Data from the NOAA AVHRR, weather maps and several cruses were used for verification of the SAR image-based interpretation.

11AM2002 POC-181 Poster
HYDROLOGICAL CONDITIONS OF THE OF THE KURIL ISLAND ZONE AND THE ADJACENT AREAS

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Structure and dynamic of the Kuril Straits were studied using thirty-year hydrological and meteorological observations in the Kuril Islands area. Characteristic differences of various water modifications (Okhotsk Sea from Pacific ocean and transformed) in the main Kuril Straits (Fourth Kuril, Kruzenshtern, Bussol, Friez, Ekaterina) were shown. The dependence of the water structure formation in the straits on the variability of the water exchange through the straits and climate was revealed. New information about hydrology-acoustical water characteristics was obtained. Various nature sound canals exist was revealed there, that is connected with hydrological structure complicated character.

11AM2002 POC-182 Oral
DIRECT CURRENT MEASUREMENTS OF THE TSUSHIMA WARM CURRENT TO THE WEST OF THE HOKKAIDO IN THE NORTHERN JAPAN SEA

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Two joint projects have been carried out to estimate the volume transport through the Soya Strait and the Tsugaru Strait. One of the projects is with Sakhalin Scientific Research Institute of Fisheries and Oceanography at the Soya Strait, and the other is with the Aomori prefecture at Tsugaru Straits. The Tsushima Warm Current off the west of the Hokkaido (TWCH) is very important as the link between the outflow current system from the Tsugaru Strait and from the Soya Strait. In order to clarify the current variability of TWCH, direct current measurements of TWCH were conducted. The first mooring which consisted of three current meters at 320, 640 and 2200 m, deployed at (42-30N, 139-01E, 3500 m deep) for a year in 1998-1999. Average northward current velocities at the upper, middle, and lower layers were 6.3 cm/s, 5.6 cm/s and 7.6 cm/s respectively. The second mooring which consisted of three current meters at 580, 1180, 2000 m, deployed at (42-30N, 137-48E, 3680 m) for 8 months in 1999-2000. Average northern current velocities at three layers were less than 0.5 cm/s. The third mooring which consisted of three current meters at 70, 430 and 1950 m, deployed at (42-41N, 139-39E, 3070 m) for a year in 2001-2002. Average northward current velocities at the upper, middle, and lower layers were 10.4 cm/s, 2.0 cm/s and 1.7 cm/s, respectively. These results indicate that deep current under TWCH is barotrophic and width of this current is likely to be narrower than that of TWCH.

11AM2002 POC-343 Oral
MIXED-LAYER HEAT BALANCE IN THE WESTERN NORTH PACIFIC

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Mixed layer heat balance in the western North Pacific is examined using historical temperature data combined with NCEP re-analysis surface wind and heat flux data. Despite different data sources, surface thermal forcing closes the mixed layer heat budget in an essentially consistent way with horizontal advection and vertical entrainment. For the long-term mean, surface thermal forcing is dominated by a pattern that contains three regimes: heating over the Mindanao Dome, cooling along the western boundary, and heating in the central northern subtropical gyre. Vertical entrainment due to Ekman pumping, geostrophic advection by the Kuroshio, and vertical entrainment associated with the deepening of mixed layer depth are primarily responsible for these regimes. Although surface thermal forcing is fundamental to the seasonal variation of sea surface temperature (SST), the effect of ocean dynamics is not negligible, and this is particularly true at the developing stage of the summer monsoon. There is a northeastward advance of warm SST (>29°C) from late May to early July in the region 120°-160°E, 10°-20°N, corresponding with the northeastward march of the onset of the summer monsoon. As the summer monsoon develops, vertical

entrainment is effective at cooling and leads to a decrease of SST against the incoming surface heat flux in a large part of the western North Pacific.

11AM2002 POC-184 Oral

EXAMINING LARGE-SCALE VARIABILITY IN THE PACIFIC OCEAN USING EARLY DATA FROM THE ARGO ARRAY OF PROFILING FLOATS

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When the Argo array is fully deployed in 2006, there will be approximately 1000 profiling floats in the Pacific Ocean measuring temperature and salinity between the surface ocean and depths of 1000 m or more, at 10 day intervals. At the present time, about 200 of the floats have already been deployed. While the spatial coverage is far from optimum at this time, it is possible to use the existing Argo data to compare the present state of the N. Pacific in some regions to historical mean values derived from the NOAA World Ocean Atlas. In this talk we examine the presently existing Argo observations and attempt to map upper ocean and deep temperature and salinity anomalies in the Northwest and Northeast portions of the Pacific.

11AM2002 POC-185 Oral

MASS AND FRESHWATER TRANSPORT BY MESOSCALE EDDIES IN THE KAMCHATKA CURRENT

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The western subarctic gyre consists of four major current systems: the Oyashio, Kamchatka Current, Alaskan Stream and Subarctic Current. During the past decade significant variability has been observed in the Oyashio and Kamchatka Current. In particular, there are two systems of anticyclonic eddies within the Oyashio and Kamchatka Current. Visible, infrared images from the NOAA satellites and INPOC hydrography show intense oceanic eddies in the Kamchatka Current. The chain of eddies extends from 50°N to 60°N. We use these images to track the Kamchatka anticyclonic eddies to show that such eddies move southward from the Bering Sea with typical speeds of ~ 5 cm/s. An individual eddy thus requires about five-six months to travel from the Kamchatka Strait to the southern tip of the Kamchatka peninsula. There is a distinctive difference between Kamchatka and Oyashio anticyclonic eddies; the latter move northward at a much slower speed (about 1 cm/s). We show that: (a) transport of mass by the Kamchatka eddies has the same value (~7 to 11 megatons per second) as the geostrophic transport by the proper Kamchatka Current (~ 6 to 16 MT/s); (b) there is significant interannual variability of the properties of eddies; and (c) freshwater transport by the Kamchatka current is a major cause of coastal sea level variations. We show that the Kamchatka coastal sea level variability is related to the Arctic Oscillation.

11AM2002 POC-186 Poster

THE CHARACTERISTIC OF THE OKHOTSK SEA WATER DYNAMIC NEAR THE WESTERN KAMCHATKA COAST IN 1996-2001

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Speed and volume transport of the West Kamchatka and Compensatory currents on the section along 55 N in April 1996-2001 were calculated based on data of TINRO-Centre research.

In 1996, the section along 55 N was shorter than in all another concerned years. Therefore the west border of West Kamchatka current was not reached. On distribution of isotachs on the chart of geostrophic speeds it may be assumed that about the half of flow was outside of survey limits. Taking this fact into consideration we conclude that water transport of West-Kamchatka current in 1996 was the same as in 1997.

The analysis of interyear variability of dynamic characteristics of the main geostrophic flows near the West Kamchatka allow to make the following conclusions: the maximum volume transport of the West Kamchatka current was in warm years (in years with warmer winters): 1996 and 1997. The volume transport in cold years was substantially lower. Thus the volume transport in 2001 was less than half of that in 1997 (0.56 and 1.28 Sv).
The Compensatory current on the section along 55 N in April in warm years was not observed. In the water area of traditional position of the Compensatory current there was observed slow water transitions in northern direction (the volume transport 0.001-0.009 Sv) with speed up to 1.3 cm/s.

In cold years there was observed permanent increase of dynamic characteristics of Compensatory current. At present, the maximum volume transport was observed in 2001 (0.09 Sv) with speed 3.9 cm/s.

11AM2002 POC-187 Oral
MEASUREMENTS OF CURRENTS AND WATER PARAMETERS IN ANIVA BAY, SOUTHERN SAKHALIN

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Aniva Bay (Southern Sakhalin) is an area of rich fishing resources, but understanding of dynamic processes in this area is strictly limited due to lack of direct current measurements in the bay. That is why, Sakhalin Research Institute of Fisheries and Oceanography installed an autonomous buoy station Eva in Aniva Bay (approximate coordinates are 46°N, 143°E) to investigate physical properties of sea water and character of its motion. This station included Aanderaa RCM-4 current-meter (depth about 75 m; measuring current velocities and temperature), 3-dimensional current-meter SonTek (35 m; temperature and salinity) and water quality monitor YSI-6660 in the upper layer (7 m; temperature, salinity, pH, oxygen, chlorophyll, and turbidity). These observations were carried out from September 25 to November 11, 2000.

The most interesting dynamic processes were observed in the intermediate layer. There were significant changes of water temperature (about 7-10°C) and salinity (1.5-2‰). Well-expressed oscillations of currents with a period of about 16 hours (close to the inertial period for this region) were the main feature of the observed currents. Northward currents dominated in the near-bottom layer and southward in the intermediate layer. Vertical component of the upper currents was mainly negative (downwelling). Water temperature decreased slowly with time in the upper layer. Chlorophyll concentration increased abruptly (more than two times) on November 3, 2000. Turbidity increased gradually during the last week of the observations.

11AM2002 POC-188 Oral
SEASONAL VARIABILITY OF HYDROCHEMICAL PROPERTIES IN THE JAPAN/EAST SEA

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Data discussed in this paper were collected during cruises in the Japan/East Sea aboard R/V *Roger Revelle* and *Professor Khromov* in summer 1999 and aboard R/V *Professor Khromov* in late winter 2000. From comparison of hydrochemical properties in the Japan/East Sea for summer and winter seasons, the conclusion have been deduced, that the seasonal variability is revealed not only for upper mixed layer, but also for deeper layers. This variability is caused by enhanced vertical mixing in the winter season. It is shown that the enhanced intensity of mixing in deep layers for winter might be caused by brine rejection and deep convection in open part of the sea as well. It is established, that the area of positive values of the biological term of apparent oxygen utilization coincides with area of deep convection for a winter season. There are two distinct climatic areas in distribution of carbon dioxide of partial pressure for both seasons. The northwestern region of the sea is a source of carbon dioxide into an atmosphere due to deep convection in wintertime and warming up in summer. Southern region is sink of

atmospheric carbon dioxide. It is caused by photosynthesis and cooling of the entering surface water through Korean Straight.

11AM2002 POC-189 Oral

TEMPORAL CHANGE IN DISSOLVED INORGANIC CARBON CONTENT IN THE WESTERN NORTH PACIFIC WATER

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The recent global warming may also change the ocean as well as the natural climate changes. It is important to distinguish them from the observation in the field. In the subpolar region of the North Pacific, the apparent oxygen utilization (AOU) and the phosphate content on the 26.7–27.2σ_θ surfaces were increasing during the period from 1968 to 1998, suggesting the reduction of formation rate of water mass. Our purpose of this study is to examine whether the oceanic dissolved inorganic carbon (DIC) content in the North Pacific has changed or not together with these changes using our decadal dataset of DIC and AOU observed along a 155°E between 35-44°N from 1992 to 2001. Both the AOU and DIC contents on the 26.9–27.2σ_θ surfaces increased significantly at KNOT (44°N, 155°E) during the period. Their averaged increase rates were 1.2±1.0 μmol/kg/yr for AOU and 2.2±0.9 μmol/kg/yr for DIC. Since the increase in AOU in the subsurface layer may imply the reduction of formation rate of water mass in the western subarctic gyre, the temporal change in the DIC is due to increase in DIC caused by the increased anthropogenic CO_2 and the change in the formation rate of water mass. Subtracting the change in the formation rate of water mass converted from the AOU change and the Redfield ratio ($\Delta C/\Delta O_2$=0.688) from the DIC change, the increase rate of CO_2 absorbed in seawater was estimated to be nearly 1.4 μmol/kg/yr in the western subarctic gyre during the period.

11AM2002 POC-190 Oral

A POSSIBLE ORIGIN OF JAPAN SEA INTERMEDIATE WATER

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The Japan Sea Intermediate Water (JSIW) is known as an intermediate water with salinity minimum. JSIW has the density of approximately 27.2 sigma theta and it is distributed all most of whole Japan Sea, but it is suggested that the formation area is limited; it is formed in the western Japan Sea only. In this study the distribution and the formation mechanism of JSIW are examined by using historical CTD data. As a result, two sources of low salinity water can be detected. One is low temperature and low salinity water originated from the Liman Current, which flows southwestward along the Russian coast. The other is high temperature and low salinity water originated from the East Korean Current. It is considered that this low salinity water is formed in the East China Sea, and it flows into the Japan Sea only in summer. According to results of numerical models, this low salinity water can reach to the western Japan Sea in 2-3 months. On the other hand, the effect of Liman Current is appeared mainly in spring-summer. Thus, it is considered that the low salinity water originated in the East China Sea is a possible source of JSIW.

11AM2002 POC-191 Oral

POSSIBLE IMPACTS OF NORTH PACIFIC INTERMEDIATE WATER ON FRONTS AND CLIMATE VARIABILITY

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North Pacific Intermediate Water is a water mass characterized by salinity minimum in the North Pacific subtropical gyre. Recent observations show that substantial subarctic waters intrudes into the subtropical gyre and transports anthropogenic CO_2 into intermediate depths. Series of simple layered models are used to examine the effects of the Okhotsk Sea low-potential vorticity water on the frontal structures in the Kuroshio-Oyashio confluence region. Thick thermocline depths at the western boundary of the Oyashio, that is possibly caused by dense shelf water formation and tidal mixing around the Okhotsk Sea, substantially alters the frontal structures. We will discuss possible interdecadal variations of these fronts and water-masses and propose a hypothesis and a research plan.

11AM2002 POC-192 Poster

NEW MECHANISM OF DEEP WATER FORMATION IN THE PETER THE GREAT GULF, THE SEA OF JAPAN

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A new mechanism for ventilation of deep bottom layers in the Sea of Japan is proposed. The mechanism is connected with upwelling of intermediate waters to the upper layer, consequent cooling at the surface and its sinking to the deep layers.

Intermediate waters with salinity greater than 34 psu appear at the surface in fall (in November). This process leads to the cooling and the increase of oxygen concentration. Strong northwestern wind produces compensatory current towards the Gulf from the offshore region during this period. Vertical component of this current arises above the continental slope and leads to upwelling of intermediate layers. These waters then cool, move to the offshore region by the wind and sink to the bottom layer. This process of renewal of deep water depends on the wind intensity. Deep-layer renewal due to high-density water formation (during ice growth on the shelf) takes place only in extremely cold winter. Since the volume of this high-density water is small in comparison with the volume of deep layer, its contribution to ventilation is also small. The above conclusion is confirmed by the field study during fall and winter.

11AM2002 POC-193 Poster

ESTIMATION OF THE SEASONAL AND INTERANNUAL VARIABILITY OF THE TEMPERATURE WATERS IN THE OKHOTSK SEA

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We examine the seasonal and long-range variability of the oceanographic regime in the Okhotsk Sea in the second half of the twentieth century using the largest T-S data set, containing about 70,000 stations. The database was compiled using oceanographic data that were generated and collected by different scientists from institutes in Russia, the U.S.A. and Japan.

Previous investigations showed a significant seasonal and interannual variability of oceanographical processes. But usually those did not contained the estimations of the reliability of the results.

In this paper the possibility of interannual variability existence is considered using factor analysis. Dispersion decomposition can be shown in the following way:

$$\sigma^2_{total} = \delta^2_{\text{int } erannual} + \overline{\sigma^2}_{occasional}$$

$$\delta^2_{\text{int } erannual} = \frac{\sum_j^m (\bar{y}_j - \bar{\bar{y}})^2 n_j}{\sum_j^m n_j} \quad , \quad \overline{\sigma^2}_{occasional} = \frac{\sum_j^m \sum_i^{n_j} (y_{i,j} - \bar{y}_j)^2}{\sum_j^m n_j}$$

where y_{ij} – water temperature i in j (year), i= 1,....n_j; n_j – number of observations in j (year), $\bar{y}_j$ - annual average water temperature in j (year), $\bar{\bar{y}}$ - multi-year average water temperature.

The Okhotsk Sea was divided into several relatively homogeneous regions where calculations were made.

Limitation coefficient (η^2) was determined due to the following equation:

$$\eta^2 = \frac{\delta^2_{\text{int } erannual}}{\sigma^2_{total}}$$

Problem of errors consideration is the most actual because oceanographic investigations are limited by a number of samplings. Considering that average monthly and year sampling values ($\bar{X}i$ и $\bar{X}j$) are calculated with errors, so probable errors was determined due to the following correlation:

$$\pm\Delta = t * \frac{\sigma}{\sqrt{n-1}},$$

where **t** - coefficient of confidence by Styudents table, **σ** – average quadric deviation of concrete row, **n** – number of observations.

Average values of samplings will distinguish if their confidence intervals do not cross. It will be correct if the following equation is made:

$$\bar{X}i - \bar{X}j > t_i * \frac{\sigma_i}{\sqrt{n_i - 1}} + t_i * \frac{\sigma_j}{\sqrt{n_j - 1}}.$$

In this work the annual amplitudes of temperature waters of different horizons and topography of the lower border of active layer are presented. Interannual variability of Cold Intermediate Waters is estimated. The summertime temperature in the core of Cold Intermediate Waters is used as an indicator for the long-term change of the hydrological regime of the Okhotsk Sea.

11AM2002 POC-194 Poster

CLASSIFICATION OF THE THERMAL CONDITIONS OF THE BOTTOM WATERS ON WESTERN KAMCHATKA SHELF

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The results of oceanography observations carried out in (May-August) 1963-2001 in the northeastern Okhotsk Sea are analyzed. Years of observations were classified according to their thermic conditions. We used about 5000 measurements of the bottom water temperatures. Seasonal variability in distribution of bottom temperature and long-term fluctuation of bottom temperature anomalies are discussed. The typification of hydrological regime was conducted on temperature anomalies of bottom waters for the area near Kamchatka Peninsula: 154°-156°5′E and 51°25′-57°25′N. There were marked four types: "extremely cold ", "cold", "normal" and "warm". This approach allows "extremely cold" (1966, 1967) years in the thermic regime of the western Kamchatka shelf. 1963, 1964, 1968, 1977, 1984, 1986, 1989, 1991, 1996 are referred to as "warm" years; while 1970, 1971, 1973, 1979, 1980,

1981, 1982, 1994, 1998, 1999, 2001 are "cold" years; the rest of years from 1963 to 2001 are "normal". Distribution of near-bottom water temperature is shown for cold, warm and normal years on based on averaged data.

During "cold" hydrological years almost whole shelf of West Kamchatka is under the waters with negative bottom temperatures, excluding only the narrow coastal area, lower part of the shelf, and extreme south region of the research area. At the same time a comparatively large nucleus of cold bordered by -0.5°C is situated in the north part of the shelf at 50-100 m. The average bottom water temperatures here reach -1°C. In the south regions of the shelf the average bottom water temperatures vary from 0.5 to 1.5°C.

In the years of "normal" thermal conditions the area of bottom water temperatures below zero is divided in two, approximately even areas, called "the cold lens". Each of these lenses is spread meridionally about 60 miles. The lowest average temperature in these lenses is approximately -0.3°C. On the central shelf the areas of lowest bottom water temperatures is rather undefined, and the south border of this area is moved 30-40 miles to the north.

During the "warm" years almost whole shelf of West Kamchatka's bottom water average temperatures are above zero. The cold lenses with negative bottom water temperatures still exist as small cold spots in the central and northern shelf.

MEQ Paper Session

Convenor: John E. Stein (U.S.A.)
Tuesday, October 22, 2002 08:30-12:30

Papers are invited on all aspects of human activity effects on the quality of the marine environment in the North Pacific. Of particular interest are following: emerging toxic chemicals of concern, long-range transport of contaminants, ecological impacts of mariculture, fate and effects of sediment-associated contaminants, and diseases in marine species related to human activities.

08:30-08:50	**Tatiana A. Belan, E.V. Oleynik, A.S. Chernova, A.V. Moschenko** Long-term changes in ecosystems in Peter the Great Bay (MEQ-155)
08:50-09:10	**Zhengyan Li, Jong-Jeel Je, Donghao Li, Jae-Ryoung Oh** Contamination of alkylphenolic compounds in Shihwa Lake, Korea (MEQ-159)
09:10-09:30	**Ichiro Yuasa** Long-term changes of coastal fauna and the monitoring techniques of index for coastal fauna in the Seto Inland Sea, Japan (MEQ-162)
09:30-09:50	**Dong Beom Yang, Jun Yu, Kyung Tae Kim, Chang Soo Chung, Young Il Kim, Gi-Hoon Hong** PAHs, PCBs and organochlorine pesticides in the bottom sediments of the southeastern Yellow Sea. Results of observation made in 1999-2000 (MEQ-161)
09:50-10:10	**John E. Stein** Recent technological advances to answer old ecotoxicology questions (MEQ-330)
10:10-10:30	**Coffee/tea break**
10:30-10:50	**Irina G. Agafonova, Dmitry L. Aminin, Richard F. Addison** Biomonitoring study with physiological biomarkers in English sole hepatocytes using fluorescent molecular probes (MEQ-310)
10:50-11:10	**Dmitry L. Aminin, Irina G. Agafonova, Richard F. Addison** Ecotoxicological monitoring of marine sediments using sea urchin embryos (MEQ-311)
11:10-11:30	**Glen Jamieson, Brenda Bauer, Herb Vandermeulen** Ecosystem-based management as part of a Marine Environmental Quality (MEQ) approach in the Central Coast, British Columbia, Canada (MEQ-158)
11:30-11:50	**Sheng Liu, W.-X. Wang** Feeding and reproductive responses of marine copepods in South China Sea to toxic and nontoxic phytoplankton (MEQ-313)
11:50-12:10	**Julia K .Parrish** Tracing the path: Contaminants, elements, and metabolites
12:10-12:30	**Discussion and summary**

Posters:

Anastasia S. Chernova, T. Lishavskaya, A. Moshchenko, T. Konovalova
Effect of physical and chemical properties of the bottom sediments on distribution of petroleum hydrocarbons, phenols and detergents contained in sediments of the northeast shelf and in a number of other coastal water areas of Sakhalin Island (MEQ-156)

Ludmila S. Dolmatova, A.L. Kovaleva, O.A. Shitkova, N.F. Timchenko
Generaton of reactive oxygen species by the coelomocytes of the holothurian eupentacta fraudatrix in response to bacterial toxin (MEQ-157)

Aleksey V. Savchenko, Lev M. Gramm-Osipov, Valentina N. Gramm-Osipova
Physico-chemical modeling of behaviour of arsenic, cromium and vanadium in the mixing zone of river and sea waters (MEQ-160)

11AM2002 MEQ-310 Oral

ECOTOXICOLOGICAL MONITORING OF MARINE SEDIMENTS USING SEA URCHIN EMBRYOS

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It is well known that echinoderms constitute an ideal material for marine ecotoxicological tests. Embryo of sea urchin *Strongylocentrotus fransciscanus* and *S. nudus* were introduced into the biomonitoring of marine sediments collected during the scientific expedition in June 2000 onboard of R/V "Vector" (IOS, Canada) along the western coast of British Columbia, Canada. Sediment samples were obtained using dredge at following stations: Kitimat, Kildala Arm, Tuwartz Inlet, Ocean Falls, Trincomali Channel, Crofton and Vancouver (Port Moody Arm). Sediments collected from several sites in each station were dried, extracted and analyzed. Samples of surface waters collected at the same places were also tested using sea urchin sperm and embryo.

There were no significant inhibitory effects upon sea urchin egg fertilization and embryo development in the tests with surface water samples collected. However, some sediment extracts were shown to be toxic to embryo development. Some extracts seemed to have anti-mitotic activity and exhibited undivided and lysed blastomeres. Some morphological abnormalities, such as abnormal cleavages and delay of development were observed also. The cytotoxicity of sediment extracts was estimated.

The data obtained indicate that the samples from Port Moody Arm, Crofton and Trincomali Channel stations seem to be the most polluted compare to Kitimat and Kildala Arm.

The trends in observed sediment embryotoxicity increases from Kitimat toward Vancouver. These results agree with the data recorded with fish liver biomarkers and maybe related to the existence of a pollutant gradient in the studied area.

11AM2002 MEQ-311 Oral

BIOMONITORING STUDY WITH PHYSIOLOGICAL BIOMARKERS IN ENGLISH SOLE HEPATOCYTES USING FLUORESCENT MOLECULAR PROBES

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During a scientific expedition in June 2000 onboard of R/V "Vector" (IOS, Canada) from Kitimat to Sidney, BC, a biomonitoring study of contaminant impact upon flatfish liver was carried out using *in vitro* methods on isolated hepatocytes. Samples of flatfish English sole, *Parophrys vetulus*, were collected by trawling in following stations: Kitimat, Kildala Arm, Tuwartz Inlet, Ocean Falls, Trincomali Channel and Crofton. Of these sites, Crofton was expected to be contaminated by pulp mill effluent and Kitimat by pulp mill effluent, smelter effluent and shipping activity; Ocean Falls was expected to be affected by past PCB discharges, and the remaining sites were considered to be "reference" sites with limited contaminant exposure. Two males and two females of fish were taken from each station for analysis. Intracellular biomarkers including lysosome activity, esterase activity, DNA content, intracellular Ca^{2+} concentration, cell biomembrane microviscosity and EROD of liver cells were measured using specific fluorescence molecular probes and spectrofluorimetry techniques.

Hepatocyte membrane microviscosity, lysosomal activity and non-specific esterase activity were significantly lower, and intracellular calcium concentration higher in hepaticytes from fishes caught at Crofton. DNA content and EROD activity were also augmented. These findings indicate that the physiological status of liver cells was damaged and fish from this area might be impacted by organic xenobiotics which induced observed changes. Data recorded with the fish caught at Kitimat showed opposite results to those at Crofton. The trends in fish liver hepatocyte lesions increased from Kitimat toward Crofton. This may be related to the existence of some pollutant gradient in the studied area. No sex differences in biomarker activity of studied fish hepatocytes were found. The results obtained using fluorescent molecular probes indicate their potential in identifying molecular and subcellular biomarkers of xenobiotic-induced cell injury in isolated liver cells.

11AM2002 MEQ-155 Oral

LONG-TERM CHANGES IN ECOSYSTEMS IN PETER THE GREAT BAY

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Comprehensive ecological expedition in Peter the Great Bay was carried out in August 2001 to obtain new data on benthic communities pattern distribution and to compare it with those revealed in 1930s, 1970s and in 1986-1990.

The distribution pattern of benthic communities in 2001 was very similar to those obtained in 1986-1990. Bivalve molluscs *Theora lubrica, Leionucula ovatotruncata* and *Mya pseudoarenaria*, polychaetes *Tharyx pacifica, Scoloplos armiger, Maldane sarsi* were the most common species in Amursky Bay. Surprisingly, polychaete *Scalibregma inflatum* was found among dominant species in 2001, as in the 1970s, while during 1986-1990 it was rare and escaped highly polluted zones in Amursky Bay. Communities of bivalves *Acila insignis, Theora lubrica, Leionucula ovatotruncata*, echinoid *Echinocardium cordatum* were widespread in Ussuriysky Bay in 2001. In Golden Horn, mainly polychaetes were found.

Biological data for the period from 1971 to 2001 showed that high density of pollution-insensitive species in the coastal zone of Peter the Great Bay occurred in 1975-1980, when industrialization and urbanization growth was very intensive. These species didn't report to be occurred in the 1930s in the study area, while at the beginning of the 1970s they were found sporadically, and became wide spread in 1975-1980. In 1986-1990 the set of positive species-indicators didn't changed. In 2001, non-tolerant species became more numerous again in some areas (as in 1970s), probably due to decreasing of pollution load of the bay. Data on chemicals in bottom sediments in the study area in 2001 demonstrated decrease in average content of PHCs, DDT and Cd in comparison with 1986-1990. However, judging by high concentration of chlorinated hydrocarbons in bottom sediments sources of DDT in the Peter the Great Bay still exist.

11AM2002 MEQ-156 Poster

EFFECT OF PHYSICAL AND CHEMICAL PROPERTIES OF THE BOTTOM SEDIMENTS ON DISTRIBUTION OF PETROLEUM HYDROCARBONS, PHENOLS AND DETERGENTS CONTAINED IN SEDIMENTS OF THE NORTHEAST SHELF AND IN A NUMBER OF OTHER COASTAL WATER AREAS OF SAKHALIN ISLAND

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The purpose of this work is to identify interrelation of distribution patterns of phenols, petroleum hydrocarbons and detergents and effect of physical and chemical properties of the bottom sediments on distribution of the said compounds.

Spatial distribution of petroleum hydrocarbons, phenols and detergents in the bottom sediments of most water areas is characterized by marked originality. And, therefore, correlations of their concentrations are usually low and statistically are insignificant. Only marked coincidence in distribution patterns of petroleum hydrocarbons and phenols at one of the latitudinal sections and in the Port of Kholmsk is exception to the rule. Generally, the degree matching of spatial distributions of studied compounds increases under increase of the water body pollution.

Distribution of petroleum hydrocarbons, phenols and detergents in the bottom sediments of most water areas is low dependent on the grain size, moisture, pH, oxidation-reduction potential and C_{org} content. However, as in case of inter-correlation, the degree of relation of the pollutant contents with various bottom sediment parameters grows under increase of the pollution level. For moisture, C_{org} and the content alevropelite correlations become undoubtedly positive, and for pH and, in less degree, for EH become negative.

11AM2002 MEQ-157 Poster

GENERATON OF REACTIVE OXYGEN SPECIES BY THE COELOMOCYTES OF THE HOLOTHURIAN *Eupentacta fraudatrix* IN RESPONSE TO BACTERIAL TOXIN

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Pure fraction (92-95%) of phagocytes (FP) and a mixture (62%:38%) of phagocytes and spherulocytes (FMPS) of the holothurian *Eupentacta fraudatrix* (Holothuroidea, Dendrochirota) were obtained using ficoll-verographine step gradient. Basal production of reactive oxygen species (ROS) in FP being quantified using reduction of nitroblue tetrazolium (NBT) was about 2-fold higher compared to that in FMPS. Thermostable toxin of Yersinia Pseudotuberculosis (TST) at different concentrations (0.1; 0.2; 0.5; 2.5 μkg/ml) stimulated NBT reduction in both cell fractions, and maximal effect was observed at a concentration of 0.2 μkg/ml. By 46 hr of incubation, TST (0.2 μkg/ml) stimulated NBT reduction in FMPS 13-fold, and in FP – 16-fold compared to the control. Addition of commercially available catalase (0.7 mkg/ml) to FP treated with TST was followed by inhibition of endogenous superoxide dismutase and increase in NBT reduction compared to those under the treatment of toxin alone. In whole, data obtained indicate that ROS generation in holothurian coelomocytes most presents in phagocytes, and that changes in ROS production by these cells may be one of the mechanisms of antibacterial protection of holothurians.

MEQ PAPER

11AM2002 MEQ-158 Oral

ECOSYSTEM-BASED MANAGEMENT AS PART OF A MARINE ENVIRONMENTAL QUALITY (MEQ) APPROACH IN THE CENTRAL COAST, BRITISH COLUMBIA, CANADA

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In 2002, Fisheries and Oceans Canada (DFO) has begun applying the ecosystem-based management approach developed at a national DFO workshop in 2001. Efforts have begun to determine from broader conceptual environmental objectives appropriate regionally-relevant operational, or MEQ, objectives, with associated indicators and reference points, that will be used in oceans management. From the broad conceptual objectives of conservation of species and habitat, we are defining MEQ objectives specific to BC's Central Coast relating to biodiversity, productivity, and the physical and chemical properties of the ecosystem. Under each of these, further nested components were defined, utilising an "unpacking" process that links the conceptual objectives to those suitable for operational management. For each nested component, a suite of biological properties or characteristics is considered that further describes the objective. Example indicators and reference points were also considered by operational objective, i.e. from the bottom up. We have developed a list of initial issues and an action plan, including recommendations for further research, that DFO now needs to address to further the implementation of ecosystem-based management in this coastal region.

11AM2002 MEQ-159 Oral

CONTAMINATION OF ALKYLPHENOLIC COMPOUNDS IN SHIHWA LAKE, KOREA

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Alkylphenols (APs) are stable degradation products of a widely used non-ionic surfactant group, alkylphenol ethoxylates (APEs). APs have been demonstrated as endocrine disruptors and consequently received much environmental concern. Shihwa Lake, located in the west coast of Korea, is an artificial lake resulting from the construction of a long sea dike. This study focused on contamination levels and distribution properties of alkylphenolic compounds in water, suspended solids, surface sediments and core samples from Shihwa Lake and

seven inflowing creeks. A total of eleven phenolic compounds including nonylphenol, octylphenol and bisphenol A were measured, based on field surveys from November 2001 to March 2002.

Nonylphenol concentrations in lake water in March 2002 ranged between 23.8 and 1533 ng/L with an average of 254.6 ng/L. Those in creek water were however much higher with an average of 2628 ng/L. Nonylphenol concentrations in lake surface sediment were measured as between 30.9 and 3429 ng/g DW with an average of 1216 ng/g DW. Distribution coefficient (lgK_d) for nonylphenol was recorded as 3.7 in average in Shihwa Lake. Core sample analysis showed that nonylphenol concentrations increased substantially with depth, probably reflecting the establishment and function of sewage treatment plants in the area. These results demonstrate that nonylphenol distribution in Shihwa Lake was under a strong influence from several industrial complexes nearby. Concentrations of alkylphenolic compounds in Shihwa Lake were within the levels recorded in other polluted areas of the world. Possible effects of high alkylphenol contents on biological community in the lake are discussed.

11AM2002 MEQ-313 Oral
FEEDING AND REPRODUCTIVE RESPONSES OF MARINE COPEPODS IN SOUTH CHINA SEA TO TOXIC AND NONTOXIC PHYTOPLANKTON

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The influences of the toxic and nontoxic dinoflagellate *Alexandrium tamarense* and the diatom *Thalassiosira weissflogii* on the feeding and reproductive responses of the calanoid copepods *Calanus sinicus* and *Paracalanus crassirostris* were examined. Experiments were carried out to investigate the functional feeding response of copepods at different food concentrations for toxic and nontoxic *A. tamarense* and diatoms. Egg production of the copepods was compared at the same cell concentration (0.21°mg C l^{-1}) for the three algal diets. The results demonstrated that the two copepods were able to feed on toxic dinoflagellates at rates similar to or higher than the rates with nontoxic dinoflagellates. Maximum ingestion rates were recorded at a food carbon concentration of 0.5°mg C l^{-1}. The toxic and nontoxic dinoflagellates were radio labeled with ^{109}Cd and ^{75}Se, respectively, and fed to the copepods as a mixture. The ratio of the two radiotracers in the copepods after feeding was comparable to the ratio measured in the cell mixture, indicating that the copepods were not able to select the particles based on the paralytic shellfish poisoning toxin content of the cells within a short exposure period. Copepods fed with the toxic dinoflagellates produced on average 17-46% fewer eggs than the animals fed with the nontoxic dinoflagellates and diatoms, although there was no significant difference among the three algal treatments due to the great variation among different individuals. The hatching success of eggs produced by copepods fed on the three diets and the larval development were, however, comparable. A field study was conducted to determine the grazing pressure of copepods on phytoplankton during a massive dinoflagellate bloom dominated by *Prorocentrum dentatum* in summer. Our calculations indicated that copepod grazing was able to remove <10% of the phytoplankton standing stocks under these conditions.

11AM2002 MEQ-160 Poster
PHYSICO-CHEMICAL MODELING OF BEHAVIOUR OF ARSENIC, CHROMIUM AND VANADIUM IN THE MIXING ZONE OF RIVER AND SEA WATERS

Aleksey V. **Savchenko**[1], Lev M. Gramm-Osipov[1] and Valentina N. Gramm-Osipova[2]

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The behaviour of chemical elements under mixing of sea and river waters is of a considerable interest for the geochemists and ecologists. There is a shift of the forms of migration of a lot of chemical elements, and also their removal from solution in this zone. Authors have carried out physico-chemical modelling of behaviour of an arsenic, chromium and vanadium in the estuary zone of the Amoursky bay - Razdolnaya River (near Vladivostok). The process of simulation was made by two software - SELECTOR - C and PRODEFA2/MINTEQA2.

The dominate forms of arsenic and vanadium as in river water as in sea water are $HASO_4^{2-}$ (66.9% and 98.26%) and $H_2AsO_4^-$ (33.09% and 1.51%); $VO_2(OH)_2^-$ (90.5% and 22.75%) and $VO_2(OH)_3^{2-}$ (9.45% and 72.5%). The dominate forms of chromium in river water are CrO_4^{2-}(77.96%) and $HcrO_4^-$(21.99%), but in sea water are CrO_4^{2-}(69.67%) and $NaCrO_4^-$(28.99%). Practically all arsenic (99.6%) and vanadium (99.5%) and only 4.6% of a chromium are sorbed on suspended matter in the river water. In the seawater nearly 16 % of arsenic, 7.5% of vanadium and 99.9% of chromium are in dissolved forms.

On the basis of modelling of sorption process of arsenic, chromium and vanadium in mixing zone is established, that the decrease of total dissolved concentrations of arsenic and chromium from a river water to seawater under of passing through a geochemical barrier is connected with its adsorption on a suspension and deposition last; and increase of total dissolved concentration of a vanadium under of passing through a barrier river water-sea water is connected with its desorption from suspended matter.

11AM2002 MEQ-330 Oral
RECENT TECHNOLOGICAL ADVANCES TO ANSWER OLD ECOTOXICOLOGY QUESTIONS

John E. **Stein**
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The field of ecotoxicology addresses a set of central questions in determining the effects of anthropogenic chemicals on aquatic and wildlife resources. Moreover, the questions are common to all species that may be exposed to a toxic chemical. In short, these questions revolve around determining to what extent exposure to a chemical alters the growth, development, reproduction and survival of individuals and how that may affect the dynamics of a population. While the questions have stayed the same the technology to answer the questions has changed dramatically. Many of the advances have come from adapting new technologies from biomedicine to the field of ecotoxicology. In this presentation, I cannot address all of the recent advances, but will focus on those techniques being used in our laboratory and those most appropriate to investigations of marine species.

11AM2002 MEQ-161 Oral
PAHS, PCBS AND ORGANOCHLORINE PESTICIDES IN THE BOTTOM SEDIMENTS OF THE SOUTHEASTERN YELLOW SEA. RESULTS OF OBSERVATION MADE IN 1999-2000

Dong-Beom **Yang**, Jun Yu, Kyung Tae Kim, Chang Soo Chung, Young Il Kim and Gi-Hoon Hong
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PAHs, PCBs and organochlorine pesticides were investigated in the bottom sediments of the southeastern Yellow Sea during 1999-2000. Total PAH concentrations varied from 14 to 111 ng g^{-1} dw with relatively higher concentrations occurring in the central muddy area. The low P/A values (1.7-7.0) of PAHs indicates that the bottom sediment of the southeastern Yellow Sea are largely originated from the incomplete combustion of organic matter. Annual total PAHs flux to the sediment was estimated to be 149$\mu g m^{-2} yr^{-1}$ in the central part of the Yellow Sea for the recent decade. Downcore depth distributions of PAHs from the relatively undisturbed core samples of the central Yellow Sea showed decreasing PAHs concentrations with core depths and suggested that the Yellow Sea has been increasingly exposed to PAH for decades. Concentrations of total HCH ranged from <MDL near the southwestern tip of Korean Peninsula to 1.6ng g^{-1} dw in the central Yellow Sea. β- and γ-HCH represented 62 and 28% of total HCH while α-HCH could hardly be found in the sediments of the southeastern Yellow Sea. Concentrations of total DDT in the surface sediment ranged from <MDL to 0.7ng g^{-1} dw. PCB levels were in the range of 0.3-4.8 ng g^{-1} dw. The maximum concentrations of chlorinated hydrocarbon pesticides are comparable to the relatively less contaminated European coastal seas.

11AM2002 MEQ-162 Oral

LONG-TERM CHANGES OF COASTAL FAUNA AND THE MONITORING TECHNIQUES OF INDEX FOR COASTAL FAUNA IN THE SETO INLAND SEA, JAPAN

Ichiro **Yuasa**

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On the coast where sea pollution advances, biota is poverty and development of the effective monitoring technique for coastal fauna is called for. In the 3rd annual meeting of PICES, I reported long-term changes from 1960 to 1990 years of coastal fauna in the Seto Inland Sea, the greatest inland sea in Japan. As for the number of species of coastal fauna in 1990, 60-75% had disappeared compared with it in 1960. This time, the recovery tendency of the coastal fauna species after the 1990s is introduced. Moreover, since horizontal monitoring investigation about *Pollicipes mitella* (Kamenote), *Oulastrea crispate* (Kikumeishimodoki) and *Thais clavigera* (Ibonishi) chosen as index in consideration of long-term changes was conducted. And the change in the number of individuals of index fauna in the seashore is grasped, the validity of the techniques of pursuing change of the habitation environment of the seashore is reported. By the investigation from 1999 to 2001, the number of individuals *Policipes mitella* and *Oulastrea crispate* tends to increase. Although they disappeared from the seashore in Kure, Hiroshima Pre. in the end of the 1980s, they appeared again entered in the 1990s. Moreover, also about *Thais clavigera* to which it is reported under the influence of an organic tin compound whether it is a female male, the number of individuals is increasing from 1995 age, and it is guessed that what did not live in the first half of the 1990s is what prohibition of use of an organic tin compound takes effect with.

W1 MONITOR Workshop
Requirements and methods for 'early detection of ocean changes'

Co-Convenors: David L. Mackas (Canada) & Sei-Ichi Saitoh (Japan)
Saturday, October 19, 2002 08:30-12:30

The goal of ocean monitoring is to provide an ongoing and reliable network of observations to detect and quantify changes in the physical, geochemical, and/or ecological "state of the ocean". From a relatively limited set of paleoceanographic and observational time-series, we now know that such changes occur, and that at least some of them are significant to climate and ecological interactions, and also to human populations. However, there has often been a time lag between the onset of ocean change, and human recognition of and response to these changes. In practice, there is sometimes an enforced trade-off between the local intensity of sampling efforts, and their spatial extent and temporal duration. This workshop will address questions such as: (i) How can we best design our monitoring programs to reduce the time lag between event and detection? (ii) What are the relative costs of false alarms vs. missed detections? and (iii) How can we make our monitoring programs robust to new modes of change?

08:30-08:45 **Introduction**

08:45-09:25 **James E. Overland**
Formal and conceptual approaches to change detection (W1-329)

09:25-09:45 **Vladimir I. Radchenko**
What tools do integrated ecosystem studies give for the changes detection (W1-326)

09:45-10:05 **Takashige Sugimoto, K. Tadokoro, P. Mishra and E. Sawabe**
Use of intake water for monitoring zooplankton biomass and dominant species in the subarctic Pacific (W1-219)

10:05-10:25 **Coffee/tea break**

10:25-10:45 **Salvador Emilio Lluch-Cota, A. Aragón-Noriega, F. Arreguín-Sánchez, D. Aurioles-Gambóa, R. Brusca, R. Cervantez-Duarte, R. Cortéz-Altamirano, A. Douglas, A. Esquivel-Herrera, M. Hendrickx, S. Hernández-Vázquez, M. Karhu, D. Lluch-Belda, D.B. Lluch-Cota, J. López-Martínez, S.G. Marinone, M.O. Nevárez-Martínez, A. Parés-Sierra, G. Ponce-Díaz, C.A. Salinas-Zavala, R.A. Schwartzlose, P.A. Sierra-Beltrán**
The Gulf of California: An ecosystem view and 2002 status report (W1-325)

10:45-11:00 **Sonia D. Batten, Warren S. Wooster**
Zooplankton detection of environmental change (W1-217)

11:00-11:15 **Quan Wen**
Marine environmental monitoring in People's Republic of China - Status and trends (W1-324)

11:15-11:30 **Yoshioki Oozeki, Kaoru Nakata, Tomowo Watanabe**
New monitoring program for detecting Global Warming in the ocean around Japan (W1-218)

11:30-11:45 **Young Sang Suh, Lee-Hyun Jang, Na-Kyung Lee, Bok-Kee Kim**
Detection of low salinity water in the northern East China Sea in summer using ocean color remote sensing (W1-336)

11AM2002 W1-217 Oral

ZOOPLANKTON DETECTION OF ENVIRONMENTAL CHANGE

Sonia D. **Batten**[1] and Warren S. Wooster[2]

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Zooplankton are promising candidates for indicating environmental change because (a) they have limited capability for independent movement, (b) have short generation times, and (c) are not directly harvested. The abundance of a particular species at a particular place should, therefore, reflect the degree to which the water provides optimum conditions for its growth. Numerous examples exist in the literature where changes in abundance of a key species or changes in zooplankton community composition are correlated with climate change or weather patterns. The Continuous Plankton Recorder deployments in the northeast Pacific over the last 5 years provide evidence of such relationships in the open ocean on large spatial scales. Voluntary Observing Ships (also called Ships of Opportunity), such as those that tow the CPR, are particularly cost-effective ways to sample open ocean zooplankton on a regular basis. For this reason, the Global Ocean Observing System (GOOS) has recognised the utility of VOS sampling and has designated the CPR program as a pilot project under its Living Marine Resources module.

In designing such zooplankton monitoring, appropriate frequency of sampling in both time and space must be considered. To detect seasonal changes, sampling at least once a month is essential - for interannual changes, quarterly sampling would seem appropriate, and this might be minimal for tracking longer period changes. In space, the ideal would be a grid with observation spacing consistent with the spatial gradients of phenomena of interest. This might be approximated by selected lines of observations cutting across circulation features. To the extent that sampling is done from VOS, sampling locations and frequency will likely be less than ideal, and interpretation of observations will require some sort of statistical treatment.

We explore the ways in which the current CPR program in the Pacific could be modified and enhanced to provide an earlier detection of large scale oceanic changes. Such modifications would include a focus on indicator species, the selection of a sub-set of samples and development of methods for their quick analysis, and the addition of sensors to record other appropriate parameters. We also consider the need to allow for developments in technology and in analytical techniques so that a long-term monitoring program can be sustained without compromise.

11AM2002 W1-325 Oral

THE GULF OF CALIFORNIA: AN ECOSYSTEM VIEW AND 2002 STATUS REPORT

Salvador E. **Lluch-Cota**, A. Aragón-Noriega, F. Arreguín-Sánchez, D. Aurioles-Gambóa, R. Brusca, R. Cervantez-Duarte, R. Cortéz-Altamirano, A. Douglas, A. Esquivel-Herrera, M. Hendrickx, S. Hernández-Vázquez, M. Karhu, D. Lluch-Belda, D.B. Lluch-Cota, J. López-Martínez, S.G. Marinone, M.O. Nevárez-Martínez, A. Parés-Sierra, G. Ponce-Díaz, C.A. Salinas-Zavala, R.A. Schwartzlose, P.A. Sierra-Beltrán

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Several physical and biological evidences indicate a major change in the North Pacific environment since the late 1990s. The magnitude and consequences of this interdecadal change is still a matter of debate, and it is likely that a comprehensive picture could only result from the comparison of several regions and variables within the basin. PICES community is currently developing a North Pacific Ecosystem Status Reports based on 12 regions covering most of the PICES region, the Gulf of California not included. We believe that having information on such an important and special region will provide many elements to the proper basin scale vision. In this report we approach abiotic (hydrography and climate, ocean circulation, chemistry) and biotic (phyto and zooplankton, fish, invertebrates, marine mammals and birds, interactions) components of the marine ecosystem, the related human dimension (fisheries and mariculture, management and conservation), and the scientific view (monitoring efforts, ongoing research, future scientific tasks) of the Gulf of California, with special focus on recent human and natural driven environmental changes. Since this is probably the first time a comprehensive view of the gulf is intended, several knowledge gaps are recognized and enlisted. We conclude our report by providing a series of what we believe are outstanding scientific questions and research tasks, a strategic plan to develop the Gulf of California ERS in the future, and an invitation to all interested contributors.

11AM2002 W1-218 Oral

NEW MONITORING PROGRAM FOR DETECTING GLOBAL WARMING IN THE OCEAN AROUND JAPAN

Yoshioki **Oozeki**[1], Kaoru Nakata[1] and Tomowo Watanabe[2]

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Monitoring program for detecting the changes in ocean by Global Warming has been launched from April 2002 as a five years project. Monitoring cruises will be done seasonally at the A-line in the Oyashio area (17 stations, 39-42°30'N, 144°50'-146°45'E), the Omaezaki line in the Kuroshio area (9 stations, 30-34°N, 138°E), the PM line in the Japan Sea area (9 stations, 36-40°N, 134°30'-136°E). Two coastal cites will be also monitored for detecting environmental changes at marginal sea, one is around the Koshiki Islands area which locates the origin of the Tsushima Warm Current and the other in the Sado Island area. Five national fisheries research institutes were involved in this project, and Maizuru Marine Observatory, Meteorological Agency, provides physical data sets and plankton samples of the PM line. Physical data sets, including vertical profiles of temperature, salinity, current velocity and the concentrations of nutrients will be obtained. Biological characteristics will also be accumulated on the primary productions and the biomass of key zooplankton species at certain stations. Both data sets will be provided through the Internet.

11AM2002 W1-329 Oral

FORMAL AND CONCEPTUAL APPROACHES TO CHANGE DETECTION

James E. **Overland**

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There are formal quantitative change detection algorithms that have been applied to the North Pacific. For example, time series can be divided into two segments and tested for statistically significant different means. All data points are tested and the transition point with the largest difference in means is considered a change point. The process is repeated until no significant differences are detected. Other formal approaches test for periodic structures and transition shapes such as sine wave or square wave oscillations. However, in the real world we are coping with multiple causation in the face of considerable uncertainty. Thus it is important to develop change detection protocols that are transparent in their methodology, and to recognize that there are many, and possibly equally valid, approaches to environmental change detection. One approach is to consider multiple lines of physical and biological evidence. If the records are statistically independent, they add credibility to the total change detection process, while covariability between different time series suggest causal links between them. Time series can be combined into metrics based on understanding of the process, such as species diversity, or mathematically, using Principal Component Analysis or other formal techniques (see Hare and Mantua, 2000). The information developed can be viewed in different ways. One can form a composite measure of ecosystem health, or consider a subset of variables independently, with each series contributing to the balance of the evidence. In summary, one must incorporate an understanding of the difficulties of the process, such as short, geographically-biased time series, the presence of large interannual "noise" in the records, serial dependence in the records, and influences of population dynamics and human influence. Despite these difficulties, the North Pacific seems poised for development of such multivariate indices.

11AM2002 W1-326 Oral

WHAT TOOLS DO INTEGRATED ECOSYSTEM STUDIES GIVE FOR THE CHANGES DETECTION

Vladimir I. **Radchenko**

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There are few key species as in planktonic as in nektonic communities, which maintain the ecosystem structure and ensure ecosystem stability. These species provide the most abundant matter transport through the food web. Changes in biomass level of key species, diet rations of high trophic level animals, their physiological and growth rates, characteristics of reproductive and vital cycles could be serve as evidences of the ecosystem changes, if they:

- affect several key species, maintained no less than 10% of energy and matter transport from one trophic level to other;
- determined by the global climate and oceanographic environment changes;
- have signs of one species (or species group) replacement by other, sharp changes of species richness, evenness, and diversity in plankton and fish communities;
- periodically occur and have historical analogue.

In the late 1980s, environmental conditions seemed to be favourable for walleye pollock reproduction. However, there was not a high-yielded year class, neither in the Bering Sea nor in the Sea of Okhotsk. Biological systems response to the physical surrounding changes earlier than this changes could be recorded by the instrumental measurements (Shuntov, 2001). Significant decrease of mesopelagic fish biomass reported for the western Bering Sea in the last years means notable weakening of the "biological pump" functioning, which ensures vertical transport of organic matters to deeper layers. Such changes can be one of the reasons of the biological productivity decrease in the Bering Sea ecosystem.

11AM2002 W1-336 Oral
DETECTION OF LOW SALINITY WATER IN THE NORTHERN EAST CHINA SEA IN SUMMER USING OCEAN COLOR REMOTE SENSING

Young-Sang **Suh**, Lee-Hyun Jang, Na-Kyung Lee, Bok-Kee Kim
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In summer season of 1996, a huge flood occurred around the Yangtze River in the eastern China. The low salinity water less than 20 PSU from the river was detected around the southeastern part of the Jeju Island which is located in the southern part of the Korean peninsula. We studied how to detect low salinity water from the Yangtze River, which gives terrible damages to the Korean fisheries.

We got the relationships between low surface salinity, turbid water from the Yangtze River and digital ocean color using remote sensing of SeaWiFS satellite in the northern East China Sea in summer season of 1998, 1999, 2000 and 2001. The charts of salinity in the northern East China Sea were made by regenerating of the satellite ocean color data with the formula from the relationships between low salinity, *in situ* turbid water (transparency) and satellite ocean color.

11AM2002 W1-219 Oral
USE OF INTAKE WATER FOR MONITORING ZOOPLANKTON BIOMASS AND DOMINANT SPECIES IN THE SUBARCTIC PACIFIC

Takashige **Sugimoto**[1], Kazuaki Tadokoro[2], Pravakar Mishra[1] and Eriko Sawabe[3]
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For early detection of ecosystem regime shifts, monitoring of replacement of dominant plankton species/size and the phase lag of their seasonal variations are important. To understand trans-Pacific distributions and seasonal-interannual variations of mesozooplankton density and dominant species/ size in the subarctic Pacific, a portion of intake water was filtered with 0.1mm mesh net almost monthly in later 1990s. The samples were collected from the bottom of M/S *Skaugran* (sails between Japan and Vancouver or San Francisco within 12-13 days) while in the running condition for about six hours every night. The results indicate that distribution patterns and the level of the wet-weight of the sample in summer, which are within 300-500 mg per m^3, are similar and in the same order with those obtained by R/V *Oshoro-Maru* in the subarctic Pacific by towing from 150m depth to the sea surface with nets of 0.33mm in mesh size. Their values of the mean wet-weight in each sub region show quite low in winter and high in summer, especially in the western subarctic Pacific, where initiation of high biomass period delayed by about one month compared with that in the other sub-regions. It is also noticed that interannual variation in the biomass level in summer is significant.

11AM2002 W1-324 Oral

MARINE ENVIRONMENTAL MONITORING IN PEOPLE'S REPUBLIC OF CHINA - STATUS AND TRENDS

Quan Wen

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Based on the status of Chinese Marine Environmental Monitoring System, the paper presents the analysis of the faced situation and opportunities for development, proposes the strategies and approaches of system development and technical improvement, and optimizes the integration of modules in the system. Meanwhile the paper discusses the scientific foundation and the technical support to the monitoring system. A new system framework is proposed to meet the requirements of the development of marine environmental monitoring and the coordination of marine economic development with marine environmental protection. And the development trends are also discussed.

W2 MONITOR Workshop
Monitoring from moored and drifting buoys

Co-Convenors: David L. Mackas (Canada) & Sei-Ichi Saitoh (Japan)
Wednesday, October 23, 2002

There is an increasing demand for systematic monitoring of the ocean. At the same time, the costs of conventional manned research vessels continue to rise. Fleets and their operating calendars are shrinking in many countries. One possible remedy to this resource crunch is increased utilization of unmanned moored and drifting buoys as observation platforms. This workshop will discuss present and future opportunities and constraints in areas such as: (i) diversity, sensitivity, and long-term reliability of sensors, (ii) on-board data processing, (iii) power requirements and sources, (iv) long range data telemetry, and (v) "smart" sampling platforms.

08:30-08:40 **Introduction**

08:40-09:00 **Tommy D. Dickey**
Toward the development of a global interdisciplinary time-series network (W2-221)

09:10-09:30 **Kentaro Ando, Yoshifumi Kuroda, Hideaki Hase, Shinya Minato, Keisuke Mizuno, Taiyo Kobayashi, Nobuyuki Shikama, Kensuke Takeuchi**
Current status of the triton buoy project and the JAMSTEC Argo project (W2-220)

09:30-09:50 **Stephen C. Riser**
Monitoring the global ocean using profiling floats (W2-318)

09:50-10:10 **Weidong Yu, Jiping Chao**
Progress on China Argo Project and relevant activities (W2-332)

10:10-10:30 **Coffee/tea break**

10:30-10:45 **George V. Shevchenko, Gennady Kantakov**
Monitoring of currents on the southwestern shelf of Sakhalin Island (W2-312)

10:45-11:00 **SungHyun Nam, Ki-Wan Kim, Hyung-Rok Kim, Chang-Bong Cho, Sang Jin Lyu, Young-Gyu Kim, Kuh Kim**
Development of ESROB (East Sea Real-time Ocean Buoy) (W2-331)

11:00-11:15 **Takahiro Iida, Sei-chi Saitoh, Kohei Mizobata**
Phytoplankton distribution as observed from bio-optical drifter and SeaWiFS images in the Bering Sea green belt (W2-222)

11:15-11:30 **Toshiro Saino**
A profiling buoy system for real time monitoring of the ocean primary productivity (W2-295)

11:30-11:45 **Ron McLaren, Brian O'Donnell**
The North Pacific Data Buoy Advisory Panel: An initiative of PICES and The Data Buoy Co-operation Panel (W2-304) *see abstract S12-304 on page 129*

11:45-12:30 **Discussion**

11AM2002 W2-220 Oral

CURRENT STATUS OF THE TRITON BUOY PROJECT AND THE JAMSTEC ARGO PROJECT

Kentaro **Ando**[1], Yoshifumi Kuroda[1], Hideaki Hase[1], Shinya Minato[1], Keisuke Mizuno[1], Taiyo Kobayashi[2], Nobuyuki Shikama[2], and Kensuke Takeuchi[2]

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The Triangle Trans-Ocean Buoy Network (TRITON) project was launched in 1998 by Japan Marine Science and Technology Center (JAMSTEC), and will complete the array (18 buoys) in this year. This array, together with the TAO (Tropical Atmosphere and Ocean, McPhaden et al, 1998) array, consists the tropical Pacific buoy network (TAO/TRITON array) to monitor El Nino. One of the advantages of the buoy is to measure salinity time series as standard from surface to 750 meters in every one hour for one-year long. The technical issues on the measurement will be introduced.

The JAMSTEC Argo project, launched in 2000 as the cooperative project with Japan Meteorological Agency and Japan Coast Guard, is now operating about 80 Argo floats in the North Pacific and the Indian Ocean. We will also play the role of regional delayed-mode Argo data center in the Pacific region in co-operation with scientists in University of Hawaii and Seattle (University of Washington, and Pacific Marine Environmental Laboratory, NOAA). At the beginning of the project, one of the technical issues was to measure salinity from autonomous float; however, so far after two years, most of the conductivity sensors on floats are confirmed to perform well and measure salinity within the required accuracy from the Argo Science Team as long the sensor is treated correctly and appropriately.

Our presentation will finally show the different points of long-term and high accurate measurement of salinity between the two monitoring platforms.

11AM2002 W2-221 Oral

TOWARD THE DEVELOPMENT OF A GLOBAL INTERDISCIPLINARY TIME-SERIES NETWORK

Tommy D. **Dickey**

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Our ability to solve problems such as global climate change, carbon cycling, variability in biomass and fish abundances, and ocean prediction is hindered by insufficient data. Optimally, data sets should be interdisciplinary, collected simultaneously, and span ten orders of magnitude in time and space scales to observe key processes. New technologies are enabling interdisciplinary sampling of the ocean at unprecedented time and space scales. Autonomous sampling of interdisciplinary variables using platforms including moorings, drifters, profiling floats, gliders, and autonomous underwater vehicles (AUVs) is becoming a major emphasis of observational oceanography. Autonomous measurements now include several key chemical, bio-optical, and biological variables. Moorings have been used to test many of the sensors and systems, which have been, or likely will be, transitioned to other autonomous sampling platforms. Some examples of the interdisciplinary mooring time series results obtained during JGOFS and other programs with suites of interdisciplinary sensors and systems are presented. Visions of new sensor technologies and a network of integrated, interdisciplinary, global scale, three-dimensional time series observations using multiple platform-types and modeling are presented. Ongoing international efforts and plans for implementation of an array of moorings equipped with interdisciplinary sensors will be described.

11AM2002 W2-222 Oral

PHYTOPLANKTON DISTRIBUTION AS OBSERVED FROM BIO-OPTICAL DRIFTER AND SeaWiFS IMAGES IN THE BERING SEA GREEN BELT

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Bering Sea is a semi-enclosed marginal sea that connects the North Pacific and Arctic Oceans through the Bering Strait. The sea consists of continental shelves and a deep basin, and the shelf edge is called "Green Belt", which is characterized by one of the highest productivity regions in the world. It related with interactions of cyclonic and anti-cyclonic eddies. The objectives of this study are to describe temporal and spatial distribution of phytoplankton using a bio-optical drifter and satellite data. In 2001, a bio-optical drifter was released in a clockwise eddy, equipped with a spectra-radiometer to measure upwelling radiance at the same wavelength as Sea Wide Field-of-view Sensor (SeaWiFS). SeaWiFS images were employed to monitor the spatial pattern of chlorophyll *a*. Sensors also measured sea surface temperature (SST). We compared Advanced Very High Resolution Radiometer (AVHRR) SST data and TOPEX/POSEIDON sea surface height (SST) data, analyzed time and scale correlation of SST and phytoplankton distribution in some eddies.

We compared with buoy position data and TOPEX/POSEIDON SSH data. The results show that a drifter is trapped in a clockwise eddy for 10 days, after that drifted to an anti- clockwise eddy and the Bering Sea slope current along the shelf edge. Finally, the buoy is staying in middle shelf. Total observation period is among 20 days. Phytoplankton concentration is higher in and around the cyclonic eddy, after that it decreased when trapped in anti-cyclonic eddy. In middle shelf, the concentration is lower as well as around anti-cyclonic eddy.

11AM2002 W2-331 Oral

DEVELOPMENT OF ESROB (EAST SEA REAL-TIME OCEAN BUOY)

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Meteorological and oceanographic data collected at a buoy deployed 10 km off the east coast of Korea are transmitted real-time to the OCEAN (Ocean Circulation and Environmental ANalysis) Laboratory at Seoul National University. Major technical advances are: (1) a two-way communication skill using CDMA (Code Division Multiple Access) cellular phone, (2) measurement of current for the entire water column of 130 meters using ADCP (Acoustic Doppler Current Profiler), (3) integration of CTD sensors to measure temperature and salinity, (4) user objective provision of real-time data on two web sites (http://eastsea.snu.ac.kr/ main2.htm and http://cdma.otronix.co.kr). Data show a monthly-scale on- and off-shore movement of major currents, a synoptic band wind-driven current and property variation, tidal band (semi-diurnal, diurnal and near-inertial) oscillation and a short-period fluctuation of currents and water properties.

11AM2002 W2-318 Oral

MONITORING THE GLOBAL OCEAN USING PROFILING FLOATS

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Profiling float technology began in the 1980s in conjunction with the WOCE project and has continued to mature since that time. Floats can now collect high quality profiles of temperature and salinity from the surface to the deep sea at regular intervals over durations as long as several years. Large numbers of such floats are being deployed in the international Argo program. In this talk some recent technology advances will be reported, and the status of the Argo program in the North Pacific and its marginal seas will be reviewed.

11AM2002 W2-295 Oral

A PROFILING BUOY SYSTEM FOR REAL TIME MONITORING OF THE OCEAN PRIMARY PRODUCTIVITY

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As a part of the Core Research for Evolutional Science and Technology (CREST) we are developing a profiling buoy system to measure ocean primary productivity in a real-time fashion, for the purpose of near-real time validation of the satellite derived estimate of primary productivity. The objectives of the project (POPPS: Project on Ocean Productivity Profiling System) is twofold; One is to develop a buoy system to obtain profiling measurements of optical parameter necessary calculate *in situ* primary productivity. The other is to develop an algorithm to estimate the daily net primary productivity in a unit area of the water column (the unit gC m^{-2} day^{-1}) from the data obtained by the optical instruments.

The buoy system is composed of an underwater winch unit, and a profiling buoy unit. The winch unit has capability of acoustic data transmission between the profiling unit and on-board controlling unit. The profiling buoy unit carries three optical sensors (FRRF, PRR800, PAR) in addition to CTD and a 3-D attitude sensor, and has capability of data processing, radio and acoustic data transmission. Field and laboratory tank test are being carried out, and the first operational model will be delivered by the end of September 2002.

Our algorithm to estimate the net primary productivity utilizes measurements on photosynthetic properties of phytoplankton by an FRRF, chlorophyll *a* profile estimated from downward spectral radiance using a neural network, and a daily PAR insolation estimated by cloud amount detected by geometeorological satellite. A validation program is now underway in Sagami Bay, Japan.

11AM2002 W2-312 Oral

MONITORING OF CURRENTS ON THE SOUTHWESTERN SHELF OF SAKHALIN ISLAND

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In 1996-2001, a number of current meters were deployed by SIFO offshore of southern Sakhalin Island. The main purpose of these measurements was to study general structure of currents in La Perouse (Soya) Strait and adjacent areas, to examine their seasonal variations, and to search for possible correlation with bioproductivity in this region.

The first group of current-meter stations was situated near Moneron Island in zones of the Tsushima and West-Sakhalin Currents. These observations enabled us to estimate the seasonal variability of Tsushima warm water flux in Tatar Strait (Sea of Japan) and, in particular, to reveal significant reduction of this flux in autumn. Another interesting result was the discovery of opposite direction currents on the southwestern shelf of Sakhalin Island. The latter demonstrates that a zone of current divergence is located in this area.

The longest current measurements (about 1.5 year) in La Perouse (Soya) Strait allowed us to estimate water discharge through this strait, which was found to have maximum values of about 1.5 – 1.6 Sv in the summers of 1999 and 2000. The minimum discharge, which normally occurs in wintertime, is about 10 times less. The most probable cause of the Sea of Japan warm water flux weakening in winter is the influence of seasonal sea level changes (in winter, sea level is much higher in the Sea of Okhotsk than in the Sea of Japan). The mooring in Aniva Bay (Sea of Okhotsk) indicated the transport of relatively warm and fresh water in autumn under influence of the East Sakhalin Current. This water was observed to be located under the pycnocline in the intermediate and near-bottom layers.

All series of current meter data were also used to calculate parameters of tidal and inertial currents in this region. These two types of currents are playing a principal role in the dynamics of the study area.

In general, the results of these measurements can be used for further verification of circulation models for the Japan and Okhotsk seas (the geostrophic models are usually inappropriate for the shelf zone) and for parameterization of hydrological characteristics. These measurements have been applied to explain formation of zones of zooplankton

abundance and invertebrates larvae accumulation on the southwestern shelf of Sakhalin and in Aniva Bay in relation to fisheries forecast.

11AM2002 W2-332 Oral

PROGRESS ON CHINA ARGO PROJECT AND RELEVANT ACTIVITIES

Weidong Yu and Jiping Chao

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With the financial support from Chinese Ministry of Science and Technology, Chinese Argo project gains material progress in 2002. The first float has been deployed in East Indian Ocean during Xue-Long's (Chinese Antarctic Survey Ship) back cruise. Subsequent floats are planned to lunch in West Pacific. Totally 6 floats are expected this year and 15 for the next year. Also the local data assembly a center is expected to work at the beginning of next year. This amount of data will serve the research projects, including: Warm Pool Variability and its Dynamics (Joint sponsored by MOST and NSF); Argo data assimilation (Sponsored by NSF).

W3 PICES-GLOBEC Data Management Workshop
GLOBEC data management: Exchange, inventory and archival of GLOBEC data

Co-Convenors: Igor I. Shevchenko (PICES TCODE) & Hester Willson (GLOBEC IPO)
Saturday, October 19, 2002 08:30-17:30

This workshop will discuss the goals and objectives of GLOBEC data management and review status of GLOBEC data inventories in PICES countries, and role of the GLOBEC International Project Office, national GLOBEC Committees and PICES Technical Committee on Data Exchange in this effort. We anticipate that the workshop will result in developing an Action Plan for PICES participation in GLOBEC data management.

08:30-08:40	**Introduction** Discussion of the goals and objects of GLOBEC data management, including role of the IPO, TCODE and national GLOBEC committees
08:40:09:00	**Hester Willson** GLOBEC Data Management (W3-333)
09:00:09:20	**Phil Williamson, Gwenaëlle Moncoiffé** Data management for UK GLOBEC and the marine productivity thematic (W3-335)
09:20-09:40	**Todd D. O'Brien** Expansion and quality control of a global plankton database (W3-223)
09:40-10:00	**Sergey Piontkovski** Potential of archived data
10:00-10:30	**Coffee/tea break**
10:30-12:00	**Status of GLOBEC Data management in PICES countries**
	Robin M. Brown, Stephen J. Romaine Canadian GLOBEC metadata inventory for the North Pacific (W3-346)
	Igor I. Shevchenko, Victoria Khan, Lilia Miromanova, Georgiy Moiseenko Metadata inventory of biological data collected by Russian Fisheries Research Institutes (W3-339)
	Elena P. Dulepova, Igor Volvenko Nekton, zooplankton, zoobenthos and trophic levels' bioproductivity databases for the North Pacific (W3-338)
	Anatoly F. Volkov, Valery I. Chuchukalo, Victor A. Nadtochy Hydrobiological data collected at TINRO-Center for the North Pacific (W3-337)
	Robert C. Groman US GLOBEC data management (S3-334)
12:00-12:30	**Igor I. Shevchenko** Report of the role of TCODE
12:30-13:30	**Lunch**
13:30-15:00	**Discussion of roles and responsibilities**
15:00:15:30	**Coffee/tea break**
15:30-16:30	**Action plan for GLOBEC data management in PICES**
16:30-17:30	**Workplan (with timelines) to achieve GLOBEC data management objectives**

11AM2002 W3-346 Oral
CANADIAN GLOBEC METADATA INVENTORY FOR THE NORTH PACIFIC

Stephen J. Romaine and Robin M. **Brown**
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The Canadian GLOBEC project was funded for the period from 1997 to 2000, with project components in both the North Pacific and North Atlantic Oceans. Over 30 research missions were conducted in the Pacific Region by both Fisheries and Oceans Canada (DFO) and universities in support of the GLOBEC program. Much of the CTD and physical data resides at the Institute of Ocean Sciences plus smaller DFO databases hold both zooplankton and fish data. Other data types, including the modelled data, reside in various formats and conditions either at DFO institutions or universities. Some of these data are readily accessible to the public; whereas others are partially processed and reside with Principal Investigator.

An electronic inventory will outline the current status of Canadian GLOBEC data collected in the North Pacific. Metadata will include: research mission and vessel used, survey areas, PI's, dates, data types collected, the current storage location for the data, and the current status of the data. This meta-database will be searchable for various data types, Principal Investigator, date ranges, or data status. The meta-database will also identify any shortfalls in data structure or data that are subject to being lost or damaged since they are located in inadequate storage locations.

11AM2002 W3-338 Oral
NEKTON, ZOOPLANKTON, ZOOBENTHOS AND TROPHIC LEVELS' BIOPRODUCTIVITY DATABASES FOR THE NORTH PACIFIC

Elena **Dulepova** and Igor Volvenko
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At the Pacific Fisheries Research Centre, for the period from 1979 to 2002 data on nekton and nektobenthos were collected for the Okhotsk, Bering, Japan Seas and some other regions of the North Pacific. Data include the numbers of research expeditions, the vessels, co-ordinates of samplings, dates and the registration forms. Besides, for the period from 1984 to 2002, data are available on biomass and productivity predatory and unpredatory zooplankton and zoobenthos for the different regions of Bering and Okhotsk Seas. Some of these data were already digitized and accessible to the TINRO research fellows at request. The rest is not accessible since in a paper form resides with the Principal Investigators.

11AM2002 W3-334 Oral
US GLOBEC DATA MANAGEMENT

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Good data management is an important component of a successful multi-year, data intensive program like US GLOBEC. Data management combines efforts in acquisition, quality control, storage design and retrieval philosophy to support the analysis and synthesis goals of the scientific investigators.

The US GLOBEC program consists of three modules: Georges Bank, Northeast Pacific and Southern Ocean. Each module has from 45 to 70 scientific investigators, laboratory and field work, modeling efforts, retrospective analysis, and synthesis activities. It is important that the results of these efforts be made available to other researchers within the program in a timely basis, and indeed that has been one of the primary goals of the data management office. This has aided chief scientists in planning their cruises and to make last minute changes in their ships' tracks based on the results and input from previous cruises.

Like many other programs, we take advantage of the Internet to allow researchers in various locations, using various different computing platforms, to access the program's data. Any standard browser, such as Internet Explorer and Netscape, can access our web site at http://globec.whoi.edu/ and follow the links to the on-line data sets. These data are served using the US JGOFS software, developed several years ago to address the US JGOFS data management needs. We have used the same software to provide both distributed data serving and distributed data access. Web

users can download listings, plots, and the data files themselves to their own computers following the guidelines of our Data Acknowledgment Policy.

11AM2002 W3-223 Oral/Poster
EXPANSION AND QUALITY CONTROL OF A GLOBAL PLANKTON DATABASE

Todd D. **O'Brien**
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The *Ocean Climate Laboratory* (OCL), a research and products division of the U.S. *National Oceanographic Data Center*, is building an archive of globally distributed historical plankton measurements and associated metadata. As part of the *World Ocean Database*, these plankton data are stored with all available, co-located temperature, salinity, nutrient, and chlorophyll data. The *World Ocean Database 2001* contains over 2.1 million globally-distributed Ocean Station Data (OSD) casts, sampled from the early 1800s to the present. Of these stations, over 98,000 contain measurements of plankton biomass (*e.g.* total mass or total volume), and over 100,000 contain taxonomic measurements (e.g. counts of individual species and/or life stages).

The OCL collaborates with international scientists and institutions, and participates in an active international program (the IOC *Global Oceanographic Data Archeology and Rescue* (GODAR) project) to identify and/or digitize historical plankton and profile data for inclusion into the database. As work continues to expand the database, attention is being focused on improving quality control techniques, comparing data from different sampling techniques, and creating gridded fields of annual and seasonal mean plankton biomass and abundance.

Multi-variable integrated databases such as the *World Ocean Database* are useful for a variety of research applications (e.g., studies on biological/physical interaction, climate change, decadal variability, biogeography and biodiversity). These data are distributed on CD-ROM as part of the *World Ocean Database 2001*, and are available online at www.nodc.noaa.gov.

11AM2002 W3-339 Oral
METADATA INVENTORY OF BIOLOGICAL DATA COLLECTED BY RUSSIAN FISHERIES RESEARCH INSTITUTES

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For the period from 1999 to 2002 the Fisheries Committee of Russia has been funding a project on implementation and maintenance of a metadata inventory of biological data collected by Russian fisheries research institutes. Metadata includes the numbers of research expeditions, the vessels, co-ordinates and regions of samplings, dates, registration forms, current storage location. Accounted are data that already digitized and stored in the computerized databases. Covered are the periods beginning from the foundations of institutes and all regions visited by the Russian research vessels including the North Pacific. The contents are updated once a year.

The inventory is searchable through the Internet at http://metadata.tinro.ru. Authorized users may even send queries using SQL.

11AM2002 W3-337 Oral
HYDROBIOLOGICAL DATA COLLECTED AT TINRO-CENTER IN THE NORTH PACIFIC

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At Laboratory of Hydrobiology of TINRO-Center, there are three main directions of research: planktonic communities, benthic communities and feed chains of mass food fishes and invertebrates. The area covered by the research includes the Russian Far Eastern Marginal Seas and Kuril-Kamchatka zone.

The following aspects are mainly studied: structure of planktonic communities of epipelagial (a layer of 200-0 m), seasonal and interannual dynamics, formation of productive zones; a plankton, as a food base of nektonic animals, structure and interannual dynamics of benthic communities, security food and its influence on structure of planktonic and ground communities.

The data are collected annually during scientific expeditions undertaken according to the complex research programs of TINRO-Center since 1984. In total, it was made more than 50 cruises. The main part of the collected data are usually processed during the cruises. The data are stored at the laboratory both in electronic(60%) and paper (40%) forms.

11AM2002 W3-335 Oral
DATA MANAGEMENT FOR UK GLOBEC AND THE MARINE PRODUCTIVITY THEMATIC

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UK GLOBEC activities are of two kinds: 1) the Marine Productivity (MarProd) thematic with component studies on North Atlantic zooplankton, funded as a 5 yr programme by the Natural Environment Research Council; and 2) work of a more diverse nature, including Southern Ocean studies (primarily by the British Antarctic Survey), research on commercially-exploited species (primarily by fishery laboratories), plankton monitoring (by SAHFOS and others) and participation in EU-funded programmes. Research leaders for projects in both groups are encouraged to provide basic information, via DIF entries, to the GLOBEC IPO. More than 40 have done so to date, providing basic information on data management and data access arrangements. For the MarProd thematic, additional data management structures have been developed to maximise the long-term scientific and societal benefits from the programme. Thus the British Oceanographic Data Centre (BODC), hosted by the NERC Proudman Oceanographic Laboratory, interacts with MarProd in the following ways:

- close involvement in fieldwork planning, formulation of data policy and protocols, and other aspects of programme development, working with the Steering Committee and individual scientists
- maintaining a data-tracking system and assembling data into an integrated database, checking on data quality and supporting documentation
- providing information services, supervising data access arrangements and publishing data collations, for users within and outside the programme.

There has been good progress to date in the transfer to BODC of datasets collected on MarProd research cruises in the northern North Atlantic. For example: 45% completion for Discovery 258 (Nov-Dec 2001), and 26% completion for Discovery 262 (April-May 2002). The programme data policy is available from www.bodc.ac.uk (using 'projects' and 'current projects' links), together with the Discovery 258 cruise report, a dataset inventory and banking status information.

11AM2002 W3-333 Oral
GLOBEC DATA MANAGEMENT

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The GLOBEC International Project Office was formed in early Autumn 1999. I was appointed data manager in December 1999. The first task I undertook as GLOBEC data manager was to collate all the information on GLOBEC's National, Multi-national and Regional Programmes. This information was published as GLOBEC Special Contribution No. 4 and distributed amongst the GLOBEC community.

In May 2001, the GLOBEC Metadata portal was launched, hosted by NASA's Global Change Master Directory. Since that time I have spent a lot of time writing the metadata entries to populate the portal (over 100). In the last few months, a few authors other than myself have started adding DIFs to the GLOBEC metadata portal

Data Management for the GLOBEC programme has been made more difficult by the fact that the data management started long after the programme had begun. Combining existing data management systems with new metadata systems has been difficult and some programmes had finished before the data management efforts had begun.

Despite a good website and an increasingly successful newsletter, it has been difficult to encourage active support for data initiatives among GLOBEC scientists. Although communication with GLOBEC National and Regional representatives is generally good, it has been difficult to reach the majority of GLOBEC scientists as information does not appear to 'filter through' well

In conclusion, data management is not 'sexy science' so often is at the very bottom of the average scientist's priorities. Things are changing but progress is slow.

W4 PICES-CLIVAR Workshop
Climate variability in the Pacific and its impact on the marine ecosystem

Co-Convenors: Kimio Hanawa (PICES) & Kelvin Richards (CLIVAR)
Sunday, October 20, 2002 08:30-17:30

The Pacific sector is influential in a wide range of climate phenomena on interannual to decadal timescales. Climatic variations in both the atmosphere and ocean have the potential to affect primary productivity and higher trophic levels of the marine ecosystem, and the cycling of important biogeochemical constituents, such as carbon. Improved understanding of the physics of these climatic phenomena and their predictability is the remit of the WCRP's CLIVAR project. PICES is concerned with the marine ecosystem from the physical forcing to primary production, biochemical cycles and fisheries in the North Pacific Ocean. The purpose of this joint PICES/CLIVAR workshop is to bring together these two scientific communities.

The workshop will explore our present understanding of the climate phenomena in the PICES area and their links to the ecosystems of the region. The outcome will be the identification of ways in which collaboration between CLIVAR and PICES can further our understanding and can aid the implementation of observational and modelling activities in the PICES area and over the wider Pacific.

08:30-08:40	**Introduction**
08:40-09:10	**Stephen C. Riser** Seasonal to decadal variability of the North Pacific Ocean (W4-211)
09:10-09:40	**Neville R. Smith** Ocean state estimation for the Pacific (W4-213)
09:40-10:10	**Tong Lee** Ocean state estimation for climate studies (W4-292)
10:10-10:30	**Coffee/tea break**
10:30-11:00	**Akimasa Sumi** Model developments in the era of the earth simulator (W4-301)
11:00-11:15	**Shoshiro Minobe** A review of decadal variability over the North Pacific and some ideas for further studies (W4-308)
11:15-11:30	**David L. Musgrave** Temporal variability In the North Pacific Subpolar Gyre (W4-323)
11:30-11:45	**Masao Fukasawa** Some 'Operational' field plans in the Pacific (W4-309)
11:45-12:30	**Discussion**
12:30-13:30	**Lunch**
13:30-14:00	**Christopher L. Sabine, Richard A. Feely, Robert M. Key, Ben McNeil, Kitack Lee, Niki Gruber** Estimates of anthropogenic CO_2 uptake in the Pacific Ocean: A comparison of three methods (W4-216) **Christopher L. Sabine** *on behalf of the GCP scientific steering committee* An introduction to the Global Carbon Project and Potential Interactions with PICES and CLIVAR (W4-210)
14:00-14:15	**Daniela Turk** Interannual variability of biological production in the Pacific basin (W4-293)

14:15-14:45 **Arthur J. Miller**
Decadal variability in the Pacific and its effects on the marine ecosystem (W4-300)

14:45-15:15 **David L. Mackas, William T. Peterson**
Interannual to decadal variability of zooplankton communities along the continental margin of the northeast Pacific (W4-302)

15:15-15:35 **Coffee/tea break**

15:35-16:05 **Richard J. Beamish**
Climate and fisheries (W4-215)

16:05-16:20 **William S. Kessler**
US CLIVAR plans for Pacific observations (W4-344)

16:20-16:35 **Humio Mitsudera, K. Levedev, M. Yaremchuk, I. Nakano, G. Yuan**
Monitoring Kuroshio Extension through dynamically constrained synthesis of the acoustic tomography, altimetry and *in situ* data (W4-287)

16:35-16:50 **Ichiro Yasuda, Emiri Takeuchi, Masayuki Noto**
Variability of the mixed layer in the North Pacific Transition Area and its relation to biological productivity and Japanese sardine (W4-214)

16:50-17:05 **Toshiro Saino**
Effects of climatic variation on lower trophic level ocean environment in the western North Pacific (W4-294)

17:05-17:20 **Yasunori Sakurai, Jun Yamamoto, Hideaki Kidokoro, Ken Mori**
How the winter wind stress might affect the stock size of Japanese common squid (*Todarodes pacificus*) (W4-212)

17:20-17:30 **Discussion and summary**

11AM2002 W4-215 Oral
CLIMATE AND FISHERIES

Richard J. **Beamish**
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It has been proposed that groups of fishes evolved to survive the variability associated with successful reproduction in a preferred habitat. The variability is caused by climate induced changes in ocean habitats. Because there are different modes of climate variability, it is reasonable to expect that groups of species respond differently to changes in climate. Pacific salmon represent one group of fishes that are affected by inter-annual variability and decadal-scale variability. It is the discovery of a decadal-scale influence that shifts quickly to a new regime, which requires that we think differently about management of Pacific salmon and other species. For example, pink salmon from the Fraser River can be shown to shift production trends in response to changes in climate and ocean regimes. Pink salmon are an excellent species for climate impact studies because they have a short life span of 2 years from egg deposition to spawning; the life cycle is simple with two distinct lines; and they have a minimal fresh water residence. Pink salmon are the most abundant of Pacific salmon, and apparently the most adaptable. It is proposed that PICES establish an international pink salmon watch as a method of understanding how to forecast the impacts of natural climate variability and greenhouse gas induced climate variability on population dynamics of pink salmon, other Pacific salmon, and other important fishes.

11AM2002 W4-309 Oral
SOME 'OPERATIONAL' FIELD PLANS IN THE PACIFIC

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JAMSTEC has been engaged in three main research programs, Tropical Ocean Climate Study, Study on Heat and Material transports and its variability in the Pacific, and Arctic Ocean Research Program. These programs support several field activities. Some of them which may be included in PICES view are summarized below.

1) TRITON equatorial array: Although we have established 18 TRITONs moorings in 2001 including two TRITONs in the Indian Ocean, we will able to maintain 16 of them for coming five years because of a budget problem.

2) WHP revisits with carbon measurements: At present JAMSTEC has a plan to re-visit P6, A10, I4+I3 (or I5) in 2003 and P10, P3 in 2005, and P2, P1 in 2007. Pacific sections will be carried out as collaborated programs under UJNR and MOU between WHOI and JAMSTEC. P2 in 2007 is very tentative.

3) Arctic regional observation: Arctic drifting buoy, J-CAD, will be launched at the north pole every year until 2004 (however there occurred a budget problem for 2003). Hydrographic surveys has been carried out under JWACS, MOU between IOS Canada and JAMSTEC. JWACS plans extensive and intensive surveys in 2003 and 2004.

4) Bio Geo Chemical array: Two mooring stations were established in the center of the western sub-arctic gyre, K1 and K2. Each array is composed of RAS, WTS, SID, ZPS, Sediment Traps and moving profiler. These stations will be maintained at least for these five years. One more station is planned to be added in the Kuroshio Extention frontal area.

5) Argo deployment and analysis: JAMSTEC/FORSGC deployed 78 floats already. One hundred of floats will be launched every year from 2002 through 2004 mainly in the Pacific. GDAC miller server and RDAC for the Pacific will be established in 2002 and 2003, respectively.

6) Kuroshio Extension System Study: Japan KESS was finished in 2001. A new KESS activity will be planned to collaborate US-KESS which will start in 2003.

11AM2002 W4-344 Oral
US CLIVAR PLANS FOR PACIFIC OBSERVATIONS

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US Pacific CLIVAR plans to move forward in three areas, all of which should be done in collaboration with international partners. First, the Kuroshio Extension System Study (KESS) has been funded by NSF. Its Japanese counterpart has already been funded, and the joint effort will now take place. KESS is an ocean dynamics experiment designed to evaluate the regional heat/salt budgets with a detailed examination of the mechanisms of cross-frontal exchange, eddy transports and the recirculation gyre. Second, US CLIVAR is starting to plan process studies aimed specifically at weaknesses in climate GCMs. The program is known as Climate Process Teams (CPT) and is intended to connect observers with model developers. In the ocean, the CPT focus will be on mixing, and two process studies on the scale of TOGA-COARE are envisioned to examine the processes of subtropical subduction, and of equatorial upwelling and emergence of subsurface properties. In conjunction with a completed Argo array, TAO moorings, and additional western boundary observations, understanding and learning to model these processes will enable the decadal variability of the subtropical-tropical Pacific to be fully described. A third proposed process study is the VAMOS Eastern Pacific Investigation of Climate (VEPIC), which is a collaboration between US and Latin American institutions to carry on from the successful EPIC program. VEPIC is aimed at boundary layer clouds and atmosphere-ocean-land interactions in the subsidence regions of the eastern Pacific. All three of these process studies remain in the planning phase, and have not yet been funded. Third, the CLIVAR goal of producing an ocean state analysis of the Pacific basin can only be met if the capability of monitoring mass and property transports in the tropical western boundary currents. We will propose an accelerated effort to test and develop technologies to do this, including gliders, moorings or repeated ship surveys.

11AM2002 W4-392 Oral
OCEAN STATE ESTIMATION FOR CLIMATE STUDIES

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Oceanic observations are incomplete in space and time. Ocean models are limited in resolution and physics. Ocean state estimation provides a necessary tool to synthesize observational data with dynamical models so as to understand how the ocean works and to investigate its effect on climate. Apart from producing optimal estimate of oceanic state, the procedure also offers such benefits as model testing, evaluation of data impact, observing system design, parameter estimation, and improving estimate of air-sea fluxes. Ocean state estimation is essentially a least-squared fit of the model to the data weighted by the respective *a priori* errors. As such, knowledge of these errors dictates the final solution. In this presentation, the challenge in quantifying model and data errors will be addressed along with other major issues such as dynamical consistency, validation, computational efficiency versus complexity of model and assimilation scheme, interaction among modelers, observationalists, and assimilators. Recent advances in ocean state estimation will be reviewed, focusing on the ECCO effort and its interdisciplinary applications. ECCO (Estimation of the Circulation and Climate of the Ocean, http://www.ecco-group.org/) is a consortium formed under the National Ocean Partnership Program of the United States, involving primarily the Jet Propulsion Laboratory, Scripps Institution of Oceanography, and Massachusetts Institute of Technology.

11AM2002 W4-302 Oral
INTERANNUAL TO DECADAL VARIABILITY OF ZOOPLANKTON COMMUNITIES ALONG THE CONTINENTAL MARGIN OF THE NORTHEAST PACIFIC

David L. Mackas[1] and William T. Peterson[2]
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For several reasons, multi-year time series of zooplankton biomass and species composition provide useful tools for examining how climate variability affects marine ecosystems. First, mesozooplankton (about 0.1-2 cm body length) are the main trophic link between the microplankton (primary producers and microheterotrophs) and larger predators

such as fish. Second, mesozooplankton are abundant, can be sampled by simple and relatively standard methods. Third, and perhaps most important, demographic traits of zooplankton make them particularly suitable for analysis of interannual ecosystem changes. Because few mesozooplankton taxa are fished, most population changes can be attributed to environmental causes. Life cycles of many species are annual: recruitment and mortality rates are slow enough that major population fluctuations are not missed by seasonal sampling, but rapid enough to track interannual changes in environmental conditions.

Continental margin zooplankton have been sampled since the 1970s both off southern British Columbia (48-49°N) and off central Oregon (44-45°N). In both regions, there have been large changes in total biomass, and even larger changes in which species are dominant. The time period 1990-2000 included particularly strong (factor of ten or larger) variations in concentrations of all major species groups. Shifts were particularly strong at the end of the 1980s and between 1998-1999. The patterns of change in species dominance in the two regions (both part of the California Current system, but separated by 450 km) were remarkably similar. Through most of the 1990s, there was a strong and cumulative shift to a more 'southerly' copepod fauna. This trend reversed sharply in 1999, following the 1997-1999 El Niño-La Niña event. Since 1999, abundance of most zooplankton taxa has been similar to the late 1970s-mid 1980s. Most of the zooplankton anomaly time series are correlated with time series of local and basin scale environmental indices, and in particular with changes in the balance between equatorward vs. poleward alongshore currents. Statistical fits derived from part of the time series (1985-1997) have continued to perform well after the recent 1998-99 shift in environment and zooplankton.

11AM2002 W4-300 Oral

DECADAL VARIABILITY IN THE PACIFIC AND ITS EFFECTS ON THE MARINE ECOSYSTEM

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Basin-scale variations in oceanic physical variables can organize patterns of biological response across the Pacific Ocean over decadal time scales. Various physical mechanisms can generate diverse basin-scale patterns of sea-surface temperature (SST), mixed-layer depth, thermocline depth, and horizontal currents. The hypothesized physical mechanisms that may control decadal variability in the Pacific will be summarized and then linked to the possible types of response they may generate in the marine ecosystem.

11AM2002 W4-308 Oral

A REVIEW OF DECADAL VARIABILITY OVER THE NORTH PACIFIC AND SOME IDEAS FOR FURTHER STUDIES

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The decadal to centennial variability, which is one of three major research topics of CLIVAR, has attracted large attentions in general, and in particular for the North Pacific climate variability associated with the stimulating terminologies, such as climatic regime shifts and Pacific Decadal Oscillation (PDO). I aim to summarize the some arguments for decadal to centennial variations focusing on the North Pacific. The nature of the PDO has been interpreted as one of two mechanisms, i.e., oscillatory or stochastic. A various oscillatory mechanisms have been proposed, but these mechanisms explain only the 10-20-year periods, but not 20-30-year lasting regimes (40-60-year oscillation period), which have been recognized as a major feature of the climatic regime shifts. The lack of the agreement of the PDO interpretation prohibits us to predict future climate variability on a reasonable scientific basis. To address this question (oscillatory or stochastic) it is important in encouraging paleoclimate analyses using so-called high-density paleoclimate proxies, careful assessments of the instrumental data, and various numerical and theoretical studies. On the other hand, the possible 1998/99 regime shift should involve a wider range of oceanographic and atmospheric studies. For successful developments of these studies, it is desirable that CLIVAR and PICES play important roles.

11AM2002 W4-287 Oral

MONITORING KUROSHIO EXTENSION THROUGH DYNAMICALLY CONSTRAINED SYNTHESIS OF THE ACOUSTIC TOMOGRAPHY, ALTIMETRY AND *IN SITU* DATA

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A finite-difference quasigeostrophic (QG) model of an open ocean region is employed for dynamically constrained synthesis of the acoustic tomography (AT) and satellite altimetry data with other *in situ* observations. The assimilation algorithm is based upon the 4D variational data interpolation scheme controlled by the model's initial and boundary conditions. The analyzed data sets include direct and differential travel times measured at the array of 5 acoustic transceivers deployed by JAMSTEC in the region of the Kuroshio Extension (KE) in 1997, Topex/Poseidon altimetry, CTD soundings, and ADCP velocity profiles. The monitored region is located within 27.5 - 36.5N, 143 - 155E.

Results of assimilation show that mesoscale variability can be effectively reconstructed by five transceivers measuring direct and reciprocal travel times supported by relatively sparse *in situ* measurements. It is shown that 80% of the ocean variability south of the KE front can be explained by QG dynamics.

The model-data misfits lie within the observational error bars for all the data types used in assimilation. We further analyze energy balances of the optimized model solution. Energy exchange between the depth-averaged and shear components of the observed currents reveal a weak decay of the barotropic mode at the rate of $0.2\pm0.7\times10^{-5}$ cm^2/s^3 due to topographic interaction. Mean currents in the region are unstable with an estimate of the available potential energy flux from the mean current to the eddies 4.7±2.3×10-5 cm^2/s^3. Kinetic energy transition has the same sign and estimated as $2.8\pm2.5\times10^{-5}$ cm^2/s^3. Potential enstrophy is transferred to mesoscale at a rate of $5.5\pm2.7\times10^{-5}$ cm^2/s^3. These figures provide an observational evidence of the properties of free geostrophic turbulence which were predicted by theory and observed in numerical experiments.

11AM2002 W4-323 Oral

TEMPORAL VARIABILITY IN THE NORTH PACIFIC SUBPOLAR GYRE

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In the past fifteen years, scientific attention has mostly focused on the temporal variability of the North Pacific Subpolar Gyre associated with the Pacific Decadal Oscillation (PDO) and El Niño effects with time scales of 20-50 and 3-7 years, respectively. Recent work indicates that the multi-decadal variability in the Bering Sea may be more closely associated with the Arctic Oscillation than the PDO. Mechanisms for the PDO remain elusive, but the subpolar effects of El Niño are associated with a Kelvin wave that propagates northward along the eastern Pacific from the equator. The spatial patterns of sea surface temperature and sea level pressure associated with the PDO and El Niño are similar. Ecosystem variability, from phytoplankton abundance to marine mammal, fish and seabird populations, have and are being studied and abrupt "regime" shifts associated with the PDO seem to occur simultaneously in the physical and ecosystem variables. However, the exact timing of the regime shifts eludes prediction and they are recognized several years after-the-fact. The variability in the ecosystems has major implications for resource management in a region that is economically dependent on fishing and tourism, and where indigenous and non-indigenous populations rely on marine resources for subsistence.

11AM2002 W4-211 Oral

SEASONAL TO DECADAL VARIABILITY OF THE NORTH PACIFIC OCEAN

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The ocean is variable over an enormous range of time scales. Variations at seasonal time scales are perhaps the best studied, owing to the nature of the available observations. Recent analyses by a number of researchers have

concentrated more on longer (decadal) time scales, with observations strongly suggesting that variability in the ocean is closely coupled to variations in the circulation of the atmosphere. Such ocean-atmosphere interaction is necessarily complex and can include complicated feedback mechanisms, as with the well-studied El Niño-Southern Oscillation phenomenon. In this talk the evidence of several manifestations of seasonal and decadal variability will be examined, including the Pacific Decadal Oscillation over the large-scale N. Pacific, and the stronger climate signals present at decadal time scales in the marginal seas of the N. Pacific Ocean.

11AM2002 W4-216 Oral

ESTIMATES OF ANTHROPOGENIC CO_2 UPTAKE IN THE PACIFIC OCEAN: A COMPARISON OF THREE METHODS

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Significant advances have been made in determining the rates of anthropogenic CO_2 uptake in the Pacific Ocean. Our group has used the *C* technique developed by Gruber et al. (1996) for estimating the total amount of anthropogenic CO_2 uptake since about 1750. Peng et al. (submitted) use a multi-parameter linear regression method to estimate DIC changes between two cruises, and the McNeil et al. (submitted) use CFC as proxy for estimating anthropogenic DIC concentrations in surface and intermediate waters of the Pacific. These approaches have differing strengths and weaknesses depending on the assumptions and the overall data quality. We will briefly review these approaches for estimating anthropogenic CO_2 in the North- and South Pacific Oceans, discussing the strengths and weaknesses of each approach.

11AM2002 W4-210 Oral

AN INTRODUCTION TO THE GLOBAL CARBON PROJECT AND POTENTIAL INTERACTIONS WITH PICES AND CLIVAR

Christopher L. **Sabine** on behalf of the GCP scientific steering committee
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The carbon cycle is central to the Earth system, being inextricably coupled with climate, the water cycle, nutrient cycles, and the production of biomass on land and in the oceans. It is one of the strongest links between PICES and CLIVAR, and the central focus of the Global Carbon Project (GCP). The GCP is an international program designed to help promote coordinated research on the global carbon cycle. Our three parent organizations are the International Geosphere-Biosphere Programme (IGBP), the International Human Dimensions Programme on Global Environmental Change (IHDP), and the World Climate Research Programme (WCRP).

Recognizing that there is a substantial amount of carbon cycle research now in progress or under development, a key role for the GCP is to work closely with other research and observation programs in Earth system science, including projects within IGBP, IHDP, and WCRP, and national and regional carbon cycle programs. This role includes both a synthesis of specific aspects of work of these programs related to the global carbon cycle, and the provision of support in aspects of their core mandates related to the carbon cycle. On a scientific level, these linkages will operate towards achieving several aims: (a) resolving inconsistencies between estimates for key terms in the carbon cycle from different methods (for instance, "top-down" and "bottom-up" estimates); (b) developing a wider scientific perspective by bringing together groups working on differing, but related aspects of the carbon cycle; and (c) facilitation of coordination among existing projects and national and regional programs. For more details visit: www.globalcarbonproject.org.

11AM2002 W4-294 Oral

EFFECTS OF CLIMATIC VARIATION ON LOWER TROPHIC LEVEL OCEAN ENVIRONMENT IN THE WESTERN NORTH PACIFIC

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Clear evidences accumulating which shows long-term variation of the lower trophic level ocean environments and the resulting change in biology and biogeochemistry in the upper layers in the western North Pacific.

In the western subarctic North Pacific, the intensification of stratification of the seasonal thermocline appears to retard the upward transport of micronutrients such as iron into the euphotic zone, and hence leads to decrease of primary productivity in spring to summer. The increasing stratification also retards the ventilation of the subsurface layer, and the dissolved oxygen decreases while nutrients such as phosphate increases. It can be also noted that decadal oscillation pattern, apparently relating to NPI, is superimposed on the linear trend. Analysis of time-series satellite imagery of chlorophyll *a*, wind stress, sea surface temperature from 1997 to 2000 reveals change in productivity regime relating to the 1998 ENSO event.

In the western subtropical North Pacific, lower trophic level environment is also related to NPI, a climatic index in the subarctic region. The winter mixed layer depth, strongly correlated with wind stress and the NPI, regulates the shallow water nutrient concentration in the wintertime, and hence the phytoplankton biomass in spring. A significant anomaly in nitrate/phosphate ratio was observed in the Subtropical Mode Water in 1980s. This probably indicates that the nitrogen fixation became intensified in that decade.

Similarity and dissimilarity in the oceanic response of the western North Pacific to the large scale variation in climatic forcing are to be discussed.

11AM2002 W4-212 Oral

HOW THE WINTER WIND STRESS MIGHT AFFECT THE STOCK SIZE OF JAPANESE COMMON SQUID (*Todarodes pacificus*)

Yasunori **Sakurai**[1], Jun Yamamoto[2], Hideaki Kidokoro[3] and Ken Mori[4]

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In short-lived squids, recruitment success most likely depends on the physical and biological environments at the spawning and nursery grounds. Annual catches of Japanese common squid, *Todarodes pacificus*, in Japanese and Korean waters have markedly increased since the late 1980s, and recent catches have equaled those of the 1960s. A previous study (by YS) suggested that the winter spawning area of *T. pacificus* in the East China Sea shrank when adult stocks decreased during a cool regime that occurred before 1988, and that its fall and winter spawning areas extended and overlapped in the Sea of Japan and East China Sea when adult stocks increased during a warm regime that occurred after 1989. Another study (by JY) suggested that successful hatching from egg masses is higher when the mixed layer depth (MLD) is shallower than the bottom depth. In the present study, we examined the relationship between annual catch of the winter-spawning stock, and wind speed and air temperature in the East China Sea in February during 1980-2000 to determine how a series of calm and warm winters might promote a stock increase related to changes in the MLD. We show that annual catches markedly increased during a decade of weak wind speed and warm air temperature from the mid-1980s to mid-1990s, suggesting that the strength of winter wind stress affects the winter-spawning stock fluctuations in *T. pacificus*.

11AM2002 W4-213 Oral
OCEAN STATE ESTIMATION FOR THE PACIFIC

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Ocean state estimation or, as it is more generally known, ocean data assimilation, is in its essence an approach to jointly determine (analyze) the state of the ocean through blending of data, scientific knowledge and models. This determination usually takes the form of ocean fields mapped onto a regular space-time grid, for the present or times past or future (a forecast). Though the method is simple in concept, it quickly becomes complex in practice as the multiple scales of ocean circulation (variability) and interaction confound any simple representation. Just as we are all aware of the limits of predictability for weather forecasts, there are also limits and constraints on ocean estimation associated with unpredictable (impossible to represent) scales of circulation and interaction. Unlike meteorology, the ocean and climate community are only now beginning to understand these limits and to begin the process of exploiting whatever predictability is present. In contrast to meteorology, the ocean and marine community probably cares just as much about the past (reanalyses and hindcasts) as it does forecasts. For CLIVAR, the goal is to understand variability and predictability in the coupled ocean-atmosphere system and this will in turn require understanding of ocean variability and skills in ocean estimation. The Global Ocean Data Assimilation Experiment (GODAE) was conceived as a way of addressing the need for advanced ocean data estimation techniques. It has many components including global observation campaigns, advanced data management and serving techniques, high-resolution and high-accuracy (climate) models, and innovative assimilation systems. The goal is creation of a sustained operational oceanography community for models and data, providing regular estimates and forecasts of the ocean. This presentation will discuss the status of GODAE and its aims for the demonstration phase 2003-2005. The North Pacific will be a region of significant activity and the paper will discuss some of the activities that will deliver advanced capabilities for the region, both for the CLIVAR community and for non-physical community within PICES.

11AM2002 W4-301 Oral
MODEL DEVELOPMENTS IN THE ERA OF THE EARTH SIMULATOR

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CLIVAR consists of three components, such as GOALS (Global Ocean Atmosphere Land System), DEC-CEN (Decadal to Centennial time-scale fluctuation) and ACC (Anthropogenic Climate Change). CLIVAR-ACC is dedicated to the global warming issue and CLIVAR-DECCEN is expected to detect the signal of global warming. In order to obtain the reliable information of the global warming, model development is a key factor and the infrastructure is indispensable for this purpose.

The Earth Simulator (ES) has been completed in 2002, March. It consists of 5120 (=640x8) processors, and as each processor has 8GFlops, its speed is supposed to be 40 TFLOPS (=8x5120). For a performance test, AFES (Atmospheric model for ES), which originated from the CCSR/NIES AGCM, was run and the sustained speed is approximately 14.5 TFlops.

By using the ES, several research groups in Japan are now developing new models. In CCSR, we are going to develop a new climate model with NIES (National Institute of Environmental Studies) and FRSGC (Frontier Research System for Global Change), where T106L50 AGCM and 1/4 x 1/6 L45 OGCM is coupled. This model is supposed to be used for the IPCC Fourth Assessment Report (FAR). In this report, we will use an ensemble method to evaluate the impact of the global warming. This research is possible only when we can use the ES.

The other direction is to develop a non-hydrostatic global atmosphere model, where 1-5 km grid is supposed. For this model, several grid systems are now proposed. In our case, the tropical global model is developed by combining the RAMS model. Several test results will be presented in this presentation.

11AM2002 W4-293 Oral

INTERANNUAL VARIABILITY OF BIOLOGICAL PRODUCTION IN THE PACIFIC BASIN

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The importance of interannual fluctuations of the coupled climate system over the Pacific Ocean have been known for quite some time as a result of the El Niño phenomenon. The significance of interannual variability in biological production and ecosystem structure in the Pacific for the global carbon cycle has been suggested, but only recently available satellite and buoy observations may provide a mean to synoptically monitor the magnitude of this variability over the large area of the Pacific Ocean.

Here, we discuss a multi-sensor approach to study the variation in biological production during 1997-1999 El Niño and La Niña events in the Pacific basin. The possible connections between variations in the tropical and North Pacific are explored, and the consequences for interannual variability in the planetary carbon cycle and ecosystem structure are discussed.

11AM2002 W4-214 Oral

VARIABILITY OF THE MIXED LAYER IN THE NORTH PACIFIC TRANSITION AREA AND ITS RELATION TO BIOLOGICAL PRODUCTIVITY AND JAPANESE SARDINE

Ichiro **Yasuda**[1], Emiri Takeuchi[1] and Masayuki Noto[2]
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Mixed layer depth (MLD) and temperature in the Kuroshio Extension regions change in inter-decadal time scales; the Japanese sardine annual survival rate significantly correlates with SST in the Kuroshio Extension regions. There are zonal fronts of MLD and chlorophyll around 30N; MLD south of the MLD front shoals even in winter. This could be related to Ekman pumping distribution and subduction/obduction phenomena. Interdecadal variations of wind-stress distribution might explain the variations of MLD, biological productivity and Japanese sardine. We will propose a hypothesis and research plan.

W5 PICES & China-Korea Joint Ocean Research Center Joint Workshop

Regional cooperation for the conservation and management of the marine environment and resources in the Yellow Sea

Co-Convenors: Dong-Young Lee (CKJORC) & Stewart (Skip) M. McKinnell (PICES)
Friday, October 25, 2002 08:30-12:30

The China-Korea Joint Ocean Research Center (CKJORC) is hosting a workshop to consider the present status of international cooperation and research in conserving and managing the living marine resources of the Yellow Sea and their environment. Topics will include the availability of necessary technologies and suggestions on new areas of bilateral and regional cooperation. Held in conjunction with the Eleventh Annual Meeting of PICES, the workshop will provide an excellent forum for exchange of ideas between scientists of the two organizations. The workshop will consist of 4-5 invited talks followed by a Panel Discussion that will include input from all workshop participants.

09:00-09:20	**Introduction**
09:20-09:40	**Yu Zhong Liu** Present status and future plans for the ocean observing system in China for the Yellow Sea
09:40-10:00	**Hee-Dong Jeong** Overview of the long-term oceanographic survey in the North East Asia Regional Seas and discussion of future improvements
10:00-10:20	**Chang S. Kim** How can we establish an operational marine environment and ecosystem prediction system for the Yellow Sea through China-Korea cooperation?
10:20-10:40	**Coffee/tea break**
10:40-11:00	**Fangli Qiao** Research activities in the marine environment and ecosystem modeling in China
11:00-11:20	**Steve Bograd** Cooperative research on marine environment and ecosystem prediction in the Northeast Pacific Ocean
11:20-11:40	**Dong-Young Lee** Regional cooperation to improve the ocean observing system in the Yellow Sea
11:40-12:00	**Stewart (Skip) M. McKinnell** PICES North Pacific Ecosystem Status Report and regional cooperation
12:00-12:30	**Discussion**

GP-BIO General Poster Session – BIO

Posters on subjects of interest to the Biological Oceanography Committee. Posters will be on display from October 21 (p.m.) – 24 (noon). There will be a "Beer & Dim Sum Poster Session" (evening of October 23) when poster presenters will be available to answer questions.

David Aurioles Gamboa
Exploration of biological and ecological variables from sea lion populations (*Zalophus californianus*) in the Gulf of California: regional organization for management (GP-BIO-266)

Irina Y. Bragina, Gennady A. Kantakov
Seasonal and interannual re-distribution of zooplankton communities between the Sea of Okhotsk and the Sea of Japan (GP-BIO-267)

Natalia G. Chupysheva
Species composition of bivalvia in the north-eastern Okhotsk Sea (GP-BIO-268)

Sergey V. Dubrovsky, Dmitry I. Vishkvarcev
Distribution of holothurian *Apostichopus japonicus* near Kunashir Island, the southern Kurils (GP-BIO-269)

Hyung-Ku Kang, Yong Joo Kang
Production of *Acartia steueri* (Copepoda: Calanoida) in Ilkwang Bay, southeast coast of South Korea (GP-BIO-270)

Sook Yang Kim, Wol Ae Lim, Sam Geun Lee, Hak Gyoon Kim, Sang Ho Jun
Distribution of photosynthetic pigments in Jinhae Bay, Korea (GP-BIO-340)

Koji Ozaki, Shin-ichi Uye, Teruichi Kusumoto, Tetsuo Hagino
Seasonal cycles in abundance of calanoid copepods in Kii Channel, the shelf water on the Pacific side of southwestern Japan – analysis from 12 years' (1987-1999) samples (GP-BIO-271)

Louisa N. Propp, Lioudmila Gavrina
Distribution of nutrient elements and chlorophyll *a* in vegetative period in Aniva Bay, the Okhotsk Sea (GP-BIO-272)

Ekaterina Selivanova
Seasonal changes in comosition of zooplankton in Kievka Bay coastal waters (The Sea of Japan) (GP-BIO-273)

Marina A. Shebanova
Distribution of *Neocalanus flemingeri* in the Okhotsk Sea in summer 1988 (GP-BIO-274)

Yanhui Yang, Nianzhi (George) Jiao
In situ daily growth rate of Prochlorococcus at the chlorophyll maximum layer in the southern South China Sea: An estimation from cell cycle analysis (GP-BIO-276)

11AM2002 GP-BIO-266 Poster

EXPLORATION OF BIOLOGICAL AND ECOLOGICAL VARIABLES FROM SEA LION POPULATIONS (*Zalophus californianus*) IN THE GULF OF CALIFORNIA: REGIONAL ORGANIZATION FOR MANAGEMENT

David **Aurioles Gamboa**
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The California sea lion population from the middle and northern Gulf of California is genetically isolated from the remaining geographic distribution. Because the population is small (less than 20,000 individuals in 13 rookeries), biological and ecological research is needed to understand its internal organization and facilitate management. Information is available for size and population growth, feeding habits, pup body condition, carbon and nitrogen stable isotopic values in hair, presence of *Morbillivirus* and *Leptospira* spp, and heavy metals in bone. We conducted cluster analysis to group sea lion rookeries with similar characteristics and to identify areas under potential environmental stress. One pattern included most of the rookeries but 3 variables (population growth, pup body condition and oceanographic habitat) produced four defined groups: one containing the northernmost rookeries (San Jorge, Consag and Isla Lobos), other having two subgroups: a) El Rasito, El Partido and Los Machos, and b) San Esteban, San Pedro Martir and Los Cantiles. One rookery (Isla Granito) was transitional between the northern central rookeries of the Gulf, and Los Islotes rookery was separated from all the others, but with its closest link with subgroup b). Other clusters had small variations from the previous pattern, but when variables associated to population stress were analyzed (declining population, high levels of heavy metals, and reduced food variability), the region around Angel de la Guarda Island arose as one under the environmental stress.

11AM2002 GP-BIO-267 Poster

SEASONAL AND INTERANNUAL RE-DISTRIBUTION OF ZOOPLANKTON COMMUNITIES BETWEEN THE SEA OF OKHOTSK AND THE SEA OF JAPAN

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Zooplankton, CTD and chemical data collected during 1995-1999 in La Perouse (Soya) Strait and vicinities are analyzed with a goal to determinate causes of zooplankton communities different structures grouping associated with Tsushima, Soya, West Sakhalin and East Sakhalin currents water masses properties. 630 zooplankton samples by the vertical haul method (Norpac net, mesh size 0.112 mm) were collected in 15 complex research expeditions. Besides currents communities, other zooplankton groups investigated in the areas of upwelling and anticyclonic eddies both presented in the divergence and convergence areas. Two aspects of abiotic factor impact to the zooplankton communities are researched: currents advection and water vertical stability features seasonally and interannually. Statistical approaches include clustering, correlation and ANOVA methods for different biological and oceanographical data. Wide zooplankton biodiversity (113 forms) in La Perouse (Soya) Strait and vicinity can being explained impact of various oceanographic factors such as subtropical vs. subarctical water masses advection, vertical layer seasonal changes, flows vergencies. Interannual and seasonal distribution features of several zooplankton forms are determined within dominant of copepods mainly, *Neocalanus plumchrus* particularly. Ecological structure of the investigation area is characterized by moderate cold water species predominance in the south subregion. Cold water species determined zooplankton biomass in the northern subregion. Evident ratio of biomasses by ecological group seasonal dependence was not determined. Meanwhile in November-December tropical and subtropical species are increased dramatically in total biomass having own peak in the summer time. Interannual total biomass decreased during positive anomaly temperatures period. Zooplankton highest concentration was localized in upwelling zone. Redistribution of zooplankton species between the Sea of Okhotsk and the Sea of Japan is discussed based on 15 research expedition results.

11AM2002 GP-BIO-268 Poster

SPECIES COMPOSITION OF BIVALVIA IN THE NORTH-EASTERN OKHOTSK SEA

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The first diving hydrobiological surveys have been conducted in shallow waters of the north-eastern Okhotsk Sea (the Aldom Bay and the Eirineyskaya Inlet) in August 1996. Physical and geographical regime of these areas differs: waters of Aldon Bay are more desalinated and cold, grounds are mostly sandy and silt-covered, in the Eirineyskaya Inlet- rocky and shingly ones. In Aldon Bay there were found 6 species of burying Bivalvia: *Peronidia lutea, Clinocardium califomiense, Siligua alta, Liocyma fluctuosa, Mya truncata, Spisula voyi.* In the Eirineyskaya there were revealed only three species: *Peronidia lutea, Clinocardium califomiense, Mya truncata.* All species from these areas belong to the boreal-arctic complex. Based on the analyzed data, the greater part of species diversity in the Aldom Bay in comparison with the Eirineyskaya Inlet is explained by soft ground predominance and more favourable temperature regime for animals and arctic-boreal complex.

11AM2002 GP-BIO-269 Poster

DISTRIBUTION OF HOLOTHURIAN *Apostichopus japonicus* NEAR KUNASHIR ISLAND, THE SOUTHERN KURILS

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Apostichopus japonicus distribution peculiarities were studied in the coastal waters of the Okhotsk Sea near Kunashir Island. The spatial differentiation of their size - age groups is observed. The young individuals up to 3 years old are the most abundunt at the depth more than 20 m in the north part of the investigated area. Holothurians at 4-5 years old are very often at the depth less than 20 m. In the south of the area adult specimen at age of 5-6 and older are the most common in all the depth range. It is supposed, that self-reproduction of *A. japonicus* population is hardly possible near Kunashir Island and it is dependent. The distribution of holothurians as well as some subtropical and tropical species is caused by larvae drift with Soya current from coast of Hokkaido Island to the north-west of Kunashir Island. Distribution peculiarities of *A. japonicus* in costal waters of Kunashir Island are caused by a hydrological regime, which is in an influence zone of the warm Soya current and cold waters of the Okhotsk Sea, and also by migration of the individuals from the north to the south.

11AM2002 GP-BIO-270 Poster

PRODUCTION OF *Acartia steueri* (COPEPODA: CALANOIDA) IN ILKWANG BAY, SOUTHEAST COAST OF SOUTH KOREA

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Production of marine calanoid copepod *Acartia steueri* was measured from October 2, 1991 to October 8, 1992 at a station in Ilkwang Bay, southeast coast of South Korea. Phytoplankton standing stock ranged from 0.41 to 20.11 mg Chl-*a* m^{-3} (mean: 2.87 mg chl-*a* m^{-3}). Annual primary productivity by the C-14 method was estimated at 200 gC m^{-2} yr^{-1}. *A. steueri* (nauplii+copepodites+adults) was present in the plankton throughout the year with seasonal variation in abundance. Biomass of *A. steueri*, excluding NI stage, was 9.96~4545.81 C m^{-3} (mean: 680.76 C m^{-3}) with peaks in November, February, May and July-early August, and relatively low biomass in September-January. Instantaneous growth rate in the nauplius stages was higher than in the copepodite stages. Egg production of *A. steueri* was estimated by the equation obtained under the laboratory experiment, showing peaks in November, February, May and August, and low fecundity in December-early February. The fecundity ranged from 7.1 to 1407.1 eggs m^{-3} d^{-1} (mean: 296.1 eggs m^{-3} d^{-1}). Annual production of *A. steueri* was 25.21 mgC m^{-3} yr^{-1} (or 166.41 mgC m^{-2} yr^{-1}), showing peaks in November, May, July-August with a small peak in February, and low production in December-April and September-October.

11AM2002 GP-BIO-340 Poster
DISTRIBUTION OF PHOTOSYNTHETIC PIGMENTS IN JINHAE BAY, KOREA

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Photosynthetic pigments were measured in sediment and seawater in Jinhae Bay 10 times during March-December 2000 to find out the potential primary productivity. Seawater was sampled at surface, and sediments were collected at six different layers (0-1 cm, 1-2 cm, 2-3 cm, 3-5 cm, 5-6 cm, 7-10 cm) from surface to 10 cm depth. Photosynthetic pigments were estimated with HPLC.

Chlorophyll-*a*, *b* and *c*, Pheophytin-a, Fucoxanthin, 19'-butanoloxyfucoxanthin, 19'-hexanoloxyfucoxanthin, Diadinoxanthin, Violaxanthin, Alloxanthin, Diatoxanthin, Zeaxanthin(Lutein), β-Carotain and Peridin were analyzed in sea-water and sediments. There was no big difference in composition of pigments and distribution between sediments and seawater. In seawater, the ratio of Pheophytin (Pheophytin/Chlorophyll-*a*+Pheophytin) was 0.45- 0.91, while the ratio of Fucoxanthin/Chlorophyll-*a* was 0.13-0.39. Chlorophyll-*b*/Chlorophyll-*a* was 0.3-3.5.

Of these survey months, the concentration was the highest in September in seawater. In the sediments, pigment concentration showed decreasing trend with increasing depths.

11AM2002 GP-BIO-271 Poster
SEASONAL CYCLES IN ABUNDANCE OF CALANOID COPEPODS IN KII CHANNEL, THE SHELF WATER ON THE PACIFIC SIDE OF SOUTHWESTERN JAPAN – ANALYSIS FROM 12 YEARS' (1987-1999) SAMPLES

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Analysis of monthly data for 12 years (1987-1999) collected from 13-21 stations in Kii Channel, the productive fishery ground on the Pacific side of southwestern Japan, was conducted to examine the seasonal occurrence of 4 major calanoid groups (numerical order: *Paracalanus parvus* s.l., *Calanus sinicus*, *Acartia omorii*, *Clausocalanus* spp.). Water column average temperature fluctuated seasonally, with the highest of ca. 24°C in summer and the lowest of ca. 12°C in early spring. Generally, these copepods appeared throughout the year. Each group showed different seasonal cycle, and also underwent year to year variation in the seasonality. Among these, *P. parvus* favoured the coldest temperature, since its abundance was > ca. 400 inds m^{-3} from January to March (mean temperature: 12.1-14.6°C). *C. sinicus* and *A. omorii* favoured slightly higher temperatures than *P. parvus*. The abundance of *C. sinicus* was highest (mean: 158-344 inds m^{-3}) during the period from April to July (13.5-21.2°C), and that of *A. omorii* was highest (87-239 inds m^{-3}) during the period from February to June (12.1-18.5°C). *Clausocalanus* spp. occurred over a wide range of temperature, and their seasonal variation looked bicyclical, being more abundant in March-April (35-38 inds m^{-3}) and August-October (30-42 inds m^{-3}).

11AM2002 GP-BIO-272 Poster
DISTRIBUTION OF NUTRIENT ELEMENTS AND CHLOROPHYLL *a* IN VEGETATIVE PERIOD IN ANIVA BAY, THE OKHOTSK SEA

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Nowadays a global control of biological processes in the sea is still in sight and the appropriate theory is at the developmental stage. For creation of this theory, the study of coastal half-closed areas of the sea is of great importance. In such waters, the development of general physical-chemical and biological mechanisms becomes obvious and can be used in creation of a functioning marine ecosystem model. Such mechanisms could become

apparent in studying the circulation of nutrient elements, and it needs knowledge of the annual dynamics of its basic forms at different depths.

This work is a part of complex investigations in seasonal changeability of different forms of nutrient elements and chlorophyll *a*, as a production index in Aniva Bay at four standard transects, located in latitudinal direction.

The experimental observation was conducted at the 13 stations. Basic characteristics of water, including contents of oxygen, mineral forms of nitrogen, phosphorus, silicon and chlorophyll *a* were observed.

It was to be expected, that there is a direct relation between contents of chlorophyll *a* and oxygen. The deficiency of oxygen becomes apparent at a depth of 20-30 m, and it is reduced to 80% of aeration at great depths. The maps of distribution of nutrient elements and chlorophyll *a* show that evolution of phytoplankton begins at the edge of the ice on shallow, and warmer stations.

Maximal concentrations of chlorophyll *a* - more than 20 microgram/liter are obtained in the east part of the bay. For optimal production of phytoplankton, besides satisfactory light conditions, warm waters and provision of nutritious salts, the calm condition of waters is also necessary. The map of distribution of chlorophyll *a* at the coastal station No. 18 visually demonstrates it. Here the content of chlorophyll *a* descends to the minimum value: from 4.2 microgram/liter at the surface and to 0.1 and 0.9 microgram/liter at the depth of 20 and 30 m, respectively. Most likely, the waters at this station, which situates near La Perouse Strait, experience strong turbulent influence of strait's current.

The content of phosphate fluctuates from 0.5 at the surface waters to 1.7 micromole at the depth. At the beginning of vegetation period phytoplankton do not have deficiency of nutrient elements, and nitrate as well. They distribute irregularly among all transects, besides those, which are located close to the sea, where their content at the central station steadily decreases from 4.6 at the surface to 18 micromole at the depth of 100 m.

The contents of chlorophyll *a* and silicon are in inverse dependence, because spring phytoplankton are appeared mainly by diatomaceous species, needing for skeleton construction.

These data are of basis account of primary production on seasonal decrease of nutrient elements in the course of year.

11AM2002 GP-BIO-273 Poster
SEASONAL CHANGES IN COMPOSITION OF ZOOPLANKTON IN KIEVKA BAY COASTAL WATERS (THE SEA OF JAPAN)

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The species list and seasonal alternations of the composition and abundance of plankton since March till November 2000 were surveyed in the nearshore areas of Kievka Bay, in the areas of fatting of juvenile salmons, smelts, redfin and other fish species. The plankton were of great variety and included ocean and neretic plankton species, as well as plankton-bentic species, larvae of seafloor inverterbrates and fishes. Plankton community in this bay forms in consequence of as currents plankton removal (*Oithona similis, Pseudocalanus newmani, Paracalanus parvus*) as the some neretic species breeding and development. The presence of copepods genuses such as Acartia, Centropages, Tortanus, Eurytemora, Sinocalanus Schmackeria points out the estuary waters propagation to a coastal fields of Kievka Bay. The seasonal change in plankton species composition is determined by a hydrological regime of this Japan Sea area. Zooplankton community is presented by cold-water species within most year (from copepods - *O. similes, P. newmani, Acartia tumida, A. hudsonica, A. steueri, Eurytemora pacifica, E. americana*; from cladocera - *Evadne nordmani, Podon leucarti*; from chetognath -*Parasagitta septicoella*). Warm-water plancters are observed in Kievka Bay during summer-autumn (from copepods - *P. parvus, Pseudodiaptomus inopinus, Oithona brevicornis, O. plumifera*, from chetognat - *Ferosagitta cristallina*, Mesosagitta, from cladocer - *Pleopis polyphemoides*). Appearance of subtropical fauna in cold-water area of Japan Sea is explained by spreading of warm current.

11AM2002 GP-BIO-274 Poster

DISTRIBUTION OF *Neocalanus flemingeri* IN THE OKHOTSK SEA IN SUMMER 1988

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A plankton survey on biomass distribution and age structure of *N. flemingeri* was carried out in the Okhotsk Sea in the summer 1988 Minimal biomass of this species was 0-20 mg/m^3 in Iono-Kashevarov, Ayano- Shantarsky in the southern sea at depths along eastern coast of Sakhalin Island. Maximal concentrations 200-500 mg/m^3 were in south-western coast of Kamchatka and in the central Okhotsk Sea at the depths. These regions are apparently affected by the bulk water of Pacific Ocean. This species is absent on the north shelf of the Okhotsk Sea and in Gulf of Shelichova. Population of *N. flemingeri* in the Okhotsk Sea was presented C4, C5 copepodites stages. C4, C5 occurred mainly up to 200 m. This species is absent in 200-500 m layer. C5 copepodite appeared in bathypelagic 500-1000 m layer. The size distributions of the prosome length were bimodal in C4, C5. Large-form C4, C5 were less abundant than small-forms C4, C5. The large-form: small-form ratio of the prosome length was 1,12: 1 for C4; and 1,30: 1 for C5. We hypothesize that the small-form C4 are sex undetermined and small C5 are males, and large form C5 are all females.

11AM2002 GP-BIO-276 Poster

In Situ DAILY GROWTH RATE OF *Prochlorococcus* AT THE CHLOROPHYLL MAXIMUM LAYER IN THE SOUTHERN SOUTH CHINA SEA: AN ESTIMATION FROM CELL CYCLE ANALYSIS

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Prochlorococcus is the dominant species of the autotrophs in the oceanic area in the South China Sea, contributing significantly to picoplanktonic carbon biomass. However, there has been no data on its growth rate and productivity available so far. By using the cell cycle approach, *in situ* population daily growth rate of *Prochlorococcus* was estimated at the chlorophyll maximum layer at 6.3°N, 110°E in the South China Sea. The daily growth rate of *Prochlorococcus* calculated from the percentage of cells undergoing S and G2 phases to the total population number during one diel cycle at the sampling station was 0.54 day^{-1}, *i.e.*, 0.72 dividing day^{-1}. Results were comparable to those reported in the other oceanic areas. Based on that growth rate, and taking the converter of carbon biomass per cell as 53 fg C cell^{-1} for *Prochlorococcus* (Campbell *et al.* 1994, Moore *et al.* 1993), the depth integrated productivity of *Prochlorococcus* was 195 mg C m^{-2} day^{-1}.

GP-FIS General Poster Session – FIS

Posters on subjects of interest to the Fishery Science Committee. Posters will be on display from October 21 (p.m.) – 24 (noon). There will be a "Beer & Dim Sum Poster Session" (evening of October 23) when poster presenters will be available to answer questions.

Jung-Hwa Choi, Sung Yun Hong, Chaewoo Ma, Chulwoong Oh
Influence on growth and reproduction of *Metapenaeopsis dalei* (Decapoda: Penaeidae) by *Parapenaeon consolidatum* (Isopoda: Bopyridae) from the southern Korea waters (GP-FIS-225)

Larissa A. Gayko
The long-term physical and weather and statistical method of the forecast of mollusks' yield of marine farms (GP-FIS-226)

Tae Won Lee, Sun Do Hwang, Won Seok Yang, Hyeong Tae Moon
The factors affecting the daily catch of glass eels in the Geum-River estuary, Korea (GP-FIS-227)

Hui Yu Li, Min Ho Son, Sung Yun Hong
Effects of sand, food supply and tank size on the growth of the sand shrimp, *Crangon uritai* (decapoda:crangonidae) (GP-FIS-228)

Igor V. Melnikov
Effect of the cold winter 2000 - 2001 on allocation and migrations of the Pacific herring in the northern Okhotsk Sea (GP-FIS-229)

Ludmila V. Milovskaya, S.B. Gorodovskaya, T.I. Tolstyak
The influence of escapement and feeding conditions on female maturation rate of sockeye salmon (*Oncorhynchus nerka walbaum*) smolts (GP-FIS-230)

Minho Son, Sung Yun Hong, Sung-Hoi Huh
Sex ratio, incidence of imposex and penis morphology in *Thais clavigera, T. luteostoma, Ceratostoma rorifluum* and *Ocinebrellus inornatum* (mollusca: gastropoda: muricidae) along the Korean coasts (GP-FIS-231)

Vladimir N. Vologdin, V.B. Darnitsky, S.P. Bomko
Behaviour and structure formation research of pelagic fishes by means of sonars and echosounders (Part 1) (GP-FIS-232)

Vladimir N. Vologdin, V.B. Darnitsky, S.P. Bomko
Behaviour and structure formation research of pelagic fishes by means of sonars and echosounders (Part 2) (GP-FIS-233)

11AM2002 GP-FIS-225 Poster

INFLUENCE ON GROWTH AND REPRODUCTION OF *Metapenaeopsis dalei* (DECAPODA: PENAEIDAE) BY *Parapenaeon consolidatum* (Isopoda: Bopyridae) FROM THE SOUTHERN KOREA WATERS

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This study describes incidence rate of a bopyrid isopod, *Parapenaeon consolidatum* on *Metapenaeopsis dalei* and it parasitic effect on growth and reproduction of the host. The prevalence of infestation by *P. consolidatum* increased with shrimp size, from 27.3% at 5 mm CL to 68.4% at 16 mm CL of the host shrimp. The length of the female isopods and that of their hosts were positively correlated. This indicated that the parasitic bopyrid infest on the host shrimp continuously and it is not detached at the time of molt of the host shrimp. Morphometric analysis indicated that the infested male and female shrimps have slightly lower body weight and length than the uninfested shrimps of the same carapace length. The GSI of the uninfested female shrimps was larger than the infested shrimps. Petasma growth of the male shrimp was affected significantly by the parasite.

11AM2002 GP-FIS-226 Poster

THE LONG-TERM PHYSICAL AND WEATHER AND STATISTICAL METHOD OF THE FORECAST OF MOLLUSKS' YIELD OF MARINE FARMS

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Planned yield is very important for operation of marine farms. In this work a method of the long-term forecast of mollusk efficiency (exemplified by the Japanese scallop) was developed. Data on marine shell yield for the Experimental Sea Base "Possyet" (where Japanese scallop were grown from 1970 to 1990) were used in this article.

To develop the method of the forecast, data on marine shell yield were used as the predictante. The term "yield" stands for a quantity unit or the density of the scallop spat settled on collectors and is expressed in specimens per square meter of the collector (specimens/m^2 and individ/m^2). Various abiotic factors were used as predictors. The scheme of the long-range prognosis of production is most sustainable, when it is multileveled, that is, accounts for simultaneous states of the underlying surface, tropospheric circulation, stratospheric circulation or helic physical factors. The technique of separate forecasting of the trend and random constituents was used for the first time for prognosis of spat yield in Primorye. As a principal method of mathematical statistics in forecasting random constituent of the Japanese scallop yield for the first time the linear discriminant analysis. Formulated for the first time are rules for making phase and quantitative forecast of the random constituent of mollusk spat yield on the basis of combination of signs of linear discriminant functions. Formalization of phisico-statistical technique of the Japanese scallop spat yield is performed, and rules of statical and dynamic complexing of forecast with different length of time before forecast phenomenon occurrence are elaborated. Quantitative criteria of mollusk yield assessment are developed. Four schemes (of statical and dynamic complexing) have been chosen, which we recommend to use for forecasting the Japanese scallop yield.

11AM2002 GP-FIS-227 Poster

THE FACTORS AFFECTING THE DAILY CATCH OF GLASS EELS IN THE GEUM-RIVER ESTUARY, KOREA

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The glass eels were collected by the bag nets and set nets in Geum-River estuary during the seasons of upstream migration in 2001. Environmental factors such as water temperature, salinity, tidal level, rainfall and wind were measured. The glass eels began to be caught in February when the water temperature raised over 5°C. The catch

showed a peak in March when the temperature reached 10°C. Few glass eels were caught when the temperature reached over 16°C in late May. The catch was high during the new and full moon throughout the sampling period. Daily catch increased when the temperature dropped or the wind was strong, and one day after the salinity declined. The daytime catch was highly correlated to the volume filtered by the net. However, the night catch was affected not only by the volume filtered but also by the environmental change.

11AM2002 GP-FIS-228 Poster
EFFECTS OF SAND, FOOD SUPPLY AND TANK SIZE ON THE GROWTH OF THE SAND SHRIMP, *Crangon uritai* (DECAPODA: CRANGONIDAE)

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The sand shrimp, *Crangon uritai* occurs in the Yellow Sea, the northern East China Sea, the central and southern parts of the East Sea and Seto Inland Sea, inhabiting sandy and sandy-mud bottom in the shallow coastal waters. Information on how abiotic factors affect the growth of this species is not available. This study investigated the effects of sand, food supply and tank size on growth of the sand shrimp *C. uritai*.

The sand shrimp, *C. uritai* were reared individually in the laboratory under the controlled conditions (14°C; 32.5‰; 12:12 L:D), providing fresh food (flesh of frozen prawns). Four groups (including one control group) were designed to determine the effects of sand, food supply and tank size on growth of females and males. Intermolt period and molt increment, as a growing parameter, were recorded.

Survival was lowest at restriction of food supply for the males and at the small sized tanks for the females. Restriction of food supply and small size tank prolonged intermolt period for both females and males. Presence of sand on the bottom of the tank prolonged intermolt period for the males but not for the females. Molt increment was increased in the tanks with sand bottom, reduced food supply and small sized tanks for both the females and males.

11AM2002 GP-FIS-229 Poster
EFFECT OF THE COLD WINTER 2000 - 2001 ON ALLOCATION AND MIGRATIONS OF THE PACIFIC HERRING IN THE NORTHERN OKHOTSK SEA

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The cold winter 2000-2001 had essential impact both on the biota of the Okhotsk Sea as a whole, and on the mass-commercial species. The pacific herring had a delayed spawning for one month and more, almost over entire northern part of the sea. Thus, the wintering of the herring has ended as usual and delays of spawning migrations are related to sluggish warming-up of the coastal water. In result, duration of the feeding period was reduced, and fish by autumn were not able to prepare for wintering. In the autumn of 2001, forage herring aggregations were observed in the northwest part of the sea before the beginning of December. The biomass of herring was estimated at 1.8 million tons. Commercial concentrations of herring in Pritauyski region appeared starting the mid-November. Autumn cooling in October hampered a migratory path of herring from Kashevarov's bank to Pritauyski region on the shelf. Because of that, herring aggregation parts migrated to the wintering region using the non-conventional way - to the east: south Kashevarov's bank passing is the usual region of pre-wintering aggregations. This had a mal-impact on fishery for the Okhotsk Sea herring, resulting in taking only 78% of the quota.

The gijigino-kamchatsk herring in September - October did not form pre-wintering aggregations off the northwestern coast of Kamchatka. The intensifying of the West-Kamchatka flow in the autumn of 2001 has resulted in temperature rise of pelagic water in the north-eastern part of the sea, therefore the herring of this population foraged in bottom layers of the western Kamchatka shelf to the end of October and migrated for wintering to Shelikhov Bay only in November - December.

11AM2002 GP-FIS-230 Poster

THE INFLUENCE OF ESCAPEMENT AND FEEDING CONDITIONS ON FEMALE MATURATION RATE OF SOCKEYE SALMON (*Oncorhynchus nerka* WALBAUM) SMOLTS

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The influence of sockeye salmon escapement, female smolt weight, water temperature and food supply on the state of reproduction cells in smolts of largest in Asia Ozernaya River sockeye salmon stock (Kuril Lake) has been analyzed. Functional relations have been described.

The percentage of reserve cells fund mostly depends on the escapement. Volume reserve cells fund determines ratio and size of cells of main fund. High escapement and low level of forage base cause reserve fund increase and decrease of the percentage of the most developed division of main cells fund under simultaneous reduction the cells diameter.

Smolt weight demonstrates negative correlation to reserve cells fund and to the percentage of I stage cells in main fund and positive relation to the size of the more advanced oocytes. Along the smolt weight growth, the size of oocytes at the stage III has been increased.

Sockeye salmon abundance is known to form during their freshwater period life. At low escapement, smolt females have better quality characteristics what is a term of stock abundance growth. At high escapement, the quality characteristics became worse, and that leads to the stock abundance decrease. The realized analysis demonstrates the abundance regulation mechanism.

11AM2002 GP-FIS-231 Poster

SEX RATIO, INCIDENCE OF IMPOSEX AND PENIS MORPHOLOGY IN *Thais clavigera*, *T. luteostoma*, *Ceratostoma rorifluum* AND *Ocinebrellus inornatum* (MOLLUSCA: GASTROPODA: MURICIDAE) ALONG THE KOREAN COASTS

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Sex ratio and incidence of imposex (the super-imposition of male characteristics onto females) in four intertidal muricid species (*Thais clavigera* (T.c.), *Thais luteostoma* (T.l.), *Ceratostoma rorifluum* (C.r.) and *Ocinebrellus inornatum* (O.i.) were investigated in samples collected from 7 to 27 stations along the coast of Korea. Sex ratios of the species were skewed towards males at most stations. At a few stations, no females were found (3 of 27 in T.c., 6 of 11 in T.l., 6 of 12 in C.r. and 2 of 7 in O.i.). Inposex in the four species occurred at most stations where females sampled (26 of 27 in T.c., 4 of 5 in T.l., 6 of 6 in C.r. and 5 of 5 in O.i.). Pseudo-penis morphology of imposexed females showed intraspecific variation in the degree of penis development. This variation has been recorded in line drawings.

The present survey of the 4 common intertidal muricids around the Korean peninsula has revealed that the incidence of 'imposex' and the biased 'sex ratio' are widespread, that all populations are affected to some degree.

11AM2002 GP-FIS-232 Poster

BEHAVIOUR AND STRUCTURE FORMATION RESEARCH OF PELAGIC FISHES BY MEANS OF SONARS AND ECHOSOUNDERS (PART 1)

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There are marked the following features of sardine, mackerels and other pelagic fishes: spottiness (irregular) distribution of fish schools; a large range of densenesses of schools and other structural formations; a complicated character of a density variability depending on the environment factors; difference in the forms of schools depending on a movement velocity and time of day in the period of formation structure study.

The structural units of sardine formations observed by means of circular electronic scanning sonar FSS-32B (FURUNO) in the period of a hydroacoustic trawl survey in the Japan Sea were conditionally divided in accordance with their relative magnification on functional various hierarchical gradation: 1 - Initial element of any aggregation - one fish; 2 - Elementary shoal, composed of 2-9 fish (Zaferman 1995); 3 – Fish school; 4 - Group of schools (sometimes called " by a spot "); 5 – Aggregation, composed of some groups; 6 – Superaggregation, composed of several aggregations.

Averaged sardine sizes varied depending on year to year and region based on data of fishery fleet operations and haul results of research vessels. For example, in the Japan Sea in 1981, it was 21.8 cm, in 1982 – 19.9 cm, and in the Pacific, accordingly, 15.2 and 16.4 cm. The essential difference in the indicated sizes is explained by a various amount immature fishes enveloped by hydroacoustic-trawl surveys per various years and in various subpopulations: the Japan Sea and the Pacific.

Based on entropy of structural formations, it is possible to suppose the following classification: A - Visible randomness of disposition of schools, distance between schools - casual; the form of group on an external outline - uncertain, shapeless formation; B - Visible order of a disposition of schools (it is possible under effect of predators or local near-surface heterogeneities of water masses); the distances between schools are approximately identical in some cases; the number of schools in groups is changed from group to group from 5 up to 20 schools, marked on indexed fixed display images; C - Rarefied aggregations of fishes in dark time of day.

The distances between schools considerably differ from distances between groups of schools. A distance between schools in groups - 10-145 m, and between groups - 510 - 870 m (sometimes - to 6 miles and more), *i.e.* difference - in some cases more than ten times.

11AM2002 GP-FIS-233 Poster

BEHAVIOUR AND STRUCTURE FORMATION RESEARCH OF PELAGIC FISHES BY MEANS OF SONARS AND ECHOSOUNDERS (PART 2)

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Heterogenity of hydrological conditions including a thin structure, microeddies of internal waves might play a key role in general randomness of school distribution inside groups.

Structure spottiness in schools and groups of schools as a feature of behaviour of sardine, mackrel and other pelagic fishes, and availability of oscillations of various scales can be measured immediately or be determined indirectly. It was observed as non-uniformity of density and variability in fish schools using the colour echosounder DVS-881B and in larger structural units as spottiness-like structures (groups of schools) and fish aggregations. The oscillations happen owing to non-uniformity of migration velocity of fishes caused by their biological and physical interaction with the environment. The density variability of fish aggregations is noticed both n latitudinal and in meridional directions. Based on data correlation to velocity distribution and movement directions of fish schools in aggregations, it is possible to make a conclusion that this variability has a spatial temporary character. So, on sonar researches of the sardine in the Japan Sea in the autumn of 1983, the variance of school number density on square mile in latitudinal direction (36.0) has appeared much more than in a meridional direction (2.0), and the average density correspond to 3.5:1, accordingly. Observed autumn fish migration to the southwest, the indicated differences in average density were explained by a pulsing migration of an aggregation called by accumulation and

consequent transition in this direction feeding schools in zones of the increased contents feed plankton. Probably, the accumulation degree of schools (or area density of migrating schools) depends, mainly on a degree of fat accumulation in a body of fishes and on a degree of cooling of enclosing waters. The analysis of histograms of distribution of density of school show that the distribution of schools in an aggregation is spotty, and the precisely expressed maximas of encounter frequency of schools on transects demonstrates availability of a limiting amount of feeding fish for concentration of feed plankton, being available in the given place.

Index of Authors

PICES Acronyms

BASS	Basin Scale Studies Task Team
BIO	Biological Oceanography Committee
CCCC	Climate Change and Carrying Capacity Program
CPR	Advisory Panel on Continuous Plankton Recorder Survey in the North Pacific
EC/IP	Executive Committee / Implementation Panel for CCCC
F & A	Finance and Administration Committee
FIS	Fishery Science Committee
GC	Governing Council
IFEP	Advisory Panel on Iron Fertilization Experiment Panel in the Subarctic North Pacific
MBM	Advisory Panel on Marine Birds and Mammals
MEQ	Marine Environmental Quality Committee
MODEL	Conceptual / Theoretical and Modeling Studies Task Team
MONITOR	Monitor Task Team
PC	Publication Committee
POC	Physical Oceanography and Climate Committee
REX	Regional Experiments Task Team
S1	Session 1: Science Board Symposium on *Technological advances in marine scientific research*
S2	Session 2: Joint BIO/MEQ Topic Session on *Food web dynamics in marginal seas: Natural processes and the influences of human impacts*
S3	Session 3: Joint BIO/POC/FIS Topic Session on *The importance of biophysical coupling in concentrating marine organisms around shallow topographies*
S4	Session 4: Joint BIO/FIS/CCCC Topic Session on *Responses of upper trophic level predators to variation in prey availability: An examination of trophic level linkages*
S5	Session 5: FIS Topic Session on *Comparison of the productivity of marginal seas with emphasis on the western Pacific (Japan/East Sea, Yellow Sea and East China Sea) with a focus on small pelagics*
S6	Session 6: FIS Topic Session on *Physical forcing of walleye pollock life history and population structure: New approaches to identifying critical temporal and spatial scales*
S7	Session 7: MEQ Topic Session on *Eutrophication, harmful algal blooms and nutrients*
S8	Session 8: Joint POC/FIS Topic Session on *Detection of regime shifts in physics and biology*
S9	Session 9: Joint PICES CCCC - GLOBEC Topic Session on *ENSO and decadal scale variability in North Pacific ecosystems*
S10	Session 10: Joint PICES CCCC - GLOBEC Topic Session on *Coupled biophysical processes, fisheries, and climate variability in coastal and oceanic ecosystems of the North Pacific*
S11	Session 11: Joint PICES CCCC - GLOBEC Poster Session on *Climate change and carrying capacity of the North Pacific: Recent results of GLOBEC and GLOBEC-like programs in the North Pacific*
S12	Session 12: TCODE Electronic Poster Session on *Data Systems to support technological advances in observation systems*
SB	Science Board
TCODE	Technical Committee on Data Exchange
W1	Workshop 1: MONITOR Workshop on *Requirements and methods for 'early detection of ocean changes'*
W2	Workshop 2: MONITOR Workshop on *Monitoring from moored and drifting buoys*
W3	Workshop 3: PICES/GLOBEC Workshop on *GLOBEC data management: Exchange, inventory and archival of GLOBEC data*
W4	Workshop 4: PICES/CLIVAR Workshop on *Climate variability in the Pacific and its impact on the marine ecosystem*
W5	Workshop 5: PICES-CKJORC Workshop on *Regional cooperation for the conservation and management of the marine environment and resources in the Yellow Sea*
WG	Working Group