

# PICES

North Pacific Marine Science Organization (PICES)

N i n t h   A n n u a l   M e e t i n g

p r o g r a m

a b s t r a c t s

o c t o b e r 20 - 28, 2000

H a k o d a t e ,   H o k k a i d o ,   J a p a n

## Table of Contents

	Page #
Program.....	1
Abstracts.....	23
Index.....	165
PICES Acronyms.....	175

Abstracts are sorted in alphabetical order 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.

## Tsukuba - 18<sup>th</sup> October, 2000 (Wednesday)

### NORTH PACIFIC CO<sub>2</sub> DATA SYNTHESIS SYMPOSIUM (09:00 - 17:30) - Part 1 (W7)

Co-Convenors: Andrew Dickson, Richard A. Feely (U.S.A.), Koh Harada & Yukihiro Nojiri (Japan)  
(Papers to be presented over 2 days.)

#### Ocean time series

Nickolas R. Bates, C.A. Carlson, D.A. Hansell, R.J. Johnson, A.F. Michaels, D.K. Steinberg and A.H. Knap. Physical and biogeochemical variability of the marine carbon cycle in the subtropical gyre of the North Atlantic Ocean. (W7-389)

John E. Dore. Carbon cycle observations at the Hawaii Ocean Time-series Station ALOHA. (W7-363)

Yukihiro Nojiri, K. Imai, N. Tsurushima, T. Saino and S. Watanabe. Biogeochemical Study at Ocean Time Series Station KNOT (44°N, 155°E) – results of 1998-2000 survey. (W7-375)

#### Basin scale studies

Richard A. Feely, C.L. Sabine, M.F. Lamb, R. Wanninkhof, R.M. Key, G.C. Johnson, F.J. Millero, K. Lee, T.-H. Peng, T. Ono, Y. Watanabe and C.S. Wong. Synthesis of Pacific Ocean DIC and TALK Survey Data. (W7-364)

Christopher L. Sabine. Carbon distributions in the Indian Ocean. (W7-378)

N. Metzl. Past, present and future CO<sub>2</sub> data in the Southern Ocean. (W7-371)

#### Overview of the poster session

## Tsukuba - 19<sup>th</sup> October, 2000 (Thursday)

### NORTH PACIFIC CO<sub>2</sub> DATA SYNTHESIS SYMPOSIUM (09:00 - 17:30) - Part 2 (W7)

Co-Convenors: Andrew Dickson, Richard A. Feely (U.S.A.), Koh Harada & Yukihiro Nojiri (Japan)  
(Papers to be presented over 2 days.)

#### Data synthesis

Kitack Lee, R. Wanninkhof, T. Takahashi, S. Doney, and R.A. Feely. Interannual variability in global net oceanic CO<sub>2</sub> uptake from 1982-1998. (W7-140)

Paulette P. Murphy, Y. Nojiri, D.E. Harrison and C.S. Wong. Ocean carbon uptake in the North Pacific: First steps in designing a sampling strategy. (W7-373)

Masao Ishii, T. Tokieda, S. Saito, H.Y. Inoue, T. Kawano, K. Matsumoto, H. Okano and I. Asanuma. Net community production in the central and western equatorial Pacific evaluated from the distributions in the oceanic CO<sub>2</sub> system. (W7-370)

#### Data integration

Ludger Mintrop, A. Körtzinger, J. Meincke and D.W.R. Wallace. The Atlantic Ocean CO<sub>2</sub> survey and CARINA. (W7-372)

Sachiko Oguma, K. Goto, M. Ishii, T. Miyake, A. Murata, Y. Nojiri, T. Ono, T. Saino, F. Shimano, T. Suzuki, Y. Tsurushima, S. Watanabe and Y.W. Watanabe. Inventory for Japanese Chemicaloceanographic Data (IJCD). (W7-376)

Jiye Zeng, Y. Nojiri and Y. Fujinuma. An introduction to an oceanic CO<sub>2</sub> database for the North Pacific. (W7-384)

#### Carbon cycle modeling

Fei Chai, M. Jiang, R.T. Barber, R.C. Dugdale, T.-H. Peng and Y. Chao. Modeling carbon cycle in the Pacific Ocean. (W7-361)

Yongfu Xu, F. Nishibori, S. Aoki and K. Harada. Sensitivity of anthropogenic CO<sub>2</sub> uptake to parameterizations of mesoscale tracer transports in a 3-D model of the North Pacific. (W7-382)

Kenneth L. Denman, S. Haigh and W. Hsieh. Will we have sufficient data to evaluate the performance of coupled 3-dimensional biogeochemical ocean basin models? (W7-390)

Masahiko Fujii, Y. Nojiri, Y. Yamanaka and M.J. Kishi. Application of one-dimensional ecosystem model to time series station KNOT observation. (W7-365)

## IFEP PLANNING WORKSHOP ON DESIGNING THE IRON FERTILIZATION EXPERIMENT IN THE SUBARCTIC PACIFIC (09:00 - 17:30) - Part 1 (W5)

Co-Convenors: C.S. Wong (Canada) & Shigenobu Takeda (Japan)

### Introduction

Kenneth Coale. Open ocean iron fertilization for scientific study and carbon sequestration. (W5-344)

Eden Rue and K. Bruland. Dissolved iron speciation in seawater. (W5-352)

Charles G. Trick. Fundamental differences in the iron acquisition systems among phytoplankton. (W5-355)

Cliff S. Law and P.W. Boyd. *In situ* testing of iron limitation in the southern ocean: an overview of the southern ocean iron enrichment experiment (SOIREE). (W5-392)

### Chemistry in the North Pacific and IronEx

C.S. Wong, S. Takeda, J. Nishioka and W.K. Johnson. Iron distribution in the Northeast Pacific Ocean. (W5-385)

Hajime Obata, E. Nakayama, M. Maruo, M. Takano and Y. Nozaki. Iron and manganese distribution in the surface waters of the North Pacific Ocean and the Bering Sea. (W5-351)

Mark L. Wells. Fe dynamics during IronEx II: The premature loss of Fe availability within the enriched patch during the phytoplankton bloom. (W5-357)

Kenshi Kuma, S. Nakabayashi, I. Kudo and M. Kusakabe. Characteristic vertical profiles of Fe(III) hydroxide solubility in the northwestern North Pacific Ocean. (W5-349)

### Biology in the North Pacific and IronEx

Paul J. Harrison, M. Lipsen and P.W. Boyd. Shifts in phytoplankton species composition during recovery from iron limitation at Stn P in the Subarctic NE Pacific: Potential effects on carbon cycling. (W5-347)

Sei-ichi Saitoh and K. Sasaoka. East-west variability of primary production in the subarctic North Pacific derived from multi-sensor remote sensing during 1996-2000. (W5-353)

William P. Cochlan. The planktonic nitrogen uptake and heterotrophic bacterial response during the second mesoscale Iron Enrichment Experiment (IronEx II) in the eastern equatorial Pacific Ocean. (W5-345)

Isao Kudo, T. Yoshimura, T. Nishida and Y. Maita. Comparison of iron enrichment experiments on board in the NE and NW subarctic Pacific Ocean. (W5-348)

Neil M. Price, J. Granger and E. Armstrong. Iron-siderophore receptors of heterotrophic marine bacteria. (W5-361)

Jun Nishioka, S. Takeda, C.S. Wong, W.K. Johnson and F.A. Whitney. The size-fraction of supplied Fe and change in the concentration of Fe in different size fraction in onboard bottle incubation experiments. (W5-350)

Atsushi Tsuda and S. Takeda. Zooplankton response to nutrient input. (W5-358)

### Physics in the North Pacific and Fe addition techniques

Richard E. Thomson. Physical Processes Affecting the Distribution of Iron-fertilized Ocean Water in the North Pacific. (W5-354)

Cliff S. Law. The application of SF<sub>6</sub> tracer lagrangian studies in iron fertilization experiments. (W5-386)

Daisuke Tsumune, N. Nakashiki, S. Takeda and J. Nishioka. Prediction of physical behavior of released iron by random walk simulation during the iron fertilization experiment in the North Pacific. (W5-356)

William R. Crawford, J.Y. Cherniawsky and J. Gower. Influence of Cape St. James on currents and eddies in the Gulf of Alaska. (W5-346)

### General discussion

## Tsukuba - 20<sup>th</sup> October, 2000 (Friday)

Working Group 13, TCODE & NPTT Joint Meeting (09:00 - 17:30)

Working Group 13 Intercalibration Workshop (09:00 - 17:30)

IFEP Planning Workshop (W5) (09:00 - 17:30) - General discussion continued

## Tsukuba - 21<sup>st</sup> October, 2000 (Saturday)

Working Group 13, TCODE & NPTT Joint Meeting (09:00 - 13:00)



## Hakodate

### 20<sup>th</sup> October, 2000 (Friday)

THE BASIS FOR ESTIMATING THE ABUNDANCE OF MARINE BIRDS AND MAMMALS, AND THE IMPACT OF THEIR PREDATION ON OTHER ORGANISMS (09:00 - 17:30)

(BIO / MBMAP Technical Workshop) (W6)

Co-Convenors: *George L. Hunt, Jr. (U.S.A.) & Hidehiro Kato (Japan)*

**George L. Hunt, Jr., P.J. Gould and K. Morgan** Results of the PICES Working Group 11 estimates of prey consumption by marine birds and challenges in developing estimates. (W6-087)

**Hidehiro Kato, J. Bengtson, N. Baba, C. Jay, L. Lowry and A. Trites.** Prey consumption by marine mammals: estimation by the PICES Working Group 11. (W6-333)

**Jeffrey L. Laake.** (invited) Estimation of marine mammal and seabird abundance. (W6-138)

**Larry B. Spear.** (invited) Estimating population size of seabirds at sea. (W6-237)

**Tomio Miyashita.** Case study - Shipboard sighting survey for marine mammals. (W6-325)

**Robert W. Furness.** (invited) Estimation of prey consumption by seabirds in the northeast Atlantic Ocean. (W6-070)

**Andrew W. Trites.** (invited) Estimating prey consumption by marine mammals in the North Pacific. (W6-256)

**Elizabeth H. Sinclair, A. York and G. Antonelis.** Case studies for stomach and scat analyses: Pinnipeds. (W6-307)

**Hiroshi Ohizumi.** Approaches to dietary study of cetaceans and problems in the analyses of stomach contents. (W6-181)

**Yutaka Watanuki, A. Takahashi, K. Sato and A. Kato.** Seabirds as a platform for monitoring marine environment with biotelemetry techniques. (W6-268)

**Hiroshi Okamura.** Consideration for modeling to incorporate prey consumption by marine birds and mammals. (W6-183)

**Patricia A. Livingston.** Overview of upper-trophic level models for assessing the impacts of climate and fishing on marine ecosystems. (W6-147)

General discussion

### CCCC Workshops Plenary Session #1 (09:00 - 12:30)

Overview of BASS, MODEL, MONITOR, REX and NPAFC-PICES Workshops

BASS Keynote speaker – **Jeffrey J. Polovina.** Investigating marine ecosystem dynamics with Ecosim.

MODEL Keynote speaker – **Kenneth A. Rose.** A review of the use of individual-based models as upper trophic level modelling tools.

MONITOR Keynote speaker – **Ned Cyr.** An overview of the LMR-GOOS strategic design.

REX Keynote speaker – **Fritz C. Funk.** Abundance and historical trends of herring in Alaskan waters.

## MONITOR WORKSHOP ON PROGRESS IN MONITORING THE NORTH PACIFIC (13:30 - 17:30) - Part 1 (W1)

Co-convenors: *Yasunori Sakurai (Japan) & Bruce A. Taft (U.S.A.)*

**David W. Welch.** Overview and CCCC Objectives.

**Sonia D. Batten.** CPR Measurements in Subarctic Pacific

**Jeffrey M. Napp.** Calibration of Zooplankton Sampling Gear

**William T. Peterson.** Monitoring Zooplankton Production in the Subarctic Pacific

**Kaoru Nakata.** A Review of the Report on Standardization of Plankton Sampling by the National Institutes of the Fisheries Agency"

**Tadafumi Ichikawa.** Optimal measuring conditions for plankton counter (W1-092)

**Vera Alexander.** Status of Census of Marine Life Census Program

**David W. Welch.** A Plan to Monitor the Migrations of Key Species in the N. Pacific

**William Sydeman.** Monitoring of Seabirds and Ecosystem Dynamics -

General discussion

## REX WORKSHOP ON TRENDS IN HERRING POPULATIONS AND TROPHODYNAMICS (13:30 - 17:30) - Part 1 (W2)

Co-convenors: *Douglas E. Hay (Canada), Tokimasa Kobayashi (Japan), William T. Peterson (U.S.A.) & Vladimir I. Radchenko (Russia)*

**Nikolai I. Naumenko.** (invited) Historical trends of herring in the Russian North Pacific waters. (W2-170)

**Tokimasa Kobayashi and K. Yabuki.** Recent state of Japanese herring populations. (W2-312)

**Jake Schweigert.** (invited) Trends in Pacific herring populations of British Columbia. (W2-222)

**Gary L. Thomas.** Oil, disease and fishing as factors in the multiple collapses of the Prince William Sound herring population. (W2-251)

**R.J. Foy and Brenda L. Norcross.** Diet and feeding of juvenile Pacific herring. (W2-338)

**Douglas E. Hay.** Temporal comparisons of juvenile and adult growth: implications for changes in trophic conditions in shelf versus nearshore waters. (W2-319)

**William T. Peterson, L.R. Feinberg and J.E. Keister.** Euphausiids as indicators of changing ocean conditions in the Oregon upwelling zone. (W2-300)

**Scott M. Rumsey.** (invited) Modelling environmental and predation-induced variability in euphausiid recruitment: Its dependence and impact on herring trophodynamics. (W2-209)

General discussion

## MODEL WORKSHOP ON STRATEGIES FOR COUPLING HIGHER AND LOWER TROPHIC LEVEL MARINE ECOSYSTEM MODELS (13:30 - 17:30) - Part 1 (W3)

Co-convenors: *Michio J. Kishi (Japan) & Bernard A. Megrey (U.S.A)*

**Bernard A. Megrey, M.J. Kishi, D.M. Ware and M. Kashiwai.** Summary of NEMURO 2000: An International Workshop to Develop a Prototype Lower Trophic Level Ecosystem Model for Comparison of Different Marine Ecosystems in the North Pacific. (W3-338)

**Michio J. Kishi and H. Kuroda.** Sensitivity analysis on NEMURO. (W3-388)

**Vadim V. Navrotsky.** To the physical forcing and the ways of improvements in the Nemuro-Model. (W3-171)

**Francisco E. Werner and D. Eslinger.** Lower trophic level models in oceanic ecosystems: status of the NEMURO LTL model and suggested extensions. (W3-269)

**Yasuhiro Yamanaka, N. Yoshie, M. Fujii and M.J. Kishi.** NEMURO Model follow up. (W3-387)

**Vladimir I. Zvalinsky.** Coupling of different trophic levels in marine ecosystem models. (W3-294)

**Daniel M. Ware.** Coupling lower and higher trophic level models in marine ecosystems: an overview. (W3-266)

General discussion

**BASS WORKSHOP ON DEVELOPMENT OF A CONCEPTUAL MODEL OF THE SUBARCTIC PACIFIC BASIN ECOSYSTEM(S) (13:30 - 17:30) - Part 1 (W4)**

Co-convenors: Richard J. Beamish (Canada), Andrei S. Krovnin (Russia), Gordon A. McFarland (Canada) & Akihiko Yatsu (Japan)

Kerim Y. Aydin. An ECOPATH model of the eastern Subarctic Pacific (Alaskan) Gyre, with implications for development of a western Subarctic Pacific model. (W4-299)

Vladimir I. Radchenko, V.V. Lapko and E.P. Dulepova. Modeling of the western Bering Sea ecosystem with help of ECOPATH software. (W4-139)

Overview of individual ecosystem models and recent modelling efforts  
General discussion

**21<sup>st</sup> October, 2000 (Saturday)**

**MONITOR WORKSHOP ON PROGRESS IN MONITORING THE NORTH PACIFIC (09:00 - 13:00) - Part 2 (W1)**

Co-convenors: Yasunori Sakurai (Japan) & Bruce A. Taft (U.S.A.)

Ned Cyr. Role of Regional Organizations in the Design of GOOS -

Martin Kuijper. Long-Term Plans at NEAR-GOOS -

Howard Freeland. ARGO: Progress Towards Implementation (W1-065)

Phillip Mundy. Design of a Northern Gulf of Alaska Monitoring Program - relation to GOOS (W1-323)

Nikolay Rykov. Recent USA/Russia/Japan Surveys of Japan and Okhotsk Seas

Tatsuro Akiba. A new instrument for POC measurements

General discussion continued

Report on MONITOR Workshop and recommendations

**REX WORKSHOP ON TRENDS IN HERRING POPULATIONS AND TROPHODYNAMICS (09:00 - 13:00) - Part 2 (W2)**

Co-convenors: Douglas E. Hay (Canada), Tokimasa Kobayashi (Japan), William T. Peterson (U.S.A.) & Vladimir I. Radchenko (Russia)

General discussion continued

Report on REX Workshop and recommendations

**MODEL WORKSHOP ON STRATEGIES FOR COUPLING HIGHER AND LOWER TROPHIC LEVEL MARINE ECOSYSTEM MODELS (09:00 - 13:00) - Part 2 (W3)**

Co-convenors: Michio J. Kishi (Japan) & Bernard A. Megrey (U.S.A.)

Steven J.D. Martell. Review on ECOPATH modelling.

Francisco E. Werner. Report from GLOBEC Focus 3 WG.

General discussion continued

Report on MODEL Workshop and recommendations

**BASS WORKSHOP ON DEVELOPMENT OF A CONCEPTUAL MODEL OF THE SUBARCTIC PACIFIC BASIN ECOSYSTEM(S) (09:00 - 13:00) - Part 2 (W4)**

Co-convenors: Richard J. Beamish (Canada), Andrei S. Krovnin (Russia), Gordon A. McFarland (Canada) & Akihiko Yatsu (Japan)

Breakout sessions

General discussion continued

Report on BASS Workshop and recommendations

**CCCC Workshops Plenary Session #2 (14:00 - 17:30)**

Reports from BASS, MODEL, MONITOR, REX and BIO-MBM Workshops

Reports on National GLOBEC Programs

Reports on International GLOBEC activities

## 22<sup>nd</sup> October, 2000 (Sunday)

BASS, MODEL, MONITOR & REX Task Team Meetings (09:00 - 12:30)  
Working Groups 14 & 16 Meetings (09:00 - 12:30)  
Working Group 15 Meeting (09:00 - 17:30)  
Science Board Meeting\* (12:30 - 13:30)  
BIO, FIS, MEQ & POC Committee Meetings (13:30 - 17:30)  
CCCC Implementation Panel/Executive Committee Meeting\* (13:30 - 17:30)  
MBM Advisory Panel Meeting (13:30 - 17:30)  
Fund-Raising Committee Meeting\* (13:30 - 17:30)  
Publication Committee Meeting\* (18:00 - 20:00)

## 23<sup>rd</sup> October, 2000 (Monday)

Registration (07:30 - 08:30)

Opening Session (09:00 - 11:00)

- Opening / welcome address by **Mr. Hiroshi Inoue**, Mayor of Hakodate, on behalf of the Local Supporting Committee and the hosting city
- Welcome address by **Mr. Yukiya Amano**, Deputy Director-General for Arms Control and Scientific Affairs, Ministry of Foreign Affairs, on behalf of the Government of Japan
- Remarks by **Dr. Hyung-Tack Huh**, Chairman of PICES
- Remarks by representatives of contracting parties
- Announcements
- Overview of PICES scientific accomplishments by **Ms. Patricia Livingston**, Chairman of Science Board
- Keynote lecture by **Dr. Takashige Sugimoto**: "Recent advance and key questions on the Kuroshio-Oyashio ecosystem"

### SUBARCTIC GYRE PROCESSES AND THEIR INTERACTION WITH COASTAL AND TRANSITION ZONES: PHYSICAL AND BIOLOGICAL RELATIONSHIPS AND ECOSYSTEM IMPACTS (11:30 - 18:00)

(Science Board Symposium: S1)

Co-Convenors: *Albert J. Hermann (U.S.A.), Masaaki Wakatsuchi & Akihiko Yatsu (Japan)*

- Richard J. Beamish**, G.A. McFarlane and J.R. King. Searching for the mechanism that links coastal and mid-ocean ecosystems. (S1-017)
- Shoshiro Minobe**. Century-scale changes of the bi-decadal oscillation over the North Pacific. (S1-157)
- Dale B. Haidvogel**, A.J. Hermann, K. Hedstrom and M. Iskandarani. (invited) Interannual variability of inter-gyre exchanges in the North Pacific. (S1-320)
- Albert J. Hermann**, D.B. Haidvogel, E.L. Dobbins, S. Hinckley, P.S. Rand and P.J. Staben. Local and remote influences on cross-shelf transport in the Coastal Gulf of Alaska. (S1-321)
- William R. Crawford**, J.Y. Cherniawsky and M.G.G. Foreman. Anomalies of the 1990s along the Pacific Canadian continental shelf, and exchange with the Gulf of Alaska. (S1-051)
- Jeffrey J. Polovina**, E.A. Howell, D.R. Kobayashi and M.P. Seki. The transition zone chlorophyll front in the North Pacific and its interaction with the subarctic gyre. (S1-193)
- Shingo Kimura**, H. Nakata, Y. Okazaki and T. Sugimoto. Biological production process associated with frontal disturbances of the Kuroshio and the Kuroshio Extension. (S1-125)
- Michael P. Seki**. Spatial and temporal variability of large scale fronts: impacts on the life history and ecology of short-lived species in the central North Pacific Transition Zone. (S1-224)
- C. Sassa**, M. Moku, K. Kawaguchi and A. Balanov. Transition zone as a nursery ground of the subarctic, transitional and subtropical mesopelagic fishes in the western North Pacific. (S1-217)
- Overview of poster session
- Vladimir A. Belayev**. (invited) Variations in the nekton community of subarctic and transitional waters in the Northwest Pacific (1974-1999). (S1-019)

\* Unless specified "Tsukuba" or "Tokyo", all sessions and meetings are held in Hakodate. \*

> Please check session schedules on display at the venue for presentation times and latest updates. <



- Akihiko Yatsu, K. Nagasawa and T. Wada. Decadal changes in abundance of dominant pelagic fishes and squids in the northwestern Pacific Ocean since the 1970s, with notes on the impact of the large-scale driftnet fishing during 1978-1992. (S1-281)
- Vadim F. Savinykh and K.A. Karyakin. Species composition, biomass and distribution patterns of the pelagic fishes in the western and eastern areas of the North Pacific transition zone. (S1-220)
- Richard D. Brodeur, Y. Ueno, J.P. Fisher, K. Nagasawa and W.G. Pearcy. (invited) An east-west comparison of the coastal epipelagic nekton of the North Pacific Ocean. (S1-028)
- Takashige Sugimoto, S. Sainz-Trapaga, S. Itoh and H.Y. Kim. Behavior of warm streamers and surface drifters in the Kuroshio-Oyashio transition region. (S1-241)

Governing Council Meeting\* (15:30 - 17:30)  
 Reception (Kokusai Hotel, time TBA)

## 24<sup>th</sup> October, 2000 (Tuesday)

### SHORT LIFE-SPAN SQUID AND FISH AS KEYSTONE SPECIES IN NORTH PACIFIC MARINE ECOSYSTEMS (09:00 - 13:00) - Part 1

(FIS Committee Topic Session: S4)

Co-Convenors: Graham E. Gillespie (Canada), Jin-Yeong Kim (Korea), Yasunori Sakurai (Japan) & Michael P. Seki (U.S.A.)

(Papers to be presented over 2 days.)

- Ron O'Dor. (invited) Can we distinguish between climatic effects on egg versus food limited recruitment? (S4-178)
- John R. Bower and J.M. Murphy. Latitudinal body-size gradients of the squid *Berryteuthis anonychus* in the eastern North Pacific. (S4-025)
- Doo Nam Kim, Y.S. Kim and J.I. Kim. Abundance of the neon flying squid, *Ommastrephes bartrami*, in the North Pacific during 1994-1998. (S4-123)
- Graham E. Gillespie, R.I. Perry and H.J. Freeland. (invited) The Canadian NE Pacific squid fishery, and the relationship of squid distributions to changing ocean conditions. (S4-073)
- Vjacheslav A. Bizikov. Long-term dynamics of school-master gonate squid *Berryteuthis magister* in the western Bering Sea. (S4-021)

#### Overview of poster session

- Atsushi Kawabata. Spatial distribution and density of Japanese common squid in the Pacific coast waters off northern Honshu determined by the acoustic survey. (S4-115)
- Jun Yamamoto, S. Masuda, K. Miyashita, R. Uji and Y. Sakurai. Distribution of early stages of the ommastrephid squid *Todarodes pacificus* near the Oki Islands (Sea of Japan). (S4-277)
- Hidetada Kiyofuji, S.-I. Saitoh, Y. Sakurai and K. Yoneta. An interaction between horizontal structures of ocean fronts and Japanese common squid fishing ground formation in the Japan/East Sea. (S4-126)
- Hideaki Kidokoro, T. Goto and S. Kasahara. Relationship between change of spawning area and fluctuation of biomass of the Japanese common squid *Todarodes pacificus* in the Sea of Japan. (S4-117)
- Nikolay M. Mokrin and O.N. Katugin. Stock dynamics, ecology, and population structure of the Japanese flying squid, *Todarodes pacificus*, in the Japan Sea. (S4-159)

### ENVIRONMENTAL ASSESSMENT OF VANCOUVER HARBOUR: RESULTS OF AN INTERNATIONAL WORKSHOP (09:00 - 13:00)

(MEQ Committee Topic Session - Vancouver Harbour Workshop: S8)

Co-Convenors: Toshihiro Horiguchi (Japan) & Carla M. Stehr (U.S.A.)

- Richard F. Addison. "Biological effects monitoring" ---what have we learned during the last twenty years? (S8-002)
- Stelvio M. Bandiera and R.F. Addison. (invited) CYP1A and related measurements in English sole (*Parophrys vetulus*) from Vancouver Harbour. (S8-012)
- Colin D. Levings. Fish communities and life history attributes of English sole (*Pleuronectes vetulus*) in Vancouver Harbour. (S8-143)

- Carla M. Stehr**, M. Myers, D. Lomax, R. Boyer, S. Spencer and J.E. Stein. PICES Vancouver Harbour Practical Workshop results: Assessment of chemical contaminant exposure and effects in English sole. (S8-238)
- Seiichi Uno**, J. Koyama and H. Yamada. Organochlorine and polyaromatic hydrocarbon residues in bivalves at Vancouver Harbor. (S8-261)
- Toshihiro Horiguchi**, S.I. Uno, M. Shimizu, H. Shiraishi and M. Morita. Contamination of organotin compounds and imposex in molluscs from Vancouver, Canada. (S8-084)
- Tatyana A. Belan**. Marine environmental quality assessment using polychaetes taxocene characteristics in Vancouver Harbour. (S8-018)
- Jong-Geel Je**, T.A. Belan, C.D. Levings and B.J. Koo. Changes in benthic communities along a presumed pollution gradient in Vancouver Harbour. (S8-336)
- Tian Yan**. Harmful algae survey in Vancouver Harbour. (S8-278)
- J.-C. Chen** and **Gary W. Heinke**. (invited) The Pearl River Estuary Pollution Project (PREPP), 1999-2001. (S8-041)

## NORTH PACIFIC CARBON CYCLING AND ECOSYSTEM DYNAMICS (09:00 - 18:00) - Part 1

(POC / BIO Joint Topic Session: S6)

Co-Convenors: *Kenneth L. Denman (Canada)*, *Steven R. Emerson (U.S.A.)* & *Toshiro Saino (Japan)*

(Papers to be presented over 2 days.)

- John J. Cullen**. (invited) Unanswered questions concerning fertilization of the ocean for commercial purposes. (S6-052)
- Nicholas R. Bates**, C.A. Carlson, D.A. Hansell, R.J. Johnson, D.K. Steinberg and A.H. Knap. Physical and biogeochemical variability in the North Atlantic Ocean: perspectives from two long-term oceanographic time-series, hydrostations S (1954-present) and the U.S. JGOFS Bermuda Atlantic time-series (BATS) site (1988-present). (S6-014)
- Phillip W. Boyd**, C.S. Wong, F. Whitney and P.J. Harrison. The coupling between pelagic and deep water fluxes in the HNLC NE Pacific: results from bio-optical and deep-water trap time-series. (S6-308)
- David M. Karl**, J.E. Dore, R.R. Bidigare, R.M. Letelier and J.R. Christian. Carbon-nitrogen-phosphorus cycling at Station ALOHA. (S6-112)
- Kazuaki Tadokoro**, T. Saino and T. Sugimoto. Long term variation of Chl *a* concentration, zooplankton biomass, and the hydrographic structure in the Oyashio water. (S6-314)
- M. Angelica Peña**. (invited) Factors influencing phytoplankton composition at shelf and deep ocean sites in the NE Subarctic Pacific. (S6-190)

### Overview of poster session

- Kenneth L. Denman**, S.P. Haigh and W.W. Hsieh. The Response of the Planktonic Ecosystem to the 1976 Climate Shift in a Coupled Ecosystem / Ocean General Circulation Model of the N. Pacific Ocean. (S6-057)
- Fei Chai**, M. Jiang, R.T. Barber, R. Dugdale and Y. Chao. Physical-biogeochemical modeling – seasonal to decadal variability in the North Pacific Ocean. (S6-036)
- Isao Koike**. (invited) Comparison of environmental factors controlling biological processes in the western and eastern subarctic Pacific and the Bering Sea. (S6-310)
- Joaquim I. Goes**, H. do R. Gomes, A. Limsakul, B. Balch and T. Saino. Interannual variations in biological production and carbon cycling in the subarctic Pacific Ocean: the role of ENSO events. (S6-075)
- Steven R. Emerson**, S. Mecking and J. Abell. Recent changes in the biological pump in the subtropical North Pacific Ocean. (S6-062)
- Paul J. Harrison**, M. Lipsen, D. Varela and P.W. Boyd. Shifts in phytoplankton species composition during recovery from iron limitation at Stn P in the subarctic NE Pacific: potential effects on carbon cycling. (S6-081)
- Paul D. Quay**. Recent changes in the surface carbon budget at Stn ALOHA in the subtropical North Pacific. (S6-198)
- Andrew W. Leising** and W.C. Gentleman. Microzooplankton grazing functions for Pacific ecosystem models: a critical review of the assumptions. (S6-142)

## LARGE-SCALE CIRCULATION IN THE NORTH PACIFIC (14:00 - 18:00) - Part 1

(POC Committee Topic Session: S5)

Co-Convenors: *Howard J. Freeland (Canada) & Kensuke Takeuchi (Japan)*

(Papers to be presented over 2 days.)

**Dean Roemmich.** (invited) The mean and time-varying meridional transport of heat in the North Pacific Ocean. (S5-204)

**Nobuyuki Shikama, I. Kaneko and T. Iwao.** Subsurface circulation measured with PALACE and APEX floats in the Western Subarctic Region of the North Pacific. (S5-322)

**A.B. Rabinovich, Richard E. Thomson and S.J. Bograd.** Drifter observations of anticyclonic eddies over the Kuril-Kamchatka Trench. (S5-200)

**Humio Mitsudera.** Modeling of the Kuroshio and Oyashio Confluence. (S5-359)

**Hiromichi Ueno and I. Yasuda.** Distribution and formation of the mesothermal structure (temperature inversions) in the North Pacific subarctic region. (S5-259)

**Howard J. Freeland.** Heat flux across Line-P during period January 1996 to June 1999. (S5-317)

**Alice C. Stuart-Menteth, A. Ostrovskii and T. Yamagata.** Dynamic height variations of the Kuroshio Current system. (S5-240)

**Nobuo Suginozono and H. Nakano.** A series of mid-depth zonal flows in the Pacific induced by winds. (S5-241)

**Victor I. Kuzin.** Variability of the North Pacific circulation model under the surface forcing from re-analysis data. (S5-136)

## RECENT FINDINGS AND COMPARISONS OF GLOBEC AND GLOBEC-LIKE PROGRAMS IN THE NORTH PACIFIC (14:00 - 18:00) - Part 1

(CCCC Program Topic Session: S7)

Co-Convenors: *R. Ian Perry (Canada) & Atsushi Tsuda (Japan)*

(Papers to be presented over 2 days.)

**Manuel Barange.** The Benguela upwelling system: can we compare the responses of different GLOBEC ecosystems to physical forcing? (S7-013)

**D. Pauly, V. Christensen, R. Froese, A. Longhurst, T. Platt, S. Sathyendranath, K. Sherman and Reg Watson.** (invited) Mapping fisheries onto marine ecosystems: regional, oceanic and global integrations. (S7-189)

**Andrei S. Krovnin, A.M. Orlov and G.P. Moury.** Long-term fluctuations in cod and herring stocks in the North Pacific and North Atlantic and their relation to climate variability in the northern hemisphere. (S7-326)

**Keith Brander.** (invited) North Atlantic GLOBEC programs and the development of ecosystem comparisons. (S7-341)

**Andrew Bakun.** (invited) Analytical and interpretative contexts for comparative studies of the factors controlling population dynamics and habitat selection of major fish stocks. (S7-011)

**Tomonori Azumaya, A. Shiimoto, K. Nagasawa and Y. Ishida.** Spatial and temporal distribution of phytoplankton, macrozooplankton, and fishes along a south-north transect in the central North Pacific Ocean and Bering Sea in summer. (S7-009)

**Tsuyoshi Kawasaki.** Regime shift and long-term variations found in tuna populations in the Northwest Pacific. (S7-116)

**Suam Kim, S. Kang, D.W. Welch, J. Helle and K. Nagasawa.** Environmental characteristics in chum salmon habitats using stable isotope contents in otoliths. (S7-119)

**Gary L. Thomas and R.E. Thorne.** From GLOBEC-like research to physical-biological nowcast-forecasting in Prince William Sound, Alaska. (S7-252)

**Xuewu Guo and Q.S. Tang.** Feeding of dotted gizzard shad, processing of sediment in the Bohai Sea. (S7-330)

**Steven J. Martell, C.J. Walters, T. Nayar, R. Briece and A. Beattie.** Simulating historical changes in the Strait of Georgia ecosystem using ecopath and ecoism. (S7-153)

**Working Group 8 Meeting (14:00 - 18:00)**

**Finance & Administration Committee Meeting\* (14:00 - 18:00)**

**Banquet (Kokusai Hotel, time TBA)**

\* Unless specified "Tsukuba" or "Tokyo", all sessions and meetings are held in Hakodate. \*

> Please check session schedules on display at the venue for presentation times and latest updates. <

25<sup>th</sup> October, 2000 (Wednesday)

BIO, FIS, MEQ & POC Committee and TCODE Meetings (09:00 - 13:00)

NORTH PACIFIC CARBON CYCLING AND ECOSYSTEM DYNAMICS (14:00 - 18:00) - Part 2

(POC / BIO Committees Joint Topic Session: S6)

Co-Convenors: Kenneth L. Denman (Canada), Steven R. Emerson (U.S.A.) & Toshiro Saino (Japan)

(Papers to be presented over 2 days.)

- Richard Matear and J. Orr. (invited) Oceanic uptake of anthropogenic CO<sub>2</sub>: Present and future estimates. (S6-309)
- Richard A. Feely, C.L. Sabine, M.F. Lamb, R. Wanninkhof, R.M. Key, G.C. Johnson, F.J. Millero, K. Lee, T.-H. Peng, T. Ono, Y. Watanabe and C.S. Wong. Synthesis of Pacific Ocean DIC and Talk survey data. (S6-063)
- Christopher L. Sabine and R.A. Feely. Anthropogenic CO<sub>2</sub> distributions in the Pacific. (S6-211)
- Shizuo Tsunogai, M. Wakita and S. Watanabe. The carbonate system of the North Pacific studied with dissolved inorganic components. (S6-258)
- Chen-Tung Arthur Chen. Shelf vs. dissolution generated alkalinity above the chemical lysocline in the North Pacific. (S6-039)
- D. Ianson and Susan E. Allen. Carbon gas exchange and export flux from the west coast of Vancouver Island, Canada: Results of 2-D model simulations. (S6-091)
- Kitack Lee. Global estimation of export production from seasonal cycles of surface water total inorganic carbon. (S6-141)

RECENT FINDINGS AND COMPARISONS OF GLOBEC AND GLOBEC-LIKE PROGRAMS IN THE NORTH PACIFIC (14:00 - 18:00) - Part 2

(CCCC Program Topic Session: S7)

Co-Convenors: R. Ian Perry (Canada) & Atsushi Tsuda (Japan)

(Papers to be presented over 2 days.)

- Arthur J. Miller, E. Di Lorenzo, B.D. Cornuelle, D.J. Neilson and J. Moisan. Modeling California Current system mesoscale observations: fitting physics and biology. (S7-156)
- Thomas C. Royer and C.E. Grosch. Analysis of low frequency signals in the northeast Pacific coastal freshwater discharge, salinity, temperature and Salmon production using wavelet techniques. (S7-208)
- William T. Peterson, J.E. Keister, L.R. Feinberg and R. Emmett. Ecosystem change in the Northern California Current -- recent shifts in copepod, euphausiid and pelagic fish abundance and species composition. (S7-301)
- A.J. Hobday and George W. Boehlert. Mixed layer depth and its relationship to survival and size of coho salmon. (S7-082)
- James F. Cole, G.W. Boehlert and L. deWitt. Forecasting coho salmon survival off the Pacific Northwest. (S7-049)
- Skip McKinnell and D.F. Bertram. Seabirds and sockeye salmon respond to variable and extreme ocean conditions in spring in Queen Charlotte Sound, BC. (S7-155)
- Gordon H. Kruse and J. Zheng. Climate fluctuations and dynamics of Alaskan crab populations. (S7-134)
- Shoko Hotta, K. Morita, H. Sakano and T. Meguro. Factors affecting the growth of chum salmon in the western North Pacific revisited. (S7-085)
- Hiroaki Saito. Can chaetognaths influence the fish recruitment? - theoretical approach with the prey and predator encounter model. (S7-212)
- Masayuki Noto and I. Yasuda. Relationship between the Japanese sardine population and sea surface temperature in the Kuroshio Extension. (S7-176)
- Yoshioki Oozeki, H. Kubota, R. Kimura, Y. Kurita and Y. Watanabe. Seasonal variation of the growth and mortality of Pacific saury (*Cololabis saira*) larvae in the northwestern Pacific. (S7-184)

## PAPERS FOR THE MARINE ENVIRONMENTAL QUALITY COMMITTEE (14:00 - 18:00)

Convenor: John E. Stein (acting MEQ Chairman)

John A. Coil, D.J. Royle, V.A. Andreeva and O.O. Sergusheva. Ecological Monitoring at the Piltun-Astohk area, NE Sakhalin Island Shelf. (MEQp048)

Lyndal L. Johnson, B.H. Horness, G.M. Ylitalo and T.K. Collier. PAH exposure levels associated with injury in marine fish. (MEQp106)

Sathy A. Naidu, J.J. Kelley, S.C. Jewett, L.K. Duffy, D. Dasher, J.M. Kennish, X. Zhang. Mercury and heavy metals in muscles of adult salmon (*Oncorhynchus* spp.) from the rivers of the East Bering Sea, Alaska. (MEQp164)

Dong Beom Yang, J. Yu, D.-H. Lee and K.-T. Kim. Distribution of organophosphorus pesticides in some estuarine environments of Korea. (MEQp280)

### Overview of poster session

Jae Ryoung Oh, D.L. Aminin, I.G. Agafonova, S.-K. Kim, Y.B. Shin and S.H. Lee. Biomonitoring study with physiological biomarkers using fluorescent molecular probes in oyster, *Crassostrea gigas*, transplanting experiments. (MEQp180)

Irina G. Agafonova, D.L. Aminin, J.R. Oh, Y.B. Shin and S.-H. Lee. Influence of TBT on physiological status of fish liver hepatocytes. (MEQp003)

Dmitry L. Aminin, I.G. Agafonova, J.R. Oh, W.J. Shim, Y.B. Shin, S.-H. Lee and J.-K. Jeon. Effect of organotins, TBT and TPHT, on flatfish liver hepatocytes in in vivo experiment. (MEQp005)

Evgueni Shumilin, G. Rodriguez-Figueroa, O. Morton Bermea, E. Lounejeva Baturina, F. Paez-Osuna, D. Yu. Sapozhnikov and E. Hernandez. New data on the anomalous trace element composition of coastal sediments near the copper mining district (Santa Rosalia, B.C.S., Mexico). (MEQp233)

Mario M. Grajeda-Muñoz, E. Shumilin, H. Windom, R. Smith and L. Godinez-Orta. Geochemical associations of elements in sediments from a coastal lagoon, adjacent to a salt producing facility. (MEQp303)

Lev. M. Gramm-Osipov, A.V. Savchenko and V.N. Gramm-Osipova. Influencing of sorption processes on a accumulation of cobalt and mercury on marine suspended matter. (MEQp076)

Yunlong Wang, Z. Xu, Y. Cheng and Y. Chen. Effects of dredging sediment mud in the Changjiang estuarine area on the spawning and embryonic development and Zn ion to the toxicity of the larval development of the Chinese crab *Eriocheir sinensis*. (MEQp262)

Zhaoli Xu, C. Yi, X. Shen, Z. Cao, Y. Wang and Y. Chen. Studying on impact of suspended sands of dredging mud on growth of two species of phytoplankton in Changjiang River estuarine area. (MEQp273)

## PAPERS FOR THE PHYSICAL OCEANOGRAPHY AND CLIMATE COMMITTEE (14:30 - 18:00)

Convenor: Vyacheslav B. Lobanov (POC Chairman)

Sergey V. Gladyshev and M. Wakatsuchi. Formation distribution and seasonal variability of the cold Okhotsk Sea intermediate water. (POCp324)

Genta Mizuta, Y. Fukamachi, K.I. Ohshima and M. Wakatsuchi. Long-term mooring measurement off the east coast of Sakhalin in the Sea of Okhotsk Part I: flow field. (POCp158)

Yasushi Fukamachi, G. Mizuta, K.I. Ohshima and M. Wakatsuchi. Long-term mooring measurement off the east coast of Sakhalin in the Sea of Okhotsk Part II: water properties. (POCp066)

Kay I. Ohshima, M. Wakatsuchi, Y. Fukamachi and G. Mizuta. Near-surface circulation and tidal currents of the Okhotsk Sea observed with the satellite-tracked drifters. (POCp182)

Nikolay A. Rykov. Seasonal variability of temperature/salinity structure on repeated sections in the Sea of Okhotsk. (POCp210)

Ikutaro Shimizu, J. Seki, Y. Saito, O. Hiroi and M. Aota. Does sea ice bring high primary production in early spring? (POCp229)

George V. Shevchenko and G.A. Kantakov. Preliminary results of direct measurements of the currents in the La Perouse (Soya) Strait. (POCp227)

Iori Tanaka and A. Nakata. A method to monitor the total volume transport of the Soya Warm Current using coastal sea level data. (POCp249)

- Young Jae Ro, S. Smirnov and Y.H. Choi. Interactions of EKWC, NKCC with mesoscale eddies in the East (Japan) Sea. (POCp202)
- Vladimir Ponomarev, O. Trusenkova, L.D. Talley, V.B. Lobanov, S. Sagalaev and A. Scherbina. The "subarctic gyre" in the Japan (East) Sea: new observation evidence and current system simulation. (POCp196)
- Yury I. Zuenko. Upwelling/downwelling in Peter the Great Bay (Japan Sea): implication for cross-shelf Exchange. (POCp293)

Science Board Meeting\* (18:00 - 21:00)  
 IFEP Meeting (18:00 - 21:00)  
 CPR Panel Meeting (18:00 - 21:00)

## 26<sup>th</sup> October, 2000 (Thursday)

PAPERS FOR THE CLIMATE CHANGE AND CARRYING CAPACITY PROGRAM (09:00 - 11:10)

Co-convenors: Suam Kim (Korea) & David W. Welch (Canada)

- Niall Ó Maoiléidigh. Summary of the ICES Working Group on North Atlantic Salmon. (CCCCp343)
- Kenneth O. Coyle, A.I. Pinchuk and T.J. Weingartner. Cross-shelf distribution of acoustically determined biomass and zooplankton density relative to major hydrographic features on the northern Gulf of Alaska shelf (initial observations on the GLOBEC long term observation program). (CCCCp050)
- Jeffrey M. Napp, C.T. Baier, K.O. Coyle, A.I. Pinchuk, R.D. Brodeur and N. Shiga. Zooplankton of the southeast Bering Sea shelf: Are there differences in biomass or community structure among recent decades? (CCCCp169)
- Atsushi Tsuda, H. Saito and H. Kasai. Comparative study on the life histories of *Neocalanus cristatus*, *N. plumchrus*, *N. flemingeri* and *Eucalanus bungii* in the subarctic Pacific. (CCCCp257)
- B.W. Lu, David L. Mackas and D. Moore. Cross-shore separation of adult and juvenile euphausiids in a shelf-break alongshore current. (CCCCp150)

CCCC Implementation Panel Meeting (11:00 - 13:00)

RECENT PROGRESS IN ZOOPLANKTON ECOLOGY STUDY IN PICES REGIONS (14:00 - 18:00) - Part 1

(BIO / CCCC Joint Topic Session: S3)

Co-Convenors: Tsutomu Ikeda (Japan), Woong-Seo Kim (Korea), Michael M. Mullin (U.S.A.) & David W. Welch (Canada)

(Papers to be presented over 2 days.)

Overview of poster session

- Charles B. Miller. (invited) Review of diapause strategies in interzonally migrating copepods. (S3-296)
- Elizabeth A. Bornhold, D.L. Mackas and P.J. Harrison. Interdecadal variations in the developmental timing of the copepod *Neocalanus plumchrus* (Marukawa) in the Strait of Georgia, BC. (S3-024)
- Kaoru Nakata, H. Ito, T. Ichikawa and K. Sasaki. Egg productivity of three oncaea species in the Kuroshio Extension in spring. (S3-167)
- Toshinori Kanehisa, T. Sawabe, Y. Ezura and T. Ikeda. 18S rDNA sequence and phylogenetic analysis of *Neocalanus cristatus* (Crustacea:Copepoda). (S3-109)
- Koji Ozaki and T. Ikeda. Life cycle of the mesopelagic copepod *Paraeuchaeta elongata* off Cape Esan, Hokkaido, Japan (western subarctic Pacific). (S3-186)
- Natalia T. Dolganova. (invited) Vertical distribution of plankton in the Japan Sea in winter and in spring. (S3-058)

\* Unless specified "Tsukuba" or "Tokyo", all sessions and meetings are held in Hakodate. \*

> Please check session schedules on display at the venue for presentation times and latest updates.<

- Yuichiro Yamada**, T. Ikeda and A. Tsuda. The developmental pattern and maturation of the hyperiid amphipod *Primno abyssalis* in the Oyashio Region, western subarctic Pacific. (S3-276)
- Hyun-Kyoung Chung**, H.Y. Soh, E.-O. Park, S.-K. Seon and H.-L. Suh. Seasonal succession of the genus *Acartia* (Copepoda: Calanoida) in the southwestern coastal water of Korea. (S3-047)
- Won Duk Yoon** and G.S. Park. *Euphausia pacifica* (Euphausiacea: Crustacea) of the Yellow Sea I. Spatial distribution. (S3-283)

## SHORT LIFE-SPAN SQUID AND FISH AS KEYSTONE SPECIES IN NORTH PACIFIC MARINE ECOSYSTEMS (14:00 - 18:00) - Part 2

(FIS Committee Topic Session: S4)

Co-Convenors: *Graham E. Gillespie (Canada)*, *Jin-Yeong Kim (Korea)*, *Yasunori Sakurai (Japan)* & *Michael P. Seki (U.S.A.)*

(Papers to be presented over 2 days.)

- Alexey A. Baytaluk** and V.A. Shelekhov. Seasonal changes in the microstructure of Pacific saury, *Cololabis saira*, otoliths. (S4-016)
- Hiroshi Nishida**, C. Watanabe, A. Yatsu, K. Mori and K. Kawasaki. Distribution and abundance of juvenile small pelagic fishes and squids in the northwestern Pacific from a midwater trawl survey, 1996-2000. (S4-173)
- Ken Mori**, K. Tsuchiya and T. Kinoshita. Community structure of epipelagic squids in the Kuroshio-Oyashio Transition Zone, western North Pacific. (S4-161)
- Yasunori Sakurai**, G. Lima, J. Yamamoto, H. Nakao and K. Itoh. Annual to decadal stock fluctuation of *Loligo bleekeri* (cephalopoda: loliginidae) responses to changes seawater temperatures near the spawning grounds: effect of low temperature of the embryonic development. (S4-213)
- Jin-Yeong Kim** and N.C.H. Lo. (invited) Pacific anchovy population stability in the ecosystem of Korean waters using matrix population model. (S4-118)

### Overview of poster session

- Chang Ik Zhang**, J.B. Lee and Y.M. Choi. Assessment of Pacific sardine (*Sardinops melanosticta*) stock in Korean waters, in consideration of the relationship between recruitment and the ocean environmental factors. (S4-289)
- Young Min Choi**, J.B. Lee, C.I. Zhang, C.I. Baek and J.H. Park. Assessment and management of common mackerel (*Scomber japonicus*) in Korean waters, based on the relationship between recruitment and the ocean environmental factors. (S4-046)
- Bambang Semedi**, S.I. Saitoh, K. Yoneta and H. Kiyofuji. An approach of DMSP/OLS satellite imagery and GIS technology to study on dynamics of Pacific saury migration. (S4-225)
- Yongjun Tian**, T. Akamine and M. Suda. The effects of climate/oceanic changes on population dynamics of Pacific saury (*Cololabis saira*) in the northwestern Pacific. (S4-254)
- Alexey A. Baytaluk**. Pacific Saury (*Cololabis saira*) distribution in the north-western Japan Sea. (S4-015)

## LARGE-SCALE CIRCULATION IN THE NORTH PACIFIC (14:00 - 18:00) - Part 2

(POC Committee Topic Session: S5)

Co-Convenors: *Howard J. Freeland (Canada)* & *Kensuke Takeuchi (Japan)*

(Papers to be presented over 2 days.)

- Hiroshi Ishizaki** and I. Ishikawa. A simulation of the NPIW circulation by a high-resolution North Pacific Ocean model. (S5-329)
- Niklas Schneider**, A.J. Miller and D.W. Pierce. Anatomy of decadal North Pacific variability. (S5-221)
- Jingyi Wang**. Cross-equatorial flow of the NW Pacific and its effects on the hurricanes occurrence over southern hemisphere. (S5-263)
- Tsuneo Ono**, K. Tadokoro, T. Midorikawa and T. Saino. Possible changes in the subsurface ocean structure and mixed-layer nutrient levels in the western subarctic Pacific during the last decade. (S5-302)
- Andrey Andreev**, M. Kusakabe, I. Kumamoto and C. Saito. Interannual variability in DO, nutrients and carbonate parameters of the western Subarctic Gyre intermediate water: role of physical processes. (S5-006)

- Anatoly Salyuk. Exchange of deep and bottom waters in the Kurile Basin, Sea of Okhotsk, with Pacific. (S5-214)
- Kosei Komatsu, Y. Hiroe, I. Yasuda and K. Kawasaki. Two distinct hydrographic characteristics of intermediate water in the Kuroshio region south of Japan. (S5-130)
- Igor A. Zhabin. Modification of the intermediate water in the western subarctic gyre. (S5-285)
- V.B. Darnitsky and N.V. Bulatov. The fragments of large-scale circulation by northern Pacific on the oceanographic and satellite surveys. (S5-054)
- Overview of poster session

## SCIENCE AND TECHNOLOGY FOR ENVIRONMENTALLY SUSTAINABLE MARICULTURE IN COASTAL AREAS (14:00 - 18:00) - Part 1

(MEQ Committee Topic Session: S9)

Co-Convenors: Colin D. Levings (Canada), Makoto Shimizu (Japan) & John E. Stein (U.S.A.)

(Papers to be presented over 2 days. Check schedules on display for exact times and latest updates.)

- Robert N. Iwamoto. (invited) Comprehensive evaluation of risks and benefits of aquaculture in marine waters. (S9-102)
- Kazufumi Takayanagi and K. Hirakawa. (invited) Water quality criteria to manage sustainable aquaculture in Japan. (S9-246)
- Ming-Jiang Zhou. (invited) Recent progress in environmentally sound mariculture in China. (S9-292)
- Hong Bin Liu and H.T. Chen. Present status of Chinese fishery. (S9-316)
- Barry T. Hargrave. (invited) Marine sediment organic matter- a consumable resource and indicator of benthic productivity affected by marine aquaculture. (S9-080)
- Jong-Geel Je, J.-R. Oh, K.-S. Choi, S.-H. Shin, B.J. Koo and D.-S. Kim. (invited) Environmental monitoring for mariculture in Korea. (S9-104)

TCODE E-Poster Session (14:00 - 18:00)

Finance & Administration Committee Meeting\* (14:00 - 18:00)

Extravaganza Dinner (Yunokawa Prince Hotel, time TBA)

## 27<sup>th</sup> October, 2000 (Friday)

### PREY CONSUMPTION BY HIGHER TROPHIC LEVEL PREDATORS IN PICES REGIONS: IMPLICATIONS FOR ECOSYSTEM STUDIES (09:00 - 13:00)

(BIO Committee Topic Session: S2)

Co-Convenors: George L. Hunt, Jr. (U.S.A.) & Hidehiro Kato (Japan)

- Hidehiro Kato and G.L. Hunt, Jr. Summary of the workshop on "The basis for estimating the abundance of marine birds and mammals, and the impact of their predation on other organisms". (S2-334)
- George L. Hunt, Jr., P.J. Gould and K. Morgan. Estimates of prey consumption by marine birds in the North Pacific Ocean. (S2-088)
- Haruo Ogi. Food and feeding habits of marine birds in the western region of the northern North Pacific. (S2-179)
- Robert W. Furness. (Invited) Sandeel consumption by predators in the North Sea: implications for fishery management. (S2-069)

Overview of poster session

- Kerim Y. Aydin, V.V. Lapko, V.I. Radchenko and P.A. Livingston. A comparison of the Eastern and Western Bering Seas as seen through predation-based food web modeling. (S2-298)
- Shino Tanaka, N. Arai, W. Sakamoto, K. Yoshida and N. Baba. Particle Induced X-ray Emission (PIXE) analysis of trace elements in teeth of northern fur seals. (S2-248)
- Tsutomu Tamura and H. Ohizumi. Foods and feeding habits of cetaceans, and their food consumption in the North Pacific - especially western North Pacific minke whales. (S2-247)
- Douglas F. Bertram, D.L. Mackas, D.W. Welch, W.S. Boyd and J.L. Ryder. Zooplankton distributions and foraging locations of breeding Cassin's Auklets from Triangle Island, British Columbia. (S2-020)

\* Unless specified "Tsukuba" or "Tokyo", all sessions and meetings are held in Hakodate. \*

> Please check session schedules on display at the venue for presentation times and latest updates. <



- Julia K. Parrish, E. Logerwell, K.D. Hyrenbach and W.J. Sydeman. Community interactions between seabirds and coastal pelagics: starvation or satiation? (S2-188)
- Alexander I. Boltnev. Regime-shift of the Bering Sea ecosystem and population trends of northern fur seals on the Commander Islands. (S2-022)

#### RECENT PROGRESS IN ZOOPLANKTON ECOLOGY STUDY IN PICES REGIONS (09:00 - 13:00) - Part 2

(BIO / CCCC Joint Topic Session: S3)

Co-Convenors: Tsutomu Ikeda (Japan), Woong-Seo Kim (Korea), Michael M. Mullin (U.S.A.) & David W. Welch (Canada)

(Papers to be presented over 2 days.)

- Rong Wang. (invited) A review of current zooplankton studies in China GLOBEC. (S3-265)
- Christine T. Baier and M. Terazaki. Effects of chaetognath predation on copepod communities of the southeast Bering Sea Shelf. (S3-010)
- Gadi Padmavati and T. Ikeda. Vertical distribution and generation time of *Metridia pacifica* in the Oyashio Region, western North Pacific. (S3-187)
- Woong-Seo Kim. (invited) History and recent progress in zooplankton studies in Korea. (S3-311)
- Mary N. Arai, K. Nagasawa, D.W. Welch and A. Dunsmuir. (invited) Predation by fish, especially chum salmon, on North Pacific coelenterates. (S3-008)
- Richard D. Brodeur, H. Sugisaki, K.Y. Aydin and J.M. Napp. Increases in jellyfish biomass in the Bering Sea: Implications for the ecosystem. (S3-027)
- Wen-Tseng Lo, Y.P. Hung and H.Y. Hsieh. Composition and spatial variations of siphonophores (cnidaria) in the waters of northern Taiwan. (S3-148)
- Victoria V. Nadochty and Y.I. Zuenko. Change of dominant species in spring-summer plankton of Peter the Great Bay (Japan Sea). (S3-163)
- Yaqu Chen, Z. Xu, Y. Wang and M. Jiang. Study on dynamic of biomass and ecology of zooplankton in East China Sea. (S3-037)

#### SCIENCE AND TECHNOLOGY FOR ENVIRONMENTALLY SUSTAINABLE MARICULTURE IN COASTAL AREAS (09:00 - 13:00) - Part 2

(MEQ Committee Topic Session: S9)

Co-Convenors: Colin D. Levings (Canada), Makoto Shimizu (Japan) & John E. Stein (U.S.A.)

(Papers to be presented over 2 days.)

- Valery A. Brykov. (invited) Mussel culture as potential source of eutrophication of coastal waters of Primorye. (S9-029)
- Katsuyuki Abo, S. Toda, T. Fujiwara and T. Take. Effects of water exchange on the occurrence of oxygen depletion in fish farms of Gokasho Bay, Central Honshu, Japan. (S9-001)
- Shigeru Montani and H. Tsutsumi. Utilization of biological activities of capitellid polychaete for treatment of organically enriched sediment deposited on the bottom fish net pen culture. (S9-160)
- Overview of poster session
- Shang Chen, M. Zhu and Y. Ma. Niche suitability assessment of maricultured region. (S9-042)
- Michael Phillips. (invited) Concepts and experiences related to the integration of aquaculture into coastal management. (S9-318)

#### PAPERS FOR THE FISHERY SCIENCE COMMITTEE (09:00 - 13:00)

Co-convenors: Douglas E. Hay (Canada)

- Svetlana V. Davidova. Early ontogenesis of fishes, understanding of the mortality nature. (FISp056)
- Houng-Yung Chen and Y.L. Chen. Pelagic anchovy did not feed on lower the food chain in the upwelling of the East China Sea. (FISp038)
- John Dower. Are declines in larval fish mortality following metamorphosis linked to hydrodynamic efficiency? (FISp059)
- Satoshi Suyama, Y. Kurita, Y. Kamei, Y. Kajiwara and Y. Ueno. Annual change of the size in each year class of Pacific saury (*Cololabis saira*) estimated based on the hyaline zone in the otolith. (FISp244)

- Yeong Hye Kim, Y.J. Kang and J.Y. Park. A Genetic Analysis of the Common Squid, *Todarodes pacificus* in Korean Waters. (FISp121)
- Hideaki Nakata, T. Kitagawa, S. Kimura and H. Yamada. Spatial and temporal distribution of short life-span squid and fish inferred from diving behavior of Pacific bluefin tuna. (FISp166)
- Kohji Iida, S. Saitoh, Y. Sakurai, T. Mukai, K. Miyashita, T. Hokimoto, Y. Fujimori, J. Yamamoto and K. Yamauchi. Multimedia observation of fish resource and environment using satellite, acoustics and ROV remote sensing. (FISp094)
- Jake Schweigert and J. O'Connell. Spectral and time series analysis of British Columbia Pacific herring recruitment in relation to environmental variables. (FISp223)
- Kerim Y. Aydin, K. Myers, R. Walker and N. Davis. ENSO- and regime-scale variation in the biogeography of Gulf of Alaska micronekton as a driving mechanism for observed growth trends in Pacific salmon. (FISp297)
- Robin P. Rigby. Does RAPT (Radio Acoustic Positioning Telemetry) tagging change spawning behaviour, a chokka squid experiment? (FISp201)
- Elena P. Dulepova. Trophic relations of pink (*Oncorhynchus gorbusha*) and chum salmon (*O. keta*) juveniles in the epipelagic layer in the southern Okhotsk Sea in fall-winter. (FISp061)

Closing Session (13:00 - 14:30)  
 Science Board Meeting\* (15:30-18:00)  
 Governing Council Meeting\* (15:30-18:00)

## 28<sup>th</sup> October, 2000 (Saturday)

Science Board Meeting\* (09:00-10:30)  
 Governing Council Meeting\* (11:00 - 15:00)

## Tokyo - 29<sup>th</sup> October, 2000 (Sunday)

NPAFC-PICES JOINT WORKSHOP ON FACTORS AFFECTING PRODUCTION OF JUVENILE SALMON: COMPARATIVE STUDIES ON JUVENILE SALMON ECOLOGY BETWEEN THE EAST AND WEST NORTH PACIFIC OCEAN (09:00-17:30)



**Poster Session** (displayed throughout the duration of meeting with designated viewing times during the oral sessions)

### S1: SB Symposium (Designated viewing time: 23<sup>rd</sup> October, 15:50-16:10)

- Valentina D. Budaeva. 1981-1991 variability of thermal fields and thermohaline water structure of the Kuroshio and Oyashio currents. (S1-031)
- Evan A. Howell and J.J. Polovina. Using ecospace to model mesoscale variability of the transition zone chlorophyll front in the North Pacific Ocean. (S1-086)
- A.N. Ivanov. The fish community of pelagial in the subarctic front of the northwest Pacific. (S1-100)
- Gennady A. Kantakov. Subtropical alternative heat and salt advection impact to the Sea of Okhotsk ecosystem. (S1-111)
- Masahide Kayeriama, M. Nakamura, M. Fukuwaka, Y. Ishida, H. Udea, R.V. Walker and K.W. Myers. Comparison of feeding ecology of Pacific salmon in the eastern and western North Pacific Ocean. (S1-108)
- Megumi Nakamura, M. Kaeriyama, Y. Ishida, H. Udea, R.V. Walker and K.W. Myers. Feeding ecology and trophic dynamics of Pacific salmon in the Gulf of Alaska. (S1-165)

\* Unless specified "Tsukuba" or "Tokyo", all sessions and meetings are held in Hakodate. \*

> Please check session schedules on display at the venue for presentation times and latest updates.<

- Yury V. Novikov, E.V. Slobodskoy and Y. Nakamura. Distribution and biological characters of neon flying squid, *Ommastrephes batramii*, in relation to water structure of the south Kuril Islands region. (S1-177)
- Vladimir Ponomarev, D. Kaplunenko and H. Ishida. Climate variation and change in the extratropic Asian - Pacific region in the XX Century. (S1-195)
- Gennadiy A. Shevtsov and Y.V. Novikov. Influence of oceanological conditions on formation of concentrations of the feeding Japanese flying squid (*Todarodes pacificus*) in the south Kuril region. (S1-228)
- Mikhail A. Stepanenko and A.V. Nikolaev. Interannual variability of eastern Bering pollock (*Theragra chalcogramma*) recruitment and distribution in the period North Pacific climate shift of 1990s. (S1-239)
- Young Sang Suh, S.G. Lee, L.H. Jang and H.J. Oh. The relationship between the ocean color from the SeaWiFS satellite and chlorophyll *a*, and suspended solid in the clear waters and the turbidity waters around Korean Peninsula. (S1-332)
- H. Watanabe and K. Kawaguchi. Decadal change in abundance of surface migrating myctophid fishes in the Kuroshio Region during 1957-1994. (S1-267)

**S2: BIO Topic Session (Designated viewing time: 27<sup>th</sup> October, 10:15-10:45)**

- Shannon L. Cass-Calay. The effects of prey availability and physical variables on the recent feeding and growth rates of larval Pacific hake, *Merluccius productus* (Ayers), in the California Current region. (S2-033)
- K. David Hyrenbach. Albatross response to survey vessels: implications for studies of distribution, abundance and prey consumption. (S2-090)
- Takeomi Isono and Y. Sakurai. Changes in the size of Steller sea lion skulls during the 1960s-1990s. (S2-097)
- Ulf Lindström, A. Harbitz, T. Haug, T. Pedersen. Foraging behaviour of minke whales (*Balaenoptera acutorostrata*) in the southern Barents Sea. (S2-146)
- V.V. Napazakov, V.I. Chuchukalo and V.I. Radchenko. Feeding features of gadoid fishes (Gadidae) in the western Bering Sea in summer and fall seasons. (S2-168)
- Alexei M.Orlov. Feeding habits and feeding competition among large predatory fishes on the western Bering Sea continental slope. (S2-185)
- William J. Sydeman, J.A. Thayer and K.L. Mills. Temporal variability in prey consumption by breeding seabirds in the California marine ecosystem. (S2-335)
- Gary L. Thomas and R.E. Thorne. Nocturnal feeding by Steller sea lions, humpback whales and seabirds on herring aggregations overwintering in Prince William Sound, Alaska. (S2-253)
- Bruce A. Wright and L.B. Hulbert. Too many sharks in the nearshore waters of the eastern Gulf of Alaska? (S2-272)

**S3: BIO/CCCC Joint Topic Session (Designated viewing time: 26<sup>th</sup> October, 16:05-16:40 & 27<sup>th</sup> October, 10:20-11:00)**

- Vera Alexander. The census of marine life: addressing the biodiversity and distribution of marine life. (S3-004)
- Irina Y. Bragina. Zooplankton communities seasonal and interannual changes in the northern part Sea of Japan. (S3-026)
- Sergey D. Bukin and N.G. Galimzyanov. Distribution of three species of larval shrimp in the Tatar Strait. (S3-032)
- Elena P. Dulepova. Comparative analysis of zooplankton productional characteristics in the Bering and Okhotsk Seas. (S3-060)
- Xifu Han and R. Wang. The study of digestive gut structure and enzyme activity of protease, amylase, and alkaline phosphatase of *Calanus sinicus* during summer in Yellow Sea and East Sea. (S3-079)
- Naoki Iguchi, H. Kazumasa and H. Nishida. Benthopelagic populations of the euphausiid *Euphausia pacifica* in the southern Japan Sea as food for pelagic fish (common mackerel). (S3-093)

- Anai Iijima and N. Shiga. Whether zooplankton community structure have changed or not in the southeastern Bering Sea shelf recently? (S3-095)
- Hideki Kaeriyama and T. Ikeda. Seasonal variations in abundance and community structure of planktonic ostracods in the Oyashio Region (site H). (S3-107)
- Jung-Hoon Kang and W.-S. Kim. Annual variation in distribution of zooplankton in the Yellow Sea, 1996-1998. (S3-110)
- Moriyuki Kotori and K. Hirano. Recently observed delay in the occurrence of spring zooplankton biomass maximum in Ishikari Bay, western Hokkaido. (S3-132)
- Donghyun Lim, W.D. Yoon, K.S. Park, S.H. Cho and Y. Lee. Biological evidence on introduction of the Kuroshio to the Yellow Sea. (S3-144)
- Donghyun Lim, W.D. Yoon, S.H. Cho and Y. Lee. Life cycle of *Oithona similis* (Copepoda: Cyclopoida) in coastal waters of the Northwestern Pacific. (S3-145)
- Luis Felipe Lopez Tachiquin, D.U. Hernandez-Becerril and E. Bravo-Sierra. Marine planktonic choanoflagellates from Baja California, Mexico. (S3-149)
- Svetlana V. Naydenko. Seasonal dynamics of structure and biomass of the plankton in the south Kuril region. (S3-172)
- Koh Nishiuchi and T. Ikeda. Interannual variabilities in abundance of *Sagitta elegans*, *S. scrippsae*, and *Eukrohnia hamata* (chaetognatha) in the central North Pacific. (S3-174)
- Stephen J. Romaine. Diversity and density changes of significant taxa along the British Columbia coast from 1990-99. (S3-206)
- Ho Young Soh, H.-L. Suh, S. Ohtsuka, Y.Ho Yoon and S.D. Choi. Ontogeny and phylogeny of appendages in copepodid stages of *Tortanus derjugini smirnov*, 1935 (copepoda, calanoida). (S3-234)
- Hiroya Sugisaki. Seasonal variation of trophic relationships between micronekton and macrozooplankton off eastern Japan. (S3-243)
- A.F. Volkov. Concerning the possibility of prediction of feeding base of nekton (sized structure and number of some mass species of a zooplankton. (S3-313)
- Won Duk Yoon and Y. Lee. *Euphausia pacifica* (Euphausiacea: crustacea) of the Yellow Sea: II. Allometric relationship. (S3-306)
- Ok Hwan Yu, H.Y. Soh and H.-L. Suh. Secondary production of *Synchelidium lenorostratum* (Crustacea, Amphipoda) in a sandy shore, southern Korea. (S3-284)
- Wuchang Zhang and R. Wang. Short time dynamics of ciliate abundance in the Bohai Sea, China. (S3-286)

**S4: FIS Topic Session (Designated viewing time: 24<sup>th</sup> October, 11:00-11:20 & 26<sup>th</sup> October, 16:00-16:20)**

- Bongjin J. Cha and C.W. Lee. Development of a depth control system for model midwater trawl gear using fuzzy logic. (S4-035)
- Hyung Kee Cha and C.W. Oh. Reproduction and population dynamics of *Penaeus chinensis* (Decapoda: Penaeidae) on the western coast of Korea, Yellow Sea. (S4-034)
- Kangseok Hwang, Y.-M. Choi and J.-H. Park. Relationship between abundance of common squid, *Todarodes pacificus* and distribution of zooplankton affected climate changes in the East Sea of Korea. (S4-089)
- Kengo Ishino. Changes in year-class strength of red halibut. (S4-096)
- Hung Y. Kim, C.W. Lee, Y.B. Kim, B.K. Kwon, B.J. Cha and S.J. Won. Development of computer aided design and analysis software for a midwater trawl gear. (S4-122)
- Chang Ik Zhang, Man Woo Lee and Kyum Joon Park. Age determination and estimation of growth parameters using otoliths of small yellow croaker, *Pseudosciaena polyactis* in Korean waters. (S4-287)
- Larisa M. Zverkova. Walleye pollock (*Theragra chalcogramma*) population organization ecological bases. (S4-295)

**S6: POC/BIO Joint Topic Session (Designated viewing time: 24<sup>th</sup> October, 15:40-16:20 & 25<sup>th</sup> October, 15:40-16:20)**

- Chen-Tung Arthur Chen**, S.-L. Wang, B.-J. Wang and C.-L. Liu. Carbonate chemistry of the South China Sea. (S6-040)
- Kumiko Fukuda**, S.-I. Saitoh, S.-I. Noriki, T. Nakatsuka and M. Wakatsuchi. Variability of chlorophyll *a* and sea ice concentration in the Okhotsk Sea as observed from satellite during 1996-1999. (S6-067)
- Makio C. Honda**, F. Hoshi, T. Sugawara, M. Kusakabe and I. Asanuma. Export flux of organic carbon in the northwestern North Pacific. (S6-083)
- Shin-ichi Ito**, M.J. Kishi and T. Miyao. Mechanisms of the seasonal variation of Chlorophyll on 144E observation line in the Mixed Water Region using a one-dimensional ecosystem model. (S6-098)
- Anatoly Obzhirov**, A. Salyuk and E. Suess. Monitoring of methane in eastern Sakhalin shelf and slope of the Okhotsk Sea. (S6-337)
- Vedula V.S.S. Sarma**. Seasonal change in effect of surface pCO<sub>2</sub> and air-sea exchange in the Arabian Sea. (S6-331)
- Yoshikazu Sasai** and M. Ikeda. A three-dimensional model of carbon cycle in the upper layer of the North Pacific. (S6-215)
- Akiyoshi Shinada**, T. Ikeda and S. Ban. Planktonic food chain dynamics in the Oyashio region, western subarctic Pacific. (S6-231)
- Pavel Yu. Tishchenko**, A.N. Derkachev, G.Yu. Pavlova, E. Suess, K. Wallmann, G. Bohrmann and J. Greinert. Formation of carbonate concretion in methane venting area on seafloor. (S6-255)
- Keiko Yamada**, J. Ishizaka, S.-I. Saitoh and M. Kishino. Interannual variability of surface chlorophyll *a* and primary production in the Japan Sea observed by satellite remote sensing. (S6-315)
- Katsumi Yokouchi**, K. Okamura, K. Kitani, S. Ohshimo and M. Tokimura. Phytoplankton crop estimated from the upper mixed layer depth and light intensity in the western waters of Kyushu, Japan. (S6-282)
- S.P. Zakharkov**, V.B. Lobanov, B.G. Mitchell and L.N. Sovetnikova. The production parameters of phytoplankton in the Japan Sea in winter and spring 2000. (S6-327)

**S7: CCCC Topic Session (Designated viewing time: 24<sup>th</sup> October, 15:40-16:00 & 25<sup>th</sup> October, 15:40-16:00)**

- David M. Checkley, Jr.**, M.M. Mullin, M. Carter, K. Ireson and M. Thimman. Time-space pattern for four indices of the abundance of zoo- and ichthyoplankton in the California Current Region. (S7-304)
- Tomonori Hamatsu** and K. Yabuki. Decadal variability on the growth rate and the age of maturation of walleye pollock off the Pacific coast of Japan. (S7-077)
- Seiji Katakura**, A. Nishimura and T. Nishiyama. Otolith growth patterns of the year-classes 1978 and 1989 walleye pollock in young ages in the Bering Sea. (S7-113)
- Toru Kobari** and T. Ikeda. The relationship between body size and water temperature of newcalanus copepods (crustacea: copepoda) in the subarctic Pacific. (S7-127)
- Kosei Komatsu**, Y. Matsukawa, K. Nakata, T. Ichikawa and K. Sasaki. A three dimensional modeling study of the ecosystem dynamics around the Kuroshio frontal region. (S7-129)
- Cathryn A. Lawrence** and L.W. Botsford. Salmon population dynamics: US GLOBEC retrospective and modeling studies in the California Current ecosystem. (S7-342)
- R. Ian Perry**, B. Hargreaves, D.L. Mackas and R.E. Thomson. Mesoscale spatial distributions and condition of juvenile Pacific salmon and comparisons with environmental conditions off southern British Columbia during the 1990s. (S7-191)
- Katsuyuki Sasaki** and K. Kawasaki. Seasonal change of primary production around Kuroshio Extension. (S7-216)
- Tsuyoshi Shiotani** and S.-I. Uye. Selective feeding of the calanoid copepod *Calanus sinicus* on the natural microplankton assemblage, with special reference to microzooplankton. (S7-232)
- Tetsuya Takatsu**, K. Imura and T. Takahashi. Dominant year-classes in brown sole *Pleuronectes herzensteini*. (S7-245)

- Patricia A. Wheeler and H.L. Corwith. El Niño related variations in nutrient and chlorophyll distributions off Oregon: causes and consequences. (S7-305)
- Terry E. Whitley, A.R. Childers and D.A. Stockwell. Nutrient and productivity relationships to physical processes on the Gulf of Alaska Shelf. (S7-270)

**S8: MEQ Topic Session (Designated viewing time: 24<sup>th</sup> October, 10:55-11:30)**

- Seiichi Uno, J. Yun, M. Kaneniwa, J. Koyama, H. Yamada and K. Ikeda. Lipid class and fatty acid composition of mussel, *Mytilus trossulus*, in Vancouver Harbor. (S8-260)
- Seiichi Uno, J. Koyama and H. Yamada. Organochlorine and polyaromatic hydrocarbon residues in English sole, *Pleuronectes vetulus*, at Vancouver Harbor. (S8-360)

**S9: MEQ Topic Session (Designated viewing time: 27<sup>th</sup> October, 10:45-11:15)**

- Ji-Young Cho and Y.-K. Hong. Purification of growth enhancers for microalgal *Isochrysis galbana* from the seaweed *Monostroma nitidum*. (S9-044)
- Jae-Suk Choi and Y.-K. Hong. Axenic isolation procedure of the neutral spore and conchocelis from the seaweed *Porphyra yezoensis*. (S9-045)
- G.S. Gavrilova. Peculiarities of scallop (*Mizuhopecten yessoensis* jay) bottom cultivation in Peter the Great Bay (the Sea of Japan). (S9-071)
- Larissa A. Gayko. The use of long-term physical and statistical methods to forecast yield of mollusks on marine farms. (S9-072)
- Myung W. Han and Y.C. Park. Potential impact of marine pollution on harvesting of seaweed off Ulsan Bay, Korea. (S9-078)
- Mi-Jung Kim, L.-G. Jin, J.Y. Park and Y.-K. Hong. Nucleotide sequences of the partial 18S rDNA from Korean scallops. (S9-124)
- I.E. Kochergin, A.A. Bogdanovsky, V.D. Budaeva, V.G. Makarov, S.M. Varlamov, N.A. Dashko, V.F. Putov and S.I. Rybalko. The technique of hydrometeorological scenario construction for the areas of Sakhalin shelf. (S9-128)
- Eun-Hee Kwon, J.-Y. Cho, J.-S. Choi, S.-Y. Hong, H.-W. Shin and Y.-K. Hong. Antifouling activity of seaweed extracts against the marine green alga and blue mussel. (S9-137)

**FIS Paper Session (Designated viewing time: 24<sup>th</sup> October, 11:00-11:20 & 26<sup>th</sup> October, 16:00-16:20)**

- E.E. Borisovets, Ju.E. Bregman, G.I. Victorovskaya and M.V. Kalinina. Chorological structure of gray sea urchin at the northwestern coast of Japan Sea and the possible mechanisms of its formation. (FISp023)
- Ludmila A. Chernoiivanova. Influence of solar activity and climate changes on *Wachna* cod reproduction in Peter the Great Bay. (FISp043)
- Svetlana V. Davidova. Peculiarities of the *Engraulis japonicus* spawn in Peter the Great Bay in 1988-1998. (FISp055)
- I.I. Glebov. Trophic relations of chinook and coho salmon in the Sea of Okhotsk. (FISp074)
- Denis V. Izmyatinsky. Species composition and abundance of fishes in Amursky Bay (Japan Sea). (FISp103)
- Sen-Tok Kim. Winter diet structure of shelf fishes in eastern slope waters of the Tatar Strait, Sea of Japan. (FISp120)
- Kenji Konishi, S. Honda and Y. Sakurai. Distribution and abundance patterns of two larval anisakine nematodes in walleye pollock collected off the Pacific coast of Hokkaido, Japan. (FISp131)
- Yukiko Matsushita, Y. Naito, H. Ogi and H. Ueda. The homing migration of lacustrine masu salmon, *Onchorynchus masou*, in Lake Toya. (FISp154)
- I.N. Moukhametov and O.N. Moukhametova. Fry of fishes of coastal waters of Gulf of Terpenia (Sakhalin Island) in June 1992. (FISp162)
- Takahiro Nobetsu. North Western Pacific Spawning and Feeding Areas of Threadfin Hake, *Laemonema longipes*. (FISp175)

- O.I. Pushchina. The size and composition of daily ration of the atca mackerel *Pleurogrammus azonus* in Primorye coastal waters (Japan Sea). (FISp197)
- Andrew B. Savin. Spatial distribution of Pacific cod (*Gadus macrocephalus*) and Arctic cod (*Boreogadus saida*) in the Olutorsky Gulf of the Bering Sea. (FISp219)
- Hyeon Ok Shin, S.C. Kim, B.K. Hyang and K.M. Kang. A data processing of the sea bottom shape. (FISp230)
- Igor Yuryevich Soukhin. Peculiarities of seasonal dynamics of feeding of Black Sea urchin *Strongylocentrotus nudus*. (FISp236)
- Sungjae Won, C.W. Lee, J.H. Lee, B.J. Cha, H.Y. Kim and Y.S. Lee. Development of fishing gear materials and accessories database software. (FISp271)
- Takashi Yanagimoto and A. Nishimura. The interannual changes of biological characters on walleye pollock, *Theragra chalcogramma*, in the Aleutian Basin of the Bering Sea. (FISp279)
- Chang Ik Zhang, K.K. Park, T.G. Kang, S.K. Lee and C.S. Kim. Stock assessment of the Korean scallop *Chlamys farreri* in the adjacent waters around Wando, Korea. (FISp288)
- Chang Ik Zhang, Y.I. Seo, S.I. Lee and M.H. Shon. A study on the multi-species assessments in Korean fisheries. (FISp290)

**MEQ Paper Session (Designated viewing time: 25<sup>th</sup> October, 15:30-15:50)**

- Valentina V. Andreeva and A.D. Samatov. Characterization of plankton in area of Piltun-Astohk oil and gas field (northeast of Sakhalin Shelf). (MEQp007)
- Tatyana V. Shaposhnikova and N.V. Ivanova. Interannual variabilities in the reproductive strategy of *Laminaria japonica* (aresch) (phaeophyta), Japan Sea. (MEQp226)
- Sean Y. Sol, L.L. Johnson, B.H. Horness, T.K. Collier and J.E. Stein. Relationship between oil exposure and reproductive parameters in fish collected following the Exxon Valdez oil spill. (MEQp235)
- Yunlong Wang, Z. Xu, Y. Cheng and Y. Chen. Effects of dredging suspended mud on the larval development and molt of Chinese crab *Eriocheir sinensis*. (MEQp264)
- Zhaoli Xu, J. Xu, Q. Yuqn, M. Jiang and Y. Chen. The impact of suspension from Changjiang dipping out and suspended mud liquid on hydrobios. (MEQp274)
- Zhaoli Xu, Q. Yuan, M. Jiang, Y. Wang and Y. Chen. The study on assemblage density of copepod dominants in plume front zone of Changjiang River estuarine area. (MEQp275)

**POC Paper Session (Designated viewing time: 26<sup>th</sup> October, 17:20-18:00)**

- Valentina D. Budaeva, V.G. Makarov and E.V. Dmitrieva. Typification of water circulation structure in Sakhalin Bay. (POCp030)
- Mikhail A. Danchenkov, D.G. Aubrey and S.C. Riser. Branch of subarctic front in the Japan Sea and south-eastward current along it. (POCp053)
- A.L. Figurkin. Okhotsk Sea shelf and slope waters circulation in cold seasons of the year. (POCp064)
- Motoyo Itoh, K.I. Ohshima and M. Wakatsuchi. Isopycnally Averaged Climatology For The Okhotsk Sea. (POCp099)
- Akie Kato and G.V. Shevchenko. Seasonal and interannual changes of SST in the Okhotsk Sea and adjacent areas. (POCp114)
- V.F. Krapivin, John J. Kelley and K. Shirasawa. Synthesis of environmental data for the Okhotsk Sea with application of other subarctic regions. (POCp133)
- Victor I. Kuzin and O.N. Nazarov. Sensitivity of model circulation of the Sea of Japan (East Sea) to grid resolution and external forcing. (POCp135)
- Vladimir A. Luchin and V.V. Plotnikov. Interannual variability of water temperature in the Japan (East) Sea. (POCp151)
- Yan Ma and Q. Zhang. Study of typhoon sea surface wind and its ecological impacts. (POCp328)
- Alexander N. Man'ko and A.D. Nelezin. Large-scale variability of water circulation in the northwest Pacific in 1981-1991. (POCp152)
- A.G. Petrov. Hydrological processes in cold period of year in the Tatar Strait. (POCp340)
- V.M. Petruk, E.O. Basyuk, G.V. Khen. Interannual variability of hydrological situation in the

- northwest part of Bering Sea. (POCp192)
- Young Jae Ro**, S. Smirnov and Y.H. Choi. Monthly circulation patterns in the East China Sea and the Yellow Sea based on the current vectors estimated by P-vector method. (POCp203)
- A.V. Saveliev**. Long-term variability of a thermal regime in the Tsushima Current zone as response to global climate changes. (POCp218)
- I.A. Zhigalov**. Seasonal variation of the dichothermal layers in the northern part of the Okhotsk Sea from May to October. (POCp291)

## W2: REX Workshop

- Elsa R. Ivshina**. Dynamics of Sakhalin-Hokkaido herring growth rate and zooplankton biomass along southwestern Sakhalin coast (Sea of Japan). (W2-101)

## Tsukuba - W7: CO<sub>2</sub> Data Synthesis Symposium (Designated viewing time: 18<sup>th</sup> October, 16:00-17:00)

- Keiri Imai**, N. Tsurushima, T. Egashira, Y. Nojiri and T. Saino. Seasonal variation of primary productivity at Station KNOT (44°N, 155°E) in the North western Pacific Ocean. (W7-366)
- Hisayuki Y. Inoue**, M. Ishii, H. Matsueda, S. Saito, K. Nemoto, T. Tokieda, T. Kawano, I. Asanuma and A. Murata. Temporal and spatial variations in carbonate system of the central and western equatorial Pacific during the period from 1987 to 2000. (W7-367)
- Masao Ishii**, H.Y. Inoue, S. Saito, K. Nemoto, T. Midorikawa, T. Yano and H. Nagai. Seasonal variation in total inorganic carbon and its controlling processes in surface waters of the western North Pacific subtropical gyre. (W7-368)
- Masao Ishii**, H.Y. Inoue and H. Matsueda. Net community production and its importance for the variability in pCO<sub>2sw</sub> in the marginal ice zone of the Southern Ocean south of Australia. (W7-369)
- Akihiko Murata**. CO<sub>2</sub> observation programs in the North Pacific and the adjacent sea by JAMSTEC. (W7-391)
- Kazuhiro Nemoto**, T. Midorikawa, A. Nakadate, K. Ogawa, T. Umeda, T. Nakano, M. Ishii and H.Y. Inoue. Long-term trend of pCO<sub>2</sub> in the western North Pacific. (W7-374)
- Tsuneo Ono**, Y. Nakano, M. Wakita, T. Watai, T. Fujimoto, Y. Suzuki and Y.W. Watanabe. Distribution of DIC and related properties in the North Pacific along 47°N measured in the late 1990s. (W7-377)
- Yoshihiro Shiraiwa**, Y. Sugimoto-Hatano, M. Sato and J.M. Sorrosa. Regulatory aspects of the growth and CaCO<sub>3</sub> production of marine coccolithophorids by nutrient supply and temperature. (W7-379)
- T. Suzuki**, K. Goto, M. Ishii, T. Miyake, A. Murata, Y. Nojiri, S. Oguma, T. Ono, T. Saino, F. Shimano, Y. Tsurushima, S. Watanabe and Y.W. Watanabe. Metadata for CO<sub>2</sub> and related oceanographic data in Japan. (W7-380)
- Nobuo Tsurushima**, K. Imai, Y. Nojiri and S. Watanabe. Seasonal variation of oceanic carbon dioxide species at the western sub-arctic Pacific time series site (KNOT) 1998–2000. (W7-381)
- Jiye Zeng**, Y. Nojiri, Y. Fujinuma, P.P. Murphy and C.S. Wong. Distributions of ΔpCO<sub>2</sub> and CO<sub>2</sub> fluxes in the northern North Pacific: Results from a commercial vessel in 1995-1999. (W7-383)



**9AM2000 S9-001 oral**  
**EFFECTS OF WATER EXCHANGE ON THE OCCURRENCES OF OXYGEN DEPLETION IN FISH FARMS OF GOKASHO BAY, CENTRAL HONSHU, JAPAN**

Katsuyuki Abo<sup>1</sup>, Satoru Toda<sup>2</sup>, Tateki Fujiwara<sup>3</sup> and Tomoyuki Takeuchi<sup>4</sup>

<sup>1</sup> *National Research Institute of Aquaculture, Mie, Japan. 516-0193 e-mail: abo@nria.affrc.go.jp*

<sup>2</sup> *Japan Sea National Fisheries Research Institute, Niigata, Japan. 951-8121*

<sup>3</sup> *Faculty of Agriculture, Kyoto University, Kyoto, Japan. 606-8502*

<sup>4</sup> *National Research Institute of Fisheries Engineering, Ibaraki, Japan. 314-0421*

There are many small semi-enclosed estuaries along the Pacific coast of Japan, where fish farms are intensively distributed. Because ca. 80% of the feed is discharged out of the culture cages as feed remnant and fish excrement, the fish farms suffer from serious organic pollution and subsequently cause the oxygen depletion in the estuaries. In Gokasho Bay, fish farming is well developed and overcrowded culturing of the fish caused oxygen depletion in the benthic layer in the stratified season. In this bay, water exchange is also the significant factor on the water quality. The internal tide and coastal upwelling control the estuarine-shelf water exchange and play an important role in evaluating hydrographic conditions related to sustainable aquaculture production. When a coastal upwelling occurs on the shelf, the lower-layer-water on the shelf can intrude into the bay as an internal bore crossing over the sill at the mouth of the bay. The intrusion of shelf water induces the water exchange and supplies oxygen into the bottom layer. However, this process lifts the oxygen-deficient water mass in the bottom towards the surface and directly affects the health and growth of the fish in the cages suspended in the shallow layer. We have also constructed a two-dimensional numerical model which can simulate such phenomena and predict the behavior of the oxygen-deficient water masses.

**9AM2000 S8-002 oral**  
**"BIOLOGICAL EFFECTS MONITORING" - WHAT HAVE WE LEARNED DURING THE LAST TWENTY YEARS?**

Richard F. Addison

*Department of Fisheries and Oceans, Institute of Ocean Sciences, P.O. Box 6000, Sidney, B.C., Canada. V8L 4B2 e-mail: AddisonR@pac.dfo-mpo.gc.ca*

The term "pollution" implies biological effects, but until fairly recently the only readily measurable biological end-point was death; while this may be adequate to assess "end-of pipe" water quality (through LC50 determinations) it is not a useful measurement for receiving waters. During the last twenty years or so many sub-lethal bioassays have been proposed or developed for use in marine environments, and several of these have been evaluated during collaborative exercises by various intergovernmental agencies; a handful of those have emerged as being consistently successful and are now used routinely to complement conventional assessments of marine pollution by chemical analyses. These bioassays range from biochemical measurements (such as hepatic mono-oxygenase induction or acetylcholinesterase inhibition) through whole organism changes (e.g., oyster embryo bioassays, measurements of "scope for growth") to measurements of (usually benthic) community structure. Some applications of these will be discussed in detail, with particular reference to the PICES-MEQ Vancouver Practical Workshop.

**9AM2000 MEQp003 oral**  
**INFLUENCE OF TBT ON PHYSIOLOGICAL STATUS OF FISH LIVER HEPATOCYTES**

Irina G. Agafonova<sup>1</sup>, Dmitry L. Aminin<sup>1</sup>, Jae Ryoung Oh<sup>2</sup>, Yeong Beom Shin<sup>2</sup> and Soo-Hyung Lee<sup>2</sup>

<sup>1</sup> *Pacific Institute of Bioorganic Chemistry, Far East Division of RAS, Prospect 100 let Vladivostoky, 159 Vladivostok 690022, Russia e-mail: irina\_grig@hotmail.com*

<sup>2</sup> *Korea Ocean Research and Development Institute (KORDI), Ansan P.O. Box 29, Seoul 425-600, Republic of Korea*

Organotin compounds have found widespread commercial use as pesticides, fungicides and stabilizers of plastics. Studies have shown that most of organotins produce very high toxicity upon different species of sea animals. But the mechanism of biological action of these compounds still remains unclear.

In present study the rapid effect of one of the toxic organotin tributyltin (TBT) upon fish hepatocytes was studied. Some intracellular biomarkers (such as lysosome activity, esterase activity, DNA content, intracellular Ca<sup>2+</sup> concentration, cell biomembrane microviscosity) of liver cells reflecting general physiological status of fish organisms were used to detect direct biological effect of TBT upon fish cells. Hepatocytes were isolated from liver of Goldfish *Carassius auratus* and cultivated as a primary culture. TBT was introduced into cell culture medium and incubated with hepatocytes during one hour. Intracellular fluorescent probe technique and spectrofluorometry were applied to investigate the mechanism of TBT biological action upon cells.

It was found that TBT acts as a cytotoxin influencing on cell viability on dose-dependent manner. Cytotoxic activity of TBT upon goldfish hepatocytes was estimated with Trypan blue dye by standard protocol. The ED50 was about 10-15g/ml.

It was showed that this compound inhibited lysosomal function, strongly reduced esterase activity and increased internal Ca<sup>2+</sup> concentration with inhibition of Ca<sup>2+</sup> transport across biomembrane and altered biomembrane microviscosity.

TBT at concentration of 10g/ml inhibited EROD (P450) activity of living hepatocytes on 100% and at concentration of 1g/ml - on around 50% for 30 min of compound incubation with cells which was estimated with Plate Reader assay and conventional spectrofluorometric method.

Investigation of double-stranded DNA content in hepatocytes after TBT action showed the increasing of intracellular DNA concentration (stimulating effect) which reflect the cell recovery and adaptation mechanisms.

The possible mechanism of TBT action is discussed.

**9AM2000 S3-004 poster**  
**THE CENSUS OF MARINE LIFE: ADDRESSING THE BIODIVERSITY AND DISTRIBUTION OF MARINE LIFE**

Vera Alexander

*School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, Fairbanks, AK 99775, U.S.A. e-mail: vera@sfos.uaf.edu*

The Census of Marine Life is an international research program that seeks to assess and explain changes in diversity, distribution and abundance of life in the oceans. Development of the program was fostered through a series of workshops, and is currently guided by an International Scientific Steering Committee (SSC) and managed by a Secretariat. The SSC is preparing a draft Scientific Strategy for review by the scientific community; the overall program will be developed in cooperation with marine scientists and funding agencies from around the world. Regional assessments of marine life will address specific questions related to ocean biogeography. Ecosystems supporting intensive fishing, mid-ocean ridges, seamounts, and open ocean pelagic environments are under consideration. An Ocean Biogeographical Information System is being developed, with several exploratory projects supported through the National Ocean Partnership Program. Other areas of interest include the History of Marine Animal Populations (HMAP), and the application of novel sampling technologies for marine populations.

**9AM2000 MEQp005 oral**  
**EFFECT OF ORGANOTINS, TBT AND TPHT, ON FLATFISH LIVER HEPATOCYTES IN *IN VIVO* EXPERIMENT**

Dmitry L. Aminin<sup>1</sup>, Irina G. Agafonova<sup>1</sup>, Jae Ryoung Oh<sup>2</sup>, Won Joon Shim<sup>2</sup>, Yeong Beom Shin<sup>2</sup>, Soo-Hyung Lee<sup>2</sup> and Joong-Kyun Jeon<sup>3</sup>

<sup>1</sup> *Pacific Institute of Bioorganic Chemistry, Far East Division of RAS, Prospect 100 let Vladivostoky, 159 Vladivostok 690022, Russia e-mail: d\_aminin@hotmail.com*

<sup>2</sup> *Korea Ocean Research and Development Institute (KORDI), Ansan P.O. Box 29, Seoul 425-600, Republic of Korea*

<sup>3</sup> *Kangnung National University, Faculty of Marine Bioscience and Technology, Kangnung, Kangwon 210-702, Republic of Korea*

Two toxic organotins were introduced in in vivo experiments with flatfishes, olive flounder (*Paralichthys olivaceus*). The fish were separated in several experimental groups, kept in 0.6 ton of 8 different aquaria and fed a nutritionally complete commercial diet. Filtered aerated natural seawater was used. To assess accumulation and effect of organotins on hepatic cells, olive flounders were exposed to tributyltin chloride (TBT) and triphenyltin chloride (TPHT) at nominal concentrations of 0.01, 0.1 and 1.0 g/L for each compound and mixture of 0.1 g/L (TBT) + 0.1 g/L (TPHT) for 30 days. Control fish were kept in another aquarium under the same condition in the absence of organotin. Seawater was renewed everyday and then adjusted to the nominal organotin concentration with TBT or TPHT stock solutions dissolved in ethanol. After 1, 3, 7, 14 and 30 days fish were sampled in triplicate, liver was excised and hepatocytes were isolated from each liver as a primary cell culture. Some biochemical parameters such as hepatocyte biomembrane microviscosity, double-stranded DNA content, non-specific esterase activity, lysosomal activity and intracellular Ca<sup>2+</sup> concentration were estimated using fluorescent molecular probes technique and spectrofluorimetry.

No significant correlation between mortality effect and organotin concentration were observed under the action of studied compounds, however for both organotins the significant changes in intracellular parameters were registered: biomembrane microviscosity was altered rapidly for 3 day from the beginning of experiments; Ca<sup>2+</sup> homeostasis was broken and several strong spikes in intracellular calcium concentration were registered during all experimental period; almost complete inhibition of esterase activity was detected even on 3rd day; some activation of lysosomal activity and increasing in DNA content were recorded within first 7 days. There were no significant difference in action of different organotin concentrations, but in some cases 1 g/L was most active. There were no significant differences in two organotin species, but in some cases TPHT was most effective.

All collected data showed that studied organotins acts as a toxins destroying cell biomebrane function and inhibiting activity of some intracellular enzymes. Probably dynamic of changes in activity of hepatocyte biomarkers under organotin action correlates with the rate of organotin accumulation in

9AM2000 S5-006 oral  
**INTERANNUAL VARIABILITY IN DO, NUTRIENTS AND CARBONATE PARAMETERS OF THE WESTERN SUBARCTIC GYRE INTERMEDIATE WATER: ROLE OF PHYSICAL PROCESSES**  
Andrey Andreev, M. Kusakabe, Y. Kumamoto and C. Saito  
*Japan Marine Science and Technology Center, Japan. e-mail: andreev@jamstec.go.jp*

Existence of a pycnocline (or halocline) located at 100-150 m depth and high rate of organic matter decomposition result in low DO and pH, and in high DIC and nutrients in the upper intermediate water of WSG. Interannual variability of the water mixing with the Okhotsk Sea and subtropical Gyre and the speed of cyclonic circulation leads to the variability in chemical parameters concentrations of the WSG intermediate water. The water mixing at the boundaries of the Okhotsk Sea - subarctic - subtropical regions leads to the increase of DO and pH, and to decrease of DIC and nutrients in the intermediate layer of the western subarctic Pacific. Also the mixing decreases the vertical density gradient in the main pycnocline and thus decreases the difference in DO, DIC and nutrients between surface and intermediate water layers of WSG.

From 1987/88 to 1991/92 the DO and pH at the  $\sigma_\theta \approx 26.9-27.1$  of WSG were increased and DIC and nitrate were decreased. These changes and also the deepening of isopycnal surfaces, and the decrease in the vertical density gradient of main pycnocline ( $\sigma_\theta \approx 26.6-26.8$ ) were related with the high inflow of subtropical waters to the subarctic region. In 1997, the reverse changes were occurred in the upper intermediate water layer of western subarctic Pacific: the vertical density gradient in the main pycnocline was increased and the concentration of DO and pH became lower and DIC and nitrate became higher those in 1991/92. Also the changes in DO, nitrate and DIC between 1991/92 and 1997/2000 can be found in the intermediate water of the Subarctic frontal zone.

We will discuss about impacts of the water mixing at the boundaries of the Okhotsk Sea - subarctic - subtropical regions on the concentration of chemical parameters in the intermediate waters of western subarctic Pacific.

9AM2000 MEQp007 poster  
**CHARACTERIZATION OF PLANKTON IN AREA OF PILTUN-ASTOKH OIL AND GAS FIELD (NORTHEAST OF SAKHALIN SHELF)**

Valentina V. Andreeva<sup>1</sup> and A.D. Samatov<sup>2</sup>

<sup>1</sup> *Sakhalin Energy Investment Company, Ltd., Yuzhno-Sakhalinsk, Russia e-mail: Valentina\_Andreeva@SakhalinEnergy.ru*

<sup>2</sup> *Sakhalin Research Institute of Fisheries & Oceanography (SakhNIRO)*

The plankton survey in the area of Piltun-Astokh field (northeast of Sakhalin shelf has been carried out by Sakhalin Energy Investment Company Ltd. for a number of years.

Neritic forms prevail among phytoplankton (92 species total). Diatom algae usually prevail both in biomass and in abundance, sometimes – both diatom and peridinium algae. High biomass of phytoplankton is observed during the autumn “bloom” (several grams per cubic meter).

In autumn season, the basis of zooplankton in that area is neritic forms of copepods, among which coldwater species and meroplankton prevail. A specific trait of zooplankton is that there are *cumacia* in the watercolumn and they may account for significant part of plankton's biomass.

No significant changes were observed in species composition, structure or quantitative characteristics of zooplankton compared to 1998. Certain changes in phytoplankton's structure registered correspond with general trends of seasonal development of phytoplankton in coastal waters of that area.

9AM2000 S3-008 invited  
**PREDATION BY FISH, ESPECIALLY CHUM SALMON, ON NORTH PACIFIC COELENTERATES**

Mary N. Arai<sup>1</sup>, Kazuya Nagasawa<sup>2</sup>, David W. Welch<sup>1</sup> and Adrienne Dunsmuir<sup>3</sup>

<sup>1</sup> *Pacific Biological Station, 3190 Hammond Bay Road, Nanaimo, B.C., Canada. V9R 5K6 e-mail: araim@island.net WelchD@pac.dfo-mpo.gc.ca*

<sup>2</sup> *National Research Institute of Far Seas Fisheries, 5-7-1 Orido, Shimizu, Shizuoka, Japan. 424 e-mail: ornatus@enyo.affrc.go.jp*

<sup>3</sup> *Dauphin Island Sea Laboratory, 101 Bienville Blvd., Dauphin Island, AL 36528, U.S.A. e-mail: adunsmuir@disl.org*

Although the importance of pelagic coelenterates (Cnidaria and Ctenophora) as predators of larval fish is well established, there has been less recognition of their role within food webs as prey of fish. In the North Pacific fish such as chum salmon (*Oncorhynchus keta*) and dogfish (*Squalus acanthias*) are among the species which feed on coelenterates. We will compare the data from literature and our own surveys on populations of coelenterates that are available as prey to data on diets of fish in comparable locations. The most abundant coelenterate available to chum salmon feeding in the central North Pacific is the hydromedusa *Aglantha digitale*. Quantitative evaluation of the proportion of coelenterates in diets, based on the proportion of

coelenterates in the contents of fish stomachs, is hindered by lack of data on comparative rates of digestion of coelenterates and other prey. We will present preliminary laboratory data on rates of digestion of coelenterates by chum salmon, and consider the contribution of coelenterates to the bioenergetic budgets for these fish.

9AM2000 S2-298 oral  
**A COMPARISON OF THE EASTERN AND WESTERN BERING SEAS AS SEEN THROUGH PREDATION-BASED FOOD WEB MODELING**

Kerim Y. Aydin, Victor V. Lapko, Vladimir I. Radchenko and Patricia A. Livingston  
*Fisheries Research Institute, University of Washington, Box 357980, Seattle, WA 98195, U.S.A. e-mail: kerim@fish.washington.edu*

We present a comparison of two quantitative food web models of the Eastern and Western Bering Seas. Food webs were created from independent estimates of production, consumption, biomass and diet from each region for multiple predator and prey species. The results highlight the differences in the trophic structure of the two food webs from the top predators' point of view, and also provide substantial insights into the relative strengths of different methods for measuring predator-prey linkages. Furthermore, dynamic modeling and sensitivity experiments indicate differences in the potential for top-down and bottom-up control in the two ecosystems. In addition, the results indicate important links between the per-biomass rates of fish population growth (P/B) and the amount of variance found in the predator-prey linkages. Finally, we discuss the high sensitivity of the model to assumed rates of predation on juvenile life stages of fishes, an element of the models which is difficult to measure in many marine ecosystems.

9AM2000 FISp297 oral  
**ENSO- AND REGIME-SCALE VARIATION IN THE BIOGEOGRAPHY OF GULF OF ALASKA MICRONEKTON AS A DRIVING MECHANISM FOR OBSERVED GROWTH TRENDS IN PACIFIC SALMON**

Kerim Y. Aydin, Katherine Myers, Robert Walker and Nancy Davis  
*Fisheries Research Institute, University of Washington, Box 357980, Seattle, WA 98195, U.S.A. e-mail: kerim@fish.washington.edu*

Micronektonic squid may be an extremely important source of food for Pacific salmon (*Oncorhynchus* spp.) in the northeast Pacific Ocean, but the year-to-year variation of squid abundance is poorly understood. Here, we show a relationship between surface oceanographic boundaries determined from CTD data, the southern limit of salmon distribution, and the northern limit of a micronektonic squid species (*Beryteuthis anomychus*), a dominant salmon prey item in the region. We use the area of species overlap to define a zone of "highest salmon growth," the size of which varies on both ENSO and decadal time scales. We calculate the area of squid/salmon overlap from oceanographic data for the years 1950-98, and show that variation in this overlap explains much of the negative correlation between sea surface temperature and adult salmon body weight. We also examine the importance of squid in salmon diets in the central North Pacific (along 180° longitude) and in the Bering Sea. The results suggest that biogeographic variation in food web structure, with micronektonic squid as a keystone species, is a mechanism that contributes to the interannual variation in salmon growth in the North Pacific.

9AM2000 W4-299 oral  
**AN ECOPATH MODEL OF THE EASTERN SUBARCTIC PACIFIC (ALASKAN) GYRE, WITH IMPLICATIONS FOR DEVELOPMENT OF A WESTERN SUBARCTIC PACIFIC MODEL**

Kerim Y. Aydin  
*Fisheries Research Institute, University of Washington, Box 357980, Seattle, WA 98195, U.S.A. e-mail: kerim@fish.washington.edu*

I present the results of a mass-balance (ECOPATH) model of the eastern Subarctic Pacific (Alaskan) Gyre, and discuss how a similar modeling approach may be structured for the western Subarctic Pacific Gyre. I discuss how this type of model may be used to develop conceptual models of the biological structure and function of the gyres by providing an explicit accounting of our understanding of food web interactions.

Specifically, I discuss: (1) the appropriate boundaries and species groupings of the model; (2) the issues involved with scaling seasonal models of lower trophic levels up to a model with an annual time scale; (3) sources for data and parameterization methods and (4) the appropriate methods for the inclusion of highly migratory species, specifically Pacific salmon (*Oncorhynchus* spp.) and marine mammals. As seasonal dynamics may play an important role in the ecology of most species in the region, I will show attempts to model both summer and winter versions of the Gyre, and suggest that a similar approach should be taken for the western model. Finally, I will discuss ways in which the model may be best designed to allow for later combination with lower trophic level (NPZ) models currently under development. By combining this type of model with ideas about physical forcing and more details regarding lower trophic level production, we can begin to use these models to examine our hypotheses about how the ecosystems operate.

9AM2000 S7-009 oral  
SPATIAL AND TEMPORAL DISTRIBUTION OF PHYTOPLANKTON, MACROZOOPLANKTON, AND FISHES  
ALONG A SOUTH-NORTH TRANSECT IN THE CENTRAL NORTH PACIFIC OCEAN AND BERING SEA IN  
SUMMER

Tomonori Azumaya, Akihiro Shiomoto, Kazuya Nagasawa, and Yukimasa Ishida  
*Hokkaido National Fisheries Research Institute, 116 Katsurakoi, Kushiro, Japan. 085-0802 e-mail: azumaya@hnf.affrc.go.jp*

To investigate the spatial and temporal distribution of phytoplankton, macrozooplankton and fishes, we applied empirical orthogonal function (EOF) analysis to the data collected along a transect at 179°30'W from 38°30' N to 58°30'N during summer (from mid-June to early July) in 1991-1998. The spatial distribution of phytoplankton, macrozooplankton and fishes was divided into the following four areas: the subtropical North Pacific, the Transition Domain, the subarctic North Pacific, and the Bering Sea. In the Subtropical North Pacific, Pacific pomfret seems to play an important role in feeding impact on macrozooplankton. In the Transition Domain and the subarctic North Pacific, when salmonids were relatively abundant, macrozooplankton biomass was low and phytoplankton biomass was high, and vice versa. These results suggest that feeding impact by fish possibly controls phytoplankton and macrozooplankton biomass in the Transition Domain and the subarctic North Pacific. However, in the Bering Sea where salmonids were abundant, annual changes in phytoplankton and macrozooplankton biomass and salmonid abundance were almost in phase. These results suggest that biological mechanism to determine the abundance of these three biological components in the Bering Sea may be different from those in the North Pacific Ocean.

9AM2000 S3-010 oral  
EFFECTS OF CHAETOGNATH PREDATION ON COPEPOD COMMUNITIES OF THE SOUTHEAST BERING SEA  
SHELF

Christine T. Baier<sup>1</sup> and M. Terazaki<sup>2</sup>

<sup>1</sup> NOAA/NMFS/AFSC, 7600 Sand Point Way NE, Seattle, WA 98115, U.S.A. e-mail: [Christine.Baier@noaa.gov](mailto:Christine.Baier@noaa.gov)

<sup>2</sup> Ocean Research Institute, University of Tokyo, Tokyo, Japan e-mail: [terazaki@ori.u-tokyo.ac.jp](mailto:terazaki@ori.u-tokyo.ac.jp)

The southeast Bering Sea Shelf is a highly productive ecosystem that supports abundant marine mammals, seabirds, and important commercial fisheries. The entire ecosystem may be affected by fluctuations in copepod communities, which provide important prey for young fish that are forage for higher trophic levels. Chaetognaths are predators that are highly abundant in all oceans, often second only to copepods in number, and can significantly affect populations of copepods, their main prey. To our knowledge there have been no studies of the ecological role of chaetognaths on the SE Bering Sea shelf. We evaluated effects of chaetognath predation on copepod abundances, species composition, and size distribution over the SE Bering Sea Shelf during spring 1995. We estimated feeding effects using chaetognath and ambient prey concentrations, gut content analysis, and experimentally-determined digestion rates. Chaetognath concentrations averaged 9 and 16 m<sup>-3</sup>, during April and May, respectively. The number of prey per chaetognath ranged from 0.18 - 0.81. The mean digestion time for natural prey at temperatures of 2-4°C was 355 min. The most numerous prey in chaetognath guts were copepod nauplii and copepodites of *Calanus marshallae* and *Pseudocalanus* spp., the most abundant ambient species after *Oithona* spp. According to our preliminary estimates, chaetognath predation removed 0-6% of total copepod standing stock per day. Effects on individual species and size classes, however, were much greater and may be important to structuring copepod communities and the prey available to fish larvae.

9AM2000 S7-011 invited  
ANALYTICAL AND INTERPRETATIVE CONTEXTS FOR COMPARATIVE STUDIES OF THE FACTORS  
CONTROLLING POPULATION DYNAMICS AND HABITAT SELECTION OF MAJOR FISH STOCKS

Andrew Bakun

*Lab. Halieutique et Ecosystèmes Aquatiques, IRD, Montpellier, France*

&

*French-South African VIBES Project, Univ. of Cape Town, South Africa*

*e-mail: [andrewbakun@europe.com](mailto:andrewbakun@europe.com)*

The comparative method and the better-known experimental method have been called "the two great methods of science". The comparative method is the method of choice when the scale of a problem precludes establishment of experimental controls. Here I present a commentary on the application of the comparative method to current issues in fisheries ecology, drawing examples mainly from pelagic fish species and from my own activities and experience.

Both experience and hypothetical considerations suggest that fish population—environment linkages may be intrinsically non-stationary (as well as nonlinear). This presents severe problems in empirical analysis, particular since the length of available time series is generally far too short to apply state-of-the-art mathematical methods for addressing such issues. However, the assumption that fish have common basic problems to solve leads to an expectation of recognizable informative patterns when available information from separate (i.e., not connected by significant exchanges of organisms or entrained matter) ecosystems are arrayed with respect to appropriate hypothetical frameworks.

This may serve to somewhat relieve the problem of insufficient time series length. An example is the comparative examination of empirical nonlinear relationships used to establish the famous *optimal environmental window* result (of Cury and Roy). It is to be stressed that this particular examination was not a random search for unspecified patterns among variables, but based on the well-founded conceptual framework, that (a) wind is the most important driver of key processes in upwelling regions and that (b) natural selection should direct a "choice" of spawning habitat which is favorable under rather normal conditions (i.e., toward the center of their frequency distributions), leading to expectation of a dome-shaped relationship of recruitment success to wind intensity.

Further, even in the absence of time series information, simply arraying known characteristic aspects of habitat selection against the climatologies of dominant environmental processes may reveal informative patterns with respect to dominant active mechanisms. An example, is the concept of *ocean triads*, the elements of which are provided by physical ocean processes or (in special cases) by active behavior of the organisms. The *ocean triads* and *optimal environmental window* findings, while developed on essentially different types of data sets, appear to converge to some remarkably similar and consistent outcomes.

Difficulties in reconciling various signals emanating from marine ecosystems (e.g., evident large-scale synchronies in low-frequency population variations and alternations) suggest a "missing dynamics" that is unaccounted for in our conventional conceptual framework for understanding marine ecosystem function. An associated search for a mechanism underlying the drastic switches between anchovy and sardine dominance, for example, has led to the hypothesized operation of a stringent *school trap*. The very strong control by the "corporate volition" of the school on individual tendencies and preferences implied by this idea, in turn, leads to an hypothesized extremely rapid evolutionary mechanism of *school-mix feedback*, which appears to convey substantial explanatory power with respect to currently unresolved issues. The new ideas seem to be converging toward a conceptual generalization that interruption of biological control, i.e., rapid population growth, may tend to occur at discontinuities, either spatial or temporal, in the physical environmental context. (Such conceptual generalizations provide a framework for arraying data and experience in new configurations that may support new a new "round" of comparative inferences).

Comparative studies cannot "prove" anything (it is a truism that science cannot prove hypotheses, but only falsify them). But a properly performed comparative study may yield a logically consistent explanation of observed phenomena and thus a rational "working basis" for activities and decisions. To cite one example, the ideas outlined here, as well as many other recent findings and realizations, suggest great value in an ability to indicate and interpret changes in habitat selection by pelagic fish populations (for example, one is drawn to conclude that the development and deployment of effective automatically-recording *egg-pump*-type survey systems should be urgently pursued).

9AM2000            S8-012            invited  
**CYP1A AND RELATED MEASUREMENTS IN ENGLISH SOLE (*Parophrys vetulus*) FROM VANCOUVER HARBOUR**  
Stelvio Bandiera<sup>1</sup> and Richard F. Addison<sup>2</sup>  
<sup>1</sup> Faculty of Pharmaceutical Sciences, University of British Columbia Vancouver, B.C., Canada. e-mail: bandiera@unixg.ubc.ca  
<sup>2</sup> Institute of Ocean Sciences, P.O. Box 6000, Sidney, B.C., Canada. V8L 4B2 e-mail: AddisonR@pac.dfo-mpo.gc.ca

English sole (*Parophrys vetulus*) were collected during May-June 1999 from various sites in Vancouver Harbour and at expected reference sites outside the harbour during the PICES-MEQ Practical Workshop. Fish were weighed, separated by sex and livers were removed. Hepatic microsomes were prepared and analyzed for total Cytochrome P450 content, CYP1A protein levels and EROD activity (the catalytic activity of CYP1A). Data are currently being analyzed and results from these analyses will be presented and discussed in the context of known distribution of chemical contaminants at the sampling sites.

9AM2000            S7-013            invited  
**THE BENGUELA UPWELLING SYSTEM: CAN WE COMPARE THE RESPONSES OF DIFFERENT GLOBEC ECOSYSTEMS TO PHYSICAL FORCING?**  
Manuel Barange  
GLOBEC IPO, Plymouth Marine Laboratory, Prospect Place, Plymouth, United Kingdom. PL1 3DH e-mail: m.barange@pml.ac.uk

GLOBEC main goal is to increase our understanding of the marine ecosystem, in order to develop a capability to forecast its responses to physical forcing. To achieve this we need to downscale from global effects (eg. SST increases in the world's oceans) to local ecosystem responses. Inter-regional comparisons are needed to establish the major paths through which physical forcing will influence the marine ecosystem. In this presentation I will summarize the structure and dynamics of the Benguela system, particularly centred on pelagic fish, as background to possible future comparisons between responses to physical forcing in the North Pacific and other major oceanic regions.

9AM2000 S6-014 oral

**PHYSICAL AND BIOGEOCHEMICAL VARIABILITY IN THE NORTH ATLANTIC OCEAN: PERSPECTIVES FROM TWO LONG-TERM OCEANOGRAPHIC TIME-SERIES, HYDROSTATION S (1954-PRESENT) AND THE U.S. JGOFS BERMUDA ATLANTIC TIME-SERIES (BATS) SITE (1988-PRESENT)**

Nicholas R. Bates, Craig A. Carlson, Dennis A. Hansell, Rodney J. Johnson, Deborah K. Steinberg and Anthony H. Knap  
*Bermuda Biological Station For Research, Ferry Reach, GE01, Bermuda e-mail: nick@bbsr.edu*

Understanding the relationship between Earth's climate and the oceanic carbon cycle requires an understanding of the time-variations of the carbon cycle and CO<sub>2</sub> in the ocean, the exchange of CO<sub>2</sub> between ocean and atmosphere and the rate of uptake of anthropogenic CO<sub>2</sub> by the ocean. Physical and biogeochemical observations at Hydrostation S (from 1954) and the U.S. Joint Global Ocean Flux Study (JGOFS) Bermuda Atlantic Time-series Study (BATS) site (from 1988) in the western North Atlantic offer a unique opportunity to investigate the seasonal, interannual and decadal variability of mixing, primary production, carbon cycling, community structure and organic carbon fluxes. We discuss the impact of seasonal forcing, mesoscale variability and episodic events on ocean carbon cycling and air-sea CO<sub>2</sub> fluxes.

On interannual timescales, inverse relationships exist between temperature anomalies, and anomalies of mixed layer depth, primary production and total carbon dioxide (TCO<sub>2</sub>). During warm temperature anomaly periods (e.g., 1989-90, 1994, 1996-97), rates of integrated primary production were lower, mixed layers shallower and levels of TCO<sub>2</sub> reduced. The coupling of ocean physics and biogeochemistry was linked to variability of atmospheric forcing over the Sargasso Sea and the phase of the North Atlantic Oscillation (NAO). We also demonstrate that interannual variability of salinity and alkalinity was linked to the phases of El Niño-Southern Oscillation (ENSO).

9AM2000 W7-389 oral

**PHYSICAL AND BIOGEOCHEMICAL VARIABILITY OF THE MARINE CARBON CYCLE IN THE SUBTROPICAL GYRE OF THE NORTH ATLANTIC OCEAN**

Nicholas R. Bates, Craig A. Carlson, Dennis, A. Hansell, Rodney J. Johnson, Anthony F. Michaels, Deborah K. Steinberg and Anthony H. Knap

*Bermuda Biological Station For Research, Ferry Reach, GE01, Bermuda e-mail: nick@bbsr.edu*

Understanding the relationship between Earth's climate and the oceanic carbon cycle requires an understanding of the time-variations of the carbon cycle and CO<sub>2</sub> in the ocean, the exchange of CO<sub>2</sub> between ocean and atmosphere and the rate of uptake of anthropogenic CO<sub>2</sub> by the ocean. Physical and biogeochemical observations at Hydrostation S (from 1954) and the U.S. Joint Global Ocean Flux Study (JGOFS) Bermuda Atlantic Time-series Study (BATS) site (from 1988) in the western North Atlantic offer a unique opportunity to investigate the seasonal, interannual and decadal variability of mixing, primary production, ocean carbon cycling, community structure and organic carbon fluxes. We will discuss the biological and physical processes that influence the ocean carbon cycle. We find that there is substantial year to year variations in dissolved inorganic carbon (DIC) and alkalinity. Our analysis also revealed that upper-ocean temperatures are inversely correlated with parameters such as mixed-layer depth, rates of integrated net primary production (NPP) and DIC. By contrast, alkalinity anomalies appear to be correlated with salinity anomalies. The most likely scenario explaining these inverse correlations is variability in wintertime convection which in turn is linked to atmospheric forcing modulated by the North Atlantic Oscillation (NAO).

9AM2000 S4-015 oral

**PACIFIC SAURY (*Cololabis saira*) DISTRIBUTION IN THE NORTHWESTERN JAPAN SEA**

Alexey A. Baytaluk

*Pacific Fisheries Research Center (TINRO-Center), 4 Shevchenko Alley, Vladivostok, Russia. 690600 e-mail: shelekhov@mail.ru*

The study is based on information on saury catches by drifting nets and trawls and on saury observations at light stations in 1977-1979, 1985-1990, and 1995.

Analysis of saury distribution in different months shows that temperature range of saury habitation and optimal values of SST are not constant but shift to higher values during May-September and to lower values – since October. From the other hand, there is observed a spatial shifting of the belt of optimal temperature: northward in summer and southward in autumn. There are eight zones of certain water structure in the northern part of the Japan Sea (Zuenko, 1998), and the belt of optimal SST moves from one zone to another, crossing the fronts:

- in May it occupies usually the southernmost zones – Subtropic and Subtropic transformed;
- in June it shifts northward to Subtropic transformed and Interfrontal (between two branches of Polar front) zones;
- in July it occupies the vast area of Subtropic transformed, Interfrontal, Interfrontal transformed, and Subarctic zones;
- in August it occupies the northernmost area – of Interfrontal, Interfrontal transformed, Subarctic, and Primorye Current zones;
- in September-October it shifts southward to Interfrontal, Interfrontal transformed, and Subarctic zones.

Saury has observed the most frequently in Interfrontal and Subarctic zones which are located at the northern sides of south and north branches of Polar front, accordingly. The highest concentrations were marked at south branch of Polar front.

Saury stock in the northwestern part of the Japan Sea was estimated on the base of visual observations at light stations carried out in 1970-1980s (Table 1).

Year	1977	1978	1979	1985	1986	1987	1988
Total biomass, th. tons	13.2	17.5	13.8	17.0	12.3	23.7	11.8

Saury stock increased in recent times. In 1997-1999 it was estimated as about 100 th. tons. Size composition of saury stock had changed in late 1990s. In late 1970s the catch was formed by small-size and medium-size fish, but in nowadays the large-size saury dominated. This change of size composition is similar to the process in late 1960s.

9AM2000 S4-016 poster  
**SEASONAL CHANGES IN THE MICROSTRUCTURE OF PACIFIC SAURY', *Cololabis saira*, OTOLITHS**

Alexey A. Baytaluk and V.A. Shelekhov  
*Pacific Research Fisheries Centre (TINRO Centre), 4 Shevchenko Alley, Vladivostok, Russia. 690600 e-mail: shelekhov@mail.ru*

Otoliths of 87 individuals of saury were used for the analysis of seasonal changes in their microstructure. Saury was caught in July 1995 and the beginning of October 1998 in area between 146°53' and 162°00' E and 41°57' and 44°00' N.

We divided saury in our samples into three groups: winter-spring, spring-summer and autumn-winter based on the amount of growth on the otoliths.

It was revealed that widest increments were near the nucleus of otolith (2-3 microns) in all groups. Increments at otoliths of saury in winter-spring group (on the average from 3 up to 1.99 microns) were wider than those of individuals of spring-summer (on the average from 2.47 up to 1.84 microns) and autumn-winter group (on the average from 2.16 up to 1.89) at first 7 months of life. Changes in monthly average width of increments occurred practically identically in the selected age groups of saury: it increased in the summer period and at the end of winter - beginning of spring, and decreased in the autumn-winter period. Average width of the daily increments in the central part of otoliths, which corresponds with larval period of growth, was less (2-3 microns) in our samples, than those found out in the experimental conditions (Watanabe, Kuji, 1991) (4.6 microns). However it exceeded width of increments at saury from the central part of Pacific Ocean (2 microns) (Suyama *et al.*, 1992).

There was not revealed the reliable link between width of increments and place of catching of saury in the same age groups. In the same time, monthly average width of increments was more in our samples, than those for samples from the central part of Pacific Ocean (Suyama *et al.*, 1992). Individuals of spring-summer and autumn-winter groups in our samples were closest to individuals from central part of Pacific Ocean by the width of increments.

9AM2000 S1-017 oral  
**SEARCHING FOR THE MECHANISM THAT LINKS COASTAL AND MID-OCEAN ECOSYSTEMS**

Richard J. Beamish, G.A. McFarlane and J.R. King  
*Pacific Biological Station, Fisheries and Oceans Canada, 3190 Hammond Bay Road, Nanaimo, B.C., Canada. V9R 5K6 e-mail: BeamishR@pac.dfo-mpo.gc.ca*

Fisheries management is now moving away from the single species concept towards ecosystem considerations. While ecosystem management represents an important change in thinking, the ecosystems tend to be distinguished mainly by national boundaries rather than natural processes. A regionalized focus on ecosystem research provides useful information but there is a more global influence on the organizations of ecosystems. We believe there is an urgency to discover the mechanism that switches the state of the climate that in turn drives the processes that reorganize ecosystems. Climate and climate change affect the state of ecosystems. The impacts of changes in climate are evident as changes in energy transfer among the rotating shells of the planet, such as the solid earth to atmosphere. It is the understanding of these global processes that will help to ensure that the management of fishes such as Pacific salmon and sardines is cost effective, culturally acceptable, and appropriate for the impacts greenhouse gas increases.



9AM2000 S8-018 oral  
MARINE ENVIRONMENTAL QUALITY ASSESSMENT USING POLYCHAETES TAXOCENE CHARACTERISTICS  
IN VANCOUVER HARBOUR

Tatyana A. Belan

*Far Eastern Hydrometeorological Research Institute (FERHI), 24 Fontannaya Street, Vladivostok, Russia. 690600 e-mail: hydromet@online.ru*

Benthic samples were taken in Vancouver Harbour in May-June of 2000 during the Firth MEQ Practical Workshop. Seven sites located in Vancouver Harbour and in Gibsons were sampled to analyze a set of chemical and biological properties.

For marine environment quality assessment characteristics of polychaetes taxocene (the number of species, total biomass and density, Shannon's, Pielou's, Margalef's and Simpson's indices) as well as environmental factors (pollutants content in bottom sediments) in Vancouver Harbour were used. For data analysis software package PRIMER (Plymouth Routines In Multivariate Ecological Research), developed at the Plymouth Marine Laboratory was used.

Ordination by Multi-Dimensional Scaling and classification by hierarchical clustering of data obtained detected four benthic groups: I (St. B-50); II (St. B-49); III (Sts. B-3A+B-11B+B-48) and IV (Sts. B-38+B-41B) due to strong dissimilarity of species composition.

Low Bray-Curtis similarity between St. B-50 and the others (15%) is determinate, mainly natural environmental factors (depth and sediment type). But differences between Group IV (Sts. B-38+B-41B) and the others (20% of similarity) probably have been caused by pollution affect.

Principal Component Analysis (PCA) of polychaetes taxocene characteristics and environmental factors has been detected Group IV (Sts. B-38+B-41B) separately. These stations are characterized by maximal and increasing contaminant concentrations in bottom sediments at more than half of all sampling stations; lowest values of number of species, as well as indices of diversity, richness, and maximal values of domination index. Domination of tolerant pollution species *Tharyx multifilis* and low density of sensitive-pollution species (*Scoloplos armiger*, *Laonice cirrata*) are detected at Sts. B-38 and B-41B.

Thus, sediments quality assessment indicates severe adverse effect at Sts. B-38 and B-41B. Sts. B-48, B-49 and B-11B are characterized by low and moderate adverse effects. St. B-3A, judging by ecological indices and species structure has intermediate position between severe and moderate adverse effect.

9AM2000 S1-019 invited  
VARIATIONS IN THE NEKTON COMMUNITY OF SUBARCTIC AND TRANSITIONAL WATERS IN THE  
NORTHWEST PACIFIC (1974-1999)

Vladimir A. Belayev

*Khabarovsk Branch Pacific Research Fisheries Centre (TINRO), Shevchenko Street, 9 Khabarovsk, Russia. 680000 e-mail: arh@arh.khv.ru*

Coastal zone of the Pacific side of Honshu, Shikoku and Kyushu islands is the main spawning ground, but transition and subarctic zone is the main feeding region of the pelagic fishes. These are specific biotops because it characterized by strong hydrology activity, biology productivity and species diversity of fishes and squids. We have spend special research cruises in this region from 1974 to 1999 and identify more than 600 of fishes (160 species in the transition zone). Main concentration of the fishes and squids were found between south and north border of subarctic zone.

Three percent of total number of species fishes are abundant only and its form structure of fish community. During last decades dominant species were saury, mackerel, sardine and anchovy. Their biomass varied from 30 to 90% from total biomass of all fishes. Sardine, mackerel, anchovy had high dynamic of biomass. Its occurrence correlated with abundance of populations. Saury is constant species in the transition zone, but it abundance fluctuates every year. Abundance of another fishes and their fluctuations in the subarctic zone was not too large.

Cyclical processes in the "Kuroshio" nekton - fish community are connected with: 1) cyclical processes in the atmosphere; 2) with fluctuations of primary production; 3) cyclical interactions between subarctic and subtropical water masses, defined position of Kuroshio and Oyashio currents; 4) fluctuations of abundance and biomass subtropical pelagic fishes and squids.

Nekton-fish community is ploidominant usual but in the period from 1980 to 1990 it was monodominant. Highest fishery productivity in the Kuroshio zone was in the 1980s (period 1950-2000).

9AM2000 S2-020 oral  
**ZOOPLANKTON DISTRIBUTIONS AND FORAGING LOCATIONS OF BREEDING CASSIN'S AUKLETS FROM TRIANGLE ISLAND, BRITISH COLUMBIA**

Douglas F. Bertram<sup>1,2</sup>, David L. Mackas<sup>3</sup>, David W. Welch<sup>3</sup>, W.S. Boyd<sup>2</sup> and J.L. Ryder<sup>1</sup>

<sup>1</sup> Simon Fraser University \*e-mail: dbertram@sfu.ca

<sup>2</sup> Canadian Wildlife Service

<sup>3</sup> Fisheries and Oceans Canada

To investigate the causal basis for patterns of marine bird feeding distributions, we coupled fisheries oceanography, radio telemetry and colony-based research. We examined the marine distributions of breeding Cassin's Auklets (*Ptychoramphus aleuticus*) from their largest colony on Triangle Island, British Columbia B.C., using aerial telemetry in 1999 and 2000. Concurrently, zooplankton was sampled at 16 stations along a cross shelf transect in the vicinity of the seabird colony. In June 1999, the majority of the birds were concentrated SW of the colony 40-75 km offshore, parallel to, but well off (35 -50 km) the continental shelf break in deep water (1500m - 2000m). Large copepods (*Neocalanus cristatus*) dominated the nestling diet in 1999. The zooplankton samples from 1999 indicated that *N. cristatus* were located primarily beyond the shelf break, demonstrating overlap with the radio-tagged parent seabirds. Satellite images suggest that the zooplankton rich waters off the shelf break were physically displaced by the extensive freshwater runoff from unusually heavy snowfalls the previous winter. Preliminary evidence from June 2000 suggests that the seabirds are feeding in the same vicinity but closer to the colony than in 1999. We will contrast the spatial distributions of seabirds and zooplankton between years and examine the underlying oceanographic processes that caused the observed variation.

9AM2000 S4-021 oral  
**LONG-TERM DYNAMICS OF SCHOOL-MASTER GONATE SQUID *Berryteuthis magister* IN THE WESTERN BERING SEA**

Vjacheslav A. Bizikov

Russian Federal Research Institute of Fisheries & Oceanography (VNIRO), 17 V.Krasnoselskaya Street, Moscow, Russia. 107140  
e-mail: bizikov@orc.ru

The 'red' squid, *Berryteuthis magister*, is the most abundant cephalopod species in the Bering Sea. Dense concentrations of adult squids are found from spring to autumn on the continental slope south to the cape Navarin and in the Olyutorsky Bay at depth from 350 to 450 m. Statoliths age determination revealed two seasonal groups of squids: spring-summer and fall-winter-hatched, the first dominating in the concentrations from April to July; the second - from August to November. The spawning of both groups occurred along the continental slope of Siberia, mainly in the Olyutorsky Bay.

Interannual dynamics of abundance and distribution of the red squid in the western Bering Sea were analyzed for 1993-1998 on the basis of regular trawl and oceanographic surveys. In the years of intensive circulation in the Bering Sea (1993-1995) the squid abundance was high in the region between capes Navarin and Olyutorsky and low in the Olyutorsky Bay. Relaxation of circulation occurred from 1996 to 1998 resulted in cutting down the squid abundance in Navarin-Olyutorsky region and growth of concentrations in the Olyutorsky Bay. Apparently, relaxation of the circulation decreased the immigration of juveniles from the eastern Bering Sea to the feeding grounds in the western part. From the other hand, lessening of the Kamtchatka current cut down the juveniles emigration from the spawning grounds in the Olyutorsky Bay and caused increasing of adult squids abundance in that region.

9AM2000 S2-022 oral  
**REGIME-SHIFT OF THE BERING SEA ECOSYSTEM AND POPULATION TRENDS OF NORTHERN FUR SEALS ON THE COMMANDER ISLANDS**

Alexander I. Boltnev

Marine Mammal Laboratory, KamchatNIRO, Nabereznaya 18, Petropavlovsk, Kamchatka 683602 Russia e-mail: nfs@mail.iks.ru

At end of the 1960s to the mid-1970s, there was regime shift in the ecosystem of western Bering Sea (WBS). Two key fish species of the WBS had different trends at that time: the stock of herring declined, and the stock of pollock increased. Observations on the Commander Islands since 1950s permitted us to document the reaction of the northern fur seal (NFS) population to this regime-shift. There were no remarkable interannual changes in the food habits of fur seals in 1960s-1970s: they fed Pacific sand lance, Salmonidae, pollock, and squid. In contrast, since the 1980s, NFS stomachs have contained mackerel and sticklebacks. In the 1990s, the quantity of squid in fur seal diets increased. The regime-shift of the WBS ecosystem affected population trends of NFS: pup production declined up to the early 1970s and fluctuated through the mid-1970s, and pup mortality increased during that period. In the 1980s with the increasing Pollock stock in WBS, pup production of NFS and pup growth rates increased. Since the mid-1980s the pollock stock has declined, and, since the mid-1990s the herring stock has increased. Many population parameters of NFS have followed these changes. Pup growth rates declined up to 1991 and then began to increase. The quantity of old and middle-aged females declined after 1985, and the quantity of young females increased up to end of 1990s. Pup production of NFS during the late 1990s fluctuated considerably. Individual observations of tagged, reproduce females

showed very high maternal investment. We found that NFS females skip reproduction often. We hypothesize that the interannual fluctuation of NFS pup production during the regime-shifts of WBS ecosystem occurred because many female NFS skipped reproduction during periods of low food resources.

9AM2000 FISp023 poster

#### CHOROLOGICAL STRUCTURE OF GRAY SEA URCHIN AT THE NORTHWESTERN COAST OF JAPAN SEA AND THE POSSIBLE MECHANISMS OF ITS FORMATION

E.E. Borisovets, Ju.E. Bregman, G.I. Victorovskaya and M.V. Kalinina

Pacific Fisheries Research Center (TINRO-Center), 4 Shevchenko Alley, Vladivostok, Russia. e-mail: root@tinro.marine.su

The spatial and size distribution of sea urchin *Strongylocentrotus intermedius* had been investigated in April-May 1996-1998.

It was shown that share of unfisherable urchins (test diameters (45 mm) did not exceed 12-15% at the southern part of studied area (Cape Povorotniy - Cape Ostrovnoy) and reached 66-67% at northern one (Cape Tumanniyy - Olga Bay). Average abundance amounted to 2-3 individuals per 1 m<sup>2</sup>. Young animals (15 mm and 15-25 mm) inhabit mainly the northern plots between capes Zavalishina - Nizmenniyy and coastal zones of islets everywhere.

To explain the results a hypothetical mechanism of urchins' chorological structure formation has been discussed. It was supposed that zones of natural reproduction, larval spreading and settling appear spontaneously under the action of coastal surface stream directed to the north of Cape Povorotniy and due to turbulence.

9AM2000 S3-024 oral

#### INTERDECADAL VARIATIONS IN THE DEVELOPMENTAL TIMING OF THE COPEPOD *Neocalanus plumchrus* (MARUKAWA) IN THE STRAIT OF GEORGIA, BC

Elizabeth A. Bornhold<sup>1</sup>, David L. Mackas<sup>1</sup> and Paul J. Harrison<sup>2</sup>

<sup>1</sup> Institute of Ocean Sciences, Department of Fisheries and Oceans, Sidney, B.C., Canada. V8L 4B2 e-mail: BornholdE@pac.dfo-mpo.gc.ca

<sup>2</sup> Department of Earth and Ocean Sciences, University of British Columbia, Vancouver, B.C., Canada

In coastal waters of the North Pacific, copepods of the genus *Neocalanus plumchrus* dominate the spring and early summer mesozooplankton community. All *Neocalanus* species undergo a very strong seasonal vertical migration that is closely linked to their developmental cycle. In the Strait of Georgia (49°5N, 123°125W), the 30-50 day annual peak of mesozooplankton biomass has historically coincided with maximum surface layer abundance of maturing large *N. plumchrus* copepodites (C4 and pre-migrant C5). We present evidence for significant changes in the timing of the vertical migration component of the *N. plumchrus* life cycle during the past 25-30 years. In the Strait of Georgia the developmental cycle is now 25-30 days earlier than it was 30 years ago, with peak biomass now occurring in mid-April (compared to mid-May previously). The variability in timing, which appears to be coincident with a warming trend of surface waters in the Strait, is likely to be ecologically significant because it shifts the relatively narrow seasonal window of maximum grazing pressure on the 10-50 mm prey, in addition it influences the availability of large copepods to upper ocean predators.

9AM2000 S4-025 oral

#### LATITUDINAL BODY-SIZE GRADIENTS OF THE SQUID *Berryteuthis anonychus* IN THE EASTERN NORTH PACIFIC

John R. Bower<sup>1</sup> and James M. Murphy<sup>2</sup>

<sup>1</sup> Faculty of Fisheries, Hokkaido University, 3-1-1 Minato-cho, Hakodate, Hokkaido, Japan. 041-8611

<sup>2</sup> Auke Bay Laboratory, Alaska Fisheries Science Center, 11305 Glacier Highway, Juneau, AK 99801-8626, U.S.A.

The gonatid squid *Berryteuthis anonychus* is an important prey of many nektonic species in the North Pacific, yet little is known about its life history. The present study describes the distribution and sizes of specimens collected in the summer of 1999 during cruises aboard the *Oshoro Maru* and *Great Pacific*. Samples were collected along 145°W between 38 and 55°N and along 165°W between 38 and 53°N. Bongo nets were used aboard the *Oshoro Maru* to collect paralarvae and a large trawl was used aboard the *Great Pacific* to collect larger juveniles and adults. Paralarvae were collected at 12 of the 16 bongo-net stations. All were caught north of 45°N. Catches were highest along 165°W north of 50°N in the Alaskan Stream, and decreased southward. Trawl-caught specimens were collected along both transects and increased in body size from 2-3 cm mantle length at 39°N to 8-11 cm at 49°N. These data suggest that *B. anonychus* migrates northward to near the Alaskan Stream to spawn. These and further observations will be discussed.

9AM2000 S6-308 oral  
**THE COUPLING BETWEEN PELAGIC AND DEEP WATER FLUXES IN THE HNLC NE PACIFIC: RESULTS FROM BIO-OPTICAL AND DEEP-WATER TRAP TIME-SERIES**

Phillip W. Boyd<sup>1</sup>, Paul J. Harrison<sup>2</sup>, C.S. Wong<sup>3</sup> and Frank Whitney<sup>3</sup>

- <sup>1</sup> National Institute of Water and Atmospheric Research Centre for Chemical Oceanography, Department of Chemistry, University of Otago, Dunedin, New Zealand e-mail: pboyd@alkali.otago.ac.nz  
<sup>2</sup> Department of Earth and Ocean Sciences, University of British Columbia, Vancouver, B.C., Canada. V6T 1Z4 e-mail: pharrison@unixg.ubc.ca  
<sup>3</sup> Ocean Science and Productivity Division, Institute of Ocean Sciences, P.O. Box 6000, Sidney, B.C., Canada. V8L 4B2 e-mail: WongCS@pac.dfo-mpo.gc.ca WhitneyF@pac.dfo-mpo.gc.ca

A growing trend in biological oceanography is the use of instrumentation to provide long time-series records over the annual cycle in the ocean. In the NE subarctic Pacific, Ocean Station Papa (OSP) has over the last 30 years provided one of the most comprehensive records of upper ocean time-series data (for example, weekly chlorophyll *a* levels from 1970-1976). In the 1980s, C.S. Wong established and has maintained a deep-moored sediment trap time-series at OSP (1982 until present). However, it is only in recent years that there has been concurrent surface and deep-water moorings at OSP. The RADIO (Response to Atmospheric Dust In the Ocean) Canadian-JGOFS bio-optical mooring was first deployed in late 1995 within the surface mixed layer (ca. 35 m) and provides a record of chlorophyll *a* levels and underwater irradiance (6 per h), temperature (1 per h) and current speed and direction (12 per day) in the upper water column. The seasonal trends in these data may related several datasets (such as satellite aerosol data), but in this presentation, the upper water column dataset for 1996 will be compared with the 1996 deep-moored trap time-series. This comparison provides one of the first opportunities to examine the nature of the coupling between surface water productivity and the deep water particulate biogenic fluxes in a High Nitrate Low Chlorophyll region.

9AM2000 S3-026 poster  
**ZOOPLANKTON COMMUNITIES SEASONAL AND INTERANNUAL CHANGES IN THE NORTHERN PART SEA OF JAPAN**

Irina Y. Bragina

Sakhalin Research Institute of Fisheries & Oceanography, 196 Komsomolskaya Street, Yuzhno-Sakhalinsk, Russia. 693023 e-mail: stab@tinro.sakhalin.ru

During analysis of seasonal and interannual changes of the 1986-1997 zooplankton samples collected in the Tartar strait (Sea of Japan) the next results were obtained.

*Neocalanus plumchrus* concentrations zones were characterized convergence between Tsushima and West-Sakhalin currents. Maximums in the zooplankton biomass in the Tartar Strait were obtained along Delanglya Bay and adjacent waters (west Sakhalin), where meroplankton part reached 90% in total biomass. During fall against spring in the cold years more high biomasses obtained. Generally, reach biomasses associated with negative 0-50 m layer temperature anomaly. Two biotops exist Tartar Strait having linkages with warm Tsushima and cold Primorskoe currents.

Copepods are mostly observed up to 82% of the total biomass. Fauna structure has been presented mostly by copepods *Neocalanus plumchrus* and chaetognaths *Parasagitta elegans*. At summer-fall periods the predominant *Neocalanus plumchrus* has been changed to the *Pseudocalanus minutus*, *Metridia pacifica*, *Calanus glacialis* and hyperiid *Parathemisto japonica*. Predatory zooplankton had most high biomass in the Primorskoe currents due chaetognaths.

The zooplankton structure consisted from moderate-coldwater complex for the Tsushima current biotop and coldwater complex for the Primorskoe current biotop. Among copepods moderate-coldwater species (67%) and coldwater species (63%) prevailed in the Tsushima and the Primorskoe currents, respectively.

Despite seasonal variations (58-466 mg/m<sup>3</sup>) of the zooplankton biomass in the Tartar Strait the values during fall period were stable in the divided biotops of the northern part of the Sea of Japan.

9AM2000 S7-341 invited  
**NORTH ATLANTIC GLOBEC PROGRAMS AND THE DEVELOPMENT OF ECOSYSTEM COMPARISONS**

Keith Brander

ICES/GLOBEC Secretary, International Council for the Exploration of the Sea (ICES), Palaegade 2-4, 1261 Copenhagen K, Denmark e-mail: keith@ices.dk

The Cod and Climate Change program is the principal regional GLOBEC activity in the North Atlantic, but a wide range of other programs exist, which are relevant and are more or less closely linked to GLOBEC. Only a few of these attempt to look at more than one or two components of the ecosystem, the Barents Sea, and the Baltic studies being notable exceptions. ERSEM (European Seas Ecosystem Model), which predates GLOBEC, is perhaps the only model developed in order to carry out ecosystem comparisons. Nevertheless, one can identify three current themes which use a comparative approach:

1. process models which are developed for specific biological and physical circumstances, but subsequently adapted and tested in other ecosystems. An example is the coupled physical-biological models of copepod population dynamics developed during the TASC program.
2. life history comparisons of the same species (e.g. *Calanus finmarchicus*, cod) in different parts of its geographic range in order to determine the causes of variability in life history and vital rates.
3. development of ecosystem metrics and concepts in order to monitor temporal changes in ecosystem state.

Work on these themes is in progress but it may be premature to regard them as a source of guidance for other programs. On the other hand they reveal rich scope for comparisons with similar work in other areas. A special session at the recent ASLO meeting in Copenhagen provided a useful opportunity to compare some of the broad characteristics of North Atlantic and North Pacific ecosystems.

9AM2000 S1-028 invited

#### AN EAST-WEST COMPARISON OF THE COASTAL EPIPELAGIC NEKTON OF THE NORTH PACIFIC OCEAN

Richard D. Brodeur<sup>1</sup>, Yasuhiro Ueno<sup>2</sup>, Joseph P. Fisher<sup>3</sup>, Kazuya Nagasawa<sup>4</sup> and William G. Pearcy<sup>3</sup>

<sup>1</sup> Northwest Fisheries Science Center, NMFS, Newport, OR 97365, U.S.A. e-mail: Rick.Brodeur@noaa.gov

<sup>2</sup> Tohoku National Fisheries Research Institute, FAJ, Hachinohe, Japan. 031-0841

<sup>3</sup> College of Oceanic and Atmospheric Sciences, Oregon State Univ., Corvallis, OR 97331, U.S.A.

<sup>4</sup> National Research Institute of Far Seas Fisheries, FAJ, Shimizu, 424 Shizuoka, Japan

During the 1980s and 1990s, scientific research cruises were conducted in both the eastern and western boundary regions of the North Pacific Ocean. The main purpose of these cruises was to examine the abundance and distribution patterns of juvenile salmon in coastal waters. These studies produced one of the most extensive databases ever collected on the relative species composition of coastal epipelagic nekton in the North Pacific Ocean. Catch data from two purse seine and two surface trawl surveys (one each from off Japan and off the West Coast of the US) will be examined using multivariate analytical techniques to analyze community structure of nektonic cephalopods, elasmobranchs, and teleosts in the coastal zone during the summer and autumn months. Juvenile salmonids are generally among the most common species caught, but in terms of overall abundance, other potential competitors with juvenile salmon, such as small squid and clupeoid fishes predominate. Species diversity and dominance will also be examined. Classification techniques will be employed to determine species associations and multivariate analyses were used to examine relationships of these assemblages to environmental data.

9AM2000 S3-027 oral

#### INCREASES IN JELLYFISH BIOMASS IN THE BERING SEA: IMPLICATIONS FOR THE ECOSYSTEM

Richard D. Brodeur<sup>1</sup>, Hiroya Sugisaki<sup>2</sup>, Kerim Y. Aydin<sup>3</sup> and Jeffrey M. Napp<sup>4</sup>

<sup>1</sup> Northwest Fisheries Science Center, National Marine Fisheries Service, Hatfield Marine Science Center, 2030 S. Marine Science Drive, Newport, OR 97365, U.S.A. e-mail: Rick.Brodeur@noaa.gov

<sup>2</sup> Tohoku National Fisheries Research Institute, 27-5 Shinhama-cho 3 chome, Shiogama, Miyagi, Japan. 985

<sup>3</sup> School of Fisheries, Box 355020, Seattle, WA 98195, U.S.A.

<sup>4</sup> Alaska Fisheries Science Center, National Marine Fisheries Service, Seattle, WA 98115, U.S.A.

Based on quantitative trawl survey data collected over the last 25 years, there has been a dramatic increase in jellyfish biomass over the Eastern Bering Sea shelf since the early 1990s that has been hypothesized to be triggered by changing climate and oceanographic conditions. We examine the hypothesis that the presence of these large carnivores has affected fisheries resources either through direct predation on larval stages or through competition for zooplankton prey. In this paper, we explore the impacts this bloom has had on the zooplankton and fish communities by using field data on abundance and species composition, size, stable isotopic signatures, and feeding habits of the major jellyfish species. These data are used together with zooplankton biomass to model the ecosystem impacts of this increase. The overall trophic position of jellyfish in the Bering Sea ecosystem is evaluated with respect to the changing climate of the region.

The center of jellyfish biomass has shifted from the Southeast Middle Shelf Domain to the Northwest in the late 1990s. The species composition of large medusae caught in trawls was dominated (>80% by number and >95% by weight) by the scyphozoan (*Chrysaora melanaster*). Dense aggregations of this species occupied the water column mainly between 10 and 40 m. Their food habits consisted mainly of pelagic crustaceans (euphausiids, copepods, amphipods) but other jellyfish and juvenile pollock were also consumed. Based on stable isotope ratios, their trophic level appears to be closer to adult pollock than age-0 pollock. Medusae were found to have a relatively low grazing impact on zooplankton overall in the Eastern Bering Sea based upon large-scale analyses with ecosystem models. On a finer scale in the area around the Pribilof Islands, *C. melanaster* was found on average to seasonally consume over half of the standing stock and 6.4% of the annual production of zooplankton in this region.

9AM2000 S9-029 invited  
**MUSSEL CULTURE AS POTENTIAL SOURCE OF EUTROPHICATION OF COASTAL WATERS OF PRIMORYE**

Valery A. Brykov  
*Institute of Marine Biology, Far East Branch, Russian Academy of Science, Vladivostok, Russia. 690041 e-mail: inmarbio@mail.primorye.ru*

Results of experimental work on rearing of Mussel *Mytilus trossilus* in suspended culture in coastal areas of Primorye are presented. Data on density dynamics, growth rate, month and annual production of mussel in suspended culture from differing by their hydrological regime water areas are considered. It is expected that increase of volume of mussel rearing could cause eutrophication of shallow water areas in coastal zone.

9AM2000 S1-031 poster  
**1981-1991 VARIABILITY OF THERMAL FIELDS AND THERMOHALINE WATER STRUCTURE OF THE KUROSHIO AND OYASHIO CURRENTS**

Valentina D. Budaeva  
*Far Eastern Regional Hydrometeorological Research Institute, 24 Fontannaya Street, Vladivostok, Russia. 690600 e-mail: vbudaeva@hydromet.com*

This research is based on the data obtained on 43 oceanographic surveys carried out within the "RAZREZY" Project mostly in February, May, August, and November in the sea between the Pacific coast of Japan and 28-43°N and 130-150°E. The climatic-statistic method was used to investigate the spatial-temporal structure of thermal fields in 0-100 m and 0-1000 m intervals. The average enthalpy anomaly for the indicated area ( $\Delta Q_{0-100}$ ,  $\Delta Q_{0-1000}$ ) registered in certain seasons, and its dispersion were used as the generalized characteristics of ocean state.

In the period of 1981-1986, less 1983, 0-100 m interval was characterized by cold-year conditions, in the period of 1987-1991 the characteristic regime in this interval was mostly the one peculiar of warm years.

In 0-1000 m interval, in 1981 and in 1989-1991, the observations in the area of the Kuroshio current revealed large-scale warming. The spring-summer extreme in 1981 was conditioned by the increasing temperature of intermediate waters and sinking of the main thermocline due to negative anomalies predominant in 0-100 interval. In the periods of extreme water cooling (winter of 1984-winter of 1985, spring 1986) temperature dropped in 0-1000 m interval at large.

In the periods of intensive heat field transformation it is observed that:

- southward shift of typical trajectories of cyclones and anticyclones near the Earth can reach 5° in latitude;
- average temperature in 0-1000 m interval in the area of the Kuroshio and Oyashio Currents vary by 3-5° per season;
- isometric fluctuations in the main thermocline make 60-80 m;
- southward shift of subarctic circulation and consequently the convergence zones of the Kuroshio Extension and Kuroshio Counter-Current constitute 300-500 km.

9AM2000 POCp030 poster  
**TIPIFICATION OF WATER CIRCULATION STRUCTURE IN SAKHALIN BAY**

Valentina D. Budaeva<sup>1</sup>, V.G. Makarov<sup>2</sup> and E.V. Dmitrieva<sup>2</sup>  
<sup>1</sup> *Far Eastern Regional Hydrometeorological Research Institute, 24 Fontannaya Street, Vladivostok, Russia. 690600 e-mail: vbudaeva@hydromet.com*

<sup>2</sup> *Pacific Oceanological Institute, 43 Baltiyskaya Street, Vladivostok, Russia. 690041 e-mail: pacific@online.marine.su*

This research is based on the data collected on 1976, 1986, 1988, 1992-1994 complex oceanographic summer-autumn (June-October) cruises of FERHRI and POI research vessels in Sakhalin Bay. Dynamic condition assessments are made using the analyzed numerical calculations of water circulation, three-dimensional current fields, horizontal density gradients, and pycnocline position and intensity. Typification of such criteria as cyclonic and anticyclonic gyre system formation and presence, and position of the Amur Current deluded waters and the Okhotsk Sea waters with characteristic residual interlayer was carried out. Two basic types of water circulation, with general northward transport of waters and formation of submeridional hydrological front being common for both horizontal water circulation types, were distinguished. In the warm periods the water circulation in Sakhalin Bay was found mostly represented by a quasiclosed cyclonic system of currents generated by the Amur, compensational North Okhotsk and Ulban currents and a hydrological front with higher property gradients. Qualitatively this type resembles the classical concept of water circulation in Sakhalin Bay. The second type was found characterized by anticyclonic rotation mainly formed by the North Okhotsk Current waters, negative setup of surface deluded waters, and lower gradients in submeridional hydrological frontal zone. In time it coincided with intensification of northern winds.

9AM2000 S3-032 poster

**DISTRIBUTION OF THREE SPECIES OF LARVAL SHRIMP IN THE TATAR STRAIT**

Sergey D. Bukin and Nicol G. Galimzyanov

196 Komsomolskaya Street, Yuzhno-Sakhalinsk, Russia. 693016 e-mail: [bukin@tinro.sakhalin.ru](mailto:bukin@tinro.sakhalin.ru)

The data of the present work were collected in June in the Tatar Strait within coordinates 48°30' - 51°05' N above the depth of 20-255 m. Plankton was sampled from the bottom to the water surface.

Shrimp larvae occurred within 49°44' - 51°02' N along the coasts above small depths. They belonged to the following three species – humpy shrimp *P. goniurus*, pink shrimp *P. borealis* and humpback shrimp *P. hypsinotus*.

The larval humpy shrimps have appeared the most widespread in catches. Their frequency was 47.3%, their density changed from 10 to 40 ind./sq.m above the depth of 47-155 m. The period of larval hatching of this species is rather stretched in time, since in catches there are found larvae from zoeae I to zoeae VI. Probably, young and adult humpy shrimp females released their larvae in different time.

The larval northern shrimps were distributed above the depth of 63-150 m, their frequency was 36.8%, and density 10-60 ind./sq.m. This species, apparently, has a shorter time of hatching. Their larvae were at stages of zoeae I and II. The second stage prevailed in plankton (92.8%).

The larval humpback shrimp frequency was 15.7%. They were distributed along the Sakhalin coast mainly above the depth of 60-100 m. These larvae, probably, come into plankton in the earliest terms, since in catches they were only at the latest stages of development – zoeae V (60%) and zoeae VI (40%). Their catches were sporadically, their density did not exceed 10 ind./sq.m. It may be associated with their passing almost through all stages of development, and the transition from one stage to another is usually accompanied by the increased mortality due to the temperature fluctuations and predation.

The water temperature on the area of larval detection changed from 6.4 to 13.3°. At the same time there was not marked the preference of any larval shrimp species to a certain optimum of temperature.

9AM2000 S2-033 poster

**THE EFFECTS OF PREY AVAILABILITY AND PHYSICAL VARIABLES ON THE RECENT FEEDING AND GROWTH RATES OF LARVAL PACIFIC HAKE, *Merluccius productus* (AYERS), IN THE CALIFORNIA CURRENT REGION**

Shannon L. Cass Calay

National Marine Fisheries Service/Southwest Fisheries Science Center, P.O. Box 271, La Jolla, CA 92038-0271, U.S.A. e-mail: [scalay@ucsd.edu](mailto:scalay@ucsd.edu)

The recruitment rate of the Pacific hake, *Merluccius productus*, varies 30-100 fold interannually. Because the relative strength of recruitment can be predicted by the abundance of late larvae, processes that affect the survival of Pacific hake larvae can affect recruitment to the adult population. The objective of this research was to determine whether prey availability, temperature and other physical variables affected the recent feeding and growth rates of Pacific hake larvae. To accomplish this objective, a combined optical particle counter (OPC) and multiple opening and closing net environmental sensing system (MOCNESS) was deployed at twenty-four stations in the California Current region during February 1996 and January 1997. The OPC/MOCNESS measured temperature, salinity and the fine-scale distribution of "prey-sized" particles, while simultaneously collecting larval Pacific hake in nine stratified samples. Multiple regression analyses were used to examine the effects of prey availability and physical variables on the recent feeding and growth rates of larval Pacific hake. Standard length, time of day, sampling depth and biovolume of "prey-sized" particles contributed significantly to variability in the volume of prey ingested ( $r^2 = 0.49$ ,  $p < < 0.001$ ) and the stomach volume ( $r^2 = 0.73$ ,  $p < < 0.001$ ) of Pacific hake larvae. Maximum otolith radius, and either the biovolume or concentration of "prey-sized" particles contributed significantly to variability in the recent otolith growth rate of larval Pacific hake ( $r^2 = 0.83$ ,  $p < < 0.001$ ). These results are important since slow-growing Pacific hake larvae are known to suffer increased mortality.

9AM2000 S4-035 poster

**DEVELOPMENT OF A DEPTH CONTROL SYSTEM FOR MODEL MIDWATER TRAWL GEAR USING FUZZY LOGIC**

Bongjin J. Cha and C.W. Lee

Marine Production Management, Pukyong National University, 599-1 Daeyeon 3-dong, Nam-gu, Pusan, Republic of Korea. 608-737 e-mail: [chabj@woonbi.pknu.ac.kr](mailto:chabj@woonbi.pknu.ac.kr)

This paper presents a control system that uses a fuzzy algorithm in controlling the depth of a model midwater trawl net, and experimental results carried out in the circulating water channel by using a model trawl winch system.

The fuzzy controller calculates the length of the warp to be changed, based on the depth error between the desired depth and actual depth of the model trawl net and the ratio of change in the depth error. The error and the error change are calculated every sampling time. Then the control input, i.e. desirable length of the warp, is determined by inference from the linguistic control rules which an experienced captain or navigator uses in controlling the depth of the trawl net during manual operation. Then the control input is transmitted to the trawl winch controller and the length of the warp is changed.

Two kinds of fuzzy control rules were tested, one was obtained from the actual operations used by a skilled skipper or navigator, and the other was a modified from the former by considering the hydrodynamic characteristics of the model trawl system.

The results of these model experiments indicate that the proposed fuzzy controllers rapidly follow the desired depth without steady-state error although the desired depth was given in one step, and show robustness properties against changes in the parameters such as the change of the towing speed. Especially, a modified rule shows smaller depth fluctuations and faster setting times than those obtained by a field oriented rule.

9AM2000 S4-034 poster  
**REPRODUCTION AND POPULATION DYNAMICS OF *Penaeus chinensis* (DECAPODA: PENAEIDAE) ON THE WESTERN COAST OF KOREA, YELLOW SEA**

Hyung Kee Cha<sup>1</sup> and Chul Woong Oh<sup>2</sup>

<sup>1</sup> National Fisheries Research and Development Institute, Korea

<sup>2</sup> Department of Marine Resources, Mokpo National University, Korea

Investigations were made on reproduction, population structure, growth, mortality, and size at sexual maturity of a penaeid shrimp (*Penaeus chinensis*) in the western coastal areas of Korea, Yellow Sea. The reproductive season of the species occurred from April to June, with peaks in the late part of this season. Insemination took place in the period from October to July. In both female and male of *P. chinensis* two principal cohorts per year were identified. The cohort spawned during the extended period over April to June, recruiting in the fished population in August. A recruitment event is compatible with a 1 year life cycle and a single breeding season. The size at 50% sexual maturity ( $CL_{50}$ ), determined from the proportions both of mature females and of inseminated females, was 39.19 mm CL and 38.71 mm CL, respectively, indicating little difference in  $CL_{50}$  between the two proportions. Fecundity was proportional to female body size and ranged from 315,620 ova in the smallest female to 642,140 ova in the largest. Ovum diameter ranged from 250  $\mu\text{m}$  to 370  $\mu\text{m}$ .

The population size distribution of two years was similar between. Specimens were not found within the study areas during winter (January to March), indicating that the shrimp had moved outside the range of the fishery, probably into deeper water. Growth was estimated by the modified von Bertalanffy growth function incorporating seasonal variation in growth. Females grew faster and reached a larger size at age than males ( $K = 0.96 \text{ yr}^{-1}$  and  $L_{\infty} = 58.6 \text{ mm CL}$ ) than males ( $K = 0.45 \text{ yr}^{-1}$ ,  $L_{\infty} = 54.9 \text{ mm CL}$ ). Total mortality ( $Z$ ) was estimated to be  $4.01 \text{ yr}^{-1}$  for females and  $3.10 \text{ yr}^{-1}$  for males. The natural mortality ( $M$ ) was  $1.10 \text{ yr}^{-1}$  for females and  $0.68 \text{ yr}^{-1}$  for males.

9AM2000 S6-036 oral  
**PHYSICAL-BIOGEOCHEMICAL MODELING - SEASONAL TO DECADEAL VARIABILITY IN THE NORTH PACIFIC OCEAN**

Fei Chai<sup>1</sup>, Mingshun Jiang<sup>1</sup>, Richard T. Barber<sup>2</sup>, Richard Dugdale<sup>3</sup> and Yi Chao<sup>4</sup>

<sup>1</sup> School of Marine Sciences, 5741 Libby Hall, University of Maine, Orono, ME 04469-5741, U.S.A. e-mail: fchai@maine.edu

<sup>2</sup> Duke University, NSOE Marine Laboratory, 135 Duke Marine Lab Road, Beaufort, NC 28516-9721, U.S.A.

<sup>3</sup> Romberg Tiburon Centers, San Francisco State University, PO Box 855, Tiburon, CA 95920-0855, U.S.A.

<sup>4</sup> Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, CA 91109, U.S.A.

The Pacific Ocean exhibits strong variations at seasonal to decadal time scales, and the changing Pacific climate has direct impacts on marine ecosystems and the global carbon cycle. A physical-biogeochemical model has been developed and used to investigate physical variations, ecosystem responses, and biogeochemical consequences. The lower trophic level ecosystem model, embedded into a three-dimensional circulation model, is forced with observed the air-sea fluxes between 1950 and 1993. The physical-biogeochemical model is capable of reproducing many observed features and their variability in the Pacific Ocean. Linkage of the ecosystem components to the carbon system provides a model estimated air-sea flux of  $\text{CO}_2$  that is comparable with the observations. Analyses of the modeled results for the North Pacific will be presented with focus on the variability at seasonal to decadal time scales. The abrupt shift in the North Pacific climate system occurred during 1970s, the modeled responses to such climate shift will be discussed. The model exhibits some different behaviors between the Northwest and Northeast Pacific, and the preliminary modeled results from these two regions will be compared.



9AM2000 W7-361 oral  
**MODELING CARBON CYCLE IN THE PACIFIC OCEAN**

Fei Chai<sup>1</sup>, M. Jiang<sup>1</sup>, R.T. Barber<sup>2</sup>, R.C. Dugdale<sup>3</sup>, T-H Peng<sup>4</sup> and Y. Chao<sup>5</sup>

<sup>1</sup> *School of Marine Sciences, 5741 Libby Hall, University of Maine, Orono, ME 04469-5741, U.S.A. e-mail: fchai@maine.edu*

<sup>2</sup> *Duke University, NSOE Marine Laboratory, 135 Duke Marine Lab Road, Beaufort, NC 28516-9721, U.S.A.*

<sup>3</sup> *Romberg Tiburon Centers, San Francisco State University, PO Box 855, Tiburon, CA 95920-0855, U.S.A.*

<sup>4</sup> *AOML/NOAA, 4301 Rickenbacker Causeway, Miami, FL 33149-1026, U.S.A.*

<sup>5</sup> *Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, CA 91109, U.S.A.*

To improve our understanding of physical variability and the carbon cycle response in the Pacific Ocean, especially on interannual and decadal time scales, we have developed a physical-biogeochemical model for the Pacific Ocean. The lower trophic level ecosystem model linked with upper ocean carbon chemistry, embedded into a three-dimensional circulation model that is forced with observed air-sea fluxes between 1950 and 1993. The improved physical-biogeochemical model produces a 44-year (1950-1993) retrospective analysis for the Pacific Ocean. The physical-biogeochemical model is capable of reproducing many observed features and their variability in the Pacific Ocean. The modeled air-sea flux of CO<sub>2</sub> from different regions is compared with the limited observations. Analyses of the modeled results are focused on two regions, the equatorial Pacific, a strong natural CO<sub>2</sub> source region to the atmosphere, and the North Pacific, a sink region for the anthropogenic carbon. The abrupt shift in the North Pacific climate system occurred during 1970s, the modeled air-sea flux of CO<sub>2</sub> and the upper ocean carbon cycle to such climate shift will be discussed.

9AM2000 S7-304 poster  
**TIME-SPACE PATTERN FOR FOUR INDICES OF THE ABUNDANCE OF ZOO- AND ICHTHYOPLANKTON IN THE CALIFORNIA CURRENT REGION**

David M. Checkley, Jr., Michael M. Mullin, Melissa Carter, Kirk Ireson and Mike Thimgan

*Marine Life Research Group, Scripps Institution of Oceanography, 9500 Gilman Drive, La Jolla, CA 92093-0218, U.S.A. e-mail: dcheckley@ucsd.edu*

We present and analyze patterns in time and space of four indices of the abundance of macrozooplankton and fish eggs in the California Current Region and compare these with data and indices for the environment. The first three indices are derived from oblique deployments of a Bongo net on station during quarterly cruises of the California Cooperative Fisheries Investigations (CalCOFI): (a) the size and abundance of zooplankters measured in situ with an Optical Plankton Counter (OPC), (b) the volume displaced by the preserved zooplankton, and (c) the size and abundance of zooplankters, in the preserved sample, measured with a laboratory OPC. The fourth index is the abundance of eggs of anchovy and sardine collected with the Continuous, Underway Fish Egg Sampler. Each of these indices differs in the quantity measured and temporal and spatial coverage, yet comparisons are possible. Two, general conclusions are made. First, pattern exists in each of these data sets and, in some cases, is related to environmental variables and indices. Second, comparisons of pattern between these different indices yields insight into the plankton not derived from the indices considered separately. For example, the concentration of macrozooplankton assessed during CalCOFI Bongo net deployments as the measured volume of collected plankton (505-micron-mesh, depth-integrated) and as the estimated volume of optically-sensed, zooplankton-sized particles are significantly, yet poorly, related when all data (10 cruises, ~600 stations) are considered. Significant variation can be partitioned among cruises, indicating inter-cruise variation in the optical characteristics of the plankton and, specifically, the relative abundance of gelatinous zooplankton.

9AM2000 S6-039 oral  
**SHELF VS. DISSOLUTION GENERATED ALKALINITY ABOVE THE CHEMICAL LYSOCLINE IN THE NORTH PACIFIC**

Chen-Tung Arthur Chen

*Institute of Marine Geology and Chemistry, National Sun Yat-Sen University, Kaohsiung 804, China Taipei e-mail: ctchen@mail.nsysu.edu.tw*

Conventional wisdom is that significant dissolution of calcium carbonate occurs only at great depths in the oceans and releases alkalinity there. This is because most surface waters are supersaturated with respect to both calcite and aragonite hence calcium carbonate does not dissolve. Recently, Milliman *et al.* (1999) suggested that as much as 60–80% of calcium carbonate is dissolved in the upper 500–1000m of the oceans, well above the chemical lysocline. They further suggested that biological processes such as ingestion, digestion and egestion by zooplankton as well as biologically mediated processes within flocculates and aggregates may be responsible for much of this dissolution. It will be shown, however, that although these processes may well happen, shelf generated alkalinity may be as important.

9AM2000 S6-040 poster  
**CARBONATE CHEMISTRY OF THE SOUTH CHINA SEA**

Chen-Tung Arthur Chen<sup>1</sup>, Shu-Lun Wang<sup>2</sup>, Bing-Jye Wang<sup>1</sup> and Ching-Lin Liu<sup>1</sup>

<sup>1</sup> *Institute of Marine Geology and Chemistry, National Sun Yat-Sen University, Kaohsiung 804, China Taipei e-mail: ctchen@mail.nsysu.edu.tw*

<sup>2</sup> *National Kaohsiung Institute of Marine Technology, Kaohsiung 811, China Taipei*

In order to study the dissolved carbonate system in the South China Sea (SCS) and to understand the water mass exchange between the SCS and the West Philippine Sea (WPS), pH, total alkalinity and total CO<sub>2</sub> were measured aboard R/V *Ocean Researcher 1*. Because of the sill separating these two seas with a maximum depth of 2200m, the SCS Deep Water has the characteristics similar to the water at about 2200 m in the WPS. The minimum in pH and the maxima in normalized alkalinity and total CO<sub>2</sub> commonly found in the open oceans at mid-depth are also prominent in the WPS but are very weak in the SCS. Mass balance calculations indicate that the SCS is a weak CO<sub>2</sub> sink in the wet season but a weak CO<sub>2</sub> source in the dry season. The anthropogenic CO<sub>2</sub> penetrates to at least 500m deep in the SCS, slightly shallower than found in the WPS. The entire SCS contains  $0.38 \pm 0.1 \times 10^{15}$ g excess CO<sub>2</sub>.

9AM2000 FISp038 oral  
**PELAGIC ANCHOVY DID NOT FEED ON LOWER THE FOOD CHAIN IN THE UPWELLING OF THE EAST CHINA SEA**

Houng-Yung Chen and Yuh-ling Lee Chen

*Institute of Marine Biology and Department of Marine Resources, National Sun Yat-sen University, 70 Lien-Hai Road, Kaohsiung 804, China Taipei e-mail: hychen@mail.nsysu.edu.tw*

Trophic components including 5 size-classes of net plankton (20-200, 200-330, 330-500, >500 and >1000 mm) and larval, juvenile as well as adult anchovy *Engraulis japonica* were collected from the Kuroshio-induced upwelling in the East China Sea off northeastern Taiwan and its adjacent waters. Measurements of stable isotopic nitrogen and carbon compositions of these trophic components reveal a trend towards enrichment in <sup>15</sup>N and <sup>13</sup>C with increasing organism size. Carbon and nitrogen requirements of larval, juvenile and adult anchovy were supplied primarily through at least 1.5, 2 and 2.5 trophic level transfers, respectively. Isotopic signatures of stomach contents from the nitrogen analysis indicated that the adult anchovy fed lower the food chain than the results from the carbon analysis. The results elucidate the complexity of the trophic relationships for the anchovy in this upwelling ecosystem. No obvious shortening in trophic category transfers within the pelagic food web is postulated.

9AM2000 S8-041 invited  
**THE PEARL RIVER ESTUARY POLLUTION PROJECT (PREPP), 1999-2001**

Jay-Chung Chen and Gary W. Heinke

*3653 Summit Place, Cobble Hill, B.C., Canada. VOR 1L1 e-mail: gheinke@home.com*

PREPP is financed under the Hong Kong SAR Chief Executive's Community Project Scheme through a contribution of \$18 million from the Hong Kong Jockey Club Charities Trust. PREPP started in early 1999 and will be completed by the end of 2001. Several institutions in Hong Kong, in Guangdong Province, and in other parts of China are collaborating. The objectives of PREPP are to gain a solid understanding of the physical, chemical and biological nature of the estuary and its pollutant load through the use of an integrated approach of traditional and new technologies, and to attempt to predict selected future pollutant status such as selected toxics, sediments, nutrient levels, and phytoplanktons. In its first year of operation, one major cruise was carried out (July 99) and several smaller cruises. Others are planned for 2000 and 2001. The presentation will provide preliminary results and outline future plans. It is clear that results of this project, and the works of others, will be important inputs for authorities in Hong Kong and in Guangdong Province to devise pollution monitoring and control strategies vital for the improvement of water quality in the Pearl River Estuary and in Hong Kong waters.

In addition to PREPP two other projects, financed by the PRC, for the Pearl River Estuary, are carried out by the same team, and will be presented.

9AM2000 S9-042 oral  
**NICHE SUITABILITY ASSESSMENT OF MARICULTURED REGION**

Shang Chen, Mingyuan Zhu and Yan Ma

*First Institute of Oceanography, State Oceanic Administration, Xianxialing Road, Hi-tech Industrial Park, Qingdao, Shandong, People's Republic of China. 266061 e-mail: qdcs@263.net*

Mariculture industry is very important in Pacific countries, like China, Korea, Japan, Canada etc. How to select the specific sea region for culturing the specific species? There is no one both quantitative and scientific method. The Niche suitability theory

was applied to assess the suitability of one region for mariculture practice. Niche suitability measures the similarity between the real resource state supplied by environment and the optimal resource state demanded by species, and reflects the match relationship between "supply" of marine environmental factors and "demand" of species for ecological factors. The niche suitability models were developed to assess the niche suitability of two Chinese bays for culturing Chinese scallop (*Chlamys farreri*). Based on the one-time-per-month field survey and in situ ecophysiological experiments about one time per season, we assess the monthly suitability of Sanggou Bay and Jiaozhou Bay. The results show the Sanggou Bay is more suitable for Chinese scallop than Jiaozhou Bay. The suitability in spring and autumn is high in both bays. While the suitability is low because dissolved oxygen become the limiting factors in summer, esp. in Sanggou Bay. The application of niche suitability theory in aquacultural ecology is useful to assess the suitability of sea region for cultured organisms and optimize the cultural planning.

9AM2000 S3-037 oral

#### STUDY ON DYNAMIC OF BIOMASS AND ECOLOGY OF ZOOPLANKTON IN EAST CHINA SEA

Yaqu Chen, Zhaoli Xu, Yunlong Wang and Mei Jiang

East China Sea Fisheries Institute, Chinese Academy of Fisheries Science, 300 Jungong Road, Shanghai, People's Republic of China. 200090 e-mail: yq\_chen@citiz.net

This paper describes dynamic of biomass and key species of zooplankton in the East China Sea based on data collected about fifty years since 1959. Analyzing results shows that average biomass of zooplankton was 142.80mg/m<sup>3</sup> in 1959 in this water. Since the 1970s it was decreasing to 125mg/m<sup>3</sup> (1973). Average value of biomass in four seasons was 64mg/m<sup>3</sup>. During 1997-1998, biomass was decreasing sharply, it shows that the second production the East China Sea was declining obviously.

Key species of zooplankton in the East China Sea are *Calanus sinicus*, *Ephansia pacifica*, *Pseudeuphausia sinica*, *Themisto gracilipes*, *Sagitta nageae*, *Sagitta enflata*, *Euchaeta concinna* etc. The relationship between quantitative fluctuation distribution and location of fishing grounds of markeral scald and cutlassfish is very closed.

9AM2000 FISp043 poster

#### INFLUENCE OF SOLAR ACTIVITY AND CLIMATE CHANGES ON WACHNA COD REPRODUCTION IN PETER THE GREAT BAY

Ludmila A. Chernovanova

Pacific Research Fisheries Center (TINRO-Center) 4 Shevchenko Alley, Vladivostok, Russia. 690600 e-mail: root@tinro.marine.su

Strong year-classes play an important role in formation of commercial stocks of Wachna Cod (*Eleginus gracilis*. Tilesius) in Peter the Great Bay. Strength of each new year-class of Wachna Cod can be estimated on its number in the age of one year, considering this value as an index of yield.

Comparison of yield index dynamics of the Wachna Cod population in Peter the Great Bay and Volf's numbers during 1967-1996 finds out presence of the inverse tendencies at a level of its reproduction within maximums of solar activity of 21st and 22nd 11-years cycles. A series of strong year-classes emerged at maximum values of Volf's numbers of 21st cycle (in the late 1970s, in the early 1980s), at the maximum of 22nd cycle (in the late 1980s, in the early 1990s) there has not appeared of any generation comparable to mean annual value in number. Decrease of yield in 1973-1974 corresponded to recession of 20th cycle of solar activity and change of its century cycle branch. The change of a reproduction level occurs in years with the minimum solar activity values. Thus, the fluctuations of strong-year classes of Wachna Cod are approximately equal to the 11-years cycle of solar activity and are characterized by drastic rise and decrease of an yield index (based on time shift to one year later of a minimum of Volf's numbers). The extreme fluctuations of Wachna Cod yield correspond to 15-16-years cycle of the magnetic disturbed Sun.

The highest level of reproduction was observed from 1976 to 1987 when there were generations of Wachna Cod with an index of yield above mean annual value. Since 1988 up to the present time there has been a very low level of reproduction intensity, and the period of 1967-1976 was intermediate with a yield level close to mean annual values. The 22nd 11-years cycle of solar activity decay has been noted recently, and it is possible to assume that the next change of Wachna Cod reproduction level lies ahead.

The cooling periods of the North Pacific Ocean water surface are connected with the total reproduction increase of Wachna Cod, and low level of productivity - with periods of high temperature predominance.

Thus, periodic fluctuations under solar influence and climate changes affect variability of strong year-classes of Wachna Cod of Peter the Great Bay.

9AM2000 S9-044 poster  
**PURIFICATION OF GROWTH ENHANCERS FOR MICROALGAL *Isochrysis galbana* FROM THE SEAWEED *Monostroma nitidum***  
Ji-Young Cho and Young-Ki Hong  
Department of Biotechnology, Pukyong National University, 599-1 Daeyondong, Nam-Gu, Namku, Pusan, Republic of Korea.  
608-737 e-mail: jycho0400@hanmail.net

*Isochrysis galbana* is an important microalga for fish culture. Preliminary experiments have shown that the green seaweed *Monostroma nitidum* contains compounds that enhance the growth of the *Isochrysis galbana*. Growth enhancers were isolated from *M. nitidum* water extracts by chromatography: Molecular fractionation, Ion-exchange, Gel-filtration and HPLC. We obtained two fractions from *Monostroma nitidum*, one more than MW10,000 and another less than MW500 by molecular fractionation. These fractions were loaded on a DEAE-cellulose ion exchange column. The former (more than MW10,000) was eluted with 0.5M NaCl, the latter (less than MW 500) with 0.1M NaCl. The 0.5M NaCl fraction was applied to a Superose 12 gel-filtration column using FPLC and we obtained a single peak at 21 min at the flow rate 0.3ml/min. The 0.1M NaCl fraction was injected in a reverse phase ODS-5 column using HPLC. Chromatography with a liner gradient showed a single peak with 25% acetonitrile. Then the main fraction was injected in DEAE-SPW column, it also shows a single peak. Both of these peaks corresponded to compounds with *I. galbana* growth enhancing activities.

9AM2000 S9-045 poster  
**AXENIC ISOLATION PROCEDURE OF THE NEUTRAL SPORE AND CONCHOCELIS FROM THE SEAWEED *Porphyra yezoensis***  
Jae-Suk Choi and Yong-Ki Hong  
Department of biotechnology, Pukyong National University, 599-1 Daeyondong, Nam-gu, Pusan, Republic of Korea. 608-737 e-mail: bioengchoi@hanmail.net

To establish an axenic culture system of *Porphyra* tissues in laboratory conditions, we have developed a procedure of axenic treatment and isolation for the neutral spores and conchocelis.

Axenic isolation of the neutral spore of *Porphyra yezoensis* was achieved by percoll-gradient centrifugation and treatment with antibiotics. *Porphyra* neutral spores were collected from the interface between 40% and 50% of percoll. To remove bacteria it has been determined 1 antimycotics and 5 antibiotics mixture (7.0 g/ml nystatin, 4.0 g/ml ampicillin, 0.04 g/ml gentamycin, 0.8 g/ml kanamycin, 0.1 g/ml neomycin, and 1.6 g/ml streptomycin) by half of MNLC of the neutral spore of *Porphyra yezoensis* against antimycotics and antibiotics.

Axenic isolation of the conchocelis of *P. yezoensis* was achieved by using a ternary procedure involving ultrasonication treatment, treatment with antibiotics and growth on agar medium. To remove diatom it was the most effective to filtrate at 100 $\mu$ m mesh after ultrasonication treatment. To remove bacteria it has been determined 4 algicidal agent and 4 antibiotics mixture (0.015% chitosan Vanson Co, 0.25 g/ml chitosan type L-40, 0.1 g/ml chitosan type S, 0.1 g/ml GeO<sub>2</sub>, 0.01 g/ml ampicillin, 0.01 g/ml gentamycin, 0.04 g/ml kanamycin, and 0.2 g/ml streptomycin) by half of MNLC of the conchocelis of *Porphyra yezoensis* against algicidal agent and antibiotics. An axenic single colony was isolated from growth on a solid medium prepared from 1.5% high-gel strength agar.

9AM2000 S4-046 oral  
**ASSESSMENT AND MANAGEMENT OF COMMON MACKEREL (*Scomber japonicus*) IN KOREAN WATERS, BASED ON THE RELATIONSHIP BETWEEN RECRUITMENT AND THE OCEAN ENVIRONMENTAL FACTORS**  
Young Min Choi<sup>1</sup>, Jae Bong Lee<sup>2</sup>, Chang Ik Zhang<sup>2,3</sup>, Chul In Baek<sup>1</sup> and Jong Hwa Park<sup>1</sup>  
<sup>1</sup> National Fisheries Research & Development Institute, 408-1 Shirang-ri, Kijang-up, Kijang-gun, Pusan, Republic of Korea. 619-900 e-mail: ymchoi@nfrdi.re.kr  
<sup>2</sup> UR Interdisciplinary Program of Fisheries and Oceanography, Pukyong National University, Pusan, Republic of Korea. 608-737  
<sup>3</sup> Dept. of Marine Production Management, Pukyong National University, Pusan, Republic of Korea. 608-737

A method for assessing common mackerel (*Scomber japonicus*) stock is developed, considering the relationship between the recruitment of mackerel and the oceanographic environmental factors during the spawning season, April-June. The method is based on spawning biomass and recruitment relationship (SRR) model, but it makes some basic assumptions about correlations between recruitment prior to the time at capture and environmental factors, such as seawater temperature, salinity and zooplankton biomass around spawning grounds. The method was applied to the assessment of the Korean purse seine fishery in Korean waters using fishery and oceanographic data from the National Fisheries Research & Development Institute. Modified SRR models with environmental factors for the 1968-1999 fishing seasons are presented. The objective of the management of the stock and fishery around Korea is to maintain the proper yield and spawning biomass above a threshold level, thus avoiding high probabilities of low recruitment in the following season. The estimates of recruitment and FABC from the analyses were used to estimate an

appropriate acceptable biological catch (ABC) of common mackerel for the total allowable catch (TAC)-based management in Korea.

9AM2000 S3-047 poster  
**SEASONAL SUCCESSION OF THE GENUS *Acartia* (COPEPODA: CALANOIDA) IN THE SOUTHWESTERN COASTAL WATER OF KOREA**

Hyun-Kyoung Chung, Ho Young Soh, Eun-Ok Park, Seo-Kyoung Seon and Hae-Lip Suh  
Chonnam National University, Puk-gu Young-bong dong 300, Kwangju, Republic of Korea, 500-757 e-mail: jhkyoung0329@hanmail.net

Spatio-temporal distribution patterns of four species in two subgenera *Acartiura* (*A. hongii* and *A. omorii*) and *Odontacartia* (*A. erythraea* and *A. pacifica*) included in the genus *Acartia* were examined at seven stations in the southwestern waters of Korea. *A. hongii* dominantly occurred in the northern regions from winter to spring when the less saline (< 30.40) water mass was extended toward the southern regions. *A. omorii* predominated in the southern regions between late spring and early summer when the more saline (> 33.0) and high chl *a* concentration water mass appeared. However, both species were disappeared with the presence of high temperature (> 20°C) water mass in the southwestern coastal waters. Then they replaced with *A. erythraea* and *A. pacifica*: the former was abundant in the middle regions in summer, while the latter predominated in all regions in fall. We suggest that the spatio-temporal distribution patterns of the genus *Acartia* were subgenus-specifically affected by environmental factors such as temperature, salinity and chl *a* concentration.

9AM2000 W5-344 oral  
**OPEN OCEAN IRON FERTILIZATION FOR SCIENTIFIC STUDY AND CARBON SEQUESTRATION**

Kenneth Coale  
Moss Landing Marine Laboratories, 8282 Moss Landing Road, Moss Landing, CA 95039, U.S.A. e-mail: coale@mlml.calstate.edu

Through a series of recent large scale iron fertilization experiments in the equatorial Pacific and the Southern Ocean, strong correlations in atmospheric iron deposition, marine production and climate change have now been mechanistically linked to iron limitation in the global ocean. These experiments have been significant in a number of ways 1) they have advanced the importance of iron in regulating phytoplankton production on global scales 2) they have demonstrated the utility of open ocean enrichment experiments for the study of ecological and physiological processes and 3) they have suggested to some that anthropogenically induced eutrophication through open ocean iron fertilization may be useful in controlling atmospheric carbon dioxide. Although the latter remains an issue of current study and debate, the utility of iron fertilization in examining a variety of biological and geochemical processes has been unequivocally demonstrated. The ability to perform such experiment, however, is not trivial and involves many geochemical considerations and demanding capabilities. Here we report the theoretical and practical considerations of creating a patch of seawater enriched with iron, then detecting this patch and the biological and chemical signal which developed, in an area dominated by advective processes. Physical and chemical models were used to predict the speciation, solubility, and the final concentration of iron in surface waters injected with acidic iron sulfate and preliminary studies of coastal incubations with iron-lingosulfanate will be presented. A Lagrangian coordinate system was established using a drogued buoy and the iron enriched area was tagged with the inert chemical tracer sulfurhexafluoride (SF<sub>6</sub>). This method has proven useful on four experiments conducted by MLML researchers in the equatorial Pacific and a recent experiment by New Zealand Scientists in the Southern Ocean (to be reported by others in this session). Shipboard analysis and airborne observations confirmed good spatial agreement between the Lagrangian drifter and the biological and chemical signatures in the patch. Although the inert tracer allowed for an estimate of the physical mixing of the enriched waters, a well constrained budget of carbon export is more difficult to calculate. Recent estimates of carbon export from the 1995 equatorial Pacific experiment will be presented together with the design of a Southern Ocean Iron Experiment to be conducted in January of 2002. These results should be helpful for consideration of a subarctic enrichment experiment.

9AM2000 W5-345 oral  
**THE PLANKTONIC NITROGEN UPTAKE AND HETEROTROPHIC BACTERIAL RESPONSE DURING THE SECOND MESOSCALE IRON ENRICHMENT EXPERIMENT (IRONEX II) IN THE EASTERN EQUATORIAL PACIFIC OCEAN**

William P. Cochlan  
Romberg Tiburon Center for Environmental Studies, San Francisco State University, 3152 Paradise Drive, Tiburon, California 94920-0855, U.S.A. e-mail: cochlan@sfsu.edu

The *in situ* responses of phytoplankton and heterotrophic bacteria were followed during the mesoscale iron-enrichment experiment conducted in the eastern equatorial Pacific during May-June, 1995 (IronEx II). The rate of planktonic nitrogen (nitrate, ammonium and urea) uptake, and the abundance and productivity of bacteria were measured within the fertilized patch and outside

of the patch (control) at 15-m depth. Fe enrichment resulted in a dramatic increase in phytoplankton biomass (chlorophyll *a* concentration increased *ca.* 20 fold), but in contrast to long-term 'grow-out' bottle experiments, the ambient nitrate concentration did not decrease to near zero, but declined by *ca.* 4-5  $\mu\text{M}$ . Absolute uptake rates of nitrate increased *ca.* 15 fold as a result of Fe enrichment, and post-incubation size-fractionation experiments demonstrate that larger phytoplankton ( $> 5 \mu\text{m}$ ) were responsible for the enhanced nitrate utilization ( $> 85\%$  of the  $\text{NO}_3$  uptake). Fe enrichment shifted the size-structure of the phytoplankton community from picoplankton dominance to larger cells, and altered the relative utilization of new and regenerated N; the daytime *f*-ratio (*f*-ratio =  $\text{NO}_3$  uptake/total N uptake) increased from *ca.* 0.65 to 0.91 (ratio uncorrected for isotopic dilution effects).

The carbon productivity and specific growth rate of heterotrophic bacteria increased 3-fold and 3-4 fold, respectively, resulting in the *in situ* accretion of bacteria (abundance increased 1.7 fold) within the Fe patch. Although these results do not demonstrate a direct stimulatory response of heterotrophic bacteria to Fe enrichment, they show that bacterial carbon demand can be potentially met by the increase in phytoplankton primary productivity.

9AM2000            MEQp048            oral  
**ECOLOGICAL MONITORING AT THE PILTUN-ASTOKH AREA, NE SAKHALIN ISLAND SHELF**

John A. Coll, Dennis J. Royle, Valentina A. Andreeva and Olga O. Sergusheva  
*Sakhalin Energy Investment Company, Ltd. (SEIC), Yuzhno-Sakhalinsk, Russia e-mail: Valentina\_Andreeva@SakhalinEnergy.ru*

Sakhalin Energy, being Operator of Sakhalin-2 Project, has organized Ecological Monitoring conducting during Molikpaq platform installation and Appraisal Drilling in 1998, within the area of the Molikpaq platform operation in 1999 at the Piltun-Astokh area, located in the Sea of Okhotsk, North-East Sakhalin Offshore, approximately 20 km southeast of the Piltun Bay.

The water column was surveyed for hydrological parameters, salinity, oxygen, nutrients, suspended solids, petroleum hydrocarbons and heavy metals; there was conducted an analysis of chlorophyll, phytoplankton, zooplankton and ichthyoplankton. The soil was surveyed for grain size distribution, heavy metal content, petroleum hydrocarbons, as well as for benthos' species composition and quantitative description.

All the surveyed hydrochemical parameters conformed to the average multiyear background values. Grain size composition study revealed no impact of the last year business activity on the structure of sediments.

9AM2000            S7-049            oral  
**FORECASTING COHO SALMON SURVIVAL OFF THE PACIFIC NORTHWEST**

James F. Cole, George W. Boehlert and Lynn deWitt  
*Pacific Fisheries Environmental Laboratory, NOAA/NMFS, 1352 Lighthouse Avenue, Pacific Grove, CA 93950, U.S.A. e-mail: jcole@pfeg.noaa.gov*

Coastal ocean conditions in the Oregon Production Index (OPI) region play an important role in influencing the survival of coho salmon. Recent retrospective analyses using SST anomalies as environmental proxies have shown a good correspondence between coastal ocean conditions and coho survival in the OPI region from the mid 1980s up to 1996, and have allowed the development of SST anomaly-based models of survival. The aims of this investigation are to evaluate the predictive potential of these models by checking how successfully they forecast survival of the 1996, 1997 and 1998 year classes and to update the models as necessary. Two models are evaluated and updated. The first uses SST anomalies from 1985-95 calculated from remotely sensed AVHRR 'Pathfinder' SST data and explains over 90% of the variation in survival during that period. The second model uses SST anomalies derived from the lower-resolution Reynolds coastal SST dataset. Using the same 1985-95 time series, slightly less (84%) of the variation in survival is explained. Back extending the model based on the Reynolds' coastal SSTs to 1982 reduced the total amount of variation accounted for to 57%, largely due to 1984 being an outlier, but nevertheless resulted in more realistic predictions for the 1996-1998 year classes. Potential alternative environmental data to extend this time series back to the higher survival levels in the early 1970s is discussed.

9AM2000            CCCCP050            oral  
**CROSS-SHELF DISTRIBUTION OF ACOUSTICALLY DETERMINED BIOMASS AND ZOOPLANKTON DENSITY RELATIVE TO MAJOR HYDROGRAPHIC FEATURES ON THE NORTHERN GULF OF ALASKA SHELF (INITIAL OBSERVATIONS ON THE GLOBEC LONG TERM OBSERVATION PROGRAM)**

Kenneth O. Coyle, Alexei I. Pinchuk and Thomas J. Weingartner  
*Institute of Marine Science, School of Fisheries & Ocean Sciences, University of Alaska Fairbanks, P.O. Box 757220, Fairbanks, AK 99775-7220, U.S.A. e-mail: coyle@ims.uaf.edu*

Three distinct water masses are observed on the northern Gulf of Alaska shelf: the Alaska Coastal Current (ACC), the shelf-break-oceanic regime, and the intermediate shelf water between the Coastal Current and the shelf break. Distinct zooplankton communities are commonly observed in each of the major water masses. Quantitative acoustic data has revealed the persistent

presence of elevated volume backscattering in the frontal regions. Concurrent net and acoustic observations suggest that the high backscattering is due in part to elevated calanoid and euphausiid biomass in the frontal regions. Episodic periods of cross-shelf advection can occasionally transport oceanic zooplankton clear into the frontal boundary on the south side of the ACC. Satellite telemetry data indicate that cross shelf advection may be influenced by mesoscale eddies propagating westward along the shelf break.

9AM2000 S1-051 poster

#### **ANOMALIES OF THE 1990S ALONG THE PACIFIC CANADIAN CONTINENTAL SHELF, AND EXCHANGE WITH THE GULF OF ALASKA**

William R. Crawford, Josef Y. Cherniawsky and Michael G.G. Foreman

*Institute of Ocean Sciences, P.O. Box 6000, Sidney, B.C., Canada. V8L 4B2 e-mail: crawfordb@pac.dfo-mpo.gc.ca*

A series of oceanic El Niño events reached the Pacific Coast of Canada during the 1990s. We examine these events by tracking anomalies of sea surface elevation and salinity/temperature versus depth, referenced to summer and winter climatology and then combined in a diagnostic finite element model that computes the buoyancy and wind-driven currents. Two specific features are warm water advection into Canadian coastal waters, and formation of eddies along the northern region in winters. Both events impact coastal biota.

Warm waters generally reach Canadian regions during El Niño years due to changes in winds in the Gulf of Alaska, and to northward propagating coastal waves. We describe these processes as observed in the 1990s.

Eddies that form along the west coast of the Queen Charlotte Islands in most winters carry coastal waters into the Gulf of Alaska. During the 1995 and 1998 El Niño winters these eddies were far larger than normal, and carried far more coastal water and nutrients away from shore. We are able to track the formation of these eddies in early winter, their separation from shore and migration through the Gulf of Alaska.

9AM2000 W5-346 oral

#### **INFLUENCE OF CAPE ST. JAMES ON CURRENTS AND EDDIES IN THE GULF OF ALASKA**

William R. Crawford, Josef Y. Cherniawsky and James Gower

*Institute of Ocean Sciences, P.O. Box 6000, Sidney, B.C., Canada. V8L 4B2 e-mail: crawfordb@pac.dfo-mpo.gc.ca*

Cape St. James lies at the southern tip of the Queen Charlotte Islands off the West Coast of British Columbia. The swift tidal streams and strong prevailing outflow currents at this cape contribute to the Haida Eddies in the Gulf of Alaska, and to outflow jets and plumes in the neighboring coastal waters. The waters at the cape itself are rich in marine life, and nutrients including iron, due to outflow of coastal water, and intense tidal mixing that stirs deep nutrient-rich water to the surface. Thomson and Wilson (1987) described an anti-cyclonic eddy that forms to the southwest of this cape, due to tidally rectified outflow currents. Crawford *et al.* (1995) found that wind-forced currents enhanced this outflow, especially in winter when storms are most intense and frequent. Satellite altimetry and infrared temperature observations provide additional insight into this region. We have re-processed the TOPEX/POSEIDON (T/P) and ERS-2 altimetry data using tidal constants based on regional tidal models (Foreman *et al.*, 2000), and on T/P data themselves (Cherniawsky *et al.*, 2000.) We have also searched through 10 years of AVHRR measurements from NOAA satellites. In winter, the eddies that form to the southwest of Cape St. James often advect northward along the West Coast of the Queen Charlotte Islands with the prevailing winter coastal current. These anticyclonic eddies eventually separate from shore, forming the Haida Eddies, which can drift for several years in the Gulf of Alaska. Normally one or two such eddies form every winter, with larger eddies in major El Niño winters. We also find that Haida Eddies may originate along the Northwest Coast of the Queen Charlotte Islands, far from Cape St. James, supporting the hypothesis that local baroclinic instability of coastal currents is another generating mechanism for this class of eddies.

9AM2000 S6-052 invited

#### **UNANSWERED QUESTIONS CONCERNING FERTILIZATION OF THE OCEAN FOR COMMERCIAL PURPOSES**

John J. Cullen

*Department of Oceanography, Dalhousie University, Halifax, NS, Canada. B3H 4J1 e-mail: John.Cullen@Dal.CA*

Recent discoveries by oceanographers, along with a growing concerns about decreasing fish stocks and increasing carbon dioxide in the atmosphere, have led to unprecedented proposals for fertilizing the oceans to promote growth of phytoplankton. It is thought that blooms of phytoplankton will draw carbon dioxide from the atmosphere and store it in the ocean, increasing the production of fish in the process. Patents have been granted for ocean fertilization procedures, and some plans for large-scale fertilization of the oceans have been revealed. No guidelines, political or scientific, have been developed to deal with inevitable proposals to fertilize international waters for commercial benefit, such as carbon tax credits. Here, I describe how ideas for ocean fertilization developed, how far they have progressed, and why there is an urgent need to resolve scientific uncertainties and to establish scientific and political guidelines before any commercial fertilization of the ocean proceeds.

9AM2000 POCp053 poster  
**BRANCH OF SUBARCTIC FRONT IN THE JAPAN SEA AND SOUTH-EASTWARD CURRENT ALONG IT**  
Mikhail A. Danchenkov, D.G. Aubrey and S.C. Riser  
Far Eastern Regional Hydrometeorological Research Institute (FERHRI), 24 Fontannaya Street, Vladivostok, Russia. 690600 e-mail: danchenk@fastmail.vladivostok.ru

Research is based on winter CTD (1995-2000) and 2-years (1999-2000) PALACE measurements in the northwestern Japan Sea. Northwestern thermal front-branch of subarctic front- was found here 3 years ago. It plays very important role in distribution and paths of migration of some fishes (sardine, salmon, herring) and heat redistribution. Along this front south-eastward current was revealed by this study. Typical characteristics of front and waters in this area were described. Variation of direction and velocity of new current were described. In area of Northwestern thermal front 2 water masses are formed. Examples of such water formation are given.

9AM2000 S5-054 oral  
**THE FRAGMENTS OF LARGE-SCALE CIRCULATION BY NORTHERN PACIFIC ON THE OCEANOGRAPHIC AND SATELLITE SURVEYS**  
V.B. Darnitsky and N.V. Bulatov  
Pacific Fisheries Research Centre (TINRO-Centre), 4 Shevchenko Alley, Vladivostok, Russia. 690600 e-mail: root@tinro.marine.su

For the period with 1960 on 1995 years TINRO has executed more than 400 oceanographic surveys in the North Pacific. 64 surveys in the Vancouver, Oregon and California areas, including under the program CalCOFI. 24 expeditions were executed in area of the Imperial Mountains and northern part of the Hawaiian ridge. Some shootings are made in areas of underwater mountains of the Alaska Gulf, on seamounts Cobb and Fiberling and on a number of anonymous mountains in system of the Californian Current.

Since 1973 the space monitoring NW Pacific (Bulatov *et al.*, 1995) is conducted. This information essentially changes the known general oceanic circulation in the Northern Pacific, received by averaging on squares of various scales. For example, at realization an oceanographic surveys above 15 underwater seamounts of the Alaska Gulf: Miller, Patfinder, Morton, Campbell and Scott seamounts in the north and Broun-Ber, Cobb, Uoruic, Eikelberg, Forster seamounts etc. in the south, has appeared, that all zone of surveys was covered cooperating cyclonic and anticyclonic eddies, in their approximately identical ratio. The speeds of orbital movements in eddies were changed from 0.14 up to 0.32 knots at the sizes from 30 up to 50 miles in diameter. The concentration of biogenic substances in a vortical field were increased: at northern group of seamounts of concentration were 18-25, at southern group of mountains the higher meanings - 36-71 were observed in the winter period and they raised up to 150-178 mkg-at/l. Biomass of mezoplankton on the greater part of surveys was within the limits of 100 and less, raising in separate some upwelling and eddies up to 340-740 mlg/m<sup>3</sup>. The similar picture was observed in area of underwater mountains Fiberling and Jusper, influence, taking place in a zone, of the Californian Current. Meandering jets of the Californian Current create an extensive vortical zone in area 25-35°N 121-130°W. The vortical zones promote development of the increased concentration of biological objects near to underwater seamounts in ecosystem of the Californian Current.

In area of southern Imperial seamounts and northern part Hawaiian ridge were made as single sections along a ridge axis, and different scales surveys (Darnitskiy, 1979). Already first large-scale survey (R/V *Academician Berg*, 1969, March) in area of Kinmey and Milwaukee seamounts and seamounts of the Hawaiian ridge up to an Cure atoll (about Green-Island) has allowed to establish large-scale meandering of branches of the Kuroshio Extension near Kinmey and Milwaukee seamounts and intensive eddy generation. The centres of the large-scale vortical circulation (100-120 miles) settled down at Kinmey and Milwaukee seamounts and anonymous mountain within the limits of the fishing zone of the U.S.A. ( $h = 878$  m,  $\varphi = 31^\circ 10$  N.,  $\lambda = 179^\circ 40'$  E.). The vortical systems of smaller scales were located at other underwater mountains. The structure of a vortical field changed in various layers, but the large-scale forms of circulation were kept up to depths of 500-600 m. Some eddy had a dipole structure.

The vortical fields caused the increased contents of biogenic elements in the intermediate layers. Even on horizon 1000 m in southern group of mountains the phosphate concentration in local upwellings raised up to 100-110  $\mu$ g/l at the background concentration 60-70  $\mu$ g/l.

In a number of cases enough of the microsveys (Colahan and Cobb seamounts) has allowed to study structure and evolution of topographical eddies located at single underwater mountains (Darnitskiy, Zigelman, 1986).

In western part of the Subarctic front to new elements of the synoptic circulation of waters the detection of the mushroom eddies, the arrow like and fir-tree like jets observed near Japan in a zone of the interaction of the various Kuroshio and Oyashio branches (Bulatov, 1995; Darnitskiy, Bulatov, 1998).

The mushroom-like structure eddies as known have a different mechanism of generation. In the subarctic frontal zone they are often generated by the cold and warm intrusions in the Kuroshio eddies. The mushroom like structure has the second Oyashio branch very often. In the case of the small width branch and weakly eddies the mushroom-like structure are transform in the



arrow-head current (Bulatov, 1979). In the case, when the cold or warm jet currents generated some pair of eddies on its periphery there is a small fir-space imagery. For example, in the 1981-85 years there was a maximum southward extension of near shore Oyashio branches and fir-tree-like currents, was visible on the space images near Japan. The temporary scale of this structure is very different. The mushroom-like eddies may be on the surface layer about few days (Fedorov, 1983). The warm intrusion from Kuroshio current inside to warm-core rings detached from main current may be live about 10-15 days.

The mushroom-like structure of the second Oyashio branch may remained about few month because she is generated the large-scale processes - warm-core ring east from Hokkaido near the cluster of seamounts.

The large-scale mushroom-like eddies have been generated once near the Idzu-ridge (Bulatov, Darnitskiy, 1998).

**9AM2000 FISp055 poster**  
**PECULIARITIES OF THE *Engraulis japonicus* SPAWN IN PETER THE GREAT BAY IN 1988-1998**

Svetlana V. Davidova  
Pacific Fisheries Research Center (TINRO-Center), 4 Shevchenko Alley, Vladivostok, Russia. 690600 e-mail:  
root@tinro.marine.su

The high level of anchovy stocks and active spawn in northern inhabit regions has ensured to it a leading role in ichthyoplankton of Peter the Great Bay during the last 10 years. The first shoal of anchovy penetrate into southern regions of Peter the Great Bay with water warming up to 9-10°C. The first pelagic eggs occur at 11-12°C in surface layer of water. The temperature is basic limiting factor for development subtropical fishes in northern areas inhabit. At short-cyclical species such as anchovy easily entering in spawn annual departure from the terms of the approaches and spawn intensity are expected.

Basis of spawning anchovy in Peter the Great Bay make fish of old class groups, namely 2-year. Larvae hatching in Peter the Great Bay growing up to 4-6 cm by October. This anchovy are juvenile. On the contrary, near the coast of Southern Korea six-month-old fish grow up to length 8.3 cm on the average and can be included in spawn for the first time. Anchovy autumn-migrating from the northwest part of the Japan Sea to southern regions can enter in spawn only in one year age in spring at coast of Korea or in summer at coast of Primorie partially. Aforesaid dates witness about more difficult population structure of subtropical species migrating for spawn in northern regions, than it is conceived.

**9AM2000 FISp056 oral**  
**EARLY ONTOGENESIS OF FISHES, UNDERSTANDING OF THE MORTALITY NATURE**

Svetlana V. Davidova  
Pacific Fisheries Research Center (TINRO-Center), 4 Shevchenko Alley, Vladivostok, Russia. 690600 e-mail:  
root@tinro.marine.su

The number of fishes population is determined at early stages of development and it fluctuations depend on condition of reproduction, eggs development and larvae survival. At the ichthyoplankton investigations number of eggs (spawn volume) is calculated in the view of the live and dead eggs part. However uniform opinion about nature of the dead eggs occurrence in ichthyoplankton samples is not generated. Two basic points of view exist: 1. Dead eggs are consequence natural mortality, as reflection of interaction of species with varying environmental condition; 2. Dead eggs are result of mechanical damage by net during the trawling process. Success of species reproduction is forecasted proceeding of these concepts, but different estimations can turn out. On an example flounder (*Pl. pinnifasciatus*), gizzard shad (*K. punctatus*), anchovy (*E. japonicus*) was made an attempt to understand nature of the fishes mortality in embryonic period. For range was chosen of coastal zone of Peter the Great Bay, information for 1996-1999 was generalized. Change of live and dead eggs portion, correlation eggs in different stages of development in samples were analyzed. This indexes depend on: 1) duration embryonic period at various temperature; 2) changes of sensitivity embryo to influence of the environmental factors during development and display of the species reaction norm at environmental influence; 3) changes of the temperature, salinity, wave disturbance and etc.; 4) time of trawling.

**9AM2000 S6-057 oral**  
**THE RESPONSE OF THE PLANKTONIC ECOSYSTEM TO THE 1976 CLIMATE SHIFT IN A COUPLED ECOSYSTEM / OCEAN GENERAL CIRCULATION MODEL OF THE NORTH PACIFIC OCEAN**

Kenneth L. Denman<sup>1</sup>, Susan P. Haigh<sup>1,2</sup> and William W. Hsieh<sup>2</sup>

<sup>1</sup> Institute of Ocean Sciences, P.O. Box 6000, Sidney, B.C., Canada. V8L 4B2 e-mail: denmank@pac.dfo-mpo.gc.ca

<sup>2</sup> Department of Earth and Ocean Sciences, University of British Columbia, Vancouver, B.C., Canada. V6T 1Z4

Around 1976 a marked change in climate occurred over the North Pacific: the Aleutian atmospheric low pressure system strengthened and changed its characteristic position, with correlated changes in sea surface temperature and wind patterns. In the eastern subarctic Pacific, widespread changes in fish populations were also detected, many of them traced back to anomalous year classes around 1976-77. Other, less well-documented changes also occurred in phytoplankton and zooplankton populations in the

North Pacific between the decades prior to and following 1976. To investigate the hypothesis that major changes in fish populations result from climatic change propagating up the fisheries foodweb, we have developed a coupled ocean general circulation model with a 4-component planktonic ecosystem model.

The Miami isopycnic model (MICOM) has been implemented on a 2° grid over the domain from 18°S to the Bering Strait, with a Kraus-Turner type mixed layer model overlaying 10 isopycnal layers. The planktonic ecosystem model has been modified from Denman and Peña (1999). MICOM is initialized with mass fields from the World Ocean Atlas 1994 September dataset, and forced with monthly sea surface winds, temperature and salinity fields from the COADS dataset. The ecosystem model is run for a 5-year period after a 30-year spinup period for MICOM. An initial basic run for the period 1952-88 is compared with seasonal SeaWiFS images and with contemporary observations of primary and export production. In the subarctic Pacific, annual net primary production and export production are comparable with estimates from long term observations at Ocean Station Papa, but in the subtropical Pacific, model estimates underestimate production by close to a factor of 8 when compared with contemporary estimates based on observations from the Hawaiian Ocean Times Series at Station ALOHA. Two subsequent runs with forcing for the periods 1952-75 and 1977-88 are contrasted and compared with existing long term observations. In the subarctic, modelled changes in phytoplankton biomass reflect changes in mixed layer depth (and presumably light) after 1976; in the subtropics, modelled changes reflect changes in the supply of new nitrogen to the euphotic zone.

9AM2000 W7-390 oral  
**WILL WE HAVE SUFFICIENT DATA TO EVALUATE THE PERFORMANCE OF COUPLED 3-DIMENSIONAL BIOGEOCHEMICAL OCEAN BASIN MODELS?**

Kenneth L. Denman<sup>1</sup>, Susan Haigh<sup>2</sup> and William Hsieh<sup>2</sup>

<sup>1</sup> *Institute of Ocean Sciences, P.O. Box 6000, Sidney, B.C., Canada. V8L 4B2 e-mail: denmank@pac.dfo-mpo.gc.ca*

<sup>2</sup> *University of British Columbia, Vancouver, B.C., Canada*

We have developed a 3 dimensional coupled ocean general circulation / ecosystem model of the North Pacific over the domain from 18S to the Bering Strait (66°N). The model, the MICOM isopycnic model, is forced with COADS monthly windspeed, windstress, and cloudiness, and with monthly sea-surface temperatures and salinities constructed from the World Ocean Database 1998. To investigate the responses to the 1976 climate shift, we constructed monthly sea surface temperature fields for the periods 1952-1975 and 1977-1989. However, there are inadequate surface salinity data to construct monthly fields for the period 1952-1975. Instead we constructed annual mean surface salinity fields for the two periods. In the 'calibration run' for the whole period 1952-1989, we found that modelled differences were minor between a run using monthly mean salinity fields for the whole period and a run using an annual mean for the whole period. Hence we used annual mean salinity fields for the rest of the study. Results for the ecosystem were even more difficult to initialize and evaluate. For the 'calibration run', net primary production and export production were in agreement with contemporary estimates for Ocean Station P in the subarctic gyre, but were 8 to 10 times too low for estimates from the Hawaiian Ocean Timeseries station ALOHA in the subtropical gyre. There were clear differences in the ecosystem responses in the two run for the periods 1952-1975 and 1977-1989, but apart from the zooplankton fields of Brodeur and Ware (1992), there exist few data with which to evaluate the results of our model. We recommend an organized international effort to assemble critical 'biogeochemical' data sets required to develop and evaluate comprehensive coupled ocean models.

9AM2000 S3-058 invited  
**VERTICAL DISTRIBUTION OF PLANKTON IN THE JAPAN SEA IN WINTER AND IN SPRING**

Natalia T. Dolganova

*Pacific Fisheries Research Center (TINRO-Center), 4 Shevchenko Alley, Vladivostok, Russia. 690600 e-mail: root@tinro.marine.su*

Vertical distribution of plankton is considered by the data of 3 day-and-night stations coupled with data of 40 tows carried out both in light and dark times. The stations were located in the zones with Subarctic and Subtropic water structure in winter and spring.

In spring the concentration of zooplankton is 3-4 times higher in the upper 100 m layer due to increasing of all groups, especially Copepods. Amplitude of daily vertical migration of Copepods is maximal in spring. The most active vertical migrations had *Neocalanus cristatus* and *Metridia pacifica* which passed daily through a layer more than 1000 m. Small-size Copepod species as *Oithona similis* and *Pseudocalanus minutus* were observed everywhere in 1000 m water column but their maximal concentrations in any time were in the upper 50 m layer. In opposite, mass species of other groups as *Themisto japonica*, *Thysanoessa longipes*, and *Euphausia pacifica* did not rise to the upper 100 m layer in early April and concentrated in the layer 100-500 m. But their migrations became more active in May when these species had maximal concentrations at the sea surface at night. Concentration of zooplankton in the layer 200-500 m is stable in day and night both in winter and spring.

9AM2000 W7-363 oral  
CARBON CYCLE OBSERVATIONS AT THE HAWAII OCEAN TIME-SERIES STATION ALOHA

John E. Dore

Department of Oceanography, School of Ocean and Earth Science & Technology, University of Hawaii, 1000 Pope Rd., Honolulu, HI 96822, U.S.A. e-mail: [jdore@soest.hawaii.edu](mailto:jdore@soest.hawaii.edu)

Hawaii Ocean Time-series program scientists have been studying carbon biogeochemistry in the central North Pacific (Station ALOHA; 22°45'N, 158°W) since 1988. Dissolved inorganic carbon (DIC; by coulometry) and total alkalinity (TA; by open-cell titration) have been measured at nearly monthly intervals since the inception of the program, yielding uninterrupted eleven-year time-series datasets. Additional inorganic carbon parameters, pH (by spectrophotometry) and the partial pressure of CO<sub>2</sub> (pCO<sub>2</sub>; by underway equilibration with infrared detection), were measured for six and two year periods, respectively. These overlapping datasets allowed for the overdetermination of the inorganic carbon system at Station ALOHA utilizing the CO<sub>2</sub> system calculation program of Lewis and Wallace (1998, ORNL/CDIAC-105). Internal consistency of measured parameters was obtained when the apparent dissociation constants of Merbach *et al.* (1973, *Limnol. Oceanogr.* 18:897) were employed. Surface ocean DIC and pCO<sub>2</sub> both showed distinct seasonal cycles (mean ranges = 15 μmol·kg<sup>-1</sup> and 34 μatm, respectively). These seasonal signals were superimposed on increasing temporal trends (1 μmol·kg<sup>-1</sup>·y<sup>-1</sup> and 2 μatm·y<sup>-1</sup>, respectively), revealing an oceanic response to rising atmospheric CO<sub>2</sub>. Concurrent ecological studies have indicated strong interannual changes in photosynthetic carbon fixation rates, particulate and dissolved organic carbon pools, and the gravitational export of particulate carbon to the deep sea. These dynamics appear to be related to fundamental climate-induced changes in the phytoplankton community structure, and may have a direct effect on the long-term sequestration of carbon in the ocean.

9AM2000 FISp059 oral  
ARE DECLINES IN LARVAL FISH MORTALITY FOLLOWING METAMORPHOSIS LINKED TO HYDRODYNAMIC EFFICIENCY?

John Dower

Earth & Ocean Sciences, University of British Columbia, 6270 University Blvd., Vancouver, B.C., Canada. V6T 1Z4 e-mail: [dower@eos.ubc.ca](mailto:dower@eos.ubc.ca)

In most marine fishes, mortality during the early life history stages declines dramatically following metamorphosis from the late-larval to the juvenile stage. This is usually attributed to the fact that juvenile fish are both better swimmers and better able to avoid predators than are larval fish. Interestingly, however, weight-specific respiration rates also decline dramatically following metamorphosis. Is it possible that declines in mortality following metamorphosis result instead from changes in "hydrodynamic efficiency"? Specifically, at around the same time that many larval fish undergo metamorphosis they also switch from living in a world dominated by viscous forces to one dominated by inertial forces. Does this also make them energetically more efficient? If so, it suggests that hydrodynamics may play a direct (but previously unrecognized) role in the growth and survival of larval fish. I will explore this possibility using a variety of fish species, including key species from the Northeast Pacific.

9AM2000 FISp061 oral  
TROPIC RELATIONS OF PINK (*Oncorhynchus gorbusha*) AND CHUM SALMON (*O. keta*) JUVENILES IN THE EPIPELAGIC LAYER IN THE SOUTHERN OKHOTSK SEA IN FALL-WINTER

Elena P. Dulepova

Pacific Fisheries Research Centre (TINRO-Centre), 4 Shevchenko Alley, Vladivostok, Russia. 690600 e-mail: [dulepov@marine.febras.ru](mailto:dulepov@marine.febras.ru)

The data collected during fall-winter 1991-1992, 1994 and 1995 in the southern Okhotsk Sea revealed that juveniles of pink and chum salmon formed the base of nekton biomass in the epipelagic layer in that seasons. Prolonged presence salmon juveniles could be conditioned by the complex of reasons the main of which is trophic circumstances. The characteristic feature of the plankton biomass in this region was the high percentage of hyperiids amphipod. As was established, both appendicularias and the hyperiids are the favorite food of pink and chum juveniles but in areas where these planktonic groups are un abundant juveniles began to feed on other plankton organisms.

In epipelagic layer other nekton species also fed on the appendicularias and hyperiids but this did not decrease food resources in this zone. That was connected to either low biomasses of potential trophic competitors (for instance; squid *Gonatus borealis*) comparing with salmon juveniles or small daily rations of some of them (deep-sea smelt *Leuroglossus schmidti*).

Although juvenile pink had high daily rations, these fish did not grow in this period because the metabolism processes only used whole food energy.

Probably in fall-winter pink salmon pass through the specific period of life history in the epipelagic layer in Okhotsk Sea. In this time growth deceleration and intensive metabolism are the necessary conditions of pink development, which precedes a sexual maturation.

9AM2000 S3-060 poster  
**COMPARATIVE ANALYSIS OF ZOOPLANKTON PRODUCTIONAL CHARACTERISTICS IN THE BERING AND OKHOTSK SEAS**

Elena P. Dulepova  
*Pacific Fisheries Research Centre (TINRO-Centre), 4 Shevchenko Alley, Vladivostok, Russia. 690600 e-mail: dulepov@marine.febras.ru*

Composition and production of zooplankton have been examined on the data collected in the Bering and Okhotsk seas in 1984-1998. Small copepods (less 3.5 mm) formed the base of un predatory zooplankton production while the chaetognaths (*Sagitta elegans* only) composed the most portion of predatory zooplankton production. This regularity was observed independently of season and region and conditioned by the high rate of daily production and large biomasses of these groups. Even small variations in the species composition of both un predatory and predatory zooplankton influenced on the value of P/B ratio.

On the whole in summer seasonal P/B ratio for un predatory zooplankton ranged from 3.7 to 4.0 and for predatory one, 0.9-1.1 in both Okhotsk and Bering Seas. In fall this characteristic for the both groups amounted 1.6-2.0 and 0.9-1.1 respectively.

In all seasons in the Bering Sea average production was lower in comparison with one in Okhotsk Sea. In summer and fall it amounted 318-618 g/m<sup>2</sup> and 108-172 g/m<sup>2</sup> for un predatory zooplankton in the Bering and Okhotsk Seas respectively. Production of predatory zooplankton was approximately equal each other - 124 and 130 g/m<sup>2</sup> in summer and 56 and 55 g/m<sup>2</sup> in fall respectively.

9AM2000 S6-062 oral  
**RECENT CHANGES IN THE BIOLOGICAL PUMP IN THE SUBTROPICAL NORTH PACIFIC OCEAN**

Steven R. Emerson, Sabine Mecking and Jeff Abell  
*School of Oceanography, University of Washington, P.O. 357940, Seattle, WA 98195, U.S.A. e-mail: emerson@u.washington.edu*

Recent observations from the Hawaii Ocean Time series indicate that a large fraction of the nitrogen supply to the euphotic zone is presently from the atmosphere via nitrogen fixation. This extra source of nitrogen creates a non-steady state nutrient flux in which the N:P ratio in particulate organic matter exiting the upper ocean (N:P = 23) is greater than the value dissolved in the upper thermocline (N:P = 15). Carbon to nitrogen ratios in the particulate export flux have remained between 7-8 in spite of the N:P changes, suggesting that nitrogen fixation may have increased the biological carbon export even though Redfield arguments would suggest phosphorus should be limiting. Comparison of AOU distributions in the upper thermocline of four meridional transects through the northeast subtropical Pacific between 1980 and 1997 suggests that there has been an increase of 20-30% over the past two decades. We argue that the results cannot be explained without invoking changes in the biological pump or upper-ocean ventilation by as much as 30-50%. Taken together, changes in the particulate organic matter P:N:C ratios and the AOU in the upper thermocline of the eastern north Pacific indicate that the onset of nitrogen fixation has resulted in an increase in the biological pump over that expected from nutrient delivery to the euphotic zone from ocean circulation. This suggests that, over these time scales, nutrient stoichiometry in organic matter is determined by supply to the euphotic zone rather than biological necessity, and that phosphorus supply in the Redfield ratio does not constrain the rate of biological carbon export from the upper ocean.

9AM2000 S6-063 oral  
**SYNTHESIS OF PACIFIC OCEAN DIC AND TALK SURVEY DATA**

Richard A. Feely<sup>1</sup>, C.L. Sabine<sup>1</sup>, M.F. Lamb<sup>1</sup>, R. Wanninkhof<sup>2</sup>, R.M. Key<sup>3</sup>, G.C. Johnson<sup>1</sup>, F.J. Millero<sup>4</sup>, K. Lee<sup>2</sup>, T.-H. Peng<sup>2</sup>, T. Ono<sup>5</sup>, Y. Watanabe<sup>6</sup> and C.S. Wong<sup>7</sup>

<sup>1</sup> NOAA/Pacific Marine Environmental Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115, U.S.A. e-mail: feely@pmel.noaa.gov

<sup>2</sup> NOAA/Atlantic Oceanographic and Meteorological Laboratory, 4301 Rickenbacker Causeway, Miami, FL 33149, U.S.A.

<sup>3</sup> Department of Geosciences, Princeton University/Guyot Hall, Princeton, NJ 08544, U.S.A.

<sup>4</sup> University of Miami/ RSMAS, 4600 Rickenbacker Causeway, Miami, FL 33149, U.S.A.

<sup>5</sup> National Research Inst. of Fisheries Science, 12-4 Hukuura, Kanazawa-Ku, Yokohama, Japan. 236-8648 Presently at: Ecosystem Change Research Program, FRSGC/IGCR, Sumitomo Hamamatsu-cho bldg. 4F, 1-18-16 Hamamatsuyto, Minato-ku, Japan. 105-0013

<sup>6</sup> National Institute for Resources and Environment, 16-3 Onogawa, Tsukuba, Ibaraki, Japan. 305-8569

<sup>7</sup> Institute of Ocean Sciences, P.O. Box 6000, Sidney, B.C., Canada. V8L 4B2

Between 1991 and 1996, dissolved inorganic carbon (DIC) and total alkalinity (TALK) measurements were made on twenty-four WOCE/JGOFS/OACES cruises in the Pacific Ocean. Investigators from 15 different laboratories and 4 countries have analyzed at least two of the four measurable ocean carbon parameters. Several different lines of evidence were used to examine the consistency including comparison of calibration techniques, results from certified reference material analyses, precision of at-sea

replicate analyses, agreement between shipboard analyses and replicate shore-based analyses, comparison of deep water values at locations where two or more cruises overlapped or crossed, consistency with other hydrographic parameters, and internal consistency with multiple carbon parameter measurements. The data have been combined to generate a Pacific Ocean data set with over 36,000 unique sample locations analyzed for at least two carbon parameters. The best data coverage was for DIC, which has an estimated overall accuracy of  $3 \mu\text{mol kg}^{-1}$  after the proposed adjustments. TALK, the second most common carbon parameter, has an estimated overall accuracy of  $5 \mu\text{mol kg}^{-1}$ . These data have been integrated into a unified internally consistent data set and the physical and chemical controls of the basinwide distributions of DIC and TALK will be discussed.

9AM2000 W7-364 oral  
**SYNTHESIS OF PACIFIC OCEAN DIC AND TALK SURVEY DATA**

Richard A. Feely<sup>1</sup>, C.L. Sabine<sup>1</sup>, M. F. Lamb<sup>1</sup>, R. Wanninkhof<sup>2</sup>, R.M. Key<sup>3</sup>, G.C. Johnson<sup>1</sup>, F.J. Millero<sup>4</sup>, K. Lee<sup>2</sup>, T.-H. Peng<sup>2</sup>, T. Ono<sup>5</sup>, Y. Watanabe<sup>6</sup> and C.S. Wong<sup>7</sup>

<sup>1</sup> NOAA/Pacific Marine Environmental Laboratory, 7600 Sandpoint Way NE, Seattle, WA 98115, U.S.A. e-mail: feely@pmel.noaa.gov

<sup>2</sup> NOAA/Atlantic Oceanographic and Meteorological Laboratory, 4301 Rickenbacker Causeway, Miami, FL 33149, U.S.A.

<sup>3</sup> Department of Geosciences, Princeton University/Guyot Hall, Princeton, NJ 08544, U.S.A.

<sup>4</sup> University of Miami/ RSMAS, 4600 Rickenbacker Causeway, Miami, FL 33149, U.S.A.

<sup>5</sup> National Research Inst. of Fisheries Science, 12-4 Hukuura, Kanazawa-Ku, Yokohama 236-8648 Japan. Currently at: Ecosystem Change Research Program, FRSGC/IGCR, Sumitomo Hamamatsu-cho bldg. 4F, 1-18-16 Hamamatsutyo, Minato-ku, 105-0013 Japan

<sup>6</sup> National Institute for Resources and Environment, 16-3 Onogawa, Tsukuba-shi, Ibaraki 305-8569 Japan

<sup>7</sup> Institute of Ocean Sciences, P.O. Box 6000, Sidney, BC, Canada. V8L 4B2

Between 1991 and 1996, dissolved inorganic carbon (DIC) and total alkalinity (TALK) measurements were made on twenty-four WOCE/JGOFS/OACES cruises in the Pacific Ocean. Investigators from 15 different laboratories and 4 countries have analyzed at least two of the four measurable ocean carbon parameters. Several different lines of evidence were used to examine the consistency including comparison of calibration techniques, results from certified reference material analyses, precision of at-sea replicate analyses, agreement between shipboard analyses and replicate shore-based analyses, comparison of deep water values at locations where two or more cruises overlapped or crossed, consistency with other hydrographic parameters, and internal consistency with multiple carbon parameter measurements.

With the adjustments proposed here, the data can be combined to generate a Pacific Ocean data set with over 36,000 unique sample locations analyzed for at least two carbon parameters. The best data coverage was for DIC, which has an estimated overall accuracy of  $\sim 3 \mu\text{mol kg}^{-1}$  after the proposed adjustments. TALK, the second most common carbon parameter, has an estimated overall accuracy of  $\sim 5 \mu\text{mol kg}^{-1}$ . The data have been integrated into a unified internally consistent data set and the physical and chemical controls of the basinwide distributions of DIC and TALK will be discussed.

9AM2000 POCp064 poster  
**OKHOTSK SEA SHELF AND SLOPE WATERS CIRCULATION IN COLD SEASONS OF THE YEAR**

A.L. Figurkin

Pacific Fisheries Research Center (TINRO-Center), 4 Shevchenko Alley, Vladivostok, Russia. 690600 e-mail: root@tinro.marine.su

The data obtained during cold season (15,000 stations) were collected to plot new monthly charts of currents. These charts differ considerably from those made by Moroshkin, Chernyavsky and Luchin, as the latter described the currents during warm seasons only. The main reason of differences between the charts is the winter formation of cold shelf waters with high salinity, which change the general spatial regularity of the density distribution. The density grows toward the coast, and causes clockwise water circulation in the Shelikhov Bay, and this is registered in April-June. The transport of dense waters from the bay onto the shelf of Western Kamchatka forms an abnormal southward current (Compensatory shelf Current), traditionally registered from February to April. Sometimes the traces of the current may be visible till August. Though after mild winters, the northern sea currents slightly resemble the currents of the warmer period, but after severe winters the North-Okhotsk Current is never observed. Instead of it there is the opposite eastward water movement. After winter period, the south water movement along Eastern Sakhalin is observed only in the cases when the density of shallow waters is lower than that of colder saline shelf waters (same as by Fujii & Abe, 1976). But in such cases the speed and the width of the current is much smaller than that in October-March. It is often when instead East Sakhalin Current there is observed the northward motion of waters, and the intensity of which is higher along the outer side of the dense water. The difference in the type of circulation of shelf waters after cold and mild winters produces great effect on the summer raise in water temperature, as well as the location and accumulation of river discharge waters. It also influences greatly on the water salinity and the content of nutritious elements, and moreover, on development of plankton and survival of fish eggs and larvae.

9AM2000 W2-338 oral  
**DIET AND FEEDING OF JUVENILE PACIFIC HERRING**

Robert J. Foy<sup>1</sup> and Brenda L. Norcross<sup>2</sup>

<sup>1</sup> Fishery Industrial Technology Center

<sup>2</sup> Institute of Marine Science, School of Fisheries & Ocean Sciences, University of Alaska Fairbanks, Fairbanks, AK 99775-7220, U.S.A. e-mail: norcross@ims.alaska.edu

Diets of juvenile Pacific herring (*Clupea pallasii*) in Prince William Sound (PWS), Alaska were examined to determine feeding characteristics from March 1996 through March 1998. We examined relationships between diets of juvenile herring, zooplankton abundance, feeding preference, and environmental conditions in PWS. We analyzed the amount of feeding, prey taxa composition and the diversity of prey in the herring diets. Non-metric multidimensional scaling ordination techniques revealed that prey species composition was correlated to spatial and seasonal trends in temperature and depth at which herring were captured and assumed feeding. Seasonal maxima in feeding, diet diversity, and amount of filter feeding were noted in the spring when zooplankton were abundant. Spring diets were dominated by small calanoid copepods and Cirripedia larvae in 1996 and 1997. Euphausiacea taxa, which were found in the 1996 spring diets, were replaced by *Metridia* sp. and *Neocalanus* sp. adults in 1997. June through August, Cladocera, invertebrate eggs, *Oikopleura* sp. and small copepods made up the majority of prey items in diets. Prey selectivity was higher during the winter months when prey was scarce, was positively correlated to fish length and negatively correlated to depth of fish capture. Juvenile herring were primarily filter feeding from 0800 h to 1600 h and particulate feeding on large calanoid copepods from 0000 h to 0800 h. Both methods of feeding were employed during low light levels from 1600 h to 2359 h when density of prey in the stomachs was highest. Increased temperatures in the summer and fall of 1997 decreased zooplankton availability and consequently decreased herring feeding. Seasonal and spatial variability in prey density significantly affects seasonal feeding patterns of herring. Environmental changes such as high temperatures can cause large fluctuations in prey availability in PWS leading to decreased feeding in juvenile herring.

9AM2000 W1-065 oral  
**Argo - PROGRESS TOWARDS IMPLEMENTATION**

Howard J. Freeland

Institute of Ocean Sciences, P.O. Box 6000, Sidney, BC, Canada. V8L 5R4 e-mail: FreelandHj@pac.dfo-mpo.gc.ca

Argo is an ambitious program that will, following implementation, supply temperature, salinity and absolute velocity data from the global ocean, every 10 days between the surface and a pressure of 2000 db. This, coupled with data from altimetric satellites, should allow the initiation of oceanic forecast models.

This talk will offer a thumbnail sketch of the technology to be used, the objectives of Argo and related projects but will focus on an update of changes that have occurred within the last 12 months and an outline of what can be expected over the next 6 months as we move into the implementation phase of Argo.

9AM2000 S5-317 oral  
**HEAT FLUX ACROSS LINE-P DURING PERIOD JANUARY 1996 TO JUNE 1999**

Howard J. Freeland

Institute of Ocean Sciences, P.O. Box 6000, Sidney, B.C., Canada. V8L 4B2 e-mail: FreelandHj@pac.dfo-mpo.gc.ca

Since 1956 Canada has conducted routine sampling along a line of stations extending from the mouth of the Juan de Fuca Strait to Ocean Station Papa (50°N, 145°W) in the Gulf of Alaska. This allows unambiguous definitions of the mean distribution of scalar ocean properties along this line.

In recent years we have been able to complete only 3 surveys per year along Line-P, but in the spring of 1997, when it became apparent that a major El Niño event was starting, the Canadian Department of Fisheries and Oceans funded an emergency "El Niño-Watch" program. This allowed a large increase in the number of expeditions sampling along Line-P and allowed us to capture the development and decay of perturbations along Line-P.

It is a simple matter to map the distribution of, say, temperature along Line-P during any given cruise, subtract a representation of the mean state and so map temperature anomalies. However, to compute heat flux anomalies requires knowledge of the velocity anomaly field and this is far more problematic. During this talk I will show velocity anomaly fields from a sequence of sections computed from a combination of the anomaly of geostrophic velocity relative to the sea surface, and the anomaly of sea-level computed using Topex-Poseidon data with the mean defined as the average over the history of Topex-Poseidon observations. The product of  $v'$  and  $T'$  integrated over the section yields an estimate of the anomaly of the flux of heat across Line-P due to the geostrophic component of velocity.

Off the coast of British Columbia we have a large array of meteorological buoys with data sets starting in 1981. These are used to estimate the Ekman heat flux anomaly.

The estimates of heat flux remain problematic because Line-P extends into the middle of the Gulf of Alaska and does not form a closed volume to the coast of Alaska. The estimates suggest a large volume flux across Line-P into the Gulf of Alaska which may or may not be compensated for by a balancing outflow along the Alaskan coast. The constraint of zero mass-flux can be forced by subtracting spatial means from the section. The two resulting estimates of the time series of heat flux with and without spatial means subtracted represent extrema, one showing a very high heat flux and the other a rather smaller heat flux. These two end-member estimates will be compared. In both cases a distinct peak is seen in both the Ekman and geostrophic heat flux estimates. This peak is substantially narrower in time than the peak shown in the temperature anomaly field.

9AM2000 W7-365 oral

#### APPLICATION OF ONE-DIMENSIONAL ECOSYSTEM MODEL TO TIME SERIES STATION KNOT OBSERVATION

Masahiko Fujii<sup>1</sup>, Yukihiko Nojiri<sup>2</sup>, Yasuhiro Yamanaka<sup>1,4</sup> and Michio J. Kishi<sup>3,4</sup>

<sup>1</sup> Graduate School of Environmental Earth Science, Hokkaido University, N10W5, Kita-ku, Sapporo 0600810, Japan e-mail: fujii@ees.hokudai.ac.jp

<sup>2</sup> National Institute for Environmental Studies, 16-2 Onogawa, Tsukuba, Ibaraki 305-0053, Japan

<sup>3</sup> Faculty of Fisheries, Hokkaido University, Minato-cho 3-1-1, Hakodate, Hokkaido 041-8611, Japan

<sup>4</sup> Frontier Research System for Global Change, Seavans North 7F, 1-2-1 Shibaura, Minato-ku, Tokyo 105-0023, Japan

A vertical one-dimensional ecosystem model was constructed and applied to Station KNOT (Kyodo North Pacific Ocean Time series, 44°N, 155°E). The model has two categories of phytoplankton, representing diatom and non-diatom phytoplankton (including coccolithophorids), respectively. Three categories for zooplankton represent zooplankton predator, large zooplankton grazing diatom, and small zooplankton grazing non-diatom phytoplankton. Nitrogen is distributed into plankton compartments, particulate organic matter, dissolved organic matter, nitrate and ammonium. Silica is distributed into diatom, sinking opal and dissolved silicate. Calcium is distributed into non-diatom phytoplankton, small zooplankton, sinking calcium carbonate and dissolved calcium. Carbon uptake is expressed by the two pass ways, one is photosynthesis having a constant C/N ratio, and the other is calcification by small phytoplankton and small zooplankton. Inorganic carbon is expressed by dissolved inorganic carbon and alkalinity, which are influenced by the photosynthesis and calcification.

This ecosystem model is coupled with a mixed layer model having 28 layers, driven by sea surface temperature and salinity obtained by KNOT time series observation. Parameters of photosynthesis and grazing along with physical conditions have high sensitivity to the temporal variation of nutrients in euphotic zone. With optimal values of these parameters, the seasonal variations of nutrients and biological productivity were well represented. The uptake of silica by diatom is assumed to have constant ratio to nitrogen uptake in the present model. This ratio is a significantly sensitive parameter not only for the temporal variation of nutrients but also for the size of each plankton compartment.

9AM2000 POCp066 oral

#### LONG-TERM MOORING MEASUREMENT OFF THE EAST COAST OF SAKHALIN IN THE SEA OF OKHOTSK PART II: WATER PROPERTIES

Yasushi Fukamachi<sup>1</sup>, Genta Mizuta<sup>2</sup>, Kay I. Ohshima<sup>1</sup> and Masaaki Wakatsuchi<sup>1</sup>

<sup>1</sup> Institute of Low Temperature Science, Hokkaido University, Nishi 8 Kita 19, Sapporo, Hokkaido, Japan. 060-0819 e-mail: yasuf@lowtem.hokudai.ac.jp

<sup>2</sup> Graduate School of Environmental Earth Science, Hokkaido University, Japan

The Sea of Okhotsk is an important source region of the North Pacific Intermediate water which spreads widely over the subtropical Pacific around a potential density surface of 26.8. The region off the east coast of Sakhalin is thought of as a pathway of this source water from the northwestern part to the southwestern part.

Along with the current velocity (presented as Part I: Flow field by Mizuta *et al.*), temperature and salinity in this region were observed by 8 current meters, 7 conductivity-temperature sensors, and 11 thermistors moored at four locations along 53°N and at two locations along 49.5°N. Most of the instruments provided valid data throughout the entire mooring period from August 1998 to September 1999.

Seasonal variability is clearly seen in both temperature and salinity. Water with potential density larger than 26.8 is observed at two moorings in the slope region (503 m and 986 m deep) along 53°N between two conductivity-temperature sensors moored around 200 m and 450 m deep. This water is mostly absent during winter at the shallower mooring, while it is present throughout the entire mooring period at the deeper mooring.

In September 1999, six moorings were deployed again near Sakhalin. These moorings are planned to be recovered during this summer. The preliminary report of the data from these moorings will be also presented.

9AM2000 S6-067 poster  
**VARIABILITY OF CHLOROPHYLL *a* AND SEA ICE CONCENTRATION IN THE OKHOTSK SEA AS OBSERVED FROM SATELLITE DURING 1996-1999**

Kumiko Fukuda, Sei-ichi Saitoh, Shin-ichiro Noriki, Takeshi Nakatsuka and Masaaki Wakatsuchi  
Graduate School of Fisheries Sciences, Minato-cho 3-1-1, Hakodate, Hokkaido, Japan. 041-8611 e-mail:  
fukuda@salmon.fish.hokudai.ac.jp

A series of satellite data from OCTS and SeaWiFS over three year period in the Okhotsk Sea, were examined to reveal spatial and temporal distribution of chlorophyll *a* (chl *a*) concentration. We compared chl *a* concentration with carbon flux detected by sediment trap, which was moored at 44°31.7'N, 144°43.9'E. In the Okhotsk Sea the sea ice, which consists entirely of first year ice, is an important characteristic and thought as one of a factor controlling phytoplankton distribution and their productivity. The objectives of this study are to examine the relationship between chl *a* and sea ice distribution and to reveal these year-to-year variability using data from two ocean color sensors and passive microwave sensor, SSM/I. During the winter of 1996-1997 and 1997-1998, the area covered with sea ice was smaller than the average of recent years. In 1998-1999 winter ice extent developed larger and pack ice were seen off Okhotsk coast of Hokkaido until April. SeaWiFS images showed high chl *a* concentration (about 3.0-20mg·m<sup>-3</sup>) expanding from coast zone to Kuril Basin during April and May 1999. Relatively low concentrations were seen in central part of the Okhotsk Sea. Variability of satellite derived chl *a* was similar to that of carbon flux observed by sediment trap.

9AM2000 W2-068 keynote  
**ABUNDANCE AND HISTORICAL TRENDS OF HERRING IN ALASKAN WATERS**

Fritz C. Funk  
Alaska Department of Fish and Game, 1255 West 8th Street P.O. Box 25526, Juneau, AK 99802-5526. U.S.A. e-mail:  
fritz\_funk@fishgame.state.ak.us

Pacific herring, *Clupea pallasii*, have been commercially harvested in Alaska for over a century, beginning with a reduction fishery in Southeast Alaska. Exploitation rates were quite high during the reduction era in the Gulf of Alaska and during the foreign fisheries in the Bering Sea, with large fluctuations in stock levels and annual harvests. During the last two decades herring have been taken primarily for sac roe, with lesser amounts taken for bait. Harvest policies have become more conservative, resulting in more stable stock levels and overall catches. The life history of Pacific herring is distinctly different in the Gulf of Alaska compared to the more northerly Bering Sea. Bering Sea herring attain large body size (to 70 cm), which may be an adaptation to their long-distance migration. Spawning is intertidal and subtidal during May and early June and occurs in discrete locations from the Alaska Peninsula to Norton Sound. The Bering Sea herring life history strategy appears to be an adaptation to take advantage of the distant rich feeding grounds and benign overwintering areas on the continental shelf edge while utilizing the protected inshore bays for summer larval nurseries. In contrast, Gulf of Alaska herring are smaller, have shorter lifespans, more frequent recruitment events and do not undergo long distance migrations. In the Gulf of Alaska, recruitment events tend to occur synchronously over fairly broad areas which contain otherwise discrete spawning aggregations. Throughout Alaska, the declining market for herring roe products may result in reduced exploitation rates in the future.

9AM2000 S2-069 invited  
**SANDEEL CONSUMPTION BY PREDATORS IN THE NORTH SEA: IMPLICATIONS FOR FISHERY MANAGEMENT**

Robert W. Furness  
University of Glasgow, Graham Kerr Building, Glasgow, United Kingdom. G12 8QQ e-mail: r.furness@bio.gla.ac.uk

The North Sea industrial fishery for sandeels takes around 800,000 tonnes p.a., with a precautionary TAC of 1 million tonnes. Sandeels are major spring and summer food of many predatory fish, marine mammals and seabirds. Around 4 million pairs of seabirds breed on North Sea coasts. Despite these large, increasing, seabird numbers and high food demand of homeotherms, bioenergetics modeling indicates consumption of sandeels to be predominantly by predatory fish. Seabird consumption (210,000 tonnes p.a.) is unlikely to affect sandeel availability to the fishery. Fishery take could affect seabirds if catches were concentrated near large seabird colonies. The low observed impact on seabirds may be due to spatial separation of peak consumption areas of birds and fishery, density-dependence of sandeel recruitment, and greatly reduced sandeel consumption by predatory fish due to depletion of those stocks. Comparing sandeel consumption in the 1970s to the 1990s shows total take decreased because reductions in stocks of predatory fish have been greater than growth of the industrial fishery and seabird populations. Quantification of trophic relations has confirmed that an ecosystem approach to sandeel management is essential. In particular, recovery of the greatly depleted North Sea mackerel and whiting stocks might have important impacts. Management must also be spatially resolved to account for patchy distributions of biota and fishing. A closure from January 2000 of the sandeel fishery, in a small area of the North Sea based on poor seabird breeding success, represents a significant step in fisheries management for sustainable ecosystems.



9AM2000 W6-070 oral  
**ESTIMATION OF PREY CONSUMPTION BY SEABIRDS IN THE NORTHEAST ATLANTIC OCEAN**  
Robert W. Furness  
University of Glasgow, Graham Kerr Building, Glasgow, United Kingdom. G12 8QQ e-mail: r.furness@bio.gla.ac.uk

A primary objective of ICES Working Group on Seabird Ecology is to provide spatially and temporally resolved estimates of consumption by seabirds in ICES and NAFO areas, for incorporation into ecosystem models. Several of these studies are now published. I will review the construction and testing of bioenergetics models, and present some implications of the results. Estimates require good data on seabird numbers, diet composition, and daily food requirements. Accuracy of estimates from bioenergetics models can be assessed by Monte Carlo simulations. These highlight the importance of accurate counts of adult seabirds in the study area and seabird diet composition. It is possible to construct sophisticated bioenergetics models incorporating detailed time-activity budgets for breeders and for nonbreeders, costs of egg production, chick growth models, molt models and accounting for influences of environmental conditions on these parameters. However, for most gross estimates of food consumption by higher-trophic-level predators, accuracy is constrained by input data on bird numbers and diet, which tend to be known only  $\pm 25\%$  or worse. Simple models based on multiples of seabird field metabolic rates (FMRs) estimated from allometric equations are preferable. Generally, seabirds consume less food than marine mammals, and much less than predatory fish. However, relative consumption by seabirds is scale-dependent. Consumption can be high in small areas around breeding colonies. Seabirds are unlikely to have big effects on fishery catches but fisheries close to seabird colonies may strongly influence food availability to central place foraging seabirds. This generalization will be illustrated by considering sandeel-seabird-fishery interactions in the North Sea.

9AM2000 S9-071 poster  
**PECULIARITIES OF SCALLOP (*Mizuhopecten yessoensis* jay) BOTTOM CULTIVATION IN PETER THE GREAT BAY (THE SEA OF JAPAN)**  
G.S. Gavrilova  
Pacific Research Fisheries Center (TINRO-Center), 4 Shevchenko Alley Vladivostok, Russia. 690600 e-mail: root@tinro.marine.su

Among the other methods of invertebrates mariculture the so-called pasturable cultivation is the most perspective and progressive for scallop cultivation. In this case the juveniles growing obtained from spawners in vivo up to market size at the bottom plantations. In the most critical period of life (from settling up to 1 year) the animals are grown up in collectors.

To select the sites for plantations formations for scallop growing it is necessary to take in to account not only the right grounds, predators, but functional structure of its natural population as well. Inside the bays of the second order Amurskiy, Strelok, Vostok scallop aggregations consist of large beds of adult mature individuals in the deepwater Bays (15-20 m) and peripheric aggregations at the depth up to 10-12 m with difference age structure. Plantations formation at the peripheric sites but close to adults will allow to obtain not only market production but to form functioning aggregations recruitment of which will be carried out not only by their own potential but also larvae pool of adult individuals. In further besides of bottom cultivation it is available to organize farm for collection spat on collectors in their sites.

In case of parents sites absence (for example Nakhodka Bay), created artificial plantations permit to obtain market production, but formation of independently functioning scallop aggregations does not occur.

9AM2000 S9-072 poster  
**THE USE OF LONG-TERM PHYSICAL AND STATISTICAL METHODS TO FORECAST YIELD OF MOLLUSKS ON MARINE FARMS**  
Larissa A. Gayko  
Far East State Marine Reserve, Institute of Marine Biology, Far East Branch Russian Academy of Sciences, Vladivostok, Russia. 690041 e-mail: inmarbio@mail.primorye.ru

Planned yield is very important for normal performance of sea farms. In this work a method of the long-term forecast of mollusks efficiency (exemplified by the Japanese scallop) was developed. Data on marine shell yield for the Experimental Sea Base "Possyet" (where the Japanese scallop was 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<sup>2</sup> and individ/m<sup>2</sup>). 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. That is why as predictors we used the following parameters: temperature and salinity of the surface water level, cumulative temperature and salinity of the sea water, with regard to various stages of the life cycle of cultivated mollusks, duration of ice period, air

temperature, wind velocity, precipitation, atmospheric pressure, weather type, forms of atmospheric circulation, type of synoptic processes, position and intensity of circumpolar eddy (the Pestereva complex index), sunshine duration, solar activity (Wolf numbers), solar and lunar eclipses.

As a result, a selection of information predictors at a given level of significance was made and a block diagram of the forecast was developed, in which separate forecasting for trend and random component of seaside shell efficiency was provided. For the first time the linear discriminant analysis was applied to forecast marine shell productivity. Forecast diagrams with various time (from 9 till 1 months) were obtained. The rules of static and dynamic complication of the forecast were developed.

The results permit us to hope that the method will be used in practice.

9AM2000 S4-073 invited  
**THE CANADIAN NE PACIFIC SQUID FISHERY, AND THE RELATIONSHIP OF SQUID DISTRIBUTIONS TO CHANGING OCEAN CONDITIONS**

Graham E. Gillespie, R. Ian Perry and Howard J. Freeland

*Pacific Biological Station, Nanaimo, B.C., Canada. V9R 5K6 e-mail: GillespieG@pac.dfo-mpo.gc.ca*

An experimental Canada fishery for neon flying squid (*Ommastrephes bartramii*) has been conducted in oceanic waters within the Canadian economic zone of the NE Pacific since 1996. It has used a variety of fishing techniques, including surface lights at night and lights at depth during the day. Catch rates and fishing locations have varied over the years, as experience was gained in the fishery and as environmental conditions changed through this period. In this study, we review the features of this fishery, and examine the relationships of squid distributions with oceanographic conditions. In particular, we examine changes in squid north-south distributions in relation to upper-layer isotherms; the by-catch of other species in relation to ocean conditions; and the spatial scale of aggregations of squid in relation to ocean conditions.

9AM2000 POCp324 oral  
**FORMATION DISTRIBUTION AND SEASONAL VARIABILITY OF THE COLD OKHOTSK SEA INTERMEDIATE WATER**

Sergey V. Gladyshev and M. Wakatsuchi

*Institute of Low Temperature Science, Hokkaido University Kita 19, Nishi 8, Sapporo 060-0819, Japan e-mail: sergey@soya.lowtem.hokudai.ac.jp*

The Okhotsk Sea is a marginal semi-enclosed sea that appears to be the main source of cold less saline and oxygenated intermediate water in the western North Pacific. A number of investigators pointed out the large difference in thermohaline properties between the Okhotsk Sea and North Pacific in the density range 26.6-27.5  $\sigma_\theta$ . In general, upper cold Okhotsk Sea Intermediate Water (upper OSIW) or Okhotsk Sea Mode Water (OSMW) results from the mixing of a few components in a density range 26.6-27.0  $\sigma_\theta$ : North Pacific water, winter Soya water and dense shelf water (DSW). The latter annually forms on the Okhotsk Sea shelves due to brine rejection in polynyas, has temperature close to the freezing point, and makes OSMW colder less saline and rich in oxygen. There is no such a source of cold water for the lower fraction of the OSIW (27.0-27.5  $\sigma_\theta$ ); therefore the reason of its cooling and oxygenation is not so clear. In order to examine possible density range of ventilation of the OSMW by DSW, subsequent spreading and distribution of the cold water in the Okhotsk Sea (including the lower OSIW) and its seasonal variability, we use Russian-Japanese data set consisting of about 25,000 stations as well as recently collected CTD surveys. We apply isopycnal analyses to construct annually mean and two-monthly mean temperature fields and analyze seasonal variations of the bottom properties in the cold-water source regions. Our results show that East-Sakhalin Current surprisingly fast transfers the most part of cold OSIW, which is a result of strong mixing of DSW and North Pacific water at the northern and eastern Sakhalin slope, to the Deep Kuril Basin (DKB). It appears that in DKB, OSMW apparent temperature minimum in May is replaced by temperature maximum in September probably due to North Pacific inflow through Bussol Strait. Seasonal changes are different in the lower OSIW, presuming another way of its formation, but also has close relation to water exchange between the Okhotsk Sea and North Pacific. Although brine rejection is certainly intensive in Sheikhov Bay and results formation of cold water with a density more than 27.1  $\sigma_\theta$  during especially severe winters, strong tidal mixing in the mouth of the Shelikhov Bay prevents outflow of cold water more than 26.8  $\sigma_\theta$  to the Tinro Basin. Strong seasonal variations of the OSIW suggest relatively short renewal time of this water.

9AM2000 FISp074 poster  
**TROPHIC RELATIONS OF CHINOOK AND COHO SALMONS IN THE SEA OF OKHOTSK**

I.I. Glebov

*Pacific Fisheries Research Center (TINRO-Center), 4 Shevchenko Alley, Vladivostok, Russia. 690600 e-mail: root@tinro.marine.su*

Chinook and coho salmon appear to be widely distributed outside of shelf and quite abundant predators inhabiting an upper epipelagic layer. They exhibit themselves as predators and potential competitors with respect to numerous planktonic and nektonic species while being food organisms for other predatory fishes, birds and marine mammals. According to its type of feeding chinook looks as predator - nekton-eater with a regional variation in the diet composition. In the Sea of Okhotsk the fishes having fork length 40-50 cm fed on mainly squids, larger specimens preferred other fish species. Squids also predominated in the chinook's diet in the pacific waters off Kuril Islands. Chinook juveniles have similar feeding habits - feed mainly on small squids in Okhotsk Sea and pacific waters. In total both feeding chinook in June-January and juveniles in August-November consumed 20.6 th.t of food organisms 11.77 th.t of which composed of fishes. Regardless of its own size and age coho salmon fed on mainly fishes and fish juveniles during whole marine life stage. Predomination of the fishes was particularly visible in the diet of mature coho caught in the coastal waters off the western Kamchatka, Sakhalin and pacific side of Kuril Islands. There was observed a high portion of hyperiids equally with juvenile fishes in the ration of juvenile coho salmon whereas the role of small squids increased in the pacific waters. In Okhotsk Sea during summer-fall (July-August) mature coho and juveniles in August-October altogether consumed 24.1 th.t of food, 17.2 th.t of which composed of fishes. In turn both coho and chinook undergone the attacks of the other predatory fishes such as daggertooth, wolfish and salmon shark. These predators consumed 0.490-1.606 mln. sp. (0.761-2.463 th.t) of Okhotsk coho, that constituted 4.3-19.5% of its abundance in the sea in August. Also the same species consumed 0.129-0.145 mln.sp. (584.7-657.8 t) of chinook that was 2.3% of its abundance in September.

9AM2000 S6-075 oral  
**INTERANNUAL VARIATIONS IN BIOLOGICAL PRODUCTION AND CARBON CYCLING IN THE SUBARCTIC PACIFIC OCEAN: THE ROLE OF ENSO EVENTS**

Joaquim I. Goes<sup>1</sup>, Helga do R. Gomes<sup>1</sup>, Atsamon Limsakul<sup>2</sup>, Barney Balch<sup>1</sup> and Toshiro Saino<sup>2</sup>

<sup>1</sup> *Bigelow Laboratories for Ocean Sciences, P.O. Box 475, McKown Point, W. Boothbay Harbor, ME 04538, U.S.A. e-mail: jgoes@bigelow.org hgomes@bigelow.org bbalch@bigelow.org*

<sup>2</sup> *Institute for Hydrospheric and Atmospheric Sciences, Nagoya University, Chikusa, Nagoya, Japan. 464-8601 e-mail: atsa@ihas.nagoya-u.ac.jp tsaino@ihas.nagoya-u.ac.jp*

A remote sensing method developed by us, enabled us to observe large deviations from normal in the magnitude of annual nitrate based new production over the north Pacific Ocean following the El Niño event of 1997. The most dramatic of these changes were observed closer to the eastern and western margins of the subarctic Pacific Ocean. Along the west coast of North America, the magnitude of annual new production was substantially lower following the ENSO event of 1997, in agreement with previous ENSO related time series studies in the region. In the western subarctic Pacific however, a substantial increase in annual new production was observed following the ENSO event of 1997. In the absence of a documented time series data set for this region, we had to rely on a large inventory of shipboard oceanographic data to verify our observations from satellite data. Here, we present our results from these investigations and attempt to draw conclusions on the possible connections between ENSO events in the tropics and biological oceanographic conditions in the subarctic Pacific Ocean. The possible consequences of ENSO events on biological productivity and carbon cycling in the western subarctic Pacific Ocean are discussed in detail based on these findings.

9AM2000 MEQp303 oral  
**GEOCHEMICAL ASSOCIATIONS OF ELEMENTS IN SEDIMENTS FROM A COASTAL LAGOON, ADJACENT TO A SALT PRODUCING FACILITY**

Mario M. Grajeda-Muñoz<sup>1</sup>, E. Shumilin<sup>1</sup>, H. Windom<sup>2</sup>, R. Smith<sup>2</sup>, L. Godinez-Orta<sup>1</sup>

<sup>1</sup> *Centro Interdisciplinario de Ciencias Marinas (CICIMAR), La Paz, BCS, México.*

<sup>2</sup> *Skidaway Institute of Oceanography, Savannah, GA. U.S.A.*

Due to the relevance of environmental studies concerning industrial developments on the seashore we carried out a geochemical evaluation of the influence of a large salt producing facility on the coastal sediments of the adjacent Ojo de Liebre Lagoon (Peninsula of Baja California, Mexico).

Environmentally important elements such as As, Ba, Cd, Co, Cu, Mg, Ni, Pb, U, Zn and Hg, as well as carrying components such as Al, Fe, Mn, Ca, organic carbon (C-org) and carbonate carbon (C-carb) were determined in surficial sediments of the lagoon using ICP-MS and atomic absorption spectrophotometry, cold vapor atomic fluorescence spectrophotometry, and classic methods for C-org and C-carb.

Observed patterns of spatial distributions of elements in surface sediments as well as the results of principal component analysis of the data showed that there are three distinct natural geochemical associations for the elements in the sediments. The first one

includes C-org, Fe, U, Mn, Co, Zn, Cu, Hg, Ni, and As which probably reflect the natural associations of the trace elements with fine particles, enriched with organic matter, Fe and Mn oxyhydroxides. The second group includes C-carbonates, Ca and Sr related to the presence of marine biogenic carbonates (shell fragments, skeletons, etc). The third group was for Al, Ba and Pb assumed to be associated with the heavy minerals in sediments of the lagoon.

**9AM2000            MEQp076            oral**  
**INFLUENCING OF SORPTION PROCESSES ON A ACCUMULATION OF COBALT AND MERCURY ON MARINE SUSPENDED MATTER**

Lev M. Gramm-Osipov<sup>1</sup>, Aleksey V. Savchenko<sup>1</sup> and Valentina N. Gramm-Osipova<sup>2</sup>

<sup>1</sup> *Pacific Oceanological Institute, 43 Baltiyskaya Street, Vladivostok, Russia. 690041 e-mail: lmgramm@nettaxi.com*

<sup>2</sup> *Far Eastern State University, Vladivostok, Russia. 690000*

A problem of accumulation of chemical elements, which one do not form independent solid mineral phases in bottom sediments is resolved till now not satisfactorily enough. At the present communication the attempt is made to estimate a role of adsorption processes in accumulation of cobalt and mercury on a suspended matter by physico-chemical modeling, because the suspended matter is a main source of chemical elements in marine sediments.

The following assumptions were accepted at modeling: 1) The main sorbent in suspended matter is ferrihydroxide; 2) The concentration of sorbent is equal to general concentration of suspended matter; 3) The different concentrations of cobalt and mercury (from  $1 \times 10^{-10}$  mol/kg up to  $1 \times 10^{-4}$  mol/kg), specific surfaces of the sorbent (from 50 m<sup>2</sup>/g up to 800 m<sup>2</sup>/g) and concentrations of suspended matter (from 0.0001 g/l up to 0.5 g/l) were adopted to simulate the processes of sorption under various conditions.

On the basis of the conducted researches the following conclusions are made: 1) The fraction of the adsorbed form of cobalt in oceanic suspended matters is negligible and under different conditions is approximately constant; 2) The contents of mercury in suspended matter depend on total concentration of metal and can make up to 2,5% from weight of suspended matter; 3) Under sorption of cobalt on suspended matters the surface complex compounds will be happened; for mercury apart from formation of above-stated compounds there is a process of a chemisorption, as a result mercury is being included in crystal lattice of an adsorbent as solid solution; the last explains the high contents Hg in suspended matter; 4) The role of process of sorption in accumulation of cobalt and mercury in bottom sediments is different. The cobalt most apparently is accumulated in bottom sediments as a result of process co-precipitate with hydroxides Fe (III) and manganese, but mercury - as a result of sorption.

**9AM2000            S7-330            oral**  
**FEEDING OF DOTTED GIZZARD SHAD, PROCESSING OF SEDIMENT IN THE BOHAI SEA**

Xuewu Guo and Qisheng Tang

*Marine Living Resources Division, Yellow Sea Fisheries Research Institute, Chinese Academy of Fishery Sciences, 106 Nanjing Road, Qingdao, Shandong, People's Republic of China. 266071 e-mail: xguo@public.qd.sd.cn*

With specimens sampled from a shrimp culture pond at coast of the Laizhou Bay, the Bohai Sea, China, we tested consumption of dotted gizzard shad (*Clupanodon punctatus*) on marine sediment by means of Elliott-Persson (1978) method. According to its prey categories, in which sediment detritus was about 99% in biomass, daily ration, and seasonal abundance in the Bohai Sea, food requirement of the fish was estimated at about 160 thousand tons per year, that means the shad population can afford to move away about the same amount of sediment from the seabed annually by its feeding activity in the Bohai Sea, contributing significantly to sediment resuspension in the ecosystem. We guess that the nature of detritivore make dotted gizzard shad adapt itself neatly to the change of food conditions like the sharp decline of zooplankton abundance in the Bohai Sea, and ensures to the population tremendous increase in biomass.

**9AM2000            S1-320            invited**  
**INTERANNUAL VARIABILITY OF INTER-GYRE EXCHANGES IN THE NORTH PACIFIC**

Dale B. Haidvogel, A. Hermann, K. Hedstrom and M. Iskandarani

*Institute of Marine & Coastal Sciences, Rutgers University, 71 Dudley Road, New Brunswick, NJ 08901, U.S.A. e-mail: dale@imcs.rutgers.edu*

Under sponsorship of U.S. GLOBEC, we have implemented and are applying a suite of coupled global-, basin-, and regional-scale circulation models with emphasis on the Northeast Pacific (NEP) and the Coastal Gulf of Alaska (CGOA). The goals of the effort are to characterize the regional impacts (both physical and biological) accompanying global climate variability, and to identify the NEP-to-CGOA linkages involved. On the large scales, use of a spectral finite element ocean model, in a layered vertical coordinate, allows us to hindcast the global wind-driven circulation with enhanced resolution (~20 km) around the periphery of the North Pacific. Here, we describe a multi-decadal simulation of the wind-driven circulation obtained with the global finite

element model. Potential vorticity and Lagrangian (pseudo-float) analyses are used to explore pathways of inter-gyre exchange during the decade of the 1990s. Some possible impacts on regional response in the CGOA are also discussed.

9AM2000 S7-077 poster

**DECADAL VARIABILITY ON THE GROWTH RATE AND THE AGE OF MATURATION OF WALLEYE POLLOCK OFF THE PACIFIC COAST OF JAPAN**

Tomonori Hamatsu and Keizou Yabuki

*Hokkaido National Fisheries Research Institute, 116 Katsurakoi, Kushiro, Hokkaido, Japan. 085-0802 e-mail: newmory@hnf.affrc.go.jp*

Pacific stock of Japan is the most abundant walleye pollock stock in Japan. Climate change in the north Pacific might affect the biological characteristics of Pacific stock. We examined annual changes of the stock abundance, the number of recruits, the growth rate, the age of maturation, the spawning potential, and the sea surface temperature in a major spawning ground, from 1983 to 1996.

The stock abundance and the number of recruits decreased from late 1980s to early 1990s. The growth rate of each year was low in late 1980s and high in early 1990s. With the increase of the growth rate, the age of maturation became younger, and annual spawning potential calculated under a standardized size of adult stock increased by 30 percent.

The sea surface temperatures in a major spawning ground in early 1990s were higher than that in late 1980s. The possibility was suggested that the variability on the stock abundance affected the growth and maturation of the Pacific stock. At the same time, we cannot rule out the possibility that the oceanographic variability affect the biological characteristics of pollock off the Pacific coast of Japan.

9AM2000 S9-078 poster

**POTENTIAL IMPACT OF MARINE POLLUTION ON HARVESTING OF SEAWEED OFF ULSAN BAY, KOREA**

Myung W. Han and Yong C. Park

*Oceanography Department, Inha University, Yong Hyung-Dong, Nam-Ku, Incheon, Republic of Korea. 402-751 e-mail: myunghan@inha.ac.kr*

Trace metal concentrations in the seawater and suspended particulate matter (SPM) were measured along the transects of three rivers running through the industrial complexes to the Ulsan Bay area. Concentrations of Cu, Cr, Pb and Cd in SPM display a clearly localized distribution, increasing with proximity to major industrial complexes. In particular, concentrations of Cu, Cr, Pb and Cd at the mouth of Daejung Stream are much greater than those of the world averages in estuaries by factors of 3, 2, 4 and 89, respectively; their contamination factors are extremely high: Cu (24), Cr (3), Pb (17) and Cd (60). Trace element concentrations in dissolved phase also diminish rapidly off the bay. Rapid decrease in the metal concentrations of both SPM and the seawater is probably because the bay is open to the East Sea. However, the metal concentrations in the seaweeds collected from offshore of the bay are slightly higher than those in the one from a pristine bay in the East Sea, apparently unaffected by industry-driven pollution. At the moment, any regulatory actions against harvesting may be inappropriate, as it is not supported by substantially conclusive evidence. However, our data suggest that an immediate attention should be given to the initiation of a long range monitoring program in the bay area.

9AM2000 S3-079 poster

**THE STUDY OF DIGESTIVE GUT STRUCTURE AND ENZYME ACTIVITY OF PROTEASE, AMYLASE, AND ALKALINE PHOSPHATASE OF *Calanus sinicus* DURING SUMMER IN YELLOW SEA AND EAST SEA**

Xifu Han and Rong Wang

*Institute of Oceanography, Chinese Academy of Science, Qingdao, People's Republic of China. 266003 e-mail: hanxifu@yeah.net*

Most of *Calanus sinicus* aggregates in mainland shelf of central Yellow Sea (depth 40-60 meters) during summer. The existence change of digestive gut cells structure and digestive enzyme activity of protease, amylase, and tissue enzyme alkaline phosphatase (ALP) of *C. sinicus* may be an adaptive response of temperature-frigid species to sharply seasonal fluctuation. The activity of digestive enzymes of protease and amylase is very low in stations near estuary of Yangze River, whereas the activity of these two enzymes showed quite high value in stations near middle of the Yellow Sea during oversummering. Some B-cells of digest intestine and villi intestinalis of *C. sinicus* are collapse due to fasting during summer in stations near estuary of Yangze River. Respiration ceased or showed quite low during summer in stations near estuary of Yangze River, whereas, it is usually high in stations near middle of the Yellow Sea. Based upon morphological characteristics of the digest gut structure, enzymes, respiration, and distribution of *C. sinicus*, we concluded that there may be a dormancy stage in this animal exist during summer season in north part of the East Sea near the seashore.

9SM2000 S9-080 invited  
**MARINE SEDIMENT ORGANIC MATTER- A CONSUMABLE RESOURCE AND INDICATOR OF BENTHIC PRODUCTIVITY AFFECTED BY MARINE AQUACULTURE**

Barry T. Hargrave

*Marine Environmental Sciences, Department of Fisheries & Oceans, Bedford Institute of Oceanography, Dartmouth, NS, Canada.  
B2Y 4A2 e-mail: hargraveb@mar.dfo-mpo.gc.ca*

Organic matter, usually measured as weight loss on ignition or by elemental (carbon, nitrogen) analysis, is often used as an indicator of organic enrichment in marine sediments that accumulate particulate wastes produced by shellfish/finfish mariculture. In fine silt/clay coastal sediments (low sand content) up to 15% of sediment weight may be present as organic matter with organic carbon accounting for up to 20% of total sediment mass. Levels of organic carbon > 5% of sediment dry weight may occur in localized areas of intensive finfish aquaculture. However, the amount is usually much lower (1-2%) due to microbial decomposition and consumption by benthic fauna. When anoxic conditions occur due to oxygen consumption through excessive aerobic bacterial growth, anaerobic metabolism (sulfate reduction) is enhanced. Preservation (accumulation and burial) of organic matter increases due to limited oxygen supply. Low oxygen concentrations also result in the absence of larger macrofauna that require oxygen for respiration. With prolonged anoxia, increased bacterial sulfate reduction leads to accumulation of reduced forms of sulfide (such as FeS) within sediments. Low oxidation reduction (Eh) potentials associated with sulfide accumulation can be used to scale the degree of organic enrichment in marine sediments that experience increased organic matter loading due to mariculture.

9AM2000 S6-081 oral  
**SHIFTS IN PHYTOPLANKTON SPECIES COMPOSITION DURING RECOVERY FROM IRON LIMITATION AT STN P IN THE SUBARCTIC NE PACIFIC: POTENTIAL EFFECTS ON CARBON CYCLING**

Paul J. Harrison<sup>1</sup>, Michael Lipsen<sup>1</sup>, Diana Varela<sup>1</sup> and Philip Boyd<sup>2</sup>

<sup>1</sup> *Department of Earth & Ocean Sciences (Oceanography), University of British Columbia, 6270 University Blvd., Vancouver, BC, Canada. V6T 1Z4 e-mail: pharrism@unixg.ubc.ca*

<sup>2</sup> *Department of Chemistry, University of Otago, Dunedin, New Zealand*

The phytoplankton at Station P are usually dominated by small cells, typical of other oceanic regions where nutrients limit primary productivity. Prymnesiophytes and prasinophytes comprise a large portion of these small cells and their biomass appears to be controlled by microzooplankton whose growth rate is similar to that of the small cells. In shipboard experiments where 2 nM Fe was added to near surface seawater, there was no increase in biomass of these small cells, however, pennate diatoms of various sizes grew up in these carboy experiments. What happens to this pennate dominated increase in phytoplankton biomass is crucial in determining how their carbon will be recycled. Preliminary experiments indicate that the pennate diatoms are not eaten by mesozooplankton. It is assumed that they sink out and make an important contribution to carbon export. Future research should focus on the ecology and physiology of this previously neglected group of pennate diatoms.

9AM2000 W5-347 oral  
**SHIFTS IN PHYTOPLANKTON SPECIES COMPOSITION DURING RECOVERY FROM IRON LIMITATION AT STN P IN THE SUBARCTIC NE PACIFIC: POTENTIAL EFFECTS ON CARBON CYCLING**

Paul J. Harrison<sup>1</sup>, Michael Lipsen<sup>1</sup> and Philip Boyd<sup>2</sup>

<sup>1</sup> *Dept. Earth and Ocean Sciences, University of British Columbia, 6270 University Blvd, Vancouver, BC, Canada. V6T 1Z4 e-mail: pharrison@eos.ubc.ca*

<sup>2</sup> *NIWA, Dept Chemistry, University of Otago, Dunedin, New Zealand*

The phytoplankton at Station P are usually dominated by small cells, typical of other oceanic regions where nutrients limit primary productivity. Prymnesiophytes and prasinophytes comprise a large portion of these small cells and their biomass appears to be controlled by microzooplankton whose growth rate is similar to that of the small cells. In shipboard experiments where 2 nM Fe was added to near surface seawater, there was no increase in biomass of these small cells, however, pennate diatoms of various sizes grew up in these carboy experiments. What happens to this pennate dominated increase in phytoplankton biomass is crucial in determining how their carbon will be recycled. Preliminary experiments indicate that the pennate diatoms are not eaten by mesozooplankton. It is assumed that they sink out and make an important contribution to carbon export. Future research should focus on the ecology and physiology of this previously neglected group of pennate diatoms.

9AM2000 W2-319 oral  
**TEMPORAL COMPARISONS OF JUVENILE AND ADULT GROWTH: IMPLICATIONS FOR CHANGES IN TROPHIC CONDITIONS IN SHELF VERSUS NEARSHORE WATERS**

Douglas E. Hay

*Pacific Biological Station, 3190 Hammond Bay Road, Nanaimo, B.C., Canada. V9R 5K6 e-mail: HayD@pac-dfo.gc.ca*

A number of different herring populations in the North Pacific were at relatively high levels of abundance in the 1990s although growth rates (length at age) declined in some since the 1980s. The length of lateral scales (from the focus to edge, measured to the nearest 0.01 mm) has a close linear relationship with total fish (standard) length (mm). This scale-length:fish-length relationship holds when compared within populations over time and between populations with different growth rates. Therefore the length of annual growth increments on scales provides a sensitive index of past growth rates. Estimates of juvenile growth rate index from selected periods (since 1970) and areas in BC show relatively little intra-population variation in time, although there are substantial inter-populations differences that are relatively consistent over time. In most populations, however, the growth increments for adult stages, between ages of 2-8 years (~24-96 months) decreased since the 1980s. Therefore the declines in growth observed in the 1990s do not reflect slower rates of juvenile growth. Rather, they indicate slower growth during adult stages. In general, juvenile stages (<24 months) are found mainly in nearshore waters whereas the adult stages are spent mainly spent in open shelf waters. This suggests that if the changes in herring populations (abundance increases, growth decreases) are related to trophic factors, changes occurred mainly in shelf waters and not necessarily in the nearshore waters used by the juvenile herring stages.

9AM2000 S1-321 oral  
**LOCAL AND REMOTE INFLUENCES ON CROSS-SHELF TRANSPORT IN THE COASTAL GULF OF ALASKA**

Albert J. Hermann<sup>1</sup>, Dale B. Haidvogel<sup>2</sup>, E.L. Dobbins<sup>1</sup>, Sarah Hinckley<sup>3</sup>, P.S. Rand<sup>4</sup> and Phyllis J. Staben<sup>5</sup>

<sup>1</sup> *JISAO, University of Washington/NOAA-PMEL, 7600 Sand Point Way NE, Seattle, WA 98115, U.S.A. e-mail: hermann@pmel.noaa.gov*

<sup>2</sup> *Rutgers University, U.S.A.*

<sup>3</sup> *NOAA/AFSC, 7600 Sand Point Way NE, Seattle, WA 98115, U.S.A.*

<sup>4</sup> *NC State, U.S.A.*

<sup>5</sup> *NOAA/PMEL, 7600 Sand Point Way NE, Seattle, WA 98115, U.S.A.*

As part of the U.S. GLOBEC NE Pacific program we are simulating currents, plankton, and salmon life histories in the Coastal Gulf of Alaska (CGOA), to explore sources of interannual and interdecadal variability. Cross-shelf transport of nutrients and plankton are suspected to have significant impacts on the annual primary production and the diets of juvenile salmon from on this continental shelf. Such transport should be influenced both by changes in the Ekman flux ("local" forcing), and by changes in the basin-scale circulation which impinges on the shelf ("remote" forcing). We examine this issue for the CGOA using a regional primitive equation circulation model, and multi-year results from a global layered circulation model, which are used for lateral boundary conditions on the regional model. Specifically, we examine the relative impacts of local versus remote forcing through a series of regional model experiments where the remote influences (for example, information from the global model) are selectively removed. We quantify this impact using passive float releases in the regional model.

9AM2000 S7-082 oral  
**MIXED LAYER DEPTH AND ITS RELATIONSHIP TO SURVIVAL AND SIZE OF COHO SALMON**

Alistair J. Hobday and George W. Boehlert

*Pacific Fisheries Environmental Laboratory, NOAA/National Marine Fisheries Service, 1352 Lighthouse Avenue, Pacific Grove, CA 93950, U.S.A. e-mail: gboehlert@pfeg.noaa.gov*

Interannual and decadal variability in ocean survival of salmon, and hence recruitment, is well documented. The mechanisms through which environmental variability affect salmon survival, however, are poorly understood. Data on tagged, hatchery-reared coho salmon were analyzed to provide information on survival and final size between 1970 and 1998, along the species' entire west coast range, from Monterey, CA to Kodiak, AK. Cluster analysis was used to identify three geographic regions with similar trends in survival and final size of returning fish. Three regions were identified with coherence in both survival and final size: Puget Sound and Strait of Georgia, the outer coast between California and the tip of Vancouver Island, and north of Vancouver Island. These regions may be related to areas of the ocean where the environment influences salmon in similar ways. Within each of these geographic regions, the variation in survival and final size was examined in relation to environmental variables including upwelling, sea level, wind speed, mixed layer depth, and SST. We investigated these relationships for three time periods: time of release, time of jack return, and time of adult return. The most important environmental variable in all regions was mixed layer depth. In all regions, survival was most influenced by environmental conditions at the time of release, as was adult size. Jack size was not consistently influenced by environmental conditions in any one time period. This study demonstrates that improved understanding of the importance of environmental conditions provides insights into patterns of size and survival of coho salmon in the coastal ocean.

9AM2000 S6-083 poster  
**EXPORT FLUX OF ORGANIC CARBON IN THE NORTHWESTERN NORTH PACIFIC**

Makio.C. Honda<sup>1</sup>, Fumiko Hoshi<sup>1</sup>, Toshikatsu Sugawara<sup>2</sup>, Masashi Kusakabe<sup>1</sup> and Ichio Asamuma<sup>1,3</sup>

<sup>1</sup> *Japan Marine Science and Technology Center, 2-15 Natsushima, Yokosuka, Japan. 237-0061 e-mail: hondam@jamstec.go.jp*

<sup>2</sup> *Marine Works Japan, Ltd., Japan*

<sup>3</sup> *National Space Development Agency of Japan, Japan*

In order to study the export flux of carbon and evaluate the efficiency of biological pump for the uptake of atmospheric CO<sub>2</sub> in the northwestern North Pacific (NWNP), organic carbon flux observed by sediment trap experiment and surface primary productivity (PP) obtained from satellite data were compared. During December 1997 and May 1999, organic carbon flux and satellite derived PP were seasonal and synchronized each other. An average of PP during experiment was estimated to be approximately 40 g·m<sup>-2</sup>·yr<sup>-1</sup>, which is lower than PP reported previously for the NWNP. The ratio of organic carbon flux deeper than 1000 m to PP was approximately 4~6% and these values are higher than its ratio of global average (< 1%). Based on empirical equation proposed this study, the ratio of organic carbon flux at 100 m to PP (E-ratio) was approximately 25% on an average and relatively higher than that previously reported in other areas. On the other hand, E-ratio decreased with increase of PP. It can be summarized that carbon flux in the NWNP is not always so high and, however, E-ratio is relatively high and organic carbon is transported vertically without significant degradation.

9AM2000 S8-084 oral  
**CONTAMINATION OF ORGANOTIN COMPOUNDS AND IMPOSEX IN MOLLUSCS FROM VANCOUVER, CANADA**

Toshihiro Horiguchi, Seiichi Uno, Makoto Shimizu, Hiroaki Shiraishi and Masatoshi Morita

*Environmental Chemistry Division, National Institute for Environmental Studies, Onogawa 16-2, Tsukuba, Ibaraki, Japan. 305-0053 e-mail: thorigu@nies.go.jp*

Field studies on imposex and contamination of organotin (butyltin and phenyltin) compounds in molluscs (gastropods and bivalves) were conducted in Vancouver from May 24 to June 7, 1999. No neogastropods were collected at sites located in Vancouver Harbour. In a few species of the dogwinkle from Victoria, imposex-exhibited females were extensively observed. However, they were slightly affected: they had tiny penes and small vasa deferentia. Low concentrations of tributyltin (TBT) were detected in tissues of these dogwinkles and the degree of imposex, such as Relative Penis Length (RPL) Index defined as the ratio of mean penis length in females to that in males, seemed positively correlated with TBT concentration in tissue. Tissue concentrations of TBT in foolish mussel from Vancouver Harbour were in the range of 14.8 - 173.2 ng/g wet wt., suggesting continuously extensive contamination with TBT in Vancouver Harbour. Thus, no collection of neogastropods at sites in Vancouver Harbour may implicate that neogastropod populations have been wiped out in Vancouver Harbour, due to reproductive failure caused by imposex induced by TBT from antifouling paints. Species difference was observed in terms of TBT concentrations in tissue of bivalves. Triphenyltin (TPHT) concentrations in tissue were under the detection limit (10 ng/g wet wt.) in all molluscan samples.

9AM2000 S7-085 oral  
**FACTORS AFFECTING THE GROWTH OF CHUM SALMON IN THE WESTERN NORTH PACIFIC REVISITED**

Shoko Hotta<sup>1</sup>, Kentaro Morita<sup>1</sup>, Hiroyuki Sakano<sup>2</sup> and Toshimi Meguro<sup>3</sup>

<sup>1</sup> *Graduate School of Fisheries Science, Hokkaido University, Hakodate, Hokkaido, Japan. 041-8611 e-mail: hotta@fish.hokudai.ac.jp*

<sup>2</sup> *National Fisheries Research Institute, Tokyo, Japan. 100-8907*

<sup>3</sup> *T/S Hokusei-maru, Faculty of Fisheries, Hokkaido University, Hakodate, Hokkaido, Japan. 041-8611*

The body size of returning Pacific salmon (*Oncorhynchus* spp.) has decreased since the 1970s, and several hypotheses regarding the cause of this decrease have been proposed such as fishing pressure, change of SST and density dependent factors. In this study, we examine recent trends in growth of chum salmon (*Oncorhynchus keta*), catch per unit effort (CPUE), sea surface temperature (SST) and sea surface salinity (SSS) in the Subarctic Domain of the Western North Pacific, and to inquire if any of three factors (SST, SSS and CPUE) were related to the growth of chum salmon. From 1979 to 1998, chum salmon CPUE increased, but fork length and back-calculated growth increment decreased significantly. SST showed no consistent pattern but SSS decreased significantly over time. Of total salmon CPUE, chum salmon CPUE, SST and SSS, only SSS was significantly correlated with growth increment; this relationship was positive. Residuals of the year-SSS relationship also correlated with residuals of the year-growth increment relationship, indicating that SSS was consistently linked to growth increment after controlling of trend in year. It is known that global warming causes a decrease in SSS, so global warming might indirectly affect the growth of chum salmon through lowered SSS.



9AM2000 S1-086 poster  
USING ECOSPACE TO MODEL MESOSCALE VARIABILITY OF THE TRANSITION ZONE CHLOROPHYLL FRONT IN THE NORTH PACIFIC OCEAN

Evan A. Howell and Jeffrey J. Polovina

*Ecosystem and Environment Investigation, National Marine Fisheries Service, Honolulu Laboratory, 2570 Dole Street, Honolulu, HI 96822, U.S.A. e-mail: ehowell@honlab.nmfs.hawaii.edu*

The Transition Zone Chlorophyll Front (TZCF) in the North Pacific Ocean is a basin-wide phenomenon typically identified by the 0.2 mg m<sup>-3</sup> surface isopleth. The TZCF shows a high degree of large scale variability in its latitudinal position and gradient strength, which is hypothesized to have a profound influence on the movement of pelagic animals such as loggerhead turtles and albacore tuna. Satellite surface chlorophyll data from SeaWiFS has made it possible to track the movement of this chlorophyll front on a large scale basis, with the 0.2 mg m<sup>-3</sup> chl *a* contour migrating roughly 1,000 km meridionally on a seasonal timescale. Preliminary analysis of albacore tuna catch data suggests a correlation between CPUE and the TZCF during years where the mesoscale variability characterizes the front. Conversely, low CPUE for albacore tuna was observed when meandering of the TZCF was low. The ECOSPACE routine (Walters and Pauly, 2000), based on the earlier ECOPATH model (Polovina, 1984), was developed to account for spatial aspects of trophic relationships. To better understand the link between albacore tuna catch and the TZCF, the ECOSPACE model was used to replicate the meanders of the TZCF in past years. This helps to decipher the role of the frontal variability on higher trophic level organisms such as albacore tuna, the results of which are presented here.

9AM2000 W6-087 oral  
RESULTS OF THE PICES WORKING GROUP 11 ESTIMATES OF PREY CONSUMPTION BY MARINE BIRDS AND CHALLENGES IN DEVELOPING ESTIMATES

George L. Hunt, Jr.<sup>1</sup>, P.J. Gould<sup>2</sup> and K. Morgan<sup>3</sup>

<sup>1</sup> *Dept. Ecology and Evolutionary Biology, University of California, Irvine, CA 92697, U.S.A. e-mail: glhunt@uci.edu*

<sup>2</sup> *U.S. Geological Survey, Biological Resources Division, Alaska Biological Science Center, 1011 E. Tudor Road, Anchorage, AK 99503, U.S.A.*

<sup>3</sup> *Canadian Wildlife Service, Institute of Ocean Sciences, P.O. Box 6000, Sidney, B.C., Canada. V8L 4B2*

To assess the consumption of prey by marine birds in the PICES area of interest in the North Pacific Ocean, PICES Working Group 11 subdivided the North Pacific Ocean into 14 subregions. Within each subregion, we assessed the available data to establish the numbers of marine birds of each species present in summer and the composition of their diets by species. Then using allometric equations, we determined their energy requirements, and the amounts of prey necessary to meet those requirements given diet composition and the energy density of prey species. We found that we had sufficient data to estimate the number of marine birds and energy requirements in 9 of the sub-regions, and prey consumption in a subset of 6 regions. Marine bird energy demands were greatest in the Gulf of Alaska (56.2 kj·km<sup>-2</sup>·d<sup>-1</sup>) and in the Eastern Bering Sea (48.8 kj·km<sup>-2</sup>·d<sup>-1</sup>). Seabird biomass was greater in both the Western Subarctic (3.8 kg·km<sup>-2</sup>) and in the Western Transition Zone (3.2 kg·km<sup>-2</sup>) than in the Eastern Subarctic (0.8 kg·km<sup>-2</sup>) or the eastern transition Zone (0.4 kg·km<sup>-2</sup>). We discuss several methodological challenges that were encountered in the process of estimating the numbers of birds present in a sub-region and the energy density of prey.

9AM2000 S2-088 oral  
ESTIMATES OF PREY CONSUMPTION BY MARINE BIRDS IN THE NORTH PACIFIC OCEAN

George L. Hunt, Jr.<sup>1</sup>, P.J. Gould<sup>2</sup> and K. Morgan<sup>3</sup>

<sup>1</sup> *Dept. Ecology and Evolutionary Biology, University of California, Irvine, CA 92697, U.S.A. e-mail: glhunt@uci.edu*

<sup>2</sup> *U.S. Geological Survey, Biological Resources Division, Alaska Biological Science Center, 1011 E. Tudor Road, Anchorage, AK 99503, U.S.A.*

<sup>3</sup> *Canadian Wildlife Service, Institute of Ocean Sciences, P.O. Box 6000, Sidney, B.C., Canada. V8L 4B2*

To assess the consumption of prey by marine birds in the North Pacific Ocean, PICES Working Group 11 subdivided the North Pacific Ocean into 14 subregions. Within each subregion, we established the numbers of marine birds of each species present in summer and the composition of their diets by species. Using allometric equations, we determined their energy requirements and the amounts of prey necessary to meet those requirements given diet composition and the energy density of prey species. We had sufficient data to estimate the number of marine birds and their energy requirements in 9 of the sub-regions, and prey consumption in a subset of 6 regions. Marine bird energy demands were greatest in the Gulf of Alaska (56.2 kj·km<sup>-2</sup>·d<sup>-1</sup>) and in the Eastern Bering Sea (48.8 kj·km<sup>-2</sup>·d<sup>-1</sup>). Seabird biomass was greater in both the Western Subarctic (3.8 kg·km<sup>-2</sup>) and in the Western Transition Zone (3.2 kg·km<sup>-2</sup>) than in the Eastern Subarctic (0.8 kg·km<sup>-2</sup>) or the Eastern Transition Zone (0.4 kg·km<sup>-2</sup>). In the Eastern Transition Zone, cephalopods were the most important prey (63% of consumption) whereas in the Western Transition Zone, fishes predominated (51%). The western North Pacific Ocean supports a greater density of avian biomass than the eastern Pacific, despite avian use of prey at an apparently higher trophic level. These observations suggest that the western North Pacific is more productive than the eastern North Pacific Ocean.

9AM2000 S4-089 poster  
**RELATIONSHIP BETWEEN ABUNDANCE OF COMMON SQUID, *Todarodes pacificus* AND DISTRIBUTION OF ZOOPLANKTON AFFECTED CLIMATE CHANGES IN THE EAST SEA OF KOREA**

Kangseok Hwang<sup>1</sup>, Young-Min Choi<sup>1</sup>, Jong-Hwa Park<sup>1</sup> and Kyu Dae Cho<sup>2</sup>

<sup>1</sup> Coastal & Offshore Fisheries Resources Division, National Fisheries Research & Development Institute, 408-1, Sirang-ri, Kijang-eup, Kijang County, Pusan, Republic of Korea. 619-900 e-mail: kswhang@nfrdi.re.kr

<sup>2</sup> Pukyong National University, Republic of Korea

Common squid, *Todarodes pacificus* is dominant species in the fisheries resource and it preponderantly captured by the angling fisheries in Korean waters. The spawning and nursery grounds of *T. pacificus* had been revealed from the southern area of East Sea to the northern area of East China Sea. Consequently the environmental conditions of this area at that time effect on the abundance of *T. pacificus* fishing condition were expected. In this study, we analyzed to relationship between climate change, distribution of zooplankton and abundance of *T. pacificus* in the Korean waters.

There existed a positive relationship between fluctuations of zooplankton and CPUE (kg/day) of *T. pacificus* in the East Sea of Korea. Main fishing season was estimated to be a duration from July to December and CPUE in April was closely related to the zooplankton biomass. Horizontal distribution of zooplankton was predominant in the coastal area off the southern part of the East Sea in April. The increase pattern of current biomass of zooplankton was originated in water temperature rise had related air temperature and Tsushima current around Korean waters in 1990s.

In conclusion from this study, climate change has a direct effect on water temperature, current biomass of zooplankton and abundance of *T. pacificus* stock step-by-step.

9AM2000 S2-090 poster  
**ALBATROSS RESPONSE TO SURVEY VESSELS: IMPLICATIONS FOR STUDIES OF DISTRIBUTION, ABUNDANCE AND PREY CONSUMPTION**

K. David Hyrenbach

Graduate Department (Q-0208), Scripps Institution of Oceanography, University of California San Diego, 9500 Gilman Drive, La Jolla, CA 92093-0208, U.S.A. e-mail: khyrenba@coast.ucsd.edu

The study of albatross ecology at sea is complicated by their tendency to follow, and otherwise attend vessels. Ship-following behavior likely biases abundance estimates, blurs the correlation between distributions and habitat features over small scales, and inhibits the statistical analysis of dispersion patterns. These biases have important implications when estimating the size of rare and endangered populations, and prey consumption by abundant species. This paper illustrates how observations of recognizable ship-following individuals can be used to mitigate the biases of vessel-attendance. I surveyed albatross distributions off southern California between August 1996 and April 1999 using CalCOFI cruises as platforms of opportunity. I quantified the degree of albatross attraction to survey vessels, and estimated that standard 300 meter strip transects overestimated their abundance by at least a factor of 3.57. Additionally, I modeled albatross ship-following behavior and determined that 95% of recognizable Black-footed (*Phoebastria nigripes*) and Laysan (*P. immutabilis*) albatrosses ceased to follow the survey vessel after 60 and 38 minutes respectively. Using these models, I calculated that standard survey methods overestimated Black-footed albatross abundance by an additional factor of 1.17 due to their ship-following behavior. When these two biases were combined, standard survey techniques overestimated albatross abundance and squid consumption by a factor of 4. Determining the degree of vessel-attraction and the temporal scale of ship-following will enhance our ability to monitor the distribution, abundance and consumption of albatross populations.

9AM2000 S6-091 oral  
**CARBON GAS EXCHANGE AND EXPORT FLUX FROM THE WEST COAST OF VANCOUVER ISLAND, CANADA: RESULTS OF 2-D MODEL SIMULATIONS**

Debby Ianson and Susan E. Allen

Department of Earth and Ocean Sciences, University of British Columbia, 6270 University Blvd., Vancouver, BC, Canada. V6T 1Z4 e-mail: allen@eos.ubc.ca

A two-dimensional carbon and nitrogen flux model for coastal upwelling regions has been developed. The model was applied to the west coast of Vancouver Island, Canada within the North Pacific eastern boundary current. All major carbon fluxes both within and below the euphotic zone are modelled focusing on time scales of days to years. Physical circulation is represented by six boxes: three horizontal regions (shelf, slope and open ocean) with two layers each. The ecosystem model is diatom-based with three state variables (particulate organic, dissolved organic and dissolved inorganic) for each currency (carbon and nitrogen). Results for net annual gas-exchange and horizontal export flux of organic and inorganic carbon from the system to the open ocean for different physical forcing are presented. In general there is gas evasion, particularly over the shelf, during the winter and gas invasion during the summer due strong biological draw down of pCO<sub>2</sub>. The upwelling and downwelling strengths are an important

influence on these fluxes thus ENSO is a major perturbation to the system. Additionally buoyancy fluxes, which are high in the region, have a major impact on pCO<sub>2</sub> and gas exchange.

9AM2000 W1-092 oral  
OPTIMAL MEASURING CONDITIONS FOR PLANKTON COUNTER

Tadafumi Ichikawa, Satoshi Kato and Kaoru Nakata

National Research Institute of Fisheries Science, 6-1-21 Sanbashi-dori, Kochi, Japan. 780-8010 e-mail: wamusi@affrc.go.jp

For the measurement of the zooplankton biomass, zooplankton abundance and biomass density, the data obtained by *in situ* Optical (OPC) and Electronic Plankton Counter (EPC) and laboratory OPC (L-OPC), were compared with those taken by manual measurements under a microscope. In the area with low abundance of gelatinous plankton and/or Noctiluca, abundance and biomass density of zooplankton measured with both OPC and EPC were positively related with those obtained by the manual measurements ( $p < 0.01$ ) under the conditions that particle densities were less than 10<sup>2</sup>/l. Similarly, both zooplankton abundance and biomass density measured with L-OPC were correlated with the manual measurements ( $p < 0.01$ ) when the density of particles passing through L-OPC were less than 5 counts sec<sup>-1</sup>. The plankton counter is capable of accurately reflecting zooplankton abundance and biomass density and can use zooplankton monitoring under these measuring conditions. However, the particle size distributions measured with L-OPC were different from those obtained by the manual measurements smaller than 0.5mm. While, the particle distributions measured with L-OPC at Scripps Institution of Oceanography gave agreement with the manual measurements, though the same samples were provided for these measurements. The flow rate passing through L-OPC may be caused of these differences.

9AM2000 S3-093 poster  
BENTHOPELAGIC POPULATIONS OF THE EUPHAUSIID *Euphausia pacifica* IN THE SOUTHERN JAPAN SEA AS FOOD FOR PELAGIC FISH (COMMON MACKEREL)

Naoki Iguchi<sup>1</sup>, Hirakawa Kazumasa<sup>2</sup> and Hiroshi Nishida<sup>3</sup>

<sup>1</sup> Fisheries Oceanography Division, Japan Sea National Fisheries Research Institute, 1 Suido-cho, Niigata, Japan. 951-8121 e-mail iguchi@jsnf.affrc.go.jp

<sup>2</sup> National Research Institute of Aquaculture, Japan

<sup>3</sup> National Research Institute of Fisheries Science, Japan

To determine the food environment for pelagic fish (common mackerel *Pneumatophorus japonicus*) off Joetsu in the southern Japan Sea, the benthopelagic populations of *E. pacifica* and other zooplankton were investigated using samples collected with a sledge net and Norpac nets in March 1998 and 2000. Collections were made at 3 locations (sea bottom depths of 50, 100, 150m) during dawn, day, dusk and night. The stomach contents of mackerel in the region was also examined. We found that benthopelagic *E. pacifica* populations appeared on the bottom at 100m depth only in the daytime, whereas the results of the Norpac nets indicated that *E. pacifica* is the dominant zooplankton species throughout the day. The stomach contents of the mackerel revealed that *E. pacifica* was their dominant food source. Off Joetsu, the main purse seine fishery ground for mackerel is from February through May and the mackerel are under the overwintering demersal period, inhabiting on the grounds at 100m depth. Because the depth that the benthopelagic *E. pacifica* populations occur off Joetsu (100m) is shallower than in other regions (160-400m) around Japan, the habitat of mackerel during the overwintering demersal period overlaps with the benthopelagic *E. pacifica* populations off Joetsu. We estimated that the shallower occurrence of the benthopelagic *E. pacifica* populations allows other pelagic fishes easier access to this food source. The ecological significance of the benthopelagic *E. pacifica* populations as a food source for pelagic fishes and the mechanisms by which the benthopelagic populations accumulate in this areas are discussed.

9AM2000 FISp094 oral  
MULTIMEDIA OBSERVATION OF FISH RESOURCE AND ENVIRONMENT USING SATELLITE, ACOUSTICS AND ROV REMOTE SENSING

Kohji Iida, S. Saitoh, Y. Sakurai, T. Mukai, K. Miyashita, T. Hokimoto, Y. Fujimori, J. Yamamoto and K. Yamauchi

Graduate School of Fisheries Sciences, Hokkaido University, 3-1-1 Minato, Hakodate, Hokkaido, Japan. 041-8611 e-mail: iidacs@fish.hokudai.ac.jp

To investigate the relationship between fish resource and marine environment, multimedia observation using satellite remote sensing and acoustical underwater remote sensing and ROV (Remote Operated Vehicle) direct sensing have conducted simultaneously around Hokkaido coastal waters, northern Japan.

Data obtained include sea surface temperatures, phytoplankton distribution, fishing boat light distribution by satellite remote sensing, and spatial distribution of spawning walleye pollock (*Theragra chalcogramma*) by the echo-sounder and sonar, and large zooplankton (*Euphausia pacifica*) and their predator, walleye pollock by ROV direct observation.

As a case study of multimedia observation, a trial cruise by R/V *Ushio Maru* was conducted in Funka Bay on May 26, 1999. The echogram by the dual frequencies echosounder showed dense sound scattering layer (SSL) off Oshima Peninsula of southern Hokkaido, Japan. The SSL showed much higher echo levels in high frequency (98kHz) than in low frequency (28kHz). Diving the ROV to the depth of SSL, the TV camera on ROV took pictures that numerous krill (*Euphausia pacifica*) and the walleye pollock who predate krill. After, sea surface temperature image derived from AVHRR on NOAA satellite showed the location consisted with the temperature front of coastal Oyashio cold current and Tsugaru Strait warm current.

Visualization of these data integrating satellite, acoustics, and ROV using GIS technique provide powerful information for interpretation the mutual relationship between fish resource and production environment.

9AM2000 S3-095 poster

#### WHETHER ZOOPLANKTON COMMUNITY STRUCTURE HAVE CHANGED OR NOT IN THE SOUTHEASTERN BERING SEA SHELF RECENTLY?

Anai Iijima and Naonobu Shiga

Laboratory of Marine Biodiversity, Graduate School of Fisheries Sciences, Hokkaido University, Japan e-mail: nao@fish.hokudai.ac.jp

The evidence is accumulating that atmospheric and oceanic conditions has changed since 1997, when the coccolithophore bloom begun in the southeastern Bering Sea shelf for summer to fall. We examined the zooplankton community structure, especially copepod species composition before and after 1997 to evaluate the effect of environmental changes on the marine ecosystem in that area.

Zooplankton samples were collected by vertical haul with a NORPAC net (45 cm in diameter, 0.33 mm mesh) at 30 hydrographic stations in mid-late July 1995 and 35 stations in late July 1998. Data on temperature, salinity and chlorophyll *a* (chl *a*) were obtained at each station concurrently.

Remarkable thermocline developed around 20 m depth in the middle domain (50 m < *z* < 100 m) on the shelf in both years. The maximum and minimum temperatures were 9.9 and -0.8 in 1995, 11.4 and 2.4 in 1998, respectively. In the middle shelf domain, water column chl *a* concentration in 1995 was statistically higher than in 1998. Copepod exclusively dominated the zooplankton community in terms of numbers and biomass in both years. There was clear tendency that *Pseudocalanus minutus*, *Acartia longiremis* and *Oithona similis* were more abundant in 1998 (warm year) than 1995 (cold year). On the other hand, *Calanus marshallae* and a chaetognath *Sagitta elegans* were less abundant in 1998 than 1995. Warm oceanic condition with weak predation pressure (small abundance of chaetognath) would be suitable for the population growth of the small-sized copepods, such as *Pseudocalanus*, *Acartia* and *Oithona*.

9AM2000 W7-366 oral

#### SEASONAL VARIATION OF PRIMARY PRODUCTIVITY AT STATION KNOT (44°N, 155°E) IN THE NORTH WESTERN PACIFIC OCEAN

K. Imai<sup>1</sup>, N. Tsurushima<sup>2</sup>, T. Egashira<sup>1</sup>, Y. Nojiri<sup>1,2</sup> and T. Saino<sup>3</sup>

<sup>1</sup> Japan Science and Technology Corporation: c/o. National Institute for Environmental Studies 16-2 Onogawa, Tsukuba, Ibaraki, 305-0053, Japan e-mail: imai.keiri@nies.go.jp

<sup>2</sup> National Institute for Environmental Studies 16-2 Onogawa, Tsukuba, Ibaraki, 305-0053, Japan

<sup>3</sup> Nagoya University

The time series observation has been started at Station KNOT (Kyodo North Pacific Ocean Time series) in the north western Pacific since June 1998. Twenty-three measurements of primary production were carried out in the three periods, June-December in 1998, May-October in 1999 and January-June in 2000. <sup>13</sup>C uptake was measured after 24 hours of incubation (*in-situ* and/or simulated *in situ*) of seawater taken by clean sampling techniques. The primary productivity for spring (May), summer (June-August), autumn (October-November) and winter (December) were 497-549 (averaged 518), 158-293 (averaged 216), 101-321 (averaged 170) and 83-121 (averaged 102) mgC/m<sup>2</sup>·d, respectively. The seasonally averaged primary productivity was highest in spring and decreased with season. The chlorophyll *a* concentrations ranged from 0.4 to 2.0 µg/l in euphotic zone. The fraction of large phytoplankton (>10µm) showed maximum proportion in May (22-38%). In summer, the fraction of large phytoplankton decreased (6-9%) and that of small phytoplankton (<2µm) increased. The lower productivity at Station KNOT compared with Station P can be characterized by shallower depth of euphotic zone (50 m in average in summer) and also by smaller assimilation ratio (1-3 µgC/µgChl *a*·h for summer in the surface mixed layer).

A large phytoplankton bloom was observed not exactly at Station KNOT but in its vicinity in May 1999. The maximum chlorophyll *a* concentration in the water column was 13.0 µg l<sup>-1</sup> and the productivity was 1,667 mgC/m<sup>2</sup>·d. The high spatial variability of primary productivity in the blooming season makes the accurate estimation of averaged productivity difficult by means of conventional shipboard observation.

9AM2000 W7-367 oral

**TEMPORAL AND SPATIAL VARIATIONS IN CARBONATE SYSTEM OF THE CENTRAL AND WESTERN EQUATORIAL PACIFIC DURING THE PERIOD FROM 1987 TO 2000**

Hisayuki Y. Inoue<sup>1</sup>, Masao Ishii<sup>1</sup>, Hidekadzu Matsueda<sup>1</sup>, Shu Saito<sup>1</sup>, Kazuhiro Nemoto<sup>1</sup>, Takayuki Tokieda<sup>1</sup>, Takeshi Kawano<sup>2</sup>, Ichio Asanuma<sup>2</sup> and Akihiko Murata<sup>2</sup>

<sup>1</sup> Meteorological Research Institute, Nagamine 1-1, Tsukuba, Ibaraki, 305-0052, Japan e-mail: hyoshika@mri-jma.go.jp

<sup>2</sup> Japan Marine Science and Technology Center, Natsushima 2-15, Yokosuka 237-0061, Japan

Measurements of pCO<sub>2</sub> (fCO<sub>2</sub>) in surface seawater and overlying air have been carried out in the western and central equatorial Pacific during cruises conducted over the period from 1987 to 2000 to resolve temporal variations in the CO<sub>2</sub> flux between the atmosphere and the ocean. In the area of the warm water pool with high SST, low SSS, and depleted macro-nutrients the surface seawater pCO<sub>2</sub> is close to equilibrium or slightly supersaturated with respect to atmospheric pCO<sub>2</sub>. East of the warm water pool, the pCO<sub>2</sub> of surface seawater increases with increasing macro-nutrients and decreasing SST due to the equatorial upwelling. On the basis of pCO<sub>2</sub> data collected over several years, we will report seasonal and long-term variations of surface seawater pCO<sub>2</sub> in the western Pacific warm water pool and cold tongue affected by the equatorial upwelling. The long-term trend will be compared with that of pCO<sub>2</sub> in the subtropics of the western North Pacific, which has been reported to be 1.6 μatm/yr.

9AM2000 W7-368 poster

**SEASONAL VARIATION IN TOTAL INORGANIC CARBON AND ITS CONTROLLING PROCESSES IN SURFACE WATERS OF THE WESTERN NORTH PACIFIC SUBTROPICAL GYRE**

Masao Ishii<sup>1</sup>, Hisayuki Y. Inoue<sup>2</sup>, Shu Saito<sup>2</sup>, Kazuhiro Nemoto<sup>2</sup>, Takashi Midorikawa<sup>3</sup>, Toshihiko Yano<sup>3</sup> and Hideki Nagai<sup>3</sup>

<sup>1</sup> Meteorological Research Institute, 1-1 Nagamine, Tsukuba, Ibaraki, 305-0052 Japan e-mail: mishii@mri-jma.go.jp

<sup>2</sup> Meteorological Research Institute, 1-1 Nagamine, Tsukuba, Ibaraki, 305-0052 Japan

<sup>3</sup> Japan Meteorological Agency, 1-3-4 Otemachi, Chiyoda-ku, Tokyo, 100-0004 Japan

Seasonal variation in total inorganic carbon (TCO<sub>2</sub>) in surface waters of the western North Pacific (137°E to 152°E) subtropical gyre was analyzed on the basis of measurements of TCO<sub>2</sub> and partial pressure of CO<sub>2</sub> (pCO<sub>2sw</sub>). The controlling processes including vertical mixing, horizontal advection, and net air-sea CO<sub>2</sub> transport, as well as biological activity were quantified. The seasonal increase in normalized TCO<sub>2</sub> (NTCO<sub>2</sub>) from autumn to winter, ranging from +19 μmol kg<sup>-1</sup> to +37 μmol kg<sup>-1</sup> in the northern part of the subtropical gyre between 24°N and 30°N, was predominantly accounted for by the upward supply of TCO<sub>2</sub> due to enhanced vertical mixing. The contribution of horizontal advection, estimated from monthly meridional NTCO<sub>2</sub> distributions and the monthly advection field of the Meteorological Research Institute (MRI)'s 3D-ocean general circulation model, was insignificant. Analyses of the mixed-layer NTCO<sub>2</sub> budget revealed that biological activity was playing an important role in the decrease in surface NTCO<sub>2</sub> from winter to summer. Annual net community production reached 48 ± 19 gC·m<sup>-2</sup> between 24°N and 30°N, and 19 ± 16 gC·m<sup>-2</sup> between 15°N and 23°N.

9AM2000 W7-369 poster

**NET COMMUNITY PRODUCTION AND ITS IMPORTANCE FOR THE VARIABILITY IN pCO<sub>2sw</sub> IN THE MARGINAL ICE ZONE OF THE SOUTHERN OCEAN SOUTH OF AUSTRALIA**

Masao Ishii, Hisayuki Y. Inoue and Hidekazu Matsueda

Meteorological Research Institute: 1-1 Nagamine, Tsukuba, Ibaraki, 305-0052 Japan e-mail: mishii@mri-jma.go.jp

In the marginal ice zone (MIZ) of the Southern Ocean south of Australia at 140°E, the net community production (NCP) above the remnant temperature-minimum ( $T_{min}$ ) layer integrated from the end of austral winter was evaluated in the austral summer 1994/95 on the basis of the deficit in NTCO<sub>2</sub> by reference to that in  $T_{min}$  layer (2182 μmol kg<sup>-1</sup> at  $S=34$ ). The integrated NCP ranged from 3 to 15 gC m<sup>-2</sup> in December 1994 and from 6 to 30 gC m<sup>-2</sup> in January 1995, showing a tendency to increase with the distance from pack ice edge and with time. About 20% of the carbon assimilated have been transformed into dissolved organic carbon and the rest 80% would be into particulate phase. From the properties of  $T_{min}$  layer, water beneath sea ice and surface water in ice-free regions such as polynya in winter is inferred to be supersaturated with CO<sub>2</sub>. The effect of biological CO<sub>2</sub> uptake was larger than that of temperature-rise after the retreat of sea ice in summer, hence pCO<sub>2sw</sub> showed a tendency to decrease with time and with the distance from the pack ice edge in the MIZ so that northern MIZ became a significant sink of CO<sub>2</sub> in austral summer. Availability of iron would be a limiting factor for the primary production in the MIZ, but the community uptake ratios of C/Si/N/P (=54/39/8.7/1) suggest that grazing was also an important factor controlling the NCP and therefore the distributions of the contemporary surface TCO<sub>2</sub> and pCO<sub>2sw</sub> in summer.

9AM2000 W7-370 oral  
NET COMMUNITY PRODUCTION IN THE CENTRAL AND WESTERN EQUATORIAL PACIFIC EVALUATED FROM THE DISTRIBUTIONS IN THE OCEANIC CO<sub>2</sub> SYSTEM

Masao Ishii<sup>1</sup>, Takayuki Tokieda<sup>1</sup>, Shu Saito<sup>1</sup>, Hisayuki Y. Inoue<sup>1</sup>, Takeshi Kawano<sup>2</sup>, Kazuhiko Matsumoto<sup>2</sup>, Hirofumi Okano<sup>2</sup>, and Ichio Asanuma<sup>2</sup>

<sup>1</sup> Meteorological Research Institute, 1-1 Nagamine, Tsukuba, Ibaraki, 305-0052 Japan e-mail: mishii@mri-jma.go.jp

<sup>2</sup> Japan Marine Science and Technology Center: 2-15 Natsushima, Yokosuka, 237-0061 Japan

Measurements of TCO<sub>2</sub> (coulometry) and pH (spectrophotometry) in the upper water columns were made in the central and western equatorial Pacific (142°E-170°W) in January 1999. Salinity front, the boarder of the eastern cold tongue and the western warm water pool, was located at 158°E. In the cold tongue, NTCO<sub>2</sub> (at S=35) in the mixed layer decreased westward from 2025 μmol kg<sup>-1</sup> at 170°W to 1955 μmol·kg<sup>-1</sup> at 158°E with the decrease in major nutrients and with the increase in temperature. In contrast, NTA calculated from TCO<sub>2</sub>, pH, T, S, and dissociation constants of carbonic acid given by Roy *et al.* showed little spatial variation (2317 ± 3 μeq·kg<sup>-1</sup>) over the regions observed. Composite plots of surface NTCO<sub>2</sub> at various locations and times in the cold tongue we have been measuring since 1994 and other data sets available from CDIAC show a good relationship with SST:  $NTCO_2 / \mu\text{mol}\cdot\text{kg}^{-1} = 1756 + 33.07 \times (T/^\circ\text{C}) - 0.8986 \times (T/^\circ\text{C})^2$  (r=0.975). Using the simple westward advection model, mean net community production was calculated to be 38 mmol·m<sup>-2</sup>·day<sup>-1</sup> in the western limb of the cold tongue, while mean CO<sub>2</sub> flux to the atmosphere was 10 mmol·m<sup>-2</sup>·day<sup>-1</sup> (to be revised), indicating that biological activity is the dominant factor for the westward decrease in NTCO<sub>2</sub>. The westward Si/N decrease ratio was 0.28. It suggests that, if compared with the Si/N uptake ratio by the diatoms in the equatorial Pacific (1.3 ± 0.2; Takeda 1998), the contribution of diatoms to the NCP was less than 20%.

9AM2000 S4-096 poster  
CHANGES IN YEAR-CLASS STRENGTH OF RED HALIBUT, *Hippoglossoides dubius*, IN FUNKA BAY

Kengo Ishino

Hokkaido Fisheries Experimental Station, 1-2-66, Yunokawa, Hakodate, Hokkaido, Japan. 042-0932 e-mail: ishinok@fishexp.pref.hokkaido.jp

Red halibut, *Hippoglossoides dubius*, is the most abundant species in the demersal fish community in Funka Bay (Uchiura Wan) (Yokoyama *et al.* 1989); it is also the principal target species in the gill-net fishery. Fishery statistics collected since 1985 for this species reveal that annual catches fluctuate between approximately 600 and 3,500 metric tons, reaching two peaks of 3,500 tons in 1987 and 2,800 tons in 1996. Monitoring surveys for stock assessment of this halibut were established in 1996. Since then, length and otolith samples have been taken from landings in the gill-net fishery at the main fish markets in this bay. Age structure was dominated by three strong cohorts that settled in 1989, 1991, and 1995, even though 9 year-classes were represented in the catches. The 1989 year-class comprised ca 40% of 1996 landings. The 1991 year-class dominated total catch over all 3 sampling years (1996-1998) and comprised ca 45, 70, and 60% of each annual landing, respectively. The 1995 year-class formed ca 50% of landings in 1999. Halibut age at recruitment to the gill-net fishery is 3 to 4 years. The number of boats in the gill-net fleet has not changed much during the survey period. Therefore, analysis of age structure for this halibut stock indicates that variable year-class strength strongly affects fluctuations in annual yield. Growth curves from different strength year-classes, and correlations between age-length parameters and stock size will also be discussed.

9AM2000 S5-329 oral  
A SIMULATION OF THE NPIW CIRCULATION BY A HIGH-RESOLUTION NORTH PACIFIC OCEAN MODEL

Hiroshi Ishizaki and Ichiro Ishikawa

Meteorological Research Institute, 1-1 Nagamine, Tsukuba, Ibaraki-ken, Japan. 305-0052 e-mail: hishizak@mri-jma.go.jp

Long-term integration of a high-resolution North Pacific Ocean model were conducted to clarify the spreading of the intermediate low salinity water and to simulate the circulation of the North Pacific Intermediate Water (NPIW) with a salinity-minimum layer. The model domain is 100°E-75°W and 15°S-65°N with 1/4 deg (EW) x 1/6 deg (NS) horizontal resolution and 44 vertical levels. Starting from a horizontally-homogeneous, vertically-stratified state of rest, the model was integrated longer than 100 years with restoring fluxes of heat and salinity at the surface, below 2000m, and in the Okhotsk and Bering Seas.

In the intermediate layer a low salinity water produced in the Okhotsk Sea enters the Pacific through channels along the Kuril Islands. It is carried southwestward by the Oyashio and mixed with the saline Kuroshio water in the confluence zone east of Japan. The mixture is advected by the clockwise circulation roughly south of 45°N and the anticyclonic one north of 45°N over the entire North Pacific. The salinity-minimum layer is formed mainly by the westward advection of low salinity in the subtropical gyre south of 30°N, rather than direct eddy activities. After impinging upon the western boundary (the Philippines), the westward-flowing low-salinity water partly goes on to the north as a lower part of the Kuroshio and encounters the confluence zone again. Several circulations of the low-salinity water may be required for the steady-state NPIW circulation to be constructed.

9AM2000 S2-097 poster  
**CHANGES IN THE SIZE OF STELLER SEA LION SKULLS DURING THE 1960S-1990S**

Takeomi Isono and Yasunori Sakurai

*Division of Marine Environment and Resources, Graduate School of Fisheries Science, Hokkaido University, 3-1-1 Minato-cho, Hakodate, Hokkaido, Japan. 041-8611 e-mail: Isono@fish.hokudai.ac.jp*

Steller sea lions *Eumetopias jubatus* breed from California to the Kuril Islands. Within the past 35 years, large changes in prey availability have resulted in a decrease in their populations. Nutritional value and accessibility of prey, as well as specimen age, determine skull development and final size. This study compares morphological growth patterns of eastern and western North Pacific (NP) sea lion skulls. The comparisons were based on the measurements of condylobasal length of skulls divided into decal blocks in the western NP, and two periods in the eastern NP: warm (1953-64) and cold (1965-78). It was found that male skull sizes in the 1970s were larger than during other decades in the western NP. In the eastern NP, male skull sizes did not differ between periods, but female skull sizes were found to be larger during the cold period. These results coincide with increases in the abundance of walleye pollock.

9AM2000 S6-098 poster  
**MECHANISMS OF THE SEASONAL VARIATION OF CHLOROPHYLL ON 144E OBSERVATION LINE IN THE MIXED WATER REGION USING A ONE-DIMENSIONAL ECOSYSTEM MODEL**

Shin-ichi Ito, Michio J. Kishi and Takashi Miyao

*Tohoku National Fisheries Research Institute, 3-27-5, Shinhamacho, Shioyama, Miyagi, Japan. 985-0001 e-mail: goito@myg.affrc.go.jp*

To clarify the mechanisms of the seasonal variation of Chlorophyll in the Mixed Water Region, we run a one-dimensional ecosystem model which is same as the one Kishi and Motono (2000) used. To compare the observational data, we selected the 144E line to make integration. The model is composed of following 10 components; large and small phytoplankton, large and small zooplankton, nitrate, ammonium, PON, DON, silicate, POS. The model includes the seasonal vertical migration effect of the large zooplankton. The model could reconstruct basic features of seasonal variation of Chlorophyll that is a strong bloom in spring and a weak one in autumn. The model results showed that the trigger of the spring bloom is the sudden drop of the wind stress in spring. It brings the strong bloom of the large phytoplankton. The bloom was terminated when the large zooplankton rise to the surface layer from the deeper layer. Also the timing of the vertical migration of the large zooplankton influenced to the start of the weak autumn bloom of the large phytoplankton.

9AM2000 POCp099 poster  
**ISOPYCNALLY AVERAGED CLIMATOLOGY FOR THE OKHOTSK SEA**

Motoyo Itoh, Kay I. Ohshima and Masaaki Wakatsuchi

*Graduate School of Environment Earth Science, Hokkaido University, N19W8, Sapporo, Hokkaido, Japan. 060-0819 e-mail: motoyo@lowtem.hokudai.ac.jp*

We made isopycnally averaged climatology data set of temperature, salinity and dissolved oxygen contents for the Okhotsk Sea by using World Ocean Data Base 1998 and recently collected data. We examined the properties of the intermediate water with a density range from 26.8-27.0 in the Okhotsk Sea. A dominant feature on the 26.8-27.0 is the existence of the coldest, freshest and oxygen richest water on the northwestern shelf. This water extends southward to the east of Sakhalin Island along the bottom contour of 500 m. Oxygen richer water also exists off the Hokkaido coast in the south. These suggest that the major ventilation originate from the northern shelf and while the minor from the Hokkaido coast. It is also shown that there is direct ventilation in these areas from our data set and suggests that these ventilation reaches to 27.0. Thickest intermediate water between 26.75 and 26.85 about 140m exists near the Bussol Strait. This feature seems to be modification due to strong tidal mixing and this vertically uniformed water affects the Pacific Ocean downstream of this Strait. We also examined interannual variation of temperature in the Okhotsk Sea. The temperature on the 27.3 surface in the Kuril Basin increases by 0.1 degree from 1970 to 1999.

9AM2000 S1-100 poster  
**THE FISH COMMUNITY OF PELAGIAL IN THE SUBARCTIC FRONT OF THE NORTHWEST PACIFIC**

A.N. Ivanov

*Pacific Scientific Research Fisheries Centre (TINRO-Centre), 4 Shevchenko Alley, Vladivostok, Russia. 690600 e-mail: root@tinro.marine.su*

The research in the Subarctic front zone of the northwest Pacific testify to essential reorganizations in community of epipelagic fishes.

Trawl surveys were conducted in 1983-1995 the transition zone of the northwest Pacific from coast to 165°E. Zone of Subarctic front is the general feeding region of the mass pelagic fishes. This is specific biotop because here is the interaction of different

kind of water mass (subtropical and subarctic structures) and it characterized by strong hydrology activity, biology productivity and species diversity of fishes. Species composition is various too. 160 species were occurred during this period. It includes fishes from boreal (32%), subtropical (58%) and tropical (10%) complexes. All fishes were divided in three groups: 1) group-fishes of very high abundance (walleye pollock, sardine, anchovy, mackerel); 2) fishes of high abundance (saury, squids, myctophids, pomfret, trachipteridae); 3) fishes of low abundance (nearly 140 species). The first two groups form structure of fish community. During last decades dominant species were saury, mackerel, sardine and anchovy. Their biomass varied from 30 to 90% from total biomass of all fishes. Sardine, mackerel, anchovy had high dynamic of biomass. Its occurrence correlated with abundance of populations. The most productive region is the area of coastal water masses between south and north border of subarctic zone. High fish productivity in the transition zone was in the 1980s (8-11 mln tons), but now it is very low, only 2.6 mln tons. Nekton community was monodominant in the 1980s but now it is polydominant community.

9AM2000 W2-101 poster

#### **DYNAMICS OF SAKHALIN-HOKKAIDO HERRING GROWTH RATE AND ZOOPLANKTON BIOMASS ALONG SOUTHWESTERN SAKHALIN COAST (SEA OF JAPAN)**

Elsa R. Ivshina

*Sakhalin Research Institute of Fisheries & Oceanography (SakhNIRO), 196 Komsomolskaya Street, Yuzhno-Sakhalinsk, Russia. 693016 e-mail: elsa@tinro.sakhalin.ru*

Sakhalin-Hokkaido herring population is in a deep long-term depression during several ten years. It is known that the fish rate in growth, including herring, is closely connected with the state of population. A negative relation between fish sizes and population abundance is recorded for herring, in particular for Korf-Karagin, eastern Bering Sea, Hokkaido western coast stocks.

On the whole, a relatively low growth rate for Sakhalin-Hokkaido herring was recorded corresponding to periods of 1955-1970 and 1990-1998, much higher – to period of 1970-1990. A parameter comparison of regression equations for feeding herring linear growth during 1955-1959 and 1991 did not show certain differences (at  $p=0.5$ ). Such regularity was marked both for immature and adult fish. The increase in growth rate during 1970-1980 years seemed to be appropriate due to a great decrease in abundance, but in 1990s a decrease in mean length at further reduction of herring stock abundance and their main food competitors (walleye pollock, sardine) reduction in abundance were recorded.

As far as fish growth is dependent on many factors, including fodder zooplankton abundance, the mean length fluctuations for Sakhalin-Hokkaido herring during 1955-1998, appeared to correspond to fluctuations of total zooplankton biomass in the area of feeding along southwestern Sakhalin coast. The herring growth rate changed not so much corresponding to generations abundance, as parallel with fluctuations of total zooplankton biomass. Supply with fodder organisms is, perhaps, one of the factors limiting herring growth in the period of their low abundance.

9AM2000 S9-102 invited

#### **COMPREHENSIVE EVALUATION OF RISKS AND BENEFITS OF AQUACULTURE IN MARINE WATERS**

Robert N. Iwamoto

*Resource Enhancement and Utilization Technologies Division, Northwest Fisheries Science Center, NMFS, Seattle, WA U.S.A. e-mail: bob.iwamoto@noaa.gov*

Science and technology must be the essential foundations for all decision-making for any development of coastal areas, for whatever purpose.

An overly zealous regulatory climate for protecting the environment that is not based on objective science and technology nurtures unnecessary uncertainties in the minds of the general public and confounds sensible development. Examples include (i) the concern of growing numbers of health-conscious people about the safety of farmed products, (ii) the sensitivity of animal-rights activists to certain farming practices, and (iii) the objections of environmentalists to nutrient over-loading. Consequently, the reality is that regulatory agencies now place more emphasis on simply avoiding possible risks and less on understanding and managing the risks so that the potential benefits can be realized with safety.

Intensive production of animals and crops is particularly targeted as an unnecessary risk. Intensive seafood production is no exception, specifically farming of salmon in saltwater net-pens and marine shrimp in coastal ponds. Moreover, and often encouraged by media, the hostility towards aquaculture in several countries is exacerbated by fishermen who perceive fish farmers as competitors and not colleagues. Consequently, if the aquaculture industry is to continue to be a major factor in food production, we must recognize and address the topical risks of the industry at the present time, and based on the best available science and technology, recommend management approaches that lead to environmentally and socially responsible industry practices.



9AM2000 FISp103 poster  
**SPECIES COMPOSITION AND ABUNDANCE OF FISHES IN AMURSKY BAY (JAPAN SEA)**

Denis V. Izmyatinsky

*Pacific Research and Fisheries Centre (TINRO-Centre), 4 Shevchenko Alley, Vladivostok, Russia. 690600 e-mail: root@tinro.marine.su*

Ichthyofauna of the Amursky Bay has been studied for almost all XX century. But complex ichthyological research has been carried out since the 1980s. Therefore questions concerning the ichthyofauna of the Amursky Bay on the whole have been considered insufficiently in literature. The objective of this study is analysis of species composition and biomass of the Amursky Bay's ichthyofauna.

Materials from eight registration trawl surveys having been carried out on June-October in 1991-1996, 1998 and 1999 by MRS-055, MRS-5005 and MRTK "Laukuva" were taken as base of this work.

During the eight surveys in the Amursky Bay between 1991 and 1999, 57 species were identified among 20 families. The greatest number of species has been registered in families Pleuronectidae - 12, Cottidae - 12, Stichaeidae - 9. There were 1-4 species in other families in that period.

Usually Japanese flounder (*Pleuronectes yokohamae*) and barfin plaice (*Pleuronectes pinnifasciatus*) as well as *Tribolodon brandti* predominate in fish communities in warm season. In June-October sardine (*Sardinops melanostictus*) and anchovy (*Engraulis japonicus*) were the most numerous species in the moments of their high abundance. In winter-spring season pacific herring (*Clupea pallasii*) and saffron cod (*Eleginus gracilis*) were the most abundant in Amursky Bay.

In trawl surveys total biomass of fishes of Amursky Bay changes from 5.1 to 10.1 thousand t, have average 7.7 thousand t. On this square density of fish accumulations as a whole changes from 6.1 to 12.2 t/km<sup>2</sup>, have average 7.7 t/km<sup>2</sup>. In 1970-1980s fish biomass was higher, than in 1990s.

9AM2000 S8-336 oral  
**CHANGES IN BENTHIC COMMUNITIES ALONG A PRESUMED POLLUTION GRADIENT IN VANCOUVER HARBOR**

Jong-Geel Je<sup>1</sup>, Tatyana Belan<sup>2</sup>, Colin D. Levings<sup>3</sup> and Bon Joo Koo<sup>1</sup>

<sup>1</sup> *Korea Ocean Research & Development Institute (KORDI), Ansan P.O. Box 29, Seoul, Republic of Korea. 425-600 e-mail: jgje@sari.kordi.re.kr*

<sup>2</sup> *Far Eastern Regional Hydrometeorological Research Institute (FERHRI), 24 Fontannaya Street, Vladivostok, Russia. 690600 e-mail: hydromet@online.ru*

<sup>3</sup> *Science Branch, Marine Environment & Habitat Science Division, Coastal & Marine Habitat Science Section, West Vancouver Laboratory, West Vancouver, B.C., Canada. V7H 1N6 e-mail: levingsc@dfo-mpo.gc.ca*

Samples of macrobenthic organisms were obtained with a van Veen grab (five replicates) at seven stations on a presumed pollution gradient from the head of Vancouver Harbor through to Howe Sound. Sediments were sieved with a 0.5 mm sieve and preliminary sorting of fauna was completed in the West Vancouver Laboratory. Detailed identification of polychaetes and was then completed in Russia (FERHRI, Vladivostok), ophiuroids, nemertineans, crustaceans, sipunculans and others at Institute of Marine Biology (Vladivostok), and molluscs in Korea (KORDI, Seoul). The data were then combined for community analyses using a station by species matrix. Grain size analyses were completed at KORDI, and showed that most stations were characterized by mud, except the Howe Sound station which was dominated by sand. 168 species were identified from the eight faunal groups. The stations were classified into three station groups by species similarity: two stations in Port Moody Arm, four stations in the Inner and Outer Harbor, and one station in Howe Sound. The results of multivariate analyses and trends in faunal composition will be presented, together with interpretations of changes relative to data on contaminants in the sediments found by other researchers in the Workshop.

9AM2000 S9-104 invited  
**ENVIRONMENTAL MONITORING FOR MARICULTURE IN KOREA**

Jong-Geel Je, Jae-Ryoung Oh, Kwang-Sik Choi, Sang-Ho Shin, Bon Joo Koo and Dong-Sung Kim

*Korea Ocean Research & Development Institute (KORDI), Ansan PO Box 29, Seoul, Republic of Korea. 425-600 e-mail: jgje@kordi.re.kr*

In Korea, coastal aquaculture production comprises 26% of the total 1999 fishery production (about 2.9 million ton). However, although aquaculture technology has been improved, aquaculture production began to decrease in 1997. The inappropriate management of aquaculture farms and intensive culturing method might be a major problem for production decrease. In order to develop sustainable management for the aquaculture farms, monitoring methods were studied for three years in Kamak Bay on south coast of Korea. Kamak Bay and area is an important region for fish (flatfish, rockfish, etc) and mussel/oyster farming. The

methods were also necessary to establish the status of the environment surrounding the farms and develop an early warning system to prevent ecological degradation.

The studies used four different methods: 1) monitoring using benthic communities including meiofauna, 2) organic pollution monitoring of sediment and water, 3) biochemical analysis of target aquaculture animals and, 4) use of an environmental atlas for farm management. From the macrobenthic surveys in Kamak Bay, the results show that abundance of organisms identified above the species level can be useful for pollution monitoring. Monitoring using data from higher taxonomic levels is much more economical in terms of time and funds needed. Meiofauna ratios such as N/C (nematodes/copepods) and N/K (nematodes/kinorhynchans) were found to be useful to detect pollution in the sediment of the Bay.

Contamination of organic pollutants had been investigated in seawater, sediment and two cultured species, oyster (*Crassostrea gigas*) and the neogastropod (*Thais clavigera*). The data indicated higher concentrations near village compared to reference area. The imposex index in *Thais clavigera* and biomarker, could also be monitor organic pollution. Also biochemical assessment techniques using cultured oysters were used at Kamak Bay. The techniques will be used to assess environmental condition for mariculture facilities.

The environmental information map for mariculture farm areas (Fish Atlas) was developed using GIS and data obtained at Kamak Bay. The atlas displays coastal habitats, sensitivity of each habitat, pollutant concentrations, local population density in each village unit, an index of fishing effort in the area, waste from industries, etc. The Atlas should be a good management tool. An environmental network of Korean mariculture farms using multimedia techniques is suggested.

9AM2000            MEQp106            oral  
**PAH EXPOSURE LEVELS ASSOCIATED WITH INJURY IN MARINE FISH**

Lyndal L. Johnson, Beth H. Horness, Gina M. Ylitalo and Tracy K. Collier  
Environmental Conservation Division, Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112, U.S.A.  
e-mail: Lyndal.L.Johnson@noaa.gov

Several economically and ecologically important marine fish species are in decline in Puget Sound, Washington. Some stocks, including rockfish and herring, have been proposed for listing under the U.S. Endangered Species Act. Various anthropogenic and natural stressors may have contributed to these declines, including exposure to chemical contaminants. The current analysis was conducted to assist in determining when fish are exposed to potentially harmful concentrations of one of the most common environmental contaminants, polycyclic aromatic hydrocarbons (PAHs). Effects thresholds were estimated through segmented regression of field data on site-specific sediment PAH concentrations and associated disease prevalences in a resident fish species, English sole. The analyses and supporting data encompass several endpoints, including DNA damage, liver lesions, and impacts on growth and reproduction. Threshold sediment PAH concentrations for toxicopathic liver lesions in English sole range from 54 to 2800 ppb dry wt, while the threshold for DNA adducts in liver was 300 ppb. Inhibited gonadal growth, inhibited spawning, reduced egg viability, and reduced growth, begin to occur at sediment PAH concentrations in a similar range. In general, liver lesion prevalences, DNA adduct levels, and other detrimental effects in English sole, are close to baseline levels at sediment PAH concentrations at or below 1000 ppb, and PAH metabolites levels below 100 mg/g bile. At higher exposure levels, there appears to be a substantial increase in the risk of these conditions. PAH exposure levels in this range have been reported in Puget Sound herring and rockfish, suggesting a potential for biological injury in these species.

9AM2000            S1-108            poster  
**COMPARISON OF FEEDING ECOLOGY OF PACIFIC SALMON IN THE EASTERN AND WESTERN NORTH PACIFIC OCEAN**

Masahide Kaeriyama, M. Nakamura, M. Fukuwaka, Y. Ishida, H. Ueda, R.V. Walker and K.W. Myers  
Hokkaido Tokai University, Minamisawa 5-1-1, Minami-ku, Sapporo, Hokkaido, Japan. 005-8601 e-mail:  
salmon@dm.htokai.ac.jp

The feeding ecology of Pacific salmon was investigated along a transect 145°W from 50°N to 56°N during early summer of 1994-1999 and a transect 165°W from 44°N to 52°N during early summer of 1999 in the Gulf of Alaska (Eastern Basin) by the Oshoromaru, and the Western North Pacific Ocean (Western Basin: along a transect 165°E from 42°N to 50°N) by the R/V Hokko-maru during middle June to middle July of 1999. In 1999, sockeye, coho, and chinook salmon fed dominantly on squids, mainly *Beryteuthis anonychus* in the Subarctic Current area of along 145°W and 165°W. Sockeye salmon in the Alaskan Gyre basin, chum and pink salmon in the Gulf of Alaska appeared to feed on more diverse preys. Dominant prey of steelhead trout was both squids and fish in the Gulf of Alaska. Sockeye, chum and pink salmon in the Western Basin mainly fed on euphausiids, copepods, amphipods, and chaetognaths. Coho salmon fed on euphausiids and squids. There were many cases where prey animals of Pacific salmon in the Western basin were more diverse and lower trophic energy than those in the Eastern Basin. In the Gulf of Alaska, the feeding of Pacific salmon was affected by the 1997 El Niño and the 1999 La Niña.

9AM2000 S3-107 poster

**SEASONAL VARIATIONS IN ABUNDANCE AND COMMUNITY STRUCTURE OF PLANKTONIC OSTRACODS IN THE OYASHIO REGION (SITE H)**

Hideki Kaeriyama and Tsutomu Ikeda

*Marine Biodiversity Laboratory, Graduate School of Fisheries Sciences, Hokkaido University, 3-1-1 Minatomachi, Hakodate, Japan. 041 e-mail: kaeri@pop.fish.hokudai.ac.jp*

Planktonic ostracods were sampled at near-monthly intervals from September 1996 through October 1997. Closing nets (0.10mm mesh) were used to collect specimens from five discrete depths between the surface and 2000m depth at Site H in the Oyashio region. The abundance of total ostracods varied 5574-22724 (inds./m<sup>2</sup>) with two abundance peaks in January and October 1997. Ostracods were distributed largely in 200-600 m depth stratum throughout the year. Ostracod species including *Conchoecia pseudodiscophora*, *C. porrecta*, *C. magna*, *C. skogsbergii*, *C. daphnoides*, *C. imbricata*, *C. curta*, *Conchoecia* sp.1 and sp. 2 were recorded in this study. From the counts of adult/subadult instars, *C. pseudodiscophora* was the most abundant ostracod species. *C. pseudodiscophora* was abundant in 200-300m depth, and their number increased during spring phytoplankton bloom (March-June 1997). Adult/subadult instars of *C. porrecta* and *C. magna* were observed in 200-700m depth, and seasonal changes in their abundance were not appreciable. Adult/subadult instars of *C. skogsbergii* and *Conchoecia* sp.1 were found in 300-800 m and ~500 m, respectively. Adult/subadult instars of these five species represent only a small fraction of the total ostracods, and the most of them are their juvenile instars. In addition to seasonal features of abundance and community structure, life cycles of some of the dominant ostracods in this region will be discussed in our presentation.

9AM2000 S3-109 oral

**18S rDNA SEQUENCE AND PHYLOGENETIC ANALYSIS OF *Neocalanus cristatus* (CRUSTACEA: COPEPODA)**

Toshinori Kanehisa, Tomoo Sawabe, Yoshio Ezura and Tsutomu Ikeda

*Graduate School of Fisheries Science, Hokkaido University, Marine Biodiversity Laboratory, 3-1-1 Minato-cho, Hakodate, Japan. 041-8611 e-mail: kanehisa@fish.hokudai.ac.jp*

Recent development of molecular biology oriented techniques makes us possible to analyze genetic relationships between species and between populations of the same of organisms with greater accuracy. These techniques can also be used as a powerful tool to investigate biodiversity and evolutionary affiliation of marine zooplankton.

*Neocalanus cristatus* is a large grazing copepod distributing throughout the entire subarctic Pacific Ocean and its marginal seas. Recent studies have shown there is regional variations in the body size of this copepod. We determined first 18s rDNA sequence of this copepod to judge whether the gene is useful as a genetic marker for population genetics of this copepod living different regions. Copepodite Stage 5 specimens of *N. cristatus* were collected from Oyashio region, preserved in 90% ethanol and homogenized individually with a grinder. Genomic DNA was extracted using DNA extraction kit (Promega), and 18S rDNA was amplified from the DNA using eukaryotic 18S rDNA amplification primers. The amplified fragment was cloned into pCR4-TOPO cloning vector (Invitrogen). In each individual, three clones were sequenced, and 18S rDNA sequence of individual copepods was determined comparing the sequences.

Since sequence homology among 3 individuals was 99.7-99.8%, the sequence of *N. cristatus* 18S rDNA was determined. Homology search displayed 97% homology with that of *Calanus pacificus*, a morphologically closely related species to *N. cristatus*. Sequencing the gene from *N. cristatus* collected from regions other than Oyashio region is underway. The heterogeneity of the sequences, if any, among regional populations of *N. cristatus* will be discussed in our presentation.

9AM2000 S3-110 poster

**ANNUAL VARIATION IN DISTRIBUTION OF ZOOPLANKTON IN THE YELLOW SEA, 1996-1998**

Jung-Hoon Kang and Woong-Seo Kim

*Marine Biology Division, Center for Marine Environment & Climate Change, Korea Ocean Research & Development Institute (KORDI), Ansan P.O. Box 29, Seoul, Republic of Korea. 425-600 e-mail: jhkang@kordi.re.kr*

Annual variation of zooplankton distribution in the Yellow Sea was investigated in spring from 1996 to 1998. Zooplankton were collected by towing a net (330  $\mu$ - mesh size) vertically from about 5 m above the bottom to the surface.

Zooplankton were dominated by copepods which comprised more than 60% of total numerical abundance. *Acartia omorii*, *Calanus sinicus*, *Paracalanus indicus*, *Centropages abdominalis* and *Oithona atlantica* were abundant in spring throughout the study period.

No distinct annual variation was observed in terms of the abundance of dominant copepods for 3 years, while peak of abundance due to protozoan blooms of *Noctiluca scintillans* was observed in 1998. Total zooplankton abundance ranged from 566 indivs. per cubic meter to 5,851 indivs. per cubic meter in 1996, 152 indivs. per cubic meter to 6,819 indivs. per cubic meter in 1997, 179 indivs. per cubic meter to 12,236 indivs. per cubic meter in 1998. The trend of higher copepod abundance in the coastal waters than in the offshore waters was observed in the Yellow Sea. Results of cluster analysis based on zooplankton abundance in 1996,

1997 and 1998 showed that the study area could be divided into three sub-areas, Korean coastal waters (Kcw), Offshore waters (Ow) and Chinese coastal waters (Ccw) near the Yangtze River. The Kcw was characterized by *Noctiluca scintillans* and *Acartia bifilosa* which are neritic species, the Ow by *Acartia omorii*, *Centropages abdominalis* and *Oithona atlantica* which are cold water species.

The Ccw was dominated by a relatively warm species, *Paracalanus indicus*. Boundaries of 3 sub-areas changed a little depending on year, which mostly varied with thermocline structures caused by surface water temperature variation.

9AM2000            S1-111            poster  
**SUBTROPICAL ALTERNATIVE HEAT AND SALT ADVECTION IMPACT TO THE SEA OF OKHOTSK ECOSYSTEM**

Gennady A. Kantakov

*Biological Oceanography, Sakhalin Research Institute of Fisheries & Oceanography, 196 Komsomolskaya Street, Yuzhno-Sakhalinsk, Russia. 693023 e-mail: okhotsk@tinro.sakhalin.ru*

Heat and salt fluxes are transported to the Sea of Okhotsk from Pacific Ocean and Sea of Japan via northern Kuril and La Perouse (Soya) straits with East-Kamchatka, Soya and West-Sakhalin currents accordingly. Sea of Okhotsk discharges waters via southern Kuril straits with Oyashio current. Oyashio has been transported Sea of Okhotsk waters along Hokkaido mixing with pacific water masses and Tsugaru Strait outflow. Meanwhile according satellite infrared images abnormal high SST was discovered in the May 1999 inside usual cold late spring Oyashio region. In June, August and November 1999 SIFO conducted CTD observations at the southern part Sea of Okhotsk and nearest Pacific up to 500 m depth. For clarify the source and reasons of the 1999 warming the SST and transect archives from 1953 to 1999, materials from submooring Astarta deployed in the La Perouse (Soya) Strait, regional dynamical topography last decade were investigated.

Finally, source of the subtropical alternative heat and salt advection inside Sea of Okhotsk originated from pacific A8 ring was confirmed. The reasons of advection inside Sea of Okhotsk in 1999 were opened up due blocking the Oyashio by A8 eddy and changing Oyashio classical rout. Heat and salt advection inside Sea of Okhotsk prolonged from late spring to the November at least, having strong influence to the southern part Sea of Okhotsk ecosystem.

The impact to the marine biota and possible treat from subtropical advection for the health of people living on the South Sakhalin, South Kuril Islands, Northern and Eastern Hokkaido is discussed.

9AM2000            S6-112            oral  
**CARBON-NITROGEN-PHOSPHORUS CYCLING AT STATION ALOHA**

David M. Karl, J.E. Dore, R.R. Bidigare, R.M. Letelier and J.R. Christian

*Department of Oceanography, University of Hawaii, 1000 Pope Road, Honolulu, HI 96822, U.S.A. e-mail: dkarl@soest.hawaii.edu*

The marine N and P cycles are inextricably linked to the marine C cycle and these coupled processes define the ecological stoichiometry (ES) of the habitat. ES controls the flux of nitrogen gas into plankton communities, the taxonomic structure and efficiency of the food web and net export from the upper water column. Consequently, the stoichiometry of dissolved and particulate matter in the sea, especially the N:P ratio, is an important parameter for studies of the nutrient control of plankton growth and for modeling biogeochemical processes, including carbon sequestration. C, N and P pools have been measured on approximately monthly intervals for a 10-yr period at a deep ocean station in the North Pacific subtropical gyre (Sta. ALOHA; 22°45'N, 158°W). These data sets reveal complex interactions, and several unexpected secular trends. Models based on steady-state assumptions will not capture these temporal variations, especially the apparently rapid response of the microbial assemblages to stochastic nutrient intrusion events, the summertime enhancements of dinitrogen fixation and the time-varying (seasonal, interannual and decadal scale) changes in dissolved matter N:P ratios. We hypothesize that these observed ecosystem trends and other related biogeochemical processes in the upper portion of the NPSG are manifestations of plankton community succession in response to climate variations. The hypothesized photosynthetic population "domain shift" toward an ecosystem dominated by prokaryotes has altered nutrient flux pathways and affected food web structure, new and export production processes, and fishery yields. Further stratification of the surface ocean resulting from global warming could lead to even more enhanced selection pressures and additional changes in biogeochemical dynamics.

9AM2000 S7-113 poster

**OTOLITH GROWTH PATTERNS OF THE YEAR-CLASSES 1978 AND 1989 WALLEYE POLLOCK IN YOUNG AGES IN THE BERING SEA**

Seiji Katakura<sup>1</sup>, Akira Nishimura<sup>2</sup> and Tsuneo Nishiyama<sup>3</sup>

<sup>1</sup> *Graduate School of Fisheries Science, Hokkaido University, 3-1-1 Minato-cho, Hakodate, Japan. 041-8611 e-mail: katakura@fish.hokudai.ac.jp*

<sup>2</sup> *Hokkaido National Fisheries Research Institute, 116 Katsurakoi, Kushiro, Japan. 085-0802*

<sup>3</sup> *Hokkaido Tokai University, 5-1-1 Minamisawa, Minami-ku, Sapporo, Japan. 005-8601*

Intermittently occurring dominant year-classes (YC) of walleye pollock substantially influence the catch and ecosystem energy flow in the Bering Sea, as exemplified by YC 1978 and YC 1989. The mechanisms causing dominant year-classes still remain uncertain, though many considerations have been argued. Besides the mean body length of pollock has increased steadily since 1990 in the Aleutian basin, suggesting changes in pollock growth trend. However, lack of fish samples with age less than 5 (not cacheable size) has prevented from clarifying the peculiarity of growth in young life stage. To analyze significant differences between the two year-classes and the fish size increase in this decade, we examined the growth characteristics of otolith in pollock ages 1 to 5.

Otolith samples of YC 1978 fish were obtained in Aug-Sept of 1987 in the center of the Aleutian basin, and those of YC 1989 fish were obtained in February of 1999 from the area around Bogoslof Island. Otoliths were mounted in epoxy resin and sectioned along the long axis. The distance was precisely measured from the focus position to edge of each annulus ring using a digital microscope to determine year growth and seasonal growth.

The difference in mean otolith length (MOL) at age 1 was not statistically significant between YC 1978 and YC 1989, while MOL at ages 2 to 5 were significantly larger in YC 1989 than in YC 1978. Difference in MOL between two year-classes is caused by the difference in growth during the period from age 1 to age 2. It is suggested that the discrepancy in otolith growth is primarily determined by environmental influences during the summer season of age 1.

9AM2000 POCp114 poster

**SEASONAL AND INTERANNUAL CHANGES OF SST IN THE OKHOTSK SEA AND ADJACENT AREAS**

Akie Kato<sup>1</sup> and George V. Shevchenko<sup>2</sup>

<sup>1</sup> *Sakhalin Regional Hydrometeorological Agency, Russia e-mail: ugms@sakhalin.ru*

<sup>2</sup> *Institute of Marine Geology & Geophysics, Russian Academy of Science, Yuzhno-Sakhalinsk, Russia e-mail: sunami@sakmail.sakhalin.ru*

The monthly mean data of sea surface temperature that obtained at the coastal hydrometeorological stations of Sakhalin Regional Agency were analyzed. The statistical characteristics (average and extreme values, standard errors etc.) were estimated for all the stations.

Multiyear average values were computed for each month. Amplitudes and phases of annual and semiannual harmonics were computed using least square method. Spatial variability of annual harmonic gives some interesting information about peculiarities of circulation in the area of investigation. For example, relatively small amplitudes in the middle part of Kuril Islands (Simushir) and northeastern coast of Sakhalin Island (Komrvo) are associated with the seasonal upwelling events. We compared obtained results with satellite SST data analysis.

Interannual changes of SST were investigated using maximal entropy method of spectral analysis. There are some mutual peaks with periods about 2-3, 5-6, 19-20 years for almost all the stations. We obtained some another peaks at various areas. For example, there is well-expressed peak with period about 9 years at stations Kholmsk and Nevelsk, southwestern coast of Sakhalin Island. Probably, this peak connected with low frequency changes of Tsushima Warm Current.

Also, we calculated parameters of SST linear trends using least square method. Calculations were carried out on the base of mean annual values and on the base of 3 month averaged values too (for different seasons).

9AM2000 S2-334 oral

**SUMMARY OF THE WORKSHOP ON "THE BASES FOR ESTIMATING THE ABUNDANCE OF MARINE BIRDS AND MAMMALS, AND THE IMPACT OF THEIR PREDATION ON OTHER ORGANISMS"**

Hidehiro Kato<sup>1</sup> and George L. Hunt, Jr.<sup>2</sup>

<sup>1</sup> *Cetacean population Biology Section, National Research Institute of Far Seas Fisheries, 5-7-1 Orido, Shimizu, Shizuoka 424-8633, Japan e-mail: katohide@enyo.affrc.go.jp*

<sup>2</sup> *Department of Ecology and Evolutionary Biology, University of California, Irvine, CA 92697, U.S.A.*

Following a recommendation by PICES Working Group 11, whose business was completed in 1999, it was agreed to have a technical workshop on "The bases for estimating the abundance of marine birds and mammals, and the impact of their predation

on the organisms" during PICES 2000. A summary of the workshop could contribute to promote a fruitful discussion in the present topic session "Prey consumption by higher trophic level predators in PICES region: implication for ecosystem studies". Thus we present an executive summary of the workshop.

9AM2000 W6-333 oral

#### PREY CONSUMPTION BY MARINE MAMMALS; ESTIMATION BY THE PICES WORKING GROUP 11

Hidehiro Kato<sup>1</sup>, John Bengtson<sup>2</sup>, Norihisa Baba<sup>3</sup>, Chadwick Jay<sup>4</sup>, Lloyd Lowry<sup>5</sup> and Andrew Trites<sup>6</sup>

- <sup>1</sup> Cetacean population Biology Section, National Research Institute of Far Seas Fisheries, 5-7-1 Orido, Shimizu, Shizuoka, Japan. 424-8633 e-mail: katohide@enyo.affrc.go.jp
- <sup>2</sup> National Marine Mammal Laboratory, NMFS/NOAA, 7600 Sand Point Way NE Seattle, WA 98115, U.S.A. e-mail: John.Bengtson@noaa.gov
- <sup>3</sup> Research Coordinate & Planning Section, National Research Institute of Far Seas Fisheries, 5-7-1 Orido, Shimizu, Shizuoka, Japan. 424-8633 e-mail: norihisa@ss.enyo.affrc.go.jp
- <sup>4</sup> National Biological Service, Alaska Science Center, Anchorage, AK 99503, U.S.A. e-mail: chad\_jay@nbs.gov
- <sup>5</sup> Alaska Department of Fish & Game, 1300 College Road, Fairbanks, AK 99701, U.S.A. e-mail: llowry@fishgame.state.ak.us
- <sup>6</sup> Marine Mammal Research Unit, Fisheries Centre, University of British Columbia, 2204 Main Mall, Vancouver, B.C., Canada. V6T 1Z4 e-mail: trites@zoology.ubc.ca

Because marine birds and mammals are important components of the North Pacific ecosystem from viewpoints of top-down control, PICES established the special group, Working Group 11, in order to assess impacts by their predations on the ecosystem. For this, Marine Mammal group firstly reviewed available information and techniques then tried to estimate energy requirements and prey consumption by marine mammals as well as reviewing their principal prey preferences in each 14 PICES sub-region. Prey for marine mammals vary from plankton and benthic vertebrates to large fish and squid even include mammals and birds, also vary by sex and reproductive condition, time and foraging locations. There were also problems in availability of information on abundance, seasonal distributions and regional prey selection in many areas. In such status above we finally obtained some quantitative estimate of 8 PICES sub-regions rather emphasizing the western Pacific. With pooling available estimates of all the 8 sub regions (49% of total PICES square), total prey consumption is estimated to be 13,019,000 metric ton during summer (92 days) per year. But obviously this estimate is extremely under-representation. Further considerations might be necessary for both estimate itself and estimation techniques to have reasonable assessment.

9AM2000 S4-115 oral

#### SPATIAL DISTRIBUTION AND DENSITY OF JAPANESE COMMON SQUID IN THE PACIFIC COAST WATERS OFF NORTHERN HONSHU DETERMINED BY THE ACOUSTIC SURVEY

Atsushi Kawabata

Tohoku National Fisheries Research Institute, Same, Hachinohe, Aomori, Japan. 031-0841 e-mail: abata@myg.affrc.go.jp

Japanese common squid *Todarodes pacificus* Steenstrup migrate to the Pacific coast waters off northern Honshu from June to December and they are fished by angling, trawl or purse-seine. Distribution and density of the squid were surveyed using the quantitative echo sounder.

Diurnal vertical distribution pattern of the squid were observed. In the daytime, squid schools were distributed in the deeper layer below 100 m and around the bottom. In the evening, most squid rose, and they were distributed in 50-100 m layer at night. As for horizontal distribution pattern of the squid were that they were abundant on the continental shelf and slope (150-250 m in depth) or around sunken rocks. These squid distribution patterns are related to the distribution of euphausiid and small pieces, which are important prey of the squid.

Squid school density were estimated to 10-20 individuals/1000 m<sup>3</sup> in natural conditions. On the other hand, when the squid were gathered by fish lamp, the density were estimated to 50-80 individuals/1000 m<sup>3</sup>. The values were 8-10 times of that of natural conditions.

The density of squid in fishing ground fluctuated annually due to annual fluctuations of stock sizes. The density in August 1996 and 1997 were estimated to 6-14 individuals /100 m<sup>2</sup>, which were at high level. And those in August 1998 and 1999 were estimated to 1-2 individuals /100 m<sup>2</sup>, at low level.

9AM2000 S7-116 oral  
**REGIME SHIFT AND LONG-TERM VARIATIONS FOUND IN TUNA POPULATIONS IN THE NORTHWEST PACIFIC**

Tsuyoshi Kawasaki

*Tohoku University, Kugenuma-Fujigaya 1-10-6, Fujisawa 251-0031, Japan e-mail: ken.k@cityfujisawa.ne.jp*

Climate-induced interdecadal and high-amplitude variations are found in fish populations at lower trophic levels such as sardines and herrings. Tunas are situated at higher levels. It has been deemed that the variations in their biomass are not affected by climate-change but are subject primarily to the change in fishing effort and the current management regime for them are based on the population dynamics. According to the Schaefer model, if the cpues are plotted against the fishing effort, this will give a line with a negative slope, and the equilibrium catch is a parabolic function of effort.

Japanese small-scale tuna longliners under a tonnage of 20 have operated in the northwest Pacific and from well-documented records between 1973 and 1998, we can get good proxies for abundance, catches per day's fishing, for tuna populations, bluefin, albacore, bigeye and yellowfin. The regressive relations of cpue against effort and those of catch against effort are diverse between populations but show common long-term cyclic trends. The trends in biomass of the bluefin and albacore and those of bigeye and yellowfin are almost in phase but different in sign.

This implies that a consistent explanation for the variations in biomass of four tuna populations cannot be given by the theory of population dynamics but this will be only possible by applying the regime shift theory to the variations in tunas.

9AM2000 S4-117 oral  
**RELATIONSHIP BETWEEN CHANGE OF SPAWNING AREA AND FLUCTUATION OF BIOMASS OF THE JAPANESE COMMON SQUID *Todarodes pacificus* IN THE SEA OF JAPAN**

Hideaki Kidokoro, Tsuneo Goto and Shogo Kasahara

*Japan Sea National Fisheries Research Institute, Suido-cho 1, Niigata, Japan. 951-8121 e-mail: kidokoro@jnsf.affrc.go.jp*

The biomass of the Japanese common squid, *Todarodes pacificus* decreased during 1970s and 1980s. But it turned to increase in 1990s, and keeps abundant now. In the Sea of Japan, most of *T. pacificus* is known to spawn in autumn. From tagging experiments, the migratory passes for the spawning area were showed to change in the biomass level. In 1960s *T. pacificus* migrated along the north of sub-arctic front to the eastern coast of Korea, then reached East China Sea through the Tsushima Strait. But in 1980s they often migrated from the center of the Sea of Japan to the coast of the Japanese mainland, crossing sub-arctic front. In 1990s the migratory pattern returned to that of shown in 1960s. The range of the paralarval distribution of *T. pacificus* also changed. Until the middle of 1970s when the biomass was considered relatively abundant, the paralarval distribution ranged from the southwestern part of the Sea of Japan to the East China Sea. But in 1980s it contracted to only southwestern part of the Sea of Japan. In recent years, the distribution expands to the East China Sea again. The change of the migratory passes and the paralarval distribution suggest the change of the spawning area of *T. pacificus*, and it connects with the fluctuation of the biomass. We consider that the change of spawning area and the fluctuation of biomass must be affected by climatic change.

9AM2000 S4-123 oral  
**ABUNDANCE OF THE NEON FLYING SQUID, *Ommastrephes bartrami*, IN THE NORTH PACIFIC DURING 1994-1998**

Doo Nam Kim, Yeong Seung Kim and Joo Il Kim

*Distant Water Fisheries Resources Division, National Fisheries Research & Development Institute, Shirang-ri 408-1, Kijang-up, Kijang-gun, Pusan, Republic of Korea. 619-900 e-mail: dnkim@nfrda.re.kr*

The stock size and abundance of the neon flying squid, *Ommastrephes bartrami* (LeSueur), in the North Pacific (140°-180°E, 34°-50°N) were estimated by length based cohort analysis (Jones, 1981) based on the dorsal mantle length and catch and effort data collected from the Korean squid jigging fishery during 1994-1998. Population parameters, including von Bertalanffy growth parameters by nonlinear regression method, survival rate, instantaneous coefficients of natural and fishing mortalities, and age were estimated. The catch per unit effort in the statistical block was treated as an abundance index.

The fit of the von Bertalanffy growth curve for both male and female squid indicates slower growth rates in summer than in fall. The recent stock biomass is in low state compared to the early 1990s. Fishing grounds were formed in somewhat limited areas in 1997 between 143°-157°E and 40°-44°N, but those in the past years and 1998 appeared to be extended toward the Central Pacific. The SST anomalies over the fishing grounds by jigging vessel showed negative values in 1997. The low stock abundance might have been derived from unsuitable conditions to squid caused by negative SST anomalies.

9AM2000 S4-122 poster  
DEVELOPMENT OF COMPUTER AIDED DESIGN AND ANALYSIS SOFTWARE FOR A MIDWATER TRAWL GEAR

Hyun Y. Kim, C.W. Lee, Y.B. Kim, B.K. Kwon, B.J. Cha and S.J. Won  
Marine Production Management, Pukyong National University, 599-1 dae-yeon 3 dong, Nam-gu, Pusan, Republic of Korea. 608-737 e-mail: hykim@mail1.pknu.ac.kr

Midwater trawl gear design software was developed in order to gain an economical benefit by reducing trial and error in gear designing stages. There is also the convenience of the design tool. This software consists of a graphic tool to draw of the fishing gear plan and an analysis tool to examine the gear performance and database for the gear materials. With the graphic tool it is possible to draw various types of midwater trawl nets especially mesh can be drawn correctly according to the hanging ratio and bar length. And analysis tool can show the net mouth shape according to towing speed, the side view of the constructed net, physical characteristics of the net by partial resistance, accumulated resistance of the net and the load of each piece of twine. This procedure is very efficient in finding errors in designing such as shapes, load of twines and selection of the materials. The errors can be corrected immediately.

The design software will be demonstrated, and its usefulness will be shown by an analysis of the gear performance.

9AM2000 S4-118 invited  
PACIFIC ANCHOVY POPULATION STABILITY IN THE ECOSYSTEM OF KOREAN WATERS USING MATRIX POPULATION MODEL

Jin-Yeong Kim<sup>1</sup> and Nancy C.H. Lo<sup>2</sup>

<sup>1</sup> National Fisheries Research and Development Institute, 408-1, shirang-Ri, Kijang-Up, Kijang-Kun, Pusan, Republic of Korea. 619-900 e-mail: jiykim@nfrda.re.kr

<sup>2</sup> NOAA, Southwest Fisheries Science Center, P.O. Box 271, La Jolla, CA 92038, U.S.A.

We applied a stage-specific population matrix, the Lefkovitch matrix, to the Pacific anchovy to determine vital rates in the life history and effect of each on population growth with 8 stage-specific mortality from egg to adult, duration of each stage and age-specific fecundity. Dominant eigenvalue is 0.99963 for the fixed duration within stage and 1.00009 for the variable duration. A crude estimate of the annual population growth rate,  $0.87365(=0.99963^{365})$  for the fixed duration and  $1.03339(=1.00009^{365})$  for the variable duration, showed that variation in growth rates of individuals enhanced the population growth.

The elasticity of population growth rate from variable growth, percentage change from a 1% change of a vital rate, was great for the mortality in embryo stage, stage durations in pre-adult and early adult stage, and fecundity of 1 year-old fish. Elasticity values for IMR and duration from fixed growth were great from embryo stage to late larval stage. A 10% decrease of the daily IMR for the embryo stage and early larval stage would result in an increase of 0.0136% and 0.00386% for the population respectively.

These results imply that seasonal oceanography and prey-predator relationship during early life stage may influence the population growth of anchovy by changing mortality and duration in each stage, which may be useful to improve management program of anchovy for the sustainable yield.

9AM2000 S9-124 poster  
NUCLEOTIDE SEQUENCES OF THE PARTIAL 18S rDNA FROM KOREAN SCALLOPS

Mi-Jung Kim<sup>1</sup>, Long-Guo Jin<sup>1</sup>, Jung Youn Park<sup>2</sup>, Yong-Ki Hong<sup>1</sup>

<sup>1</sup> Department of Biotechnology, Pukyong National University, Nam-Gu, Nanku, Pusan, Republic of Korea. 608-737 e-mail: spud1@hanmail.net

<sup>2</sup> Biotechnology Division, National Fisheries Research & Development Institute, Pusan, Republic of Korea. 626-900

Sequences of partial 18S rDNA have been analyzed to elucidate genetic diversity of the scallops collected from Korean coasts. The scallops used in this genetic comparison are *Agropecten irradians concentricus*, *Amusium japonicum japonicum*, *Chlamys farreri farreri*, *Chlamys swifti*, *Patinopectin yessoensis*.

These sequences were aligned by Clustal W program. The phylogenetic tree was drawn by Treecon W program. The scallops were divided into two groups - the Family Pectinidae containing *Amusium japonicum japonicum* and the Family Propeamussiidae containing *Agropecten*, *Chlamys*, *Patinopectin* genera.

The species of *Chlamys swifti* was closer to the *Patinopectin yessoensis* rather than *Chlamys swifti*.



9AM2000 FISp120 poster  
WINTER DIET STRUCTURE OF SHELF FISHES IN EASTERN SLOPE WATERS OF THE TATAR STRAIT, SEA OF JAPAN

Sen-Tok Kim

Sakhalin Research Institute of Fisheries & Oceanography, 196 Komsomolskaya Street, Yuzhno-Sakhalinsk, Russia. 693000 e-mail: kim@tinro.sakhalin.ru

The materials were collected in January-February in 1999 and 2000, from the slope waters off southwestern coast of Sakhalin Island by trawl surveys. By fall in temperature of shallow waters in northern Sea of Japan the most of shelf fishes is concentrated in the slope at depth of 300-1000 m. In that zone 44.8-99.4% (average 88.2) of total biomass of various shelf fish species was distributed. All period of wintering feeding for few species - some flat-fish, is not observed, but other ones especially predatory fishes carry on to consume their prey. The high concentration of fishes in the comparatively narrow zone of the western Sakhalin slope makes the changes of trophic structure of fish's communities being at the large depth zone. Probably weakening winter diet a many of species affects to reduce its competition. The diet structure similarities of 24 most abundance species reaches middle and small level. Three groups of fishes with overlap of diet 34-56% were selected. The trophic relationships between large fish predatory in the slope waters are characterized by different intensity. Predators in this waters were represented by three species: cod - large numerous fish and two sculpins - shorthorn *M. jaok* and great sculpin *M. polyacanthocephalus*. The diet similarities of three species were low, maximum 16.9% for cod and great sculpin. Shorthorn sculpin added to them with 3.9-7.3% of similarities. The base of food resources for these species was mainly consists of other fishes. On the second place in diet of all species, decapods (shrimps) are revealed. Winter diet for shelf fishes exceeds their total biomass approximately in five times. Ratio weight of food and weight of fish body for various species have changed from 0.02 to 5.9%, excluding this parameter for great sculpins (21.1).

9AM2000 S7-119 oral  
ENVIRONMENTAL CHARACTERISTICS IN CHUM SALMON HABITATS USING STABLE ISOTOPE CONTENTS IN OTOLITHS

Suam Kim<sup>1</sup>, Sukyung Kang<sup>1</sup>, David Welch<sup>2</sup>, Jack Helle<sup>3</sup>, and Kazuya Nagasawa<sup>4</sup>

<sup>1</sup> Department of Marine Biology, Pukyong National University, 599-1 Daeyeon3-Dong Nam-Gu, Pusan, Republic of Korea. 608-737 e-mail: suamkim@pknu.ac.kr

<sup>2</sup> Ocean Sciences & Productivity Division, Pacific Biological Station, Department of Fisheries & Oceans, Nanaimo, BC, Canada V9R 5K6

<sup>3</sup> National Oceanic and Atmospheric Administration, Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle, WA 98115, USA

<sup>4</sup> North Pacific Resources Division, National Research Institute of Far Seas Fisheries 7-1 Orido, 5-chome, Shimizu, Shizuoka-ken, Japan. 424-8633

To investigate the geographical distribution, stock separation and habitat characteristics of chum salmon (*Oncorhynchus keta*) in the North Pacific Ocean, the stable isotopes d18O and d13C in otoliths were measured. Salmon otoliths were obtained from four hatcheries in the eastern (Canada and USA) and western (Japan and Korea) North Pacific during 1997 and 1998 spawning seasons. Statistical analysis with d18O and d13C isotopes indicated that they were largely separated into two groups: Asian and North American chum salmon. Oxygen stable isotope of Japan salmon showed the highest values, and Canada salmon lowest with difference ca. 0.85 ‰ in both years. On the other hand, carbon stable isotope appeared in the opposite pattern. Assuming d18O and d13C values are the indicatives for ocean temperature and productivity at salmon habitats respectively, Asian salmon seem to reside in cooler temperature and more productive area than North American stocks. These results coincide generally the facts that the western gyre shows lower sea surface temperature and higher primary productivity compare to the eastern gyre in the North Pacific. There are interannual differences in stable isotope content of otolith between 1997 and 1998. In 1997, d18O and d13C were ca. 0.19 ‰ and ca. 0.17 ‰ higher than those in 1998, respectively. The lower oxygen stable isotope in 1998, which represents warmer seawater temperature than in 1997, may be related to changes of oceanic environment such as the strong El Niño in 1997/1998. (Environmental changes in the North Pacific due to the El Niño are under being analysed to interpret the relationship between fish behavior and climate change.)

9AM2000 FISp121 oral  
A GENETIC ANALYSIS OF THE COMMON SQUID, *Todarodes pacificus* IN KOREAN WATERS

Yeong Hye Kim<sup>1</sup>, Yong Joo Kang<sup>2</sup> and Jung Youn Park<sup>3</sup>

<sup>1</sup> South Sea Fisheries Research Institute, NFRDI, Yeosu, Cheonnam 556-820, Republic of Korea e-mail: yhkim@kios.pknu.ac.kr

<sup>2</sup> Department of Marine Biology, Pukyong National University, Pusan 608-737, Republic of Korea

<sup>3</sup> National Fisheries Research & Development Institute, Pusan, 619-900, Republic of Korea

The purpose of this study is to examine the genetic polymorphism of each cohort. We will use the genetic method, and we will compare our results with, Kim *et al.* (1997)'s morphological and ecological research. In order to estimate the genetic variability and differentiation in common squid, eleven isozymic loci, coded for nine enzymes detected by starch gel electrophoresis, were scored from nine spawning cohorts in four localities. The expected average heterozygosity ranged from 0.00019 (between II-S2 and Na-W) to 0.00814 (Between Pu-S and Na-W) in nine different spawning cohorts in four localities. A dendrogram, based on genetic distance mentioned, illustrated that nine different spawning cohorts were divided into three groups, similar to the result estimated by their ecological.

9AM2000 S3-311 invited  
HISTORY AND RECENT PROGRESS IN ZOOPLANKTON STUDIES IN KOREA

Woong-Seo Kim

Marine Biology Division, Center for Marine Environment and Climate Change, Korea Ocean Research and Development Institute, Ansan P.O. Box 29, Seoul, Republic of Korea. 425-600 e-mail: wskim@kordi.re.kr

The first record on plankton was found in 1403, saying that color of the southern coastal water of Korea changed into brown, black, and red, resulting in mass mortality of fishes. Initial researches on zooplankton were conducted by foreign planktologists in early 1930s, and studies by Korean planktologists began in 1950s. The CSK (Cooperated Study of Kuroshio and Adjacent Area) project in 1960s was the starting point of active zooplankton study. For about 40 years, a lot of information on species composition, abundance, distribution of zooplankton in the Yellow Sea, Southern Sea, and East Sea (Japan Sea) have been accumulated. Copepods of 179 species have been reported in the southern Sea, and 148 species in the Yellow Sea. Progress in zooplankton ecology in Korea has been made recently. The CPR (Continuous Plankton Recorder) and on board continuous sampling system were used to investigate continuous distribution pattern of zooplankton in large areas in short time. Mesocosm was used for the toxicity test of various pollutants to zooplankton, and bubble-powered zooplankton grazing wheel was invented and used to measure grazing rate of zooplankton. GLOBEC (Global Ocean Ecosystem Dynamics)-Korea is now ready to be launched.

9AM2000 S1-125 oral  
BIOLOGICAL PRODUCTION PROCESS ASSOCIATED WITH FRONTAL DISTURBANCES OF THE KUROSHIO AND THE KUROSHIO EXTENSION

Shingo Kimura, Hideaki Nakata, Yuji Okazaki and Takashige Sugimoto

Ocean Research Institute, University of Tokyo, 1-15-1 Minamidai, Nakano, Tokyo, Japan. 164-8639 e-mail: kimuras@ori.u-tokyo.ac.jp

Frontal disturbances of the Kuroshio and the Kuroshio Extension in the Pacific Ocean cause meso-scale eddies which contribute to accelerating biological productivity in the frontal region. Temporal and spatial changes in nutrients and phytoplankton biomass observed in the vicinity of the meso-scale eddies in recent several research cruises revealed a mechanism of high primary production in the offshore, and suggested an uptake process of the upwelled nutrient by phytoplankton. In this study, we proposed a newly developed Upwelling-Production Diagram for evaluating nutrient consumption in relation to primary production and showed that this diagram would be one of the promising ways to estimate temporal changes in the biological production process from Eulerian observational data. According to observations and numerical simulations in the Kuroshio Extension, maximum chlorophyll *a* concentration in the eddy reached 3-4ng/l in 3-4 days corresponding to the estimates in the Kuroshio region. This indicates that primary production caused by the frontal eddies is a ubiquitous phenomenon in the Kuroshio and the Kuroshio Extension. In addition, density of copepod nauplii increased with chlorophyll *a* concentration in the eddy, and large numbers of eggs and larvae of anchovy were recognized at stations where the copepods were highly concentrated. It may be difficult to explain that the physical phenomenon directly affects larval survival in a week, however this correspondence strongly indicates that the frontal disturbances contribute to not only primary production but also fish reproduction.

9AM2000 W3-388 oral  
SENSITIVITY ANALYSIS ON NEMURO

Michio J. Kishi and Hiroshi Kuroda

Hokkaido University, Graduate School of Fisheries Sciences, Hakodate, Hokkaido, 041-8611 Japan e-mail: kishi@coast0.fish.hokudai.ac.jp

Sensitivity analysis was performed on NEMURO using Monte Carlo analysis. The ecological parts of the model were run to calculate the nitrogen-based biomass of each compartment until steady state solutions were obtained. Values of each compartment and ecological parameters were stored to be used as the baseline values around which random perturbations were generated and put into the Monte Carlo error analysis. A Monte Carlo error analysis with 600 individual calculations was made with input parameters and initial values perturbed independently over random error distribution with limits of +/- 10% of base line values. Principal component analysis was used to reduce the 600 sets of output of biological parameters and initial values. The PCA indicated four factors which together expanded 22% of variance in data space. The first factor is clearly related to photosynthesis of PL accounted for 10% of data space variance; VmaxS, VmaxL, and PL, NO<sub>3</sub>, NH<sub>4</sub>. The second factor is related to ZL and ZS. Based on this sensitivity analysis, we applied data assimilation method to A7 using NEMURO and guessed parameter values.

9AM2000 S4-126 oral  
AN INTERACTION BETWEEN HORIZONTAL STRUCTURES OF OCEAN FRONTS AND JAPANESE COMMON SQUID FISHING GROUND FORMATION IN THE JAPAN/EAST SEA

Hidetada Kiyofuji, Sei-ichi Saitoh, Yasunori Sakurai and Kunisaburo Yoneta

Laboratory of Marine Environment and Resource Sensing, Hokkaido University, 3-1-1, Minato-cho, Hakodate, Hokkaido, Japan. 041-8611 e-mail: kiyofuji@salmon.fish.hokudai.ac.jp

Our objectives of this study are, (1) to describe the spatial structures of thermal fronts derived from NOAA/AVHRR sea surface temperature and color front from SeaWiFS chlorophyll *a*, and (2) to investigate the spatial relationship between thermal fronts or color fronts and Japanese common squid fishing ground. We apply mainly satellite data set, which are sea surface temperature (NOAA/AVHRR), ocean color (SeaWiFS) and night visible images (DMSP/OLS). The study period is from January 1998 to January 1999. Study area is the Japan/East Sea from (32°N, 124°E) to (46°N, 143°E). As results are (1) thermal fronts and color fronts permanently exist and fluctuate with meander near 40°N from east to west of Japan/East Sea through a year, (2) we can also confirm characteristics of fronts distribution along the east coast of Korea, between Tsushima and Cheju Island, and (3) the fishing ground of Japanese common squid form along those fronts. These results suggest that both thermal and color fronts are one of the important environment factors to consider of Japanese common squid distribution. We may conclude that spatial distribution of thermal and color front affect the spawning migration from the north to south of Japan/East Sea.

9AM2000 S7-127 poster  
THE RELATIONSHIP BETWEEN BODY SIZE AND WATER TEMPERATURE OF NEOCALANUS COPEPODS (CRUSTACEA: COPEPODA) IN THE SUBARCTIC PACIFIC

Toru Kobari<sup>1</sup> and Tsutomu Ikeda<sup>2</sup>

<sup>1</sup> Miyagi Prefecture Fisheries Research & Development Center, Japan Science & Technology Corporation 97-6 Sodenohama Watanoha, Ishinomaki, Miyagi, Japan. 986-2135 e-mail: toru.k@f3.dion.ne.jp

<sup>2</sup> Biological Oceanography Laboratory, Faculty of Fisheries, Hokkaido University, 1-1 Minato-cho, 3 chome, Hakodate, Hokkaido, Japan. 041-5541 e-mail: tom@pop.fish.hokudai.ac.jp

Studies have shown that the body size of Neocalanus copepods (*N. cristatus*, *N. plumchrus*, *N. flemingeri*) varies latitudinally within the subarctic Pacific. Our recent analysis of 20 year records on the body size (prosoma length of C5 stage) of the three Neocalanus species collected from many stations in the Alaskan Current System through the northern Subtropical Current System on the 180° longitude (central subarctic Pacific) during summer showed a consistent pattern of the gradual reduction from north to south in their prosoma length. Taking into account trophic features (grazers), annual life-history patterns and extensive ontogenetic vertical migration behavior of the three Neocalanus species, searches for possible biotic and abiotic attributes to the north-to-south reductions in the prosoma length reached a conclusion that water temperature is the most important attribute. Phytoplankton abundance was of minor importance as an attribute to their latitudinal prosoma length variations. Correlation analysis of the prosoma length with mean temperature integrated over various depths yielded dissimilar results (correlation coefficients), and the best correlation was obtained by using the mean temperatures over 0-50 m depth (T0-50) for *N. plumchrus* and that over 0-250 m depth (T0-250) for *N. cristatus* and *N. flemingeri*;

$$N. cristatus: PL = -2.496 \log_{10} T0-250 + 8.607, r^2 = 0.950$$

$$N. plumchrus: PL = -0.643 \log_{10} T0-50 + 4.312, r^2 = 0.913$$

$$N. flemingeri: PL = -0.685 \log_{10} T0-250 + 3.672, r^2 = 0.912$$

The validity of the relationships was tested by comparing the predicted prosome length with observed ones of each *Neocalanus* species having been collected from various regions within the subarctic Pacific and Okhotsk and Japan Seas during various seasons of the year. The agreement between the two was generally good, if the mean temperature was referred to their growing seasons (March to July) for the data sets originated from non-growing seasons.

9AM2000 W2-312 oral  
**RECENT STATE OF JAPANESE HERRING POPULATIONS**

Tokimasa Kobayashi and Keizo Yabuki

*Hokkaido National Fisheries Research Institute, 116 Katsurakoi, Kushiro, Hokkaido, Japan. 085-0802 e-mail: tokikoba@hnf.affrc.go.jp*

Judging from the fluctuation of the catch data the stock condition of each population distributed around Japan is showing different phase each other.

Hokkaido-Sakhalin population herring spawn in high salinity shallow waters and its life span is longer than 15 years and migration range is wide within these populations.

Annual catch had been maintained more than three hundred thousand tons from 1880s to mid 1930s with a historical peak of about one million tons in 1897. However the catch declined since mid 1940s and has been still in quite low level since 1955 except the appearance of 1983 year-class which was caught totally about one hundred thousand tons.

Mangoku-Ura population spawn in high salinity waters but migration range is smaller and life span is shorter than Hokkaido-Sakhalin population. Its annual catch increased gradually from 1977 and reached to about six hundred tons in 1984. But it decreased since 1987 due to the small recruitment relating to the rise of water temperature in spawning season.

For Lake-Furen population which spawn in brackish lake its annual catch had fluctuated below ten tons before 1984. Since 1985 it gradually increased and reached to about seven hundred tons in 1997 but it decreased below fifty tons in 1999 and 2000 due to the weak year-classes of 1997 and 1998.

Different phases of stock condition observed among each population may be deeply related to the inherent ecological and physiological abilities of adaptation to the number of oceanic condition factors.

9AM2000 S9-128 poster  
**THE TECHNIQUE OF HYDROMETEOROLOGICAL SCENARIO CONSTRUCTION FOR THE AREAS OF SAKHALIN SHELF**

I.E. Kochergin<sup>1</sup>, A.A. Bogdanovsky<sup>1</sup>, V.D. Budaeva<sup>1</sup>, V.G. Makarov<sup>1</sup>, S.M. Varlamov<sup>1</sup>, N.A. Dashko<sup>1</sup>, V.F. Putov<sup>2</sup> and S.I. Rybalko<sup>1</sup>

<sup>1</sup> *Far Eastern Regional Hydrometeorological Research Institute (FERHRI), 24 Fontannaya Street, Vladivostok, Russia. 690600 e-mail: IKochergin@hydromet.com*

<sup>2</sup> *Ecological Company of Sakhalin (ECS), Yuzhno-Sakhalinsk, Russia*

To forecast sustainable mariculture farming it is necessary to know hydrometeorological conditions of the environment. Such investigations help to reduce the risks caused by extremal hydrological and meteorological impacts, to assess the characteristics of external sources-potential contributors of contaminants and toxic substances to sea-farming areas, and to calculate plantation productivity under typical hydrometeorological conditions. The described approach to *hydrometeorological (h/m) scenario* construction includes the well-reputed methods of scenario preparation for forecast oil spill modeling.

For the stated above purposes a set of *h/m scenarios* is constructed. It includes a necessary amount of *scenarios* of specified duration. *H/m scenario* is defined as a set of *typical h/m situations* successively replacing one another. *Typical h/m situations* define a set of interrelated meteorological and hydrological fields characterized by statistically significant probability, duration, and probabilistic coefficients of from-one-to-another-situation transition. These interrelated fields include the averaged wind fields characterized by a certain probability of occurrence, corresponding to them nontidal current fields, calculated tidal current fields for specified periods, as well as characteristics of wave height and air and water temperature, salinity, and background hydrochemical properties.

The technique was tested by comparing the constructed *h/m scenario* characteristics with the real conditions observed in the areas of Sakhalin shelf. The paper provides the practical examples of scenario construction for various purposes, such as investigation of regime and extremal impact characteristics and contamination transport.

9AM2000 S6-310 invited

**COMPARISON OF ENVIRONMENTAL FACTORS CONTROLLING BIOLOGICAL PROCESSES IN THE WESTERN AND EASTERN SUBARCTIC PACIFIC AND THE BERING SEA**

Isao Koike

*Ocean Research Institute, University of Tokyo, Tokyo, Japan. e-mail: koike@ori.u-tokyo.ac.jp*

Recent studies suggest that high-nutrient and low chl *a* (HNLC) region, which originally reported in the Gulf of Alaska (G.A.) gyre, extends to larger part of the western subarctic Pacific. In those regions, high concentrations of major nutrients (nitrate, phosphate and silicate) are present in the surface water during stratified season, indicating iron limitation of phytoplankton growth. However, occasional summer depletion of silicate was observed in the Bering Sea Basin (B.S.) and Oyashio Region (O.R.). Also, depth integrated ammonium concentration (0-200 m) in B.S. was ca. 4 times higher than that of G.A. in summer, suggesting higher heterotrophic activities and more availability of regenerated nitrogen for phytoplankton in the former region. Depletion of silicate with relatively high amounts of nitrate in B.S. surface water can be explained by additional supply of nitrogen under no iron limited condition. During ca. 50 days interval in summer, increase in surface silicate/nitrate (Si/N) ratio (from ca. 2.0 to 2.8) was observed in G.A., while the ratio was rather constant (1.5-2.0) in the B.S. and O.R. This observation is consistent with the idea that iron limitation suppresses especially the growth of diatoms among the phytoplankton assemblages.

Another example of trace metal limitation of biological processes is a possible role of zinc on microbial protein degradation through ectoenzymes. Recent our study showed that activity of amino peptidase in the upper layer of subarctic Pacific decreased eastward, while that of glucosidase remained constant. Since zinc is key metal for the function of amino peptidase and depletion of zinc in the upper layer of subarctic Pacific is much severe in eastern part of subarctic Pacific, trace metals like zinc would be also important regulating the process of organic matter degradation.

9AM2000 S5-130 oral

**TWO DISTINCT HYDROGRAPHIC CHARACTERISTICS OF INTERMEDIATE WATER IN THE KUROSHIO REGION SOUTH OF JAPAN**

Kosei Komatsu<sup>1</sup>, Yutaka Hiroe<sup>1</sup>, Ichiro Yasuda<sup>2</sup> and Kiyoshi Kawasaki<sup>1</sup>

<sup>1</sup> *National Research Institute of Fisheries Science, 2-12-4 Fukuura, Kanazawa-ku, Yokohama, Kanagawa, Japan. 236-8648 e-mail: kosei@nrifs.affrc.go.jp*

<sup>2</sup> *University of Tokyo, Japan*

Hydrographic observations were performed with focus on the intermediate water of density from 26.5 to 27.5 sigma-theta along the TOPEX/POSEIDON satellite southeastward tracks across the Kuroshio offshore Japan in May 1998 and August 1999. The intermediate water was clearly clustered into two groups taking 31°-32°N as a boundary, although the surface and the deep water has similar hydrographic properties along the meridional section. The offshore-side intermediate water was less saline than the inshore-side one. On the assumption of isopycnal mixing, the mixing ratio between the Oyashio and the Kuroshio water was estimated to be negligible for the inshore-side intermediate water and typically 20% for the offshore-side one. A sharp salinity minimum was observed around 26.8 sigma-theta throughout the section and the dissolved oxygen maximum was observed at almost the same depth as the salinity minimum. In the upper intermediate depth from 26.5 to 27.0 sigma-theta surrounding the oxygen maximum, the dissolved oxygen decreases toward the inshore-side. On the other hand, in the lower intermediate depth from 27.0 to 27.5 sigma-theta, oxygen increases toward the inshore-side; the oxygen minimum in the inshore-side lower intermediate water attains such a high value as is not observed on the same sigma surface in other northern or eastern regions of the North Pacific. This result suggests the invasion of high oxygen water transferred northward along the western boundary which is influenced by the Antarctic Intermediate Water characterized by higher oxygen.

9AM2000 S7-129 poster

**A THREE DIMENSIONAL MODELING STUDY OF THE ECOSYSTEM DYNAMICS AROUND THE KUROSHIO FRONTAL REGION**

Kosei Komatsu, Y. Matsukawa, K. Nakata, T. Ichikawa and K. Sasaki

*National Research Institute of Fisheries Science, 2-12-4 Fukuura, Kanazawa-ku, Yokohama, Kanagawa, Japan. 236-8648 e-mail: kosei@nrifs.affrc.go.jp*

A new ecosystem model was developed to be incorporated biological processes of lower trophic level into a three-dimensional physical primitive model, and applied to the region around the Kuroshio extension in the northwestern Pacific where most of winter-spawned larvae of Pacific saury (*Cololabis saira*) are distributed. Mesoscale eddies and meander around the extension were appropriately reproduced, and biological results responded to the temporal change of physical field and indicated strong sensitivity to wavelength of the meander and depth of the mixed layer. In comparison of model estimates with observed values by research vessels in meridional cross sections across the Kuroshio, the supply of nutrient from lower layer was richer especially in the north-side of the ridge of meander, and the model showed chlorophyll maximum at surface in spring and at sub-surface in summer as well as observations. The model also simulated the almost similar seasonal variation and spatial distribution of zooplankton biomass which is one of important factors responsible for growth and mortality of saury larvae.

9AM2000 FISp131 poster  
**DISTRIBUTION AND ABUNDANCE PATTERNS OF TWO LARVAL ANISAKINE NEMATODES IN WALLEYE POLLOCK COLLECTED OFF THE PACIFIC COAST OF HOKKAIDO, JAPAN**

Kenji Konishi, S. Honda and Y. Sakurai

Graduate School of Fisheries Science, Hokkaido University, Minatocho 3-1-1, Hakodate, Hokkaido, Japan. 041-0823 e-mail: tododani@fish.hokudai.ac.jp

Several studies of distribution and abundance patterns in anisakine nematodes from walleye pollock have been studied over large survey areas. This study examined distribution and abundance patterns of *Anisakis simplex* and *Contracaecina* (*Contracaecum* / *Phocascaris* spp.) larvae in walleye pollock from geographically small-scale area within the Pacific stock, and discussed factors which affect the abundance patterns of the two larval nematodes. In 1999, pollock were collected from the Pacific coast of eastern Hokkaido by the Hokkaido National Fisheries Research Institute. There were no differences in abundance due to host sex for both larvae, and *A. simplex* larvae were more abundant than *Contracaecina* larvae. The abundances of both larvae were highest in the eastern part of the sampling area. However, the abundances of the two larvae were correlated with pollock growth, and larger pollock distributed in eastern part of the sampling area. So, the abundance data were standardized to remove the effects of pollock growth. The standardized abundance of *A. simplex* larva was still highest in the eastern part of the sampling area. Conversely, the standardized abundances of *Contracaecina* larva were variable, but had no geographical trend. These results suggested that the eastern part of sampling area is suitable for the transmission of *A. simplex*. The abundances of final hosts are the most considerable factor which affect the abundances of the two larvae. However, feeding habit of the pollock differ within the sampling area, hence the abundances of intermediate hosts could be alternative factors.

9AM2000 S3-132 poster  
**RECENTLY OBSERVED DELAY IN THE OCCURRENCE OF SPRING ZOOPLANKTON BIOMASS MAXIMUM IN ISHIKARI BAY, WESTERN HOKKAIDO**

Moriyuki Kotori and Kazuo Hirano

Hokkaido Central Fisheries Experimental Station, Hamanaka-cho 238, Yoichi, Japan. 046-8555 e-mail: kotorim@fishexp.pref.hokkaido.jp

Present address: Hokkaido Kushiro Fisheries Experimental Station, Kushiro, Hokkaido, Japan. 085-0024

Zooplankton samplings have been routinely made by the Hokkaido Central Fisheries Experimental Station at 4 stations (Stns J31-J34) in Ishikari Bay, western Hokkaido, faced on the northern part of the Japan Sea/East Sea from the year 1989. Samples were collected bimonthly, February, mid April, late May to early June, late July to early August, early October, and late November to early December. Hauls were made mainly during daytime from the bottom to the surface at Stns J31 and J32, and from 150-m depth to the surface at Stns J33 and J34 (depth of the bottom is more than 150 m at the two stations) by vertical tows of a Norpac net or a cylinder-cone type remodelled Norpac net (45-cm mouth diameter, 0.33-mm mesh opening). Zooplankton biomass was estimated based on wet weight of samples and volume of water filtered by the net. The annual maximum of the biomass appeared in April before 1991, and the maximum has shifted to May-June after 1992. Copepods were dominated in both cases, and *Neocalanus plumchrus* (Marukawa) made up more than half of total copepod biomass at the time of maximum zooplankton biomass. This suggests that the shift of the annual maximum of zooplankton biomass was reflected by the change in developmental timing of *N. plumchrus* in the present area as is already reported at Ocean Station P in the northeastern North Pacific.

9AM2000 POCp133 poster  
**SYNTHESIS OF ENVIRONMENTAL DATA FOR THE OKHOTSK SEA WITH APPLICATION OF OTHER SUBARCTIC REGIONS**

Vladimir F. Krapivin<sup>1</sup>, John J. Kelley<sup>2</sup> and Kunio Shirasawa<sup>3</sup>

<sup>1</sup> Institute of Radioengineering and Electronics, Russian Academy of Sciences, Moscow, Russia

<sup>2</sup> Institute of Marine Science, University of Alaska Fairbanks, 245 O'Neill Building, Fairbanks, AK 99775-7220, U.S.A. e-mail: fjjk@uaf.edu

<sup>3</sup> Sea Ice Research Laboratory, Hokkaido University, Mombetsu, Hokkaido, Japan

Recently investigators have reported a variety of problems in monitoring complex systems for meaningful collection and synthesis of environmental information concerning the Okhotsk Sea. The Okhotsk Sea exhibits high productivity and functions under a rigorous climate regime. In response to these difficulties a method was devised to integrate a Geographical Information System (GIS) with models and field measurements. A Geographic Information Monitoring System (GIMS) is focused on the systematic observation and evaluation of the environment related to changes attributable to human impact on the marine system. One of the important functional aspects of the integrated system is the possibility of developing a forecasting capability to warn of undesirable changes in the environment. Application of mathematical modeling to the monitoring effort improves simulation of the natural processes. The model contains ecosystem, climate and anthropogenic processes. Anthropogenic processes are related to fishing and pollution.

Simulation of biosphere dynamics is one of the important functions of the GIMS. The basic objective in the development of the GIMS technology is to describe the regional biogeosystem as a biosphere sub-system. Therefore, application of the GIMS technology to the study of the Okhotsk Sea Environment entails synthesis of a model of the Okhotsk Sea which describes the associated ecosystem dynamics. The set of components for the model of the Okhotsk Sea environment is divided into three types of information sources: mathematical models of the ecological and hydrophysical processes, service software, and a scenarios generator.

9AM2000 S7-326 oral  
**LONG-TERM FLUCTUATIONS IN COD AND HERRING STOCKS IN THE NORTH PACIFIC AND NORTH ATLANTIC AND THEIR RELATION TO CLIMATE VARIABILITY IN THE NORTHERN HEMISPHERE**

Andrei S. Krovnin, A.M. Orlov and G.P. Moury  
*Russian Federal Research Institute of Fisheries & Oceanography (VNIRO), 17 V. Krasnoselskaya, Moscow, Russia. 107140 e-mail: akrovnin@mx.iki.rssi.ru*

Long-term fluctuations in several cod and herring stocks living in the North Pacific and North Atlantic are analyzed in the context of climatic changes in the whole Northern Hemisphere. For this purpose data on mean winter anomalies of surface atmospheric pressure, geopotential heights on 700- and 500 hPa surfaces, sea surface temperature, water temperature at standard sections in the Norwegian and Barents Seas, indices of well-known teleconnection patterns and some others for the 1950-1998 period are used. The research is focused on comparison of fluctuations in the above fish stocks abundance between the North Atlantic and North Pacific. The mechanisms that may be responsible for relationships of fluctuations among different stocks are considered.

9AM2000 S7-134 oral  
**CLIMATE FLUCTUATIONS AND DYNAMICS OF ALASKAN CRAB POPULATIONS**

Gordon H. Kruse and Jie Zheng  
*Alaska Department of Fish and Game, Division of Commercial Fisheries, P.O. Box 25526, Juneau, AK 99802-5526, U.S.A. e-mail: gordon\_kruse@fishgame.state.ak.us*

Wide swings in abundance associated with recruitment variability are typical of king (*Paralithodes*, *Lithodes*), Tanner and snow crab (*Chionoecetes*) populations off Alaska. We examined recruitment patterns of 15 crab stocks in the Gulf of Alaska and eastern Bering Sea. Of these, 7 stocks, mostly in the northern and western Gulf of Alaska, had recruitment trends that appear related to decadal climate shifts; periods of strong winter Aleutian Lows coincide with periods of weak recruitment. Recruitment patterns of other stocks were divergent, suggesting the importance of local conditions not indexed by the Aleutian Low. Based on abundance and recruitment data, we investigated 3 hypotheses about relationships between 5 crab and 3 groundfish populations in the Bering Sea: (1) Predation hypothesis - increased predation by groundfish caused declines in crab recruitment, (2) Common forcing hypothesis - physical forcing caused inverse responses in recruitment of crabs and groundfish, and (3) Species replacement hypothesis - declines in crab abundance preceded species replacement by groundfish. Of the 45 correlations, only 4 were statistically significant when the effective number of degrees of freedom in the time series were corrected for autocorrelation. We expect 2 out of 45 correlations to be significant at the 95% confidence level by chance alone. The lack of general inverse relationships between crabs and groundfish in the Bering Sea is largely attributable to the variety of recruitment patterns among crab stocks whereas many groundfish populations experienced common patterns. These exploratory data analyses have laid the groundwork for research into causal mechanisms for crab stock variability.

9AM2000 W5-348 oral  
**COMPARISON OF IRON ENRICHMENT EXPERIMENTS ON BOARD IN THE NE AND NW SUBARCTIC PACIFIC OCEAN**

Isao Kudo, Takeshi Yoshimura, Takaaki Nishida and Yoshiaki Maita  
*Graduate School of Fisheries Science, Hokkaido University, Minato 3-1-1, Hakodate 041-8611, Japan e-mail: ikudo@fish.hokudai.ac.jp*

It is recognized that Fe plays a key role in controlling phytoplankton growth and primary productivity in the ocean, especially in HNLC (high nutrient, low chlorophyll) regions. Subarctic Pacific Ocean is one of them. We conducted three iron enrichment experiments on board in the summer of 1999 at St. Knot (NW) and St. P (NE) in the Pacific and one station in the Bering Sea. The original surface seawaters (5 m) were at HNLC condition with different nutrient compositions. We added Fe at two concentrations into each bottles and some of them were also enriched with Zn. Size fractionated chl *a*, nutrients, dissolved Fe were measured at 2 days interval. The measurement of NRA (nitrate reductase activity) and APA (alkaline phosphatase activity) and the flowcytometric analysis for phytoplankton and bacteria were also conducted for several occasions. The results indicated that productivity at three stations seemed to be Fe-limited, but the response to the enrichment was not the same.

9AM2000 W5-349 oral  
**CHARACTERISTIC VERTICAL PROFILES OF Fe(III) HYDROXIDE SOLUBILITY IN THE NORTHWESTERN NORTH PACIFIC OCEAN**

Kenshi Kuma<sup>1</sup>, Shigeto Nakabayashi<sup>2</sup>, Isao Kudo<sup>1</sup> and Masashi Kusakabe<sup>2</sup>

<sup>1</sup> Graduate School of Fisheries Sciences, Hokkaido University, Hakodate 041-8611, Japan e-mail: kuma@fish.hokudai.ac.jp

<sup>2</sup> Ocean Research Department, Japan Marine Science and Technology Center, 2-15 Natsushima, Yokosuka 237-0061, Japan

Recently, a number of studies pointed out that the Fe(III) complexation with natural organic ligands is possible in oceanic waters, but the detailed vertical distribution, origin and chemical identity of organic ligands are largely unknown. Here we report the spatial vertical distributions of Fe(III) hydroxide solubility in subarctic and subtropical water masses and the boundary zone in the northwestern North Pacific Ocean. The detailed vertical profiles of Fe(III) hydroxide solubility have the following features in common: the solubility in the surface mixed layer (0-50-100 m) is generally high and variable (0.3-1.9 nM); the solubility minima (0.2-0.4 nM) occur at depths of 75-125 m, below the surface mixed layer; the subsequent solubility levels in middepth waters appear to increase with depth relatively in association with the increase in nutrient concentrations in the subtropical and the boundary zone (0.2-0.7 nM) or to vary little with high constant solubility (0.7 nM) and nutrient values in the subarctic zone (upwelling area); the solubility levels in deep waters (>1000-1500 m) tend to decrease a little to 0.4-0.5 nM with depth in association with the decrease in nutrient concentrations. The higher Fe(III) hydroxide solubility in the surface mixed layer is probably due to higher concentration or stronger affinity of natural organic Fe(III) chelators, which were possibly released by phytoplankton or bacteria through their metabolism. There are significant correlations between the Fe(III) hydroxide solubility and the nutrients (PO<sub>4</sub>, NO<sub>3</sub>+NO<sub>2</sub>) concentration in deeper waters below the depth of minimum solubility, suggesting the regenerative formation of organic Fe(III) chelators through the oxidative decomposition and transformation of biogenic organic matter sinking into the deep waters.

9AM2000 S5-136 oral  
**VARIABILITY OF THE NORTH PACIFIC CIRCULATION MODEL UNDER THE SURFACE FORCING FROM RE-ANALYSIS DATA**

Victor I. Kuzin and Valery M. Moiseev

*Institute of Computational Mathematics and Mathematical Geophysics, (The former Computing Center) Siberian Division RAS, pr. Ak.Lavrentieva, 6, Novosibirsk-90, Russia. 630090 e-mail: kuzin@sscc.ru*

The 3-D finite element North Pacific Circulation Model developed in the Novosibirsk Institute of Computational Mathematics and Mathematical Geophysics (ICMMG) is used to study the variability of the North Pacific circulation to the varying boundary conditions at the surface. For this purpose the ten-days mean distribution of the surface forcing was adopted from the European Center Medium-Range Forecast (ECMWF) Seasonal Ensemble Simulation, 1987 as well as from the ECMWF Re-Analysis Sample Data 1979-1993. The numerical simulation was concerned with the prognostic experiments to study the response of the North Pacific hydro-physical characteristics to real forcing. The integration period was characterized as period of the El Niño and La Niña events. The initial conditions were taken from the results of diagnostic numerical experiments of climatic circulation which were carried out on the basis of climatic temperature and salinity data and wind-stress. The results show the development of the main temperature anomalies in the eastern part of the tropical Pacific derived by the Kelvin waves, from the west to this region. However, ocean variability concerns not only the tropical Pacific, but also sub-polar region where significant anomalies also arise during this period. The analysis of these processes and the comparison with the climatic state are done in the paper. The work is supported by RFBR, Grant 99-05 64684.

9AM2000 POCp135 poster  
**SENSITIVITY OF MODEL CIRCULATION OF THE SEA OF JAPAN (EAST SEA) TO GRID RESOLUTION AND EXTERNAL FORCING**

Victor I. Kuzin and Oleg N. Nazarov

*Institute of Computational Mathematics and Mathematical Geophysics SD RAS, pr. Ac. Lavrentieva, 6, Novosibirsk-90, Russia. 630090 e-mail: kuzin@sscc.ru*

The present paper continues the study of the SOJ/ES circulation on the basis of the Novosibirsk Computing Center Ocean Circulation Model (NCCOCM).

The results present the further step of the variability study of the eddy resolving SOJ circulation model with the seasonal cycle in the boundary conditions and external forcing.

Discretisation of the model is based on the finite element technique. Regular A-grid is implemented with FEM. First experiments were run at coarse grids (1/4 deg., 1/8 deg.). Their results are compared with finer grid, spatial resolution 1/12 deg. with 24 non-uniform standard levels. Time integration is a combination of implicit and explicit treatments of model terms. The climatic data by Levitus, 1994 and Hellerman, Rosenstein, 1983 is used for the seasons as initial and boundary conditions.



The numerical experiments were undertaken in the following manner: diagnostic and short-range spin-up of the model were carried out on the basis of the climatic data for the seasons.

At the next stage the seasonal external forcing conditions were applied to the surface. The prognostic simulation was carried out for a few years. The results show influence of resolution on mesoscale circulation structure. The pictures of currents show more detailed features of meandering and currents, keeping the main peculiarities.

This work was supported by RFBR, Grant No 99-05-64684.

**9AM2000 S9-137 poster**  
**ANTIFOULING ACTIVITY OF SEAWEED EXTRACTS AGAINST THE MARINE GREEN ALGA AND BLUE MUSSEL**

Eun-Hee Kwon<sup>1</sup>, Ji-Young Cho<sup>1</sup>, Jae-Suk Choi<sup>1</sup>, Sung-Youl Hong<sup>1</sup>, Hyun-Woung Shin<sup>2</sup> and Yong-Ki Hong<sup>1</sup>

<sup>1</sup> Department of Biotechnology, Pukyong National University, 599-1 Daeyondong Nam-Gu, Namku, Pusan, Republic of Korea. 608-737 e-mail: eunhee0406@hanmail.net

<sup>2</sup> Department of Biological Resources, Soonchunhyang University, Ansan 336-900, Republic of Korea

Twenty-seven species of common seaweed from the coast of Korea have been screened for the antifouling activity. The seaweed extracts were tested in laboratory assays against the marine fouling green alga *Enteromorpha prolifera* and the blue mussel *Mytilus edulis*. Spore settlement, zygote formation, sporeling and tissue growth of the green alga were inhibited by the methanol extracts of the seaweed *Ishige sinicola* and *Sargassum horneri*. The spore settlement was strongly inhibited at concentrations as low as 10 mg·mL<sup>-1</sup> of *Ishige sinicola* and 40 mg·mL<sup>-1</sup> of *Sargassum horneri*. Repulsive activity of the mussel foot was completely inhibited by the methanol extracts of the seaweed *I. sinicola* and *Scytosiphon lomentaria* at each concentration of 4 mg·mL<sup>-1</sup>.

**9AM2000 W6-138 oral**  
**ESTIMATION OF MARINE MAMMAL AND SEABIRD ABUNDANCE**

Jeffrey L. Laake

National Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115, U.S.A. e-mail: Jeff.Laake@noaa.gov

Prey consumption depends first and foremost on the abundance of the predator population. Estimating abundance of top marine predators, marine mammals and birds, is a challenging problem because of their behavior and the difficulties associated with sampling in the marine environment. An at-sea observational survey based on line transect or strip transect sampling is the primary technique for estimating marine mammal and bird abundance. The process of estimating abundance from strip and line transect sampling can be logically divided into two components: 1) "measuring" density within the sampled transect area, and 2) extrapolation from the sampled transect area to estimate abundance within a larger area of inference based on an appropriate sampling design. I will focus on the first component as it applies to marine mammals and birds and will only highlight some issues relevant to the second component. In particular, I will compare the advantages and disadvantages of strip and line transect sampling and describe how each approach addresses visibility bias and the difficulties in satisfying the assumptions with marine mammals and birds. I will also describe multi-observer and multi-platform surveys that can compensate for violation of the standard assumptions.

**9AM2000 W4-139 oral**  
**MODELING OF THE WESTERN BERING SEA ECOSYSTEM WITH HELP OF ECOPATH SOFTWARE**

Victor V. Lapko, E.P. Dulepova and V.I. Radchenko

Pacific Research Institute of Fisheries & Oceanography (TINRO-Center), 4 Shevchenko Alley, Vladivostok, Russia 690600 e-mail: lapvic@fastmail.vladivostok.ru

ECOPATH software has been used for modeling of the western Bering Sea (WBS) ecosystem bordered by the Russian EEZ and covered total area 702 200 km<sup>2</sup>. It encompasses a wide range of marine habitats including shelf, slope and deep basins, but was treated as a single homogenous region. Our model was constructed for the period 1980s as for the most provided by the primary data and for comparing with a similar model made by Trites *et al.* (1999) for the eastern Bering Sea (EBS) for the same time period. WBS model is annual average one, i.e. all necessary statistics were seasonally and annually averaged to provide a year round annual average ones. To describe WBS ecosystem we have separated all hydrobionts into 48 functional groups, composed of a single species or aggregation of ecologically similar species and covered all trophic levels from phytoplankton to marine birds and mammals. Commercial fishery catch was also included into the model. Preliminary results of the WBS modeling revealed that in total WBS ecosystem functioned much more intensively in comparison to EBS one. Various ecological indices describing ecosystem parameters appeared to be 3-5 times as higher in WBS than in EBS. For instance, if total biomass in WBS ecosystem was 1.75 times as much only, but both net system production and total system throughput were 4 times as higher, etc. At the same time it should be taken into account that EBS is warmer and shallower comparing to WBS that should in theory cause

reversed situation than we have obtained. The main reason as we suppose lies in averaged higher ecological characteristics we have applied to describe some functional groups of species and first of all these are P/B and Q/B ratios. So, we presume there is an evident necessity to compare and discuss methodical approaches for determining the most important ecological parameters of common species and groups in the northern Pacific. It will be undoubtedly useful for further ECOPATH modeling of this region.

9AM2000 W5-386 oral  
**THE APPLICATION OF SF<sub>6</sub> TRACER LAGRANGIAN STUDIES IN IRON FERTILIZATION EXPERIMENTS**

Cliff S. Law

*Plymouth Marine Laboratory, Centre for Coastal and Marine Science, Prospect Place, The Hoe, Plymouth, Devon PL1 3DH, UK  
e-mail: csl@ccms.ac.uk*

The recent application of *in situ* SF<sub>6</sub> tracer Lagrangian studies has introduced a new dimension to biogeochemical studies of the surface ocean. The combination of high analytical sensitivity and rapid sample throughput in a fully automated analytical system has facilitated the tracking of mesoscale surface releases of SF<sub>6</sub> in near real-time, despite dispersion and transport over relatively large distances. Although this technique has provided a valuable new approach to observational time-series studies of process rates, it has received most attention for its use in deliberate manipulation studies, such as IronEx and SOIREE. As a molecular tracer SF<sub>6</sub> is uncompromisingly Lagrangian and so provides a label for the iron-enriched water body, even in the event of subduction. The SF<sub>6</sub> also functions as a surrogate for the iron when the latter is no longer detectable, and defines an area/volume so facilitating budgetary calculations. In addition, the dispersion of the tracer provides valuable physical information in terms of vertical and horizontal diffusivities and gas exchange rates. From a logistical perspective, the SF<sub>6</sub> tracer provides a cruise sampling strategy in terms of identification of sampling stations IN and OUT of the fertilised patch. The properties of SF<sub>6</sub> and the relevant analytical technology for profiling and surface measurement will be reviewed, and the technical aspects of deployment and mapping of SF<sub>6</sub> patches will be discussed. In addition, the limitations that a SF<sub>6</sub> experiment imposes, in terms of locale, hydrography and timescale, will also be examined.

9AM2000 W5-392 oral  
**IN SITU TESTING OF IRON LIMITATION IN THE SOUTHERN OCEAN: AN OVERVIEW OF THE SOUTHERN OCEAN IRON ENRICHMENT EXPERIMENT (SOIREE)**

Cliff S. Law<sup>1</sup> and Phillip W. Boyd<sup>2</sup>

<sup>1</sup> *Plymouth Marine Laboratory, Centre for Coastal and Marine Science, Prospect Place, The Hoe, Plymouth, Devon PL1 3DH, UK e-mail: csl@ccms.ac.uk*

<sup>2</sup> *Centre of Excellence for Chemical and Physical Oceanography, University Otago, Dunedin, NZ e-mail: pboyd@alkali.otago.ac.nz*

Limitation of phytoplankton productivity in High-Nutrient Low-Chlorophyll regions by iron (Fe) has long been suspected, and was confirmed for the Equatorial Pacific by the IronEx2 study. Despite the strong response observed to iron addition, modelling suggests that variation in iron availability in this region may have little net effect upon the global ocean C sink, and that it is the Southern Ocean where Fe-induced increases in productivity may have greatest impact. The first *in situ* Fe release in the surface waters of the Southern Ocean took place during SOIREE (Southern Ocean Iron Release Experiment) south of the Polar Front at 61-62S in February 1999. Four successive Fe infusions to a 65m surface mixed layer were undertaken over thirteen days to determine the response of phytoplankton growth rates and mixed layer biogeochemistry to increased iron supply. The first significant biological response was observed on Day 4 after two iron infusions, with an increase in phytoplankton photosynthetic competence ( $F_v/F_m$ ), followed by increases in chlorophyll *a* and production. By the end of the 13-day experiment the increase in productivity had stimulated significant drawdown of carbon dioxide and macromutrients, with associated increases in dimethyl sulphide. The results confirm that iron availability controls the magnitude of phytoplankton production in this region during summer. Furthermore the persistence of a high chlorophyll feature in ocean colour images of this region for an additional 6-8 weeks after SOIREE indicated that iron availability and CO<sub>2</sub>/macronutrient drawdown continued into the early Austral winter.

9AM2000 S7-342 poster  
**SALMON POPULATION DYNAMICS: US GLOBEC RETROSPECTIVE AND MODELING STUDIES IN THE CALIFORNIA CURRENT ECOSYSTEM**

Cathryn A. Lawrence and Louis W. Botsford

*Department of Wildlife, Fish, and Conservation Biology, University of California, Davis, CA 95616, U.S.A. e-mail: clawrence@ucdavis.edu*

The focus of the GLOBEC Northeast Pacific program is the inverse relationship between productivity of salmon and zooplankton in the California Current System (CCS) and the Gulf of Alaska, as evidenced in physical/biological interactions in the early ocean life of salmon. Modeling and retrospective investigations have clarified expected results from the GLOBEC NEP field studies. It is not widely realized that not all CCS salmon species were affected by the regime shift in the mid-1970s. Total chinook salmon

catches changed little while coho salmon abundance declined dramatically. Interannual variability in coho and chinook abundance depend on ENSO conditions synchronously coastwide for coho while in a spatial pattern for chinook. Moreover, the environment influenced salmon survival in both the year of entry and the year of return. The GLOBEC NEP focus on early ocean life raises the question of how much we miss by not studying environmental effects on the older stages. Modeling results showed that the environmental variability in survival at ocean entry and at spawning return have independent effects on coho population dynamics, but additive effects on chinook population dynamics. Population modeling also indicated that the interaction between variability in spawner age distribution and environmental variability affects probability of extinction. Modeling studies at the individual level, and analyses of existing data clarify how variability in salmon survival may be forced by either bottom up mechanisms (i.e., feeding and growth rate) or top down mechanisms (i.e., shifts in predators).

9AM2000 W7-140 oral  
**INTERANNUAL VARIABILITY IN GLOBAL NET OCEANIC CO<sub>2</sub> UPTAKE FROM 1982-1998**

Kitack Lee<sup>1,2</sup>, R. Wanninkhof<sup>1</sup>, T. Takahashi<sup>3</sup>, S. Doney<sup>4</sup> and R.A. Feely<sup>5</sup>

<sup>1</sup> *Atlantic Oceanographic and Meteorological Laboratory/NOAA, Ocean Chemistry Division, 4310 Rickenbacker Cswy, Miami, FL 33149, U.S.A. e-mail: lee@aoml.noaa.gov*

<sup>2</sup> *RSMAS/CIMAS, University of Miami, Miami, FL, U.S.A.*

<sup>3</sup> *Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY, U.S.A.*

<sup>4</sup> *Climate and Global Dynamics, NCAR, Box 3000, Boulder, CO, U.S.A.*

<sup>5</sup> *Pacific Marine Environmental Laboratory, NOAA, Seattle, WA, U.S.A.*

Large interannual variability of 2-4 Gt C/yr in oceanic CO<sub>2</sub> uptake deduced from atmospheric CO<sub>2</sub> observations and atmospheric transport models is in sharp contrast to a recent estimate of Lee et al. (1998), which is based on observed seasonal pCO<sub>2</sub>-SST relationships and interannual variations in SST and in wind speed. This is the first effort utilizing oceanic observations of delta pCO<sub>2</sub> (Takahashi *et al.*, 1997) to extrapolate interannual variability in global net air-sea CO<sub>2</sub> flux. The followings supplementing the Lee *et al.* preliminary work are presented: (1) Validation of the assumption by comparison of modeled fluxes with time-series observations over extensive period of time; (2) Comparison of our results with outputs from a 3-D global-scale model including components of ocean circulation and biogeochemistry and from double deconvolution calculations; and (3) Estimation of relative contribution of environmental factors to interannual net air-sea CO<sub>2</sub> flux variations.

9AM2000 S6-141 oral  
**GLOBAL ESTIMATION OF EXPORT PRODUCTION FROM SEASONAL CYCLES OF SURFACE WATER TOTAL INORGANIC CARBON**

Kitack Lee

*Atlantic Oceanographic and Meteorological Laboratory/NOAA, Ocean Chemistry Division, 4310 Rickenbacker Causeway, Miami, FL 33149, U.S.A. e-mail: lee@aoml.noaa.gov*

The export of carbon from the ocean's surface waters to the ocean interior is a key mechanism controlling the net uptake of carbon dioxide from the atmosphere. Existing indirect estimates of the vertical carbon export vary greatly in regional and global comparisons. Here I estimate biologically-mediated vertical carbon export, referred to as "new production", from the mean annual cycle of total inorganic carbon concentration normalized to salinity ( $NC_T = C_T \times 35/S$ ) in the mixed layer assuming that the decrease in  $NC_T$  from the winter to the fall is solely a function of biological uptake and subsequent transport out of the upper oceans. Seasonal drawdown of  $NC_T$  in the mixed layer is quantified from regional algorithms relating  $NC_T$  to sea surface temperature (SST) and nitrate ( $NO_3^-$ ) combined with seasonal changes in SST and  $NO_3^-$  fields, and separately from the surface partial pressure of CO<sub>2</sub> and total alkalinity fields using thermodynamic models. The two independent methods show similar regional trends and give global new production of  $7.5 \pm 2.0$  Gt C yr<sup>-1</sup> and  $8.6 \pm 2.0$  Gt C yr<sup>-1</sup>, respectively, for 1990.

9AM2000 S6-142 oral  
**MICROZOOPLANKTON GRAZING FUNCTIONS FOR PACIFIC ECOSYSTEM MODELS: A CRITICAL REVIEW OF THE ASSUMPTIONS**

Andrew W. Leising and Wendy C. Gentleman

*School of Oceanography, University of Washington, Box 357940, Seattle, WA 98195-7940, U.S.A. e-mail: aleising@ocean.washington.edu*

The equatorial and oceanic subarctic Pacific are HNLC (High Nitrate Low Chlorophyll) regions. Modeling and in-situ process studies have confirmed the importance of microzooplankton grazing in maintaining the HNLC condition. However, both the parameters and functions representing microzooplankton grazing within current ecosystem models are poorly constrained. Current models rely upon traditional grazing functions adapted from other uses and therefore contain assumptions that have not been tested rigorously for the specific microzooplankton living within these HNLC regions. Two assumptions in particular - the existence of a lower grazing threshold and the formulation used for prey switching when multiple prey items exist - are critical to achieve the

HNLC condition in most models. The current contribution will show how the lower feeding threshold can be eliminated while still maintaining the same dynamics as current models, and also describe what may be a fundamental flaw in the currently used formulations for prey switching. The choice of the proper grazing formulation is critical; different formulations for microzooplankton grazing may give the same realistic results under current climatological forcing, however, the different formulations may give wildly different results if used to extrapolate to other regions or when perturbed beyond currently observed forcing. Ecosystem models that predict carbon production and export are therefore extremely sensitive to these assumptions (without these assumptions, most models would not produce the HNLC condition), suggesting that future studies need to concentrate on the functional responses of microzooplankton before these models can be used for more than simple interpolation.

9AM2000 S8-143 oral  
**FISH COMMUNITIES AND LIFE HISTORY ATTRIBUTES OF ENGLISH SOLE (*Pleuronectes vetulus*) IN VANCOUVER HARBOUR**

Colin D. Levings

Fisheries and Oceans, Science Branch, West Vancouver Laboratory, 4160 Marine Drive, West Vancouver, B.C. Canada V7V 1N6  
e-mail: levingsc@dfo-mpo.gc.ca

Twenty-nine species of fish and three species of crabs were obtained in 21 trawls at four stations in the harbour and one reference site in Howe Sound. The number of species per trawl ranged from 12 to 19, with a trend toward fewer species in the inner harbour stations. English sole (*Pleuronectes vetulus*) was the most abundant fish except for one station where blackbelly celpout (*Lycodopsis pacifica*) dominated. Several key life history aspects of English sole were investigated, including age, growth rates, condition factor, and feeding habits. Mean age of English sole ranged from 6.4 to 9.3 y with the older fish more abundant in the inner harbour stations ( $p < 0.05$ ). Preliminary data suggest fish from the middle harbour stations showed the highest growth rates. English sole from an inner harbour station fed more extensively on annelid worms relative to fish from other stations in the survey. The species composition of the fish community in Vancouver harbour was similar to that found in baseline studies in 1985.

9AM2000 S3-144 poster  
**BIOLOGICAL EVIDENCE ON INTRODUCTION OF THE KUROSHIO TO THE YELLOW SEA**

Donghyun Lim, Won D. Yoon, Kyung S. Park, Sung H. Cho and Yoon Lee

West Sea Fisheries Research Institute, 98-36 Buksungdong 1ga, Junggu, Incheon, Republic of Korea. 400-201 e-mail: dhlilim@nfrdi.re.kr

To identify introduction of the Kuroshio to the Yellow Sea using zooplankton assemblages, zooplankton sample was collected from April 1997 to February 1999 bimonthly at 34 stations of the Yellow Sea. The spatio-temporal distribution patterns of about 50 copepod species and one euphausiid contained indicator species of Kuroshio were similar. Occurrence of these species was restricted from August to December. In terms of the spatio-temporal distribution patterns of these species, we verified patterns in introduction of the Kuroshio to the Yellow Sea.

9AM2000 S3-145 poster  
**LIFE CYCLE OF *Oithona similis* (COPEPODA: CYCLOPOIDA) IN COASTAL WATERS OF THE NORTHWESTERN PACIFIC**

Donghyun Lim, Won D. Yoon, Sung H. Cho and Yoon Lee

West Sea Fisheries Research Institute, 98-36 Buksungdong 1ga, Junggu, Incheon, Republic of Korea. 400-201 e-mail: dhlilim@nfrdi.re.kr

Seasonal variation in population structure of *Oithona similis* was investigated from March 1988 to February 1989 in the coastal waters of East Sea, Korea, northwestern Pacific. The population density was high from December to next June (12 to 17), with the highest value in April (13). Prosome lengths of female were relatively short in summer and autumn, and largest in winter. On the other hand, prosome width was largest in spring, and the smallest in autumn. Considering the gravid female, the breeding season was from winter to early summer, and seemed to be restricted below 17. The average of sex ratios was very low (0.084). Its mean value was 0.102 during the breeding seasons, and 0.059 during the rest of the seasons. These results suggested the possibility of two generations of *O. similis* in Korean waters; the spring and the winter generation.

9AM2000 S2-146 poster  
**FORAGING BEHAVIOUR OF MINKE WHALES (*Balaenoptera acutorostrata*) IN THE SOUTHERN BARENTS SEA**  
Ulf Lindström<sup>1</sup>, Alf Harbitz<sup>1</sup>, Tore Haug<sup>1</sup> and Torstein Pedersen<sup>2</sup>

<sup>1</sup> Norwegian Institute of Fisheries & Aquaculture, N-9291 Tromsø, Norway e-mail: ulf.lindstrom@fiskforsk.norut.no

<sup>2</sup> Norwegian College of Fishery Science, University of Tromsø, N-9037 Tromsø, Norway e-mail: torstein@mfh.uit.no

The aim of this study was to use data on Minke whale diet and prey abundance from the southern Barents Sea to assess quantitatively feeding strategies and prey selectivity of minke whales in the area. Stomach content samples from 27 minke whales, caught during the Norwegian commercial whaling in the period May-June 1999, were obtained from three sub areas in the southern Barents Sea. Simultaneously, a comprehensive resource survey was conducted in order to identify and estimate the abundance of potential prey items for the whales in the same sub-areas. The small-scale resource surveys revealed significant variations in absolute and relative prey abundance both between sub areas and, temporally, within sub areas. This was, to some extent, also reflected in the whale diets which were dominated by herring and capelin.

9AM2000 S9-316 oral  
**PRESENT STATUS OF CHINESE FISHERY**

Hong Bin Liu and He Ting Chen

*Institute of Marine Economics, Qingdao, Shandong, People's Republic of China. 266071 e-mail: hbliu@public.qd.sd.cn*

Chinese output of marine aquatic products has reached 23.57 million tons, the gross output value of marine aquatic industry has reached 177.21 billion Chinese yuan in 1998, registering an increase of 13.0% as against that in the previous year.

Thanks to the intensified effort of protecting offshore fishery resources, extension of the rest period of fishing and expansion of the extent of fishing prohibition, the stock number offshore has seen an obvious rise again and the output of marine fishing reached 14.97 million tons, 8.0% up from that in the previous year; In 1998, the area of mariculture has amounted to 1003.53 thousand hectares, 7.0% up from that in the previous year. Through enhancing the effort of spreading science and technology, the content of science and technology in aquaculture has reached 8563kg/hect., registering an increase of 129kg/hect. as against that in the previous year and the total output of mariculture reached 8.60 million tons, 8.7% up from that in the previous year.

Although great efforts have been made by the coastal provinces (municipalities and autonomous regions) to control the sewage discharged into the sea, the pollution of the nearshore waters is still serious and the overall quality of the marine environment tends to be deteriorated and the open-sea waters is also being threatened. The task for the sustainable development of marine resources has a long way to go.

9AM2000 W6-147 oral  
**OVERVIEW OF UPPER-TROPHIC LEVEL MODELS FOR ASSESSING THE IMPACTS OF CLIMATE AND FISHING ON MARINE ECOSYSTEMS**

Patricia A. Livingston

*Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA, 7600 Sand Point Way NE, Seattle, WA 98115-0070, U.S.A. e-mail: Pat.Livingston@noaa.gov*

A variety of models have been developed, from conceptual models to full ecosystem models, to understand and eventually predict the effects of climate, fishing or both of these processes on marine ecosystems. This overview touches on some of the basic model types now being used in these investigations and describes how they are being used in addition to outlining some of the basic model requirements, common assumptions, and inherent limitations of these approaches.

9AM2000 S3-148 oral  
**COMPOSITION AND SPATIAL VARIATIONS OF SIPHONOPHORES (CNIDARIA) IN THE WATERS OF NORTHERN TAIWAN**

Wen-Tseng Lo, Y.P. Hung and H.Y. Hsieh

*Department of Marine Resources, National Sun Yat-Sen University, Kaohsiung, 804, China Taipei e-mail: lowen@mail.nsysu.edu.tw*

The species composition and numerical abundance of siphonophores were studied in the waters of northern Taiwan from epipelagic zooplankton samples collected during May 1993. Thirty-one species belonging to thirteen genera of Siphonophora were recorded at 18 stations, with *Bassia bassensis*, *Chelophyes appendiculata*, and *Chelophyes contorta* the most abundant overall. The presence of the Kuroshio current, the East China Sea shelf waters, and an upwelling were observed influencing patterns of siphonophore distribution. The overall density of siphonophores was found to be lower within the Kuroshio Current than in the shelf waters. High densities of siphonophores were found in the Kuroshio front and the edge of the upwelling, whereas they were scarce in the area of the main upwelling where cold waters might reach the surface. The community structure of siphonophores

was different between the Kuroshio Current and the shelf waters, in that *Bassia bassensis* dominated in the shelf waters while *Chelophyes contorta* were common in the Kuroshio frontal zone. Cluster analysis using the Pearson correlation yielded two distinct assemblages, which were correlated with local hydrographic conditions.

9AM2000 S3-149 poster  
**MARINE PLANKTONIC CHOANOFLAGELLATES FROM BAJA CALIFORNIA, MEXICO**

Luis Felipe López Tachiúin, David U. Hernández-Becerril and Ernesto Bravo-Sierra  
*Instituto de Ciencias del Mar y Limnología, UNAM, Apdo. postal 70-305, México e-mail: duhb@hp.fciencias.unam.mx*

Choanoflagellates are a group relatively small of heterotrophic flagellates, with particular morphological characteristics, including the presence of a single smooth flagellum, a pseudopodial collar and, in many species, a lorica made up of siliceous strips. Taxonomy of the group is based on the external morphological characters, and not necessarily it reflects their phylogeny. Their role as bacteria, nano and picoplankton grazers is important in the plankton food web. For this study, we used material collected from two oceanographic cruises in Baja California waters, following different protocols for collecting and preserving samples. Observations were made by light and electron microscopy (both transmission and scanning). We have found 12 species (9 of which have been positively identified): all species are new records in the Mexican Pacific, as this seems to be the first study devoted to Choanoflagellates. Diversity and distribution of the group, the methods and techniques used to analyze "delicate" flagellates, and the perspectives of future studies (ecological and physiological aspects) of heterotrophic flagellates are discussed in this paper.

9AM2000 CCCCp150 oral  
**CROSS-SHORE SEPARATION OF ADULT AND JUVENILE EUPHAUSIIDS IN A SHELF-BREAK ALONGSHORE CURRENT**

BeiWei Lu<sup>1</sup>, David L. Mackas<sup>2</sup> and Douglas Moore<sup>2</sup>

<sup>1</sup> *School of Earth and Ocean Sciences, University of British Columbia, Vancouver, B.C., Canada*

<sup>2</sup> *Institute of Ocean Sciences, P.O. Box 6000, Sidney, B.C., Canada. V8L 4B2 e-mail: mackasd@pac.dfo-mpo.gc.ca*

Euphausiids aggregate along the British Columbia shelf break near a zone of strong alongshore current. However, within this general alongshore band of high abundance, spatial distributions of adult and early larval stages are known to be negatively correlated. We examined the detailed spatial structure and mechanisms responsible for this segregation, using closely spaced net tows and physical oceanographic measurements. Adult stages have a strong diel migration, while larval stages reside in the surface layer throughout the day. Direction and amount of cross-shore displacement of larvae is well explained by Ekman transport. Depending on the timing of reproduction relative to seasonally variable alongshore winds, larvae may either be transported onto the nutrient and phytoplankton rich continental shelf, or offshore into relatively blue water and a strong equatorward jet.

9AM2000 POCp151 poster  
**INTERANNUAL VARIABILITY OF WATER TEMPERATURE IN THE JAPAN (EAST) SEA**

Vladimir A. Luchin<sup>1</sup> and Vladimir V. Plotnikov<sup>2</sup>

<sup>1</sup> *Far Eastern Regional Hydrometeorological Research Institute, Vladivostok, 24 Fontannaya Street, Vladivostok, Russia. 690600 e-mail: hydromet@online.ru*

<sup>2</sup> *Pacific Oceanological Institute, 43 Baltiyskaya Street, Vladivostok, Russia, 690041 e-mail: pacific@online.marine.su*

All available oceanographic data were combined. The joint database contains oceanographic data that has been generated and collected by different scientists from different institutes located in Russia, US, Korea and Japan. Formation of the joint data archive was based on a common definition of the Japan (East) Sea. Nowadays a joint oceanographic database contains 140,000 oceanographic stations covered time spanning between 1900-1999.

We search for leading processes that are responsible for interannual variability in oceanography of the Japan (East) Sea in the second half of XX century. EOF analysis of the sea temperature has been applied to investigate structure of the wintertime (February-March) spatial and temporal interannual thermic variability of the Japan (East) Sea at horizon 100 m. Maximal variability was found at shallow areas, where values of mean square deviation ( $\sigma$ ) reaches 0.9°C. Local maximum of  $\sigma$  was found in the Tsushima Strait. Its because advection of a great water masses of Pacific waters.

The EOF spatial analysis at horizon 100 m shows that the first 4 modes reflect 79.2% of the wintertime interannual thermic variability:

- the 1<sup>st</sup> mode, 43.8%, reflects synchronous interannual variability for the Japan (East) Sea in whole;
- the 2<sup>nd</sup> mode, 15.1%, reflects the variability in intensity of convection and the coming of Pacific waters;
- the 3<sup>rd</sup> mode (11.9%) and the 4<sup>th</sup> mode (8.4%), is related probably with processes of fluctuation in position of main currents and the variability in intensity of convection and the coming of Pacific waters.

A spectral-correlation analysis demonstrates: EOF-1 includes 11-yr, 7-8 yr and 3-4 yr periodicity. Also 11-yr and 2-3 yr cycling was found in time variability of EOF-(2-4). We assume that 11-yr cycling is induced with solar activity; 3-4 yr cycling can be related with El Niño events.

We identify "cold" ( $T < -0.674 \sigma$ ) and "warm" ( $T > 0.674 \sigma$ ) hydrological years. There are "cold" (1963, 1968, 1981, 1984-1987), "warm" (1954-1956, 1959, 1962, 1965, 1972, 1973, 1979, 1989, 1990) hydrological winters in the Japan (East) Sea.

Analysis of wintertime (February-March) thermic state of the active layer of the Japan (East) Sea demonstrates a general cooling tendency (about  $0.6^\circ$  during 38 years).

9AM2000 POCp328 poster  
**STUDY OF TYPHOON SEA SURFACE WIND AND ITS ECOLOGICAL IMPACTS**

Yan Ma<sup>1</sup> and Qinghua Zhang<sup>2</sup>

<sup>1</sup> *First Institute of Oceanography, State Oceanic Administration, Qingdao, Shandong, People's Republic of China. 266003*

<sup>2</sup> *Key Lab of Marine Science and Numerical Modeling, Qingdao, Shandong, People's Republic of China. 266003*

Making use of altimeter wind data and standard sounding data in a mesoscale numerical model of PSU/NCAR (MM5), we tested four-dimensional data assimilation schemes based on nudging. The sounding and surface data were used throughout model integration, rather than at only initial time.

To determine what meteorological fields and what assimilation method have positive effect on four-dimensional data assimilation by means of simulating a typhoon case in MM5. We performed seven experiments for 9608 (Herb): one control experiment, three analyzed nudging experiments, two observed nudging experiments and combination experiment of analyzed nudging and observed nudging. The sea level pressure became an effective measure to test four dimensional data assimilation while no sea level pressure data were assimilated in the mesoscale model.

Assimilation of altimeter wind data showed the best result for sea level pressure because altimeter wind data have the remarkable characteristics of wind field on the sea surface. The result also showed that assimilation of both wind and thermal data could effectively improve model simulation accuracy. And assimilation of wind data had positive impact on the mesoscale wind fields, but had no remarkable improvement for temperature fields. The thermal fields had negative impact on wind fields and sea level pressure fields during the period of assimilation.

We also analyzed all typhoon events occurred in China Seas in recent 20 years and their impacts on coastal marine ecosystem, esp. on the maricultral ecosystem and mangrove ecosystem. Some interesting results were found.

9AM2000 POCp152 poster  
**LARGE-SCALE VARIABILITY OF WATER CIRCULATION IN THE NORTHWEST PACIFIC IN 1981-1991**

Alexander N. Man'ko and Alexander D. Nelezin

*Far Eastern Regional Hydrometeorological Research Institute (FERHRI), 24 Fontannaya Street, Vladivostok, Russia. 690600 e-mail: hydromet@online.ru*

The ocean renders the large influence on climatic system. Northwest Pacific is one of most well-informed part of the World Ocean reflecting a condition of the ocean-atmosphere climatic system. From 1981 to 1991, the regular seasonal oceanographic surveys were carried out in the Northwest Pacific in according to the Russian national program "Sections". More than 40 oceanographic surveys were fulfilled in area  $130^\circ$ - $150^\circ$ E.,  $28^\circ$ - $43^\circ$ N.

The thermodynamic structure of currents was investigated in region to the South from Honshu for period developed southern meander Kuroshio (SMK). This meander was generated in the autumn 1981. The analysis of the data has shown, that SMK was observed per 1981-1991 and meander was absent only at the end of 1985, at the end of 1986 and also in May - November 1989. The thermodynamic system of the SMK and anticyclonic eddy to the South from Honshu was investigated.

9AM2000 S7-153 oral  
**SIMULATING HISTORICAL CHANGES IN THE STRAIT OF GEORGIA ECOSYSTEM USING ECOPATH AND ECOSIM**

Steven J. Martell, Carl J. Walters, Tarun Nayar, Robin Briese and Alasdair Beattie

*Fisheries Centre, University of British Columbia, 2204 Main Mall, Vancouver, BC, Canada. V6T 1Z4 e-mail: smartell@fisheries.com*

Historically the Strait of Georgia, B.C. was an important body of water for many commercial fisheries. In the last 3 decades we have observed the collapse of many fisheries including Pacific salmon, herring, and lingcod, along with many rockfish (*Sebastes* sp.) species. With the exception of pacific herring, many over-fished stocks are failing to recover, or are recovering at rates slower than anticipated. In recent years, Pacific salmon have declined at an alarming rate and the evidence suggests that declining

marine survival rates are responsible. Using Ecopath with Ecosim (EwE) we examine hypotheses about changes in marine primary productivity that may explain increases in natural mortality rates for some species. Retrospective reconstruction of the Strait of Georgia ecosystem suggest that substantial changes in primary productivity must have occurred in order to explain the observed declines. Although fishing mortality drives most of the dynamics, recent declines in many commercial species, including resident salmon populations, are best explained by a recent decline in primary productivity. Simulated primary productivity regimes correlate well with environmental parameters such as wind speed and the Pacific Decadal Oscillation Index.

9AM2000 S6-309 invited  
OCEANIC UPTAKE OF ANTHROPOGENIC CO<sub>2</sub>: PRESENT AND FUTURE ESTIMATES

Richard J. Matear and Jim Orr

CSIRO Division of Marine Research, GPO Box 1538, Hobart, TAS, Australia 7001 e-mail: richard.matear@marine.csiro.au

The marine carbon cycle plays a major role in controlling atmospheric carbon dioxide (CO<sub>2</sub>) concentrations. The oceans presently remove between 20 and 40 per cent of the annual anthropogenic CO<sub>2</sub> emissions. The Ocean Carbon Model Inter-comparison Project (OCMIP), is an international effort that is comparing 13 different models with the goal of improving our estimates of the oceanic uptake of anthropogenic CO<sub>2</sub>. For the 1990s, the suite of OCMIP models estimate a global oceanic uptake anthropogenic CO<sub>2</sub> that ranges between 1.7 and 2.2 Gt C /yr which is comparable to the estimates from atmospheric data and ocean observations. The tight range in the 1990s OCMIP model uptakes is surprising given that these model have large differences in their simulations of CFCs and natural <sup>14</sup>C in the ocean. Although for the 1990s the OCMIP models show a tight convergence in uptake the simulations of uptake over the next several centuries show a large divergence in anthropogenic CO<sub>2</sub> uptake ( $\pm$  50%). The divergence in the modeled uptakes reflects how these models simulate intermediate and deep water formation. We will compare the modeled uptake of anthropogenic CO<sub>2</sub> in the North Pacific and try to assess the performance of the model by comparing the modeled inventory of anthropogenic CO<sub>2</sub> to values derived from observations. Finally, by using a climate model with an ocean carbon module we will speculate on how climate change may impact the oceanic uptake of anthropogenic CO<sub>2</sub> in the North Pacific. We will show that climate change will alter the formation of North Pacific Intermediate Water reducing the uptake of anthropogenic CO<sub>2</sub>.

9AM2000 FISp154 poster  
THE HOMING MIGRATION OF LACUSTRINE MASU SALMON, *Onchorynchus masou*, IN LAKE TOYA

Yukiko Matsushita<sup>1,3</sup>, Yasuhiko Naito<sup>2</sup>, Haruo Ogi<sup>3</sup> and Hiroshi Ueda<sup>1</sup>

<sup>1</sup> Toya Lake Station, Hokkaido University, Abuta, Hokkaido, Japan. 049-5723 e-mail: yukiko@fish.hokudai.ac.jp

<sup>2</sup> National Institute of Polar Research, Japan

<sup>3</sup> Graduate school of Fisheries Science, Hokkaido University, Japan

Recent rapid advances in biotelemetry techniques on free-swimming fish make it possible to monitor underwater fish movement, as well as to analyze physiological aspects of fish behavior. The micro-datalogger has been applied to investigate behavior change during the homing migration of lacustrine masu salmon (*Onchorynchus masou*) in Lake Toya, Hokkaido, Japan. They offer good model systems for studying the amazing ability of salmon to migrate a long distance from open water to natal stream for spawning. During pre-spawning and spawning seasons, swimming depth and ambient water temperature of adult male masu salmon were recorded using a micro-datalogger in Lake Toya, a volcanic caldera lake, average depth 116m, maximum depth 179m, and area of 70 km<sup>2</sup>. Stomach contents and empty rate of stomach were also examined whether they fed or not. In order to determine the beginning of spawning season. Serial time data of swimming depth and ambient temperature were separated into four different phases. The phases based on the number of rising behavior to the surface: recovery phase, daily cycle phase, transition phase, and final phase. After recovery from the surgical operation (phase1), fish rose to the surface frequently during the day and dived below to deeper (40~50m) from near the thermocline (about 10m) during the night. 1 week before beginning the upstream migration, fish rose more frequently to the surface from the thermocline all day. These results suggest that the behavior patterns of lacustrine masu salmon might change with the advance of gonad maturation. During this maturation period, navigational mechanisms may change with the aid of visual and olfactory cues.

9AM2000 S7-155 oral  
SEABIRDS AND SOCKEYE SALMON RESPOND TO VARIABLE AND EXTREME OCEAN CONDITIONS IN SPRING IN QUEEN CHARLOTTE SOUND, BC

Skip McKinnell<sup>1</sup> and Douglas F. Bertram<sup>2</sup>

<sup>1</sup> PICES Secretariat, P.O. Box 6000, Sidney, B.C., Canada. V8L 4B2 e-mail: mckinnell@ios.bc.ca

<sup>2</sup> Simon Fraser University, c/o Canadian Wildlife Service, 5421 Robertson Road, RR #1, Delta, B.C., Canada. V4K 3N2 e-mail: dbertram@sfu.ca

The seasonal timing of reproduction at a major coastal seabird breeding colony (Triangle Island, Queen Charlotte Sound, BC) varies significantly among years and this variability appears to result in predictable reproductive success. When spring warming is



early and/or warmer than average, the indices of reproductive success are low whereas when spring warming is delayed and/or colder, the indices are much higher. Likewise, in years when seabirds are breeding early, sockeye salmon that emigrate from nearby Rivers Inlet and Smith Inlet experience very low survival in the ocean. During the past decade, these sockeye populations have experienced some of their lowest recorded survival and they have occurred during periods of extreme ocean climate variation in the region. In contrast, both the ocean and seabird behaviour changed dramatically in 1999 and if there is a causal association between these changes and sockeye salmon ecology, the 1997 brood year should experience much better marine survival. We discuss possible mechanisms for the changes in Queen Charlotte Sound.

9AM2000 W3-338 oral

**SUMMARY OF NEMURO 2000: AN INTERNATIONAL WORKSHOP TO DEVELOP A PROTOTYPE LOWER TROPHIC LEVEL ECOSYSTEM MODEL FOR COMPARISON OF**

Bernard A. Megrey<sup>1</sup>, Michio J. Kishi<sup>2</sup>, Daniel M. Ware<sup>3</sup> and Makoto Kashiwai<sup>4</sup>

<sup>1</sup> Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA, 7600 Sand Point Way NE, Seattle, WA 98115-0070, U.S.A. e-mail: Bern.Megrey@noaa.gov

<sup>2</sup> Faculty of Fisheries, Hokkaido University, 3-1-1 Minato-cho, Hakodate, Hokkaido, Japan. 041 e-mail: kishi@salmon.fish.hokudai.ac.jp

<sup>3</sup> Adjunct-Professor, Department of Earth and Ocean Sciences, University of British Columbia. Mailing address: 3674 Planta Road, Nanaimo, B.C., V9T 1M2. Canada. e-mail: ware\_mrc@island.net

<sup>4</sup> Hokkaido National Fisheries Research Institute, 116 Katsurakoi, Kushiro, Hokkaido, Japan. 085-0802 e-mail: kashiwai@ss.hnf.affrc.go.jp

An ecosystem model with eleven compartments was developed in order to describe primary and secondary production in the Northern Pacific Ocean. This model was made by the request of the PICES/GLOBEC CCCC program. Model equations describe the interactions of nitrate, ammonium, silicate, two phytoplankton size fractions (tentatively, these are diatom and flagellate), three zooplankton size fractions (tentatively, microzooplankton, copepods, and predatory zooplankton), as well as nutrient kinetics. Formulations for the biological processes are based primarily upon process equations presented in (Kawamiya *et al.*, 1995). A 1-D physical-biological coupled model including a mixed layer closure model (1-D NPZ model) is used to simulate time dependent features of the ecosystem at three locations: Ocean Station P, Station A7 of the Akkeshi line off Hokkaido Island, Japan, and a region in the southeast Bering Sea. Time series of biological dynamics from the biological model as well as time-depth distributions of nutrient and plankton obtained from the 1D NPZ mode for three regions in the North Pacific are compared. This presentation summarizes the work and accomplishments of the PICES CCCC Model Task Team Nemuro Workshop, held in Nemuro Japan in January 2000.

9AM2000 W7-371 oral

**PAST, PRESENT AND FUTURE CO<sub>2</sub> DATA IN THE SOUTHERN OCEAN**

N. MetzI

Laboratoire de Physique et Chimie Marine, LPCM/IPSL, Université P.et M. Curie, Case 1344, place Jussieu, 75252 Paris Cedex 05, France e-mail: metzl@ccr.jussieu.fr

In the far, windy and glacial Southern Ocean, new observations and results have been obtained during the recent WOCE/JGOFS era. However, cold waters of the Southern Ocean still contain mysteries for biogeochemistry, paleoclimatology and climate changes studies. One of these concerns the air-sea CO<sub>2</sub> fluxes estimate: the sign of the fluxes (CO<sub>2</sub> source or sink?) generally differs when using ocean data (or ocean models) or atmospheric inverse approaches. Other uncertainties are related to the anthropogenic CO<sub>2</sub> inventory in the ocean: the differences between indirect methods based on data collection and ocean models reach a factor 3 at high latitudes in the southern hemisphere. Reducing these uncertainties is important not only for the present knowledge of the global carbon budget but also because it has been suggested that the Southern Ocean would be highly sensitive to climate change; the "C5" studies (Climate Change/Carbon-Cycle Coupling) includes changes in dynamics, biological communities, export production. The primary productivity in the Southern Ocean is also presented as a dominant factor for explaining the glacial/interglacial greenhouse gas variabilities. For all these studies, data synthesis is an important step towards a better description of the processes that control the spatio-temporal variabilities of the oceanic carbon cycle, including validations of C5 models.

After a brief introduction based on recent international results, I will try to present the actuality (under construction) of the ocean CO<sub>2</sub> data, including past cruises and future projects. This is based on information received from international involded in Southern Ocean carbon measurements.

9AM2000 S7-156 oral  
**MODELING CALIFORNIA CURRENT SYSTEM MESOSCALE OBSERVATIONS: FITTING PHYSICS AND BIOLOGY**

Arthur J. Miller<sup>1</sup>, Emanuele Di Lorenzo<sup>1</sup>, Bruce D. Cornuelle<sup>1</sup>, Douglas J. Neilson<sup>1</sup> and John Moisan<sup>2</sup>

<sup>1</sup> *Scripps Institution of Oceanography, University of California, San Diego, 9500 Gilman Drive, La Jolla, CA 92093-0224, U.S.A. e-mail: ajmiller@ucsd.edu*

<sup>2</sup> *NASA GSFC/Wallops Flight Facility*

Hydrographic and ADCP surveys of temperature, salinity and velocity from CalCOFI surveys, altimetric measurements of sea level and drifter observations of temperature and velocity during the 1997-98 El Niño are now being fit using a Green's function technique (strong constraints) with an eddy-resolving ocean model of the Southern California Bight region to obtain dynamically consistent estimates of eddy variability. These fields also are driving a 3-D NPZD-type model of the region to be fit to sub-surface chlorophyll and nitrate from CalCOFI hydrography and surface chlorophyll from SeaWiFS. Skill evaluations are quantified by the model-data mismatch (rms error) during the fitting interval and after the forecasting of independent data. Dynamical and ecosystem balances of the resulting fits will be discussed.

9AM2000 S3-296 invited  
**REVIEW OF DIAPAUSE STRATEGIES IN INTERZONALLY MIGRATING COPEPODS**

Charles B. Miller

*Oregon State University, Corvallis, OR 97331, U.S.A. e-mail: cm@oce.orst.edu*

Vinogradov described the large, grazing copepods of the subarctic Pacific as interzonal migrators. Such species are *Neocalanus plumchrus*, *N. flemingeri*, *N. cristatus*, and *Eucalanus bungii*. Similar patterns are prevalent throughout the family calanidae and occur in several other families. Vinogradov meant that these animals spend different parts of their life histories in widely separated vertical zones. The copepodite stages inhabit the surface mixed layer for feeding, growing and finally preparing a large mass of liquid lipid (often wax) as a store of nutriment. The late copepodite stages carry this lipid down and retain it through diapause phase at great depth, for the subarctic Pacific species below 500 m. Details of diapause, including stage it occurs in and timing, are clearly among the adaptations most readily accessible to selection pressure and vary within and even among species. Examples of this flexibility will be drawn from recent work with *Neocalanus* and *Calanus*. Insights about physiological diapause mechanisms are coming very slowly for both subarctic Pacific copepods and related species in other oceans. Problems of experimental analysis center on adoption by copepods of alternate life histories in closely confined and shallow spaces, even mesocosms. They will not exhibit diapause in confinement. Some hypothetical control variables, for example photoperiod, probably can be eliminated based on field data and the available, if inadequate, experiments. The proposed paper will review the status of these issues.

9AM2000 S1-157 oral  
**CENTURY-SCALE CHANGES OF THE BIDECADEAL OSCILLATION OVER THE NORTH PACIFIC**

Shoshiro Minobe

*Graduate School of Science, Hokkaido University, N-10, W-9, Sapporo, Hokkaido, Japan. 060-0810 e-mail: minobe@ep.sci.hokudai.ac.jp*

A new method is proposed to extract a climate variation, which changes its pattern in association with its change of period. This method is applied to the bidecadal oscillation over the North Pacific. The bidecadal oscillation has been known to change its timescale through the 20th century; the period increased from 15 years to 20 years from 1930 to 1950 (e.g., Minobe 2000, special issue for North Pacific Regime shifts in Progress in Oceanography). This method successfully revealed the changes of the spatial structure corresponding the changes of the dominant frequency. The bidecadal oscillation concentrate to the North in the beginning of the present century and then migrate southward probably corresponding to the period increase. The animation of the migration including propagation in each bidecadal cycle will be shown (if a PC projector is available).

The structure changes pose significant implications for the mechanisms of the bidecadal oscillation. Also, the lack of the simultaneous phase reversal between the bidecadal and pentadecadal oscillation may be related with the century scale structure change of the bidecadal oscillation. These points will be discussed.

The significance of the bidecadal oscillation can be detected by a conventional spectral analysis method, as well as the pentadecadal oscillation, in the strength of the Aleutian low. Thus, these results strengthened the conclusion presented in PICES VIII that the Pacific Decadal Oscillation is likely to be a superposition of the bidecadal and pentadecadal oscillations.

9AM2000 W7-372 oral  
**THE ATLANTIC OCEAN CO<sub>2</sub> SURVEY AND CARINA**

Ludger Mintrop<sup>1,2</sup>, Arne Körtzinger<sup>3</sup>, Jens Meincke<sup>1</sup> and Douglas W.R. Wallace<sup>2</sup>

<sup>1</sup> *Institute of Marine Research, Sect. Regional Oceanography, Troplowitzstr. 7, 22529 Hamburg, Germany e-mail: lmintrop@ifm.uni-kiel.de*

<sup>2</sup> *Institute of Marine Research, Div. Marine Biogeochemistry, Duesternbrooker Weg 20, 24105 Kiel, Germany*

<sup>3</sup> *Alfred Wegener Institute Foundation for Polar and Marine Research, P.O. Box 120161, 27515 Bremerhaven, Germany*

The international activities in compiling CO<sub>2</sub> data from the North Atlantic are reported, which result from a CO<sub>2</sub>-data workshop held in June 1999 in Germany. The project CARINA (CARbon dioxide IN the North Atlantic ocean), formulated at this meeting, forms a framework to assist in collection of existing data from various research programs, to coordinate future field programs and to build up working groups which jointly address special topics in data synthesis under different aspects. The organization of CARINA and its data collection is outlined and a number of examples for workgroup activities are given. The further work and perspectives are presented and the linkage to other oceanic regions, including the Equatorial Atlantic and South Atlantic, and the Southern Ocean, is discussed. In addition, some recent ideas and plans for forthcoming carbon observations in the North Atlantic are given.

9AM2000 S5-359 oral  
**MODELING OF THE KUROSHIO AND OYASHIO CONFLUENCE**

Humio Mitsudera

*Frontier Research System for Global Change, Japan, and*

*International Pacific Research Center, SOEST, University of Hawaii, U.S.A. e-mail: humiom@soest.hawaii.edu*

Simulation of the Kuroshio and Oyashio system has been conducted using a realistic regional ocean model based on POM. The model exhibits various realistic features of Kuroshio and Oyashio confluence that were difficult to be simulated, such as (1) sharp separation of Kuroshio from the Boso Peninsula followed by intense Kuroshio Extension (KE), (2) Oyashio penetration along the northeast coast of Japan, and (3) complex water-mass characteristics in the Mixed Water Region (MWR).

It is found that the water exchange between the Sea of Okhotsk and Pacific Ocean is crucial ingredient in the formation of the observed subpolar water penetration along the Tohoku coast, the northeastern coast of Japan. Water property is transformed in the Sea of Okhotsk to that with low potential vorticity (PV), so that it consequently flows out from the strait as a density current. This exchange is about 4 Sv in this experiment. This enables Oyashio to penetrate further south along the northeastern coast of Japan, crossing the wind-driven gyre boundary at about 42N. If the exchange is blocked (i.e., the strait is closed), the warm Kuroshio water occupies the upper ocean off the Tohoku coast totally by westward propagating eddies. This results in the formation of northward current there, instead of the southward current, due to higher offshore sea level. Thus, unlike the exchange case, the Oyashio is prevented from penetrating southward across the wind-driven gyre boundary in this blocked case.

Once the Oyashio water reaches the Tohoku coast, it tends to turn offshore due to the interaction with warm anticyclonic eddies. A part of the flow returns to the subpolar gyre. However, the other part flows southward below warm eddies in the Mixed Water Region (MWR), and subsequently subducts below KE. It finally spreads in the intermediate layer (at about 27 sigma-theta) of the MWR, carried by eddies as they emanate from KE. If the influx of the Oyashio water is not present (i.e., the blocked case), PV distribution in the intermediate layer is strikingly higher than that of the exchange case, indicating that stratification in the layer is eroded due to mixing with the warm Kuroshio Water above. Therefore, even though the exchange between the Sea of Okhotsk and Pacific Ocean is only 4 SV, the stratification in the MWR depends crucially on this exchange.

9AM2000 W6-325 oral  
**CASE STUDY - SHIPBOARD SIGHTING SURVEY FOR MARINE MAMMALS**

Tomio Miyashita

*Cetacean Resources Management Section, National Research Institute of Far Seas Fisheries, 5-7-1 Orido, Shimizu-shi, Shizuoka, Japan. 424-8633 e-mail: miyachan@enyo.affrc.go.jp*

Shipboard sighting survey is an effective tool for abundance estimation and distribution analysis of marine mammals. In the western North Pacific, Japan Fisheries Agency has conducted systematic line transect sighting surveys using research vessel every year from early 1980s. Research vessel traversed on the pre-determined track line and collected the distance information when they found cetaceans. They covered from the equator to the northern most of the Sea of Okhotsk (62°N), and other adjacent waters (South China Sea, the East China Sea, the Yellow Sea and the Sea of Japan). During the research distance of 344 thousands nautical miles from 1982 to 1996, seven species of baleen whales and 23 of toothed whales were identified. While minke, fin, Bryde's and right whales are distributed in both the Pacific Ocean and the adjacent waters, blue and sei whales are only in the Pacific Ocean. The widest distribution is observed in killer whales from the tropical to the northern Sea of Okhotsk. Sperm whales are not observed in the Sea of Japan and the Sea of Okhotsk. Beaked whales inhabit all waters. Other dolphins and porpoises are categorized generally by the inhabiting water temperature. Abundance and biomass of major whales and dolphins in

mid summer were estimated based on the distance information. For long diving animals like sperm and Baird's beaked whales, and the species like minke whales of which sighting cue is difficult to be seen, it is necessary to estimate the probability to detect animals on the track line.

9AM2000 POCp158 oral  
LONG-TERM MOORING MEASUREMENT OFF THE EAST COAST OF SAKHALIN IN THE SEA OF OKHOTSK  
PART I: FLOW FIELD

Genta Mizuta<sup>1</sup>, Yasushi Fukamachi<sup>2</sup>, Kay I. Ohshima<sup>2</sup> and Masaaki Wakatsuchi<sup>2</sup>

<sup>1</sup> Graduate School of Environmental Earth Science, Hokkaido University, Kita 10 Nishi 5, Sapporo, Hokkaido, Japan. 060-0810 e-mail: mizuta@ees.hokudai.ac.jp

<sup>2</sup> Institute of Low Temperature Science, Hokkaido University

Flow field along the western boundary of the Sea of Okhotsk is important as a basic quantity for the estimation of the transport of sea ice and water mass such as dense shelf water, which is thought to ventilate North Pacific Intermediate Water. We carried out long-term mooring observations off the east coast of Sakhalin Island from August 1998 to September 1999. Eight current meters and 4 ADCPs were deployed along 49.5°N and 53°N. In both latitudes vigorous southward currents (East Sakhalin Current) were observed in winter. Maximum monthly mean current speed in 53°N was around 30 cm/s near surface and 10 cm/s at a depth of 871 m. The southward current becomes quite weak or disappears in summer. A phase lag exists between the seasonal variation of the current speed in shelf region and that in slope region. In shelf region southward current starts to develop in October and attenuates by April. In slope region current speed is quite weak until November and southward currents up to 20 cm/s are still observed in April. In October strong vertical shear is observed in shelf region, suggesting density driven current due to less saline water affected by Amur River discharge. Also we will analyze the current data which are to be recovered in this July.

9AM2000 S4-159 oral  
STOCK DYNAMICS, ECOLOGY, AND POPULATION STRUCTURE OF THE JAPANESE FLYING SQUID, *Todarodes pacificus*, IN THE JAPAN SEA

Nickolay M. Mokrin and Oleg N. Katugin

Pacific Research Fisheries Centre (TINRO-Centre), 4 Shevchenko Alley, Vladivostok, Russia. 690600 e-mail: root@tinro.marine.su

In the last several decades, considerable rearrangements within marine ecosystems of the northwest Pacific occurred. Marked changes have been observed in the Japan Sea, where until recently Japanese sardine, *Sardinops melanostictus*, was most abundant species in off-shore nekton communities in upper epipelagic zone. Nowadays, nekton communities are dominated by the Japanese flying squid, *Todarodes pacificus*. This species is known for extreme changes in its stock abundance. Basing on biomass assessments made in TINRO-Centre, *T. pacificus* biomass in the Russian Exclusive Economic Zone of the Japan Sea was at its minimum of about 60,000 metric tons (t) in 1986, reached its maximum of approximately 800,000 t in 1991, and ranged from 200,000-500,000 t during 1990s.

Interannual dynamics of the squid stock abundance is putatively related to complicated intraspecific structure of *T. pacificus*. There are four cohorts in *T. pacificus* with different breeding seasons (winter, spring, summer, and autumn), size composition and migratory patterns. During the summer period in 1996 and 1997 all four seasonal cohorts from the Peter the Great Bay and off-shore regions of the central Japan Sea differed from each other in two metric characters of females: dorsal mantle and nidamental gland lengths.

Females from all four seasonal cohorts were compared using a biochemical genetic approach. Individuals from the autumn cohort appeared significantly different from those classified among the winter, spring, and summer cohorts in allele frequency distribution at protein-coding genetic loci. No genetic differentiation has been observed between three non-autumn cohorts. Such a pattern of genetic variability among seasonal cohorts of *T. pacificus* was revealed in 1996 and 1997.

Intraspecific genetic differences in *T. pacificus* from the Japan Sea are possibly related to differences in ecology and life-cycle of seasonal groups. Paralarvae and young squid from the autumn spawning are characterized by comparatively short northward dispersal with prevailing currents, and their distribution area is generally restricted to subtropical waters south of the Polar Front zone. By contrast, newly hatched and juvenile specimens from the other three cohorts are broadly distributed far north in the Japan Sea, up to north Tatar Strait and Asian coastal areas of Russia. Distribution type is strongly related to recruitment dynamics in a semelparous annual migratory species such as *T. pacificus*, so that long-distance travel inevitably reduces chances of the young squid survival. Conversely, comparatively short migration routes during initial ontogenetic stages within stable food-rich areas south of the Front zone should enhance the chance of survival. High paralarval survival provide high abundance and long-term constancy of the autumn-spawning *T. pacificus* stock in the Japan Sea. In contrast, year-to-year fluctuations in abundance are much more pronounced in three non-autumn cohorts.

General subdivision of seasonal cohorts of *T. pacificus* into the off-shore type (autumn cohort) and in-shore type (winter, spring and summer cohorts) is supported by genetic evidence, and could have arisen as a result of intraspecific divergence both on genetic

and epigenetic levels. Such a type of population structure, when ecologically dependent divergence accompanied by genetic variability is maintained between successive broods, enabled *T. pacificus* to use its niche to full advantage and retain dominant positions in epipelagic communities in the Japan Sea.

9AM2000 S9-160 oral  
**UTILIZATION OF BIOLOGICAL ACTIVITIES OF CAPITELLID POLYCHAETE FOR TREATMENT OF ORGANICALLY ENRICHED SEDIMENT DEPOSITED ON THE BOTTOM BELOW FISH NET PEN CULTURE**

Shigeru Montani<sup>1</sup> and Hiroaki Tsutsumi<sup>2</sup>

<sup>1</sup> Department of Life Sciences, Kagawa University, Miki, Kagawa, Japan. 761-0795 e-mail: montani@ag.kagawa-u.ac.jp

<sup>2</sup> Faculty of Environmental & Symbiotic Sciences, Prefectural University of Kumamoto, Tsukide, Kumamoto, Japan. 862-8502

Over the past three decades, fish farming using pens has developed in the coastal areas throughout Japan. However, this new style of fishery is often accompanied by serious organic pollution of the water and bottom sediment around the fish farm due to organic waste from the fish farm itself. The organic pollution tends to cause depletion of dissolved oxygen in the bottom water and production of high levels of hydrogen sulphide in the sediment in summer. Such anoxic conditions in bottom environment result in catastrophic environmental disturbance to the benthic communities. We have attempted to reduce the organic pollution of the bottom sediment by biological treatment. In the organically enriched or polluted sediment, several species of deposit feeding polychaetes such as *Capitella* sp1. And spionids often predominate. In this study, we reproduce the process of population growth of a *Capitella* species after colonization to the sediments with continuous organic input in the laboratory and *in situ*. The purposes of this study are to describe the population growth of the laboratory colonies of *Capitella* sp1. to examine the changes of chemical characteristics of the sediment used in the experiments, and to clarify how the biological activities of *Capitella* sp1. can modify the chemical characteristics of the sediment in the process of rapid population growth. We also discuss the possibility that the biological activities of *Capitella* sp1. can be applied as a method of biological treatment for organically enriched sediment.

9AM2000 S4-161 oral  
**COMMUNITY STRUCTURE OF EPIPELAGIC SQUIDS IN THE KUROSIHO-OYASHIO TRANSITION ZONE, WESTERN NORTH PACIFIC**

Ken Mori<sup>1</sup>, Kotaro Tsuchiya<sup>2</sup> and Takahiro Kinoshita<sup>1</sup>

<sup>1</sup> Hokkaido National Fisheries Research Institute, 116 Katsurakoi, Kushiro, Hokkaido, Japan. 085-0802 e-mail: moriken@hnf.affrc.go.jp

<sup>2</sup> Tokyo University of Fisheries, Japan

Kurosiho-Oyashio Transition Zone of western North Pacific is recognized as an important nursery ground for not only the pelagic fishes on fisheries importance, such as Mackerel, Sardine, or Pacific Saury, but also the large pelagic squids as *Todarodes pacificus* or *Ommastrephes bartrami*. Present study aims to clarify the distribution pattern of epipelagic cephalopods and discuss the cephalopod community structure.

Materials were collected with the large pelagic trawl net by the R/V *Tanshu-Maru* during May-June of 1996 to 2000 in the Water east off Honshu, Japan (35°-40°N, 141°-170°E) in the depth shallower 100 m.

Based on the materials from 5 cruises, it was recognized that the community is mainly constructed by three families, Eupoloteuthidae, Ommastrephidae and Onychoteuthidae, which three families occupies 90-99% in population, and 99% in wet-weight against that in total cephalopods. On the longitudinal areal comparison of distribution, the survey area is divided in two major area with the boundary of 160°E line. Western water has abundant population of distant-neritic species such as *T. pacificus* or *W. scintillans*, in contrast to the eastern water with the open water species such as *Abraliopsis felis*. The materials are mainly consisted of young and immature specimens excluding some mature ones such as *W. scintillans* or *Eucloteuthis luminosa*.

9AM2000 FISp162 poster  
**FRY OF FISHES OF COASTAL WATERS OF GULF OF TERPENIA (SAKHALIN ISLAND) IN JUNE 1992**

I.N. Moukhametov and O.N. Moukhametova

Sakhalin Research Institute of Fishery & Oceanography (SakhNIRO), 196 Komsomolskaia Street, Yushno-Sakhalinsk, Russia. e-mail: ilyas@tinro.sakhalin.ru

For estimation of quantity of pink salmon *Oncorhynchus gorbuscha* in early-marine-life stage at coastal waters of Gulf of Terpenia it was conducted investigations with used of two-layer simmetric trawl 11.9/9.0 m (32 stations). Trawl was towed at surface for 30 min at 3-3.5 kts. Works were carried out only at light time. At that time we collected information about another species of fishes in parallel with pink salmon (Table - not include larvae of 3 species (6 specimens), that unidentified at this time). Maximum number of species on separate station was 7.

Table

List of species, length and numbers of fishes, that were captured and percent of occurrence for larvae and fry (Gulf of Terpenia, June, 1992).

Species	Standard length (mm)	Total number	% of occurrence
<b>Petromyzonidae</b>			
Petromyzonidae gen. sp.	152	2	
<b>Clupeidae</b>			
Clupea harengus pallasi	85-95	52	
<b>Salmonidae</b>			
Oncorhynchus gorbuscha	27-51	2551	44
Oncorhynchus masu	120-150	12	
Salvelinus leucomaenis	175	4	
<b>Osmeridae</b>			
Hypomesus olidus	125-170	22	
Osmerus mordax dentex	180-280	3	
<b>Gadidae</b>			
Theragra chalcogramma	11-27	411	69
<b>Gasterosteidae</b>			
Gasterosteus aculeatus	53-86	557	
Pungitius pungitius	65	1	
<b>Stichaeidae</b>			
Chirolophis snyderi	28	2	6
Lumpenus sagitta	20-46	169	44
Stichaeus punctatus pulcherrimus	15-23	321	53
<b>Hexagrammidae</b>			
Hexagrammidae gen. sp.	30-54	47	19
<b>Cottidae</b>			
Enophrys diceraus	14	2	6
Melletes papilio	19-23	11	19
Myoxocephalus sp.	11-21	1110	84
<b>Agonidae</b>			
Agonomalus jordani	15	1	3
Pallasina barbata	21-33	6	19
Podothecus gilberti	16-23	20	13
Podothecus thompsoni	16-23	11	22
<b>Pleuronectidae</b>			
Platichthys stellatus	350-400	2	

Fry of sculpins of gen. *Myoxocephalus* (*M. jaok* and *M. polyacanthocephalus*) were more abundant after pink salmon and they met more frequent than all other species. An average length of fishes was - 17.3 mm, an average weight - 80.7 mg. Than closer to coast that more largely sculpins were. An average length of sculpins on distance from coast 7.1 miles was 17.6 mm (74 sp.), on distance 1.9 miles - 18.1 mm (113 sp.), on distance 0.4 miles - 18.95 mm (120 sp.) (transection near Makarov town).

Walleye pollock *Theragra chalcogramma* was met on 22 stations with number from 1 to 85. An average length - 19 mm, weight - 38 mg. They were more abundant at northeast of Gulf on distance from coast 5-7 miles.

Arctic shanny *Stichaeus punctatus* was more abundant at east of Gulf. It was collected on 17 stations (1-58 sp.). Only two specimens were caught at west of Gulf. An average length - 19.9 mm, weight - 45.4 (17-63) mg.

Snakefish *Lumpenus sagitta* was met a few number through all area of our investigations, but near Makarov town were sampled 149 specimens from total 169. An average length of snakefish was 35,2 mm.

Larvae and fry of another fishes were not numerous in ours samples.

It was dominate only one species at any sampled station (in several cases it were appreciable share of two species on station: walleye pollock- arctic shanny and *Myoxocephalus*- snakefish).

Also we studied zooplankton at the same area (11 stations) and feed of most abundant fishes in ours samples. The numbers of stomachs, that were considered are: sculpins - 196, pink salmon - 100, arctic shanny - 85, walleye pollock - 66, greenling *Hexagrammidae* gen. sp. - 17. Samples of zooplankton were processed by N.A. Fedotova and most of stomachs were processed by I.A. Nemchinova (both SakhNIRO).

9AM2000 W1-323 poster

**A REGIONAL MODEL OF A LONG-TERM MARINE SCIENCE PROGRAM: GULF ECOSYSTEM MONITORING, GEM**

Phillip R. Mundy

*Exxon Valdez Oil Spill Trustee Council, 645 G Street Suite 400, Anchorage, AK 99501-3451, U.S.A. e-mail: phil\_mundy@oilspill.state.ak.us*

The opportunity to design a regional marine monitoring program in perpetuity was created in 1999 when the Exxon Valdez Oil Spill Trustee Council dedicated the income from a US\$115 million fund to activities in the northern Gulf of Alaska. The Trustee Council intends the monitoring program to support management efforts that sustain the healthy and biologically diverse marine ecosystem in the northern Gulf of Alaska on which human uses such as fisheries depend. Contributions to management are expected in the form of information and synthesis permitting greater understanding the roles of geophysical forces and human activities on productivities of fish, birds, and mammals. Plans call for design activities to cover a three-year period culminating in an invitation for proposals in late winter 2002. The first projects are to be funded starting in October 2002.

Activities during the first year of the design phase produced the draft Gulf Ecosystem Monitoring (GEM) program now under review by a committee of the U.S. National Research Council (USNRC). Drawing on the expertise of scientists from many different institutions and the scientific literature, the draft program describes the scientific basis for monitoring in the region within the contexts of North Pacific and global processes. The draft program also presents a conceptual foundation describing how geophysical and human factors combine to determine the production of birds, fish and mammals in the region through control of food production, habitats, and removals. In addition to scientific information and synthesis, the draft program also defines environmental matters of concern to the region, the Trustee Council's vision for addressing those concerns and the institutional structure and processes necessary to implement the Trustee Council's vision.

During the current design year the specific monitoring plan that is necessary to implement the draft program is being drafted. Scientific and policy experts, managers and user groups are being consulted on the specifics of what to measure, when and where to measure it, and why it should be measured. The consultations will proceed to a public workshop in October 2000, and the design year will conclude with submittal of the draft monitoring plan for review by the USNRC committee in March 2001. Note that the draft monitoring plan will not address the retrospective statistical analyses necessary to understand precision and power as functions of sampling frequencies for the monitoring measures identified. Analyses of the spatial and temporal frequencies of sampling needed to answer questions will begin in design year three and continue thereafter as one of the essential processes of GEM. All concerned scientists and administrators are invited to submit comments on the drafts, which are posted on the web as they become available.

9AM2000 W7-373 oral

**OCEAN CARBON UPTAKE IN THE NORTH PACIFIC: FIRST STEPS IN DESIGNING A SAMPLING STRATEGY**

Paulette P. Murphy<sup>1</sup>, Yukihiro Nojiri<sup>2</sup>, D.E. Harrison<sup>3</sup> and C.S. Wong<sup>4</sup>

<sup>1</sup> *National Oceanographic Data Center, National Oceanic & Atmospheric Administration, Silver Spring, MD 20910-3282, U.S.A.*

<sup>2</sup> *National Institute for Environmental Studies, Tsukuba, Ibaraki 305-8569, Japan*

<sup>3</sup> *Pacific Marine Environmental Laboratory, National Oceanic & Atmospheric Administration, Seattle, WA 98115, U.S.A.*

<sup>4</sup> *Institute for Ocean Sciences, Sidney, B.C., Canada. V8L 4B2*

Annual assessments of ocean carbon uptake can only be obtained at present by integrating regional fluxes, which are the product of CO<sub>2</sub> air-sea disequilibrium and CO<sub>2</sub> gas exchange coefficient (a non-linear function of wind speed). Accurate determinations of ocean carbon uptake depend on appropriate sampling in time and space for all observations required to calculate fluxes: sea surface temperature and salinity, wind speed and the CO<sub>2</sub> concentration gradient at the air-sea interface. Data from the volunteer observing ship *M/S Skaugran* have been used to examine the spatial and seasonal variability of CO<sub>2</sub> fluxes for different oceanographic regimes in the North Pacific. Appropriate sampling strategies for these parameters as a function of location and season will be presented as a first step toward designing a sampling strategy to determine accurate basin-scale mean ocean carbon uptake values.

9AM2000 S3-163 oral

**CHANGE OF DOMINANT SPECIES IN SPRING-SUMMER PLANKTON OF PETER THE GREAT BAY (JAPAN SEA)**

Victoria V. Nadtochy and Yury I. Zuenko

*Pacific Fisheries Research Center (TINRO-Center), 4 Shevchenko Alley, Vladivostok, Russia. 690600 e-mail: root@tinro.marine.su*

Variability of plankton state is considered on the 342 samples collected in coastal and pre-estuarine zones of Peter the Great Bay in spring-summer of 1980, 1981, 1986, 1993-1996, and 1998-1999. Three classes of years were distinguished which differed by both ratio of mass species and environmental conditions, as water temperature and salinity.

In 1980s, both temperature and salinity were relatively low. Cladocera and small copepod *Acartia aff. clausi* were abundant. Total plankton concentration in spring-summer was 400-2600 mg/m<sup>3</sup>.

In 1993-1996, both temperature and salinity were heightened because of advection of subtropic waters. Dominant species were Copepods *Pseudocalanus minutus* s.l., *Oithona* spp., *Paracalanus parvus*, Sagittas. Meroplankton was abundant as well, but Cladocera and *A.aff. clausi* were scarce. Total biomass was 600-2000 mg/m<sup>3</sup>.

Period 1998-1999 was distinguished by lowered water temperature but salinity was relatively high, especially in spring - early summer. *P. minutus* and *Oithona* spp. prevailed accompanied by an abundance of phytoplankton. Number of Cladocera increased relatively to 1993-1996. Total biomass increased as well to 700-2400 mg/m<sup>3</sup>.

Obviously, the reason of dominant species change is the variation of environments, and besides, certain species react to temperature fluctuations, other ones - to salinity changes. The higher the temperature, the more abundant warm-water Copepods as *P. parvus* and *C. pacificus*; the higher the salinity, the more abundant the species of the open sea as *Oithona* spp., *P. minutus*, Sagittas; lowered temperature possibly is favorable for Cladocera; and lowered salinity is favorable for *A. aff. clausi*. Note that theoretically one more combination of temperature and salinity anomalies is available: high temperature by low salinity that had not been observed yet. Prevalence of small Copepods as *P. parvus* and *A.aff. clausi* is supposed in this case.

9AM2000 MEQp164 oral  
**MERCURY AND HEAVY METALS IN MUSCLES OF ADULT SALMON (*Oncorhynchus* SPP.) FROM THE RIVERS OF THE EAST BERING SEA, ALASKA**

Sathy A. Naidu<sup>1</sup>, J.J. Kelley<sup>1</sup>, S.C. Jewett<sup>1</sup>, L.K. Duffy<sup>1</sup>, D. Dasher<sup>1</sup>, J.M. Kennish<sup>2</sup> and X. Zhang<sup>1</sup>

<sup>1</sup> *Institute of Marine Science, School of Fisheries & Ocean Sciences, University of Alaska Fairbanks, Fairbanks, AK 99770-1080, U.S.A. e-mail: jfsan@uaf.edu*

<sup>2</sup> *University of Alaska Anchorage, Anchorage, AK 99508, U.S.A.*

Total Mercury (THg) was analyzed by CVAF in 33 muscle and liver samples of salmon species (chinook: *O. tshawytscha*; chum: *O. keta*; sockeye: *O. nerka*; coho: *O. kisutch*) from the Alaskan Bering Sea rivers (Yukon, Kuskokwim, Nushagak and Kvichak). Additionally, heavy metals (V, Ni, Cu, Zn, As, Cd, and Pb) were analyzed by ICP/MS in a representative muscle sample of Kuskokwim and Nushagak sockeyes, Yukon chum, and Kvichak coho.

The THg in muscles range from 25 to 137 ng/g (ppb, wet wt.) with marked variations between species and rivers. The muscle THg values are generally lower than 50 ng/g in sockeyes and cohos from all the rivers and in the Kuskokwim chums. The THg in chinook muscles from Kuskokwim and Nushagak range from 90 to 137 ng/g, which is higher by a factor of 2-2.5 than those from the Yukon. Likewise, THg in chinook livers from the Kuskokwim (mean: 86 ng/g) and Nushagak (mean: 123 ng/g) are also 2-2.5 times higher than that in the Yukon. Several factors may account for the relatively higher values of THg in the chinooks of the above two rivers, one of which is the cinnabar (HgS) deposits in the rivers' drainage basins. In muscle no correlations exist between THg and the levels of Se, lipid and omega 3 fatty acids, sizes and sexes of the salmon species. The THg levels in muscles of all the salmon species from the four rivers are significantly below WHO/ICPS advisory limit (500 ng/g ww) for human consumption. All heavy metals in the salmon muscles are low, indicating no contamination.

9AM2000 S1-165 poster  
**FEEDING ECOLOGY AND TROPHIC DYNAMICS OF PACIFIC SALMON IN THE GULF OF ALASKA**

Megumi Nakamura<sup>1</sup>, M. Kaeriyama<sup>1</sup>, Y. Ishida<sup>2</sup>, H. Ueda<sup>3</sup>, R.V. Walker<sup>4</sup> and K.W. Myers<sup>4</sup>

<sup>1</sup> *Hokkaido Tokai University, Minamisawa 5-1-1-1, Minami-ku, Sapporo, Hokkaido, Japan. 005-8601 e-mail: 99sgb104@gbs.htokai.ac.jp*

<sup>2</sup> *Hokkaido National Fisheries Research Institute, Japan*

<sup>3</sup> *Faculty of Fisheries, Hokkaido University, Japan*

<sup>4</sup> *FRI - School of Fisheries, University of Washington, U.S.A.*

We investigated stomach contents for Pacific salmon, and measured stable carbon (<sup>13</sup>C/<sup>12</sup>C) and nitrogen (<sup>15</sup>N/<sup>14</sup>N) isotope values in tissue samples of Pacific salmon and their prey animals collected by the R/V *Oshoro-maru* at the Subarctic Current and Alaskan Gyre areas in the Gulf of Alaska during early summer of 1999. From results of analysis of <sup>13</sup>C/<sup>12</sup>C and <sup>15</sup>N/<sup>14</sup>N isotope values and stomach contents, feeding behavior of Pacific salmon was divided into the plankton feeder (sockeye, chum, and pink salmon) and the nekton feeder (coho and chinook salmon, and steelhead trout). The repeated measure ANOVA showed that isotope values of all species were no difference among sampling stations. Isotope values of chum and pink salmon increased with their growth. On the basis of the relationship of <sup>13</sup>C/<sup>12</sup>C and <sup>15</sup>N/<sup>14</sup>N values in Pacific salmon and prey animals, trophic position increased in the following sequence: (1) pink and chum, (2) sockeye, and (3) coho, chinook salmon and steelhead trout. Trophic level relationship between Pacific salmon and prey animals was observed in the Subarctic Current area, while was not observed in the Alaskan Gyre area.



9AM2000 FISp166 oral  
**SPATIAL AND TEMPORAL DISTRIBUTION OF SHORT LIFE-SPAN SQUID AND FISH INFERRED FROM DIVING BEHAVIOR OF PACIFIC BLUEFIN TUNA**  
Hideaki Nakata, Takashi Kitagawa, Shingo Kimura and Harumi Yamada  
Faculty of Fisheries, Nagasaki University, 1-14 Bunkyo-machi, Nagasaki, Japan. 852-8521 e-mail: nakata@net.nagasaki-u.ac.jp

Immature Pacific bluefin tuna (*Thunnus thynnus orientalis*), attached with an archival tag, were released near Tsushima Island in the eastern East China Sea. Using the time-series data on water temperature and swimming depth recorded every 128 seconds by the tags retrieved from those fish, we have tried to relate the swimming behavior of the bluefin with the distribution of their prey. One of the major prey items could be small fish, therefore this may open the way to look at the spatial and temporal distribution of short life-span squid and fish in detail and to understand the role of those fish as a link to higher trophic levels.

The results are summarized as follows; (1) In winter, bluefin mainly swam within the surface mixed layer during the daytime and nighttime. It should be noticeable however that some individuals showing prominent diel periodicity (deeper during the daytime) tended to migrate to southwestern offshore, where larger temperature gradients existed in the vertical water column under stronger influence of Tsushima Warm Current. (2) Responding to the development of thermocline in summer, bluefin became to spend most of the time at the surface, avoiding cool water below the thermocline, however during the daytime they show spike-like diving passing through the thermocline probably for foraging. (3) It is suggested from the above results that higher prey density for bluefin feeding could be found just below the thermocline in summer, and in winter as well under the influence of a warm water mass. These suggestions are apparently consistent with recent field surveys on the distribution of mesopelagic fish using a quantitative echo sounder.

9AM2000 S3-167 oral  
**EGG PRODUCTIVITY OF THREE ONCAEA SPECIES IN THE KUROSHIO EXTENSION IN SPRING**  
Kaoru Nakata, Hiroshi Ito, Tadafumi Ichikawa and Katsuyuki Sasaki  
National Institute of Fisheries Science, 2-12-4 Fukuura Kanazawa-ku, Yokohama, Kanagawa, Japan. 236-8648 e-mail: may31@nrifs.affrc.go.jp

Small copepods whose prosomal length was smaller than 1mm dominated not only numerically but also in biomass in the copepod communities in the upper 200 m depth of the Kuroshio extension, in April 1999. *Oncaea* species were one of the dominant groups in the small copepod biomass. RNA/DNA ratios of adult females of three *Oncaea* species (*O. media*, *O. venusta f. venella*, *O. venusta*), mainly distributed in the upper layers of the Kuroshio extension, were positively related with their daily egg production. Vertical distribution of temperature, individual numbers and RNA/DNA ratios of the adult females of the *Oncaea* spp. collected with MOCNESS 1/4 (0.064mm mesh) revealed that the *Oncaea* spp. reproduced in the considerably restricted depth layers. Results of stepwise multiple linear regression analyses of the RNA/DNA ratios against temperature, delta sigma-t and chlorophyll *a* showed that their reproductive activities tend to increase with temperature and/or development of stratification. In contrast with large copepods in the Kuroshio, whose biomass is likely to be limited by new production even in early spring, warm and stratified condition may contribute to dominance of the small copepods such as *Oncaea* species.

9AM2000 S2-168 poster  
**FEEDING FEATURES OF GADOID FISHES (GADIDAE) IN THE WESTERN BERING SEA IN SUMMER AND FALL**  
V.V. Napazakoy, V.I. Chuchukalo, and V.I. Radchenko  
Pacific Research Institute of Fisheries & Oceanography (TINRO-Centre), 4 Shevchenko Alley, Valdivostok, Russia. 690600 e-mail: root@tinro.marine.su

This study is based on data collected in the TINRO-Center integrated expeditions in the western Bering Sea in 1998 - 1999. Surveys covered an area bounded by 59°04' to 65°13' N and 165°43' E to 173°20' W, where 548 trawl hauls were conducted in depths ranging from 50 to 762 m. A total of 5642 stomachs from walleye pollock (*Theragra chalcogramma*), Pacific cod (*Gadus macrocephalus*), Polar cod (*Boreogadus saida*), and saffron cod (*Eleginus gracilis*) were sampled.

Walleye pollock sized 10-40 cm fed upon large zooplankton (3.5 - 20 mm). Euphausiids, their furcilia larvae, and copepods were the main food components, and contributed more than 60% of daily diet. Pollock larger 40 cm fed upon shrimps, fish, adult euphausiids, squid, and gammarids. Pacific cod aged 0+ chiefly fed upon euphausiids (50%) and crab larvae (30 %) in the Anadyr Gulf. The proportion of fish in cod diets and prey size gradually increased with a linear increase in fish size. For pollock and Pacific cod, daily food rations gradually decreased with a linear increase in the size of sampled fish. Daily ration varied from 4.8% to 1.5% body weight (BW) for pollock size groups from 10-20 cm to above 60 cm, and from 3.1% to 1.4% BW for cod size groups from below 10 cm to 70-90 cm.

Both demersal crustaceans (mysids, cumaceans, gammarids, decapods) and zooplankton (copepods and chaetognats) occurred in the diets of Polar cod sized 5-10 cm. Polar cod sized above 20 cm consumed shrimp, fish, and copepods. Daily food ration was estimated at 4.2-4.5% BW. Saffron cod mainly consumed fish, gammarids, polychaetes, and shrimp. Mysids, and juvenile snow

crabs have occurred in less degree. Daily food ration was estimated at 3.2% BW for saffron cod sized 20-30 cm, and 2.6% BW for size group 30-40 cm.

Interannual differences in gadoid food spectra and rations are analyzed.

9AM2000 CCCCp169 oral  
**ZOOPLANKTON OF THE SOUTHEAST BERING SEA SHELF: ARE THERE DIFFERENCES IN BIOMASS OR COMMUNITY STRUCTURE AMONG RECENT DECADES?**

Jeffrey M. Napp<sup>1</sup>, C.T. Baier<sup>1</sup>, K.O. Coyle<sup>2</sup>, A.I. Pinchuk<sup>2</sup>, R.D. Brodeur<sup>3</sup> and N. Shiga<sup>4</sup>

<sup>1</sup> NOAA/Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle, WA 98115-0070, U.S.A. e-mail: Jeff.Napp@noaa.gov

<sup>2</sup> Institute of Marine Science, University of Alaska, Fairbanks, AK 99775-7220, U.S.A.

<sup>3</sup> NOAA/Northwest Fisheries Science Center, Newport, OR 97365-5297, U.S.A.

<sup>4</sup> Faculty of Fisheries, Hokkaido University, Hakodate, Japan

Recent northern hemisphere weather anomalies have affected the physical and biological environment of the southeastern Bering Sea shelf. This ecosystem is an important fishing ground for fin- and shellfish, and is the summer foraging grounds for planktivorous seabirds and marine mammals. In 1997, summertime clear skies and low winds resulted in: a shallow mixed layer, record surface water temperatures (+4°C anomaly), and net primary production below the pycnocline. Concurrent with these observations were low densities of adult euphausiids (*Thysanoessa raschii*) along the inner shelf and a massive die-off of short-tailed shearwaters (*Puffinus tenuirostris*), a planktivorous seabird. Recent anomalies in weather or short-term climate may be a valuable tool to understand and predict how longer-term climate change would affect this ecosystem.

We are gathering historical zooplankton biomass and species composition data for the southeastern Bering Sea shelf to compare with our recent data (1994-1999). We ask: 1) has the zooplankton community changed, 2) how has it changed, and 3) were the changes uniform across the shelf? Our first result from the comparison is that the *Oshoro Maru* zooplankton time series is spatially aliased. The area of sample collection was highly variable until 1994 and low biomass years (1990-1993) in this valuable time series may be due to the spatial distribution of samples, rather than physical or biological processes that depressed zooplankton biomass. We will present this result as well as results from a comparison of our recent data to data collected during the early 1980s.

9AM2000 W2-170 oral  
**HISTORICAL TRENDS OF HERRING IN THE RUSSIAN NORTH PACIFIC WATERS**

Nikolai I. Naumenko

Kamchatka Research Institute of Fisheries & Oceanography, Russia e-mail: mail@kamniro.kamchatka.su

Pacific herring (*Clupea pallasii*), inhabiting the Far Eastern seas, is represented by three ecological morphs: marine, inshore and brackish-water ones. More than 20 populations of this species there are in Russian waters, including 6 typically marine populations. Marine herring have important fishery value. Total domestic catch of Pacific herring in XX century overreached 18 million tons.

Far Eastern marine herring populations, according to character of year-classes abundance dynamics, exhibit two groups: northern (Gizhiga-Kamchatka, Okhotsk, Korf-Karaginsky, Anadyrsky) and southern (the Great Peter Bay, Sakhalin-Hokkaido). Period of rotation strong generations for the group of northern populations is short, taking 5 years approximately. Abundant and poor year-classes in the group of southern populations appear by series.

Stock abundance of the northern populations was the highest in the 1950s-1960s, i.e. in the period of maximum solar activity of the last hundred-year cycle. In the 1970s-1980s abundance of these populations reached its' minimum. Next increase of stock abundance of the northern populations was observed in 1990s. In 1997-1999 domestic catches of herring in the Sea of Okhotsk and in Bering Sea amounted 330-410 thousand tons, what is significantly more being compared to the average for many years catch.

Herring populations, inhabiting Japan Sea, reached their maximum abundance by late XIX - early XX, i.e. during the time of minimum solar activity of the last hundred-year cycle. These populations exhibit extensive depression during recent years.

9AM2000 W3-171 oral  
TO THE PHYSICAL FORCING AND THE WAYS OF IMPROVEMENTS IN THE NEMURO-MODEL

Vadim V. Navrotsky

Pacific Oceanological Institute, 43 Baltiyskaya Street, Vladivostok, Russia. 690041 e-mail: navr@online.vladivostok.ru

Supposing we know the behavior of the biological part of an ecosystem with stationary physical conditions, the problem is to define the main physical parameters and the ways of their influence on the ecosystem behavior. In the NEMURO-model the main physical parameter, entering almost all equations, is temperature, which is calculated with the use of a mixed layer model. Many observations (examples for the northwestern Pacific and Okhotsk Sea are given) show, that small-scale fluctuations of the temperature gradient vertical structure (fine-structure FS and microstructure MS) are important as for vertical distribution of plankton, so for its integral biomass. Mechanisms of FS and MS influence on phytoplankton and zooplankton production may be different, but as a first approximation we propose to use in all temperature-dependent terms an additional coefficient proportional to rms of the temperature vertical fluctuations in the layer studied (0-330 m). The values of rms can be easily obtained from observations (XBT, for example), and a model is proposed, that helps to evaluate them theoretically.

Some additional improvements in the model are discussed, including 1) time-lag in dependence between zooplankton and phytoplankton concentrations; 2) adjusting averaging scales to the intrinsic (biological) and forced (physical) time scales; 3) interdependence between input parameters; 4) criteria for comparisons between models and observations.

9AM2000 S3-172 poster  
SEASONAL DYNAMICS OF STRUCTURE AND BIOMASS OF THE PLANKTON IN THE SOUTH KURIL REGION

Svetlana V. Naydenko

Pacific Fisheries Research Center (TINRO-Center), 4 Shevchenko Alley, Vladivostok, Russia. 690600 e-mail: root@tinro.marine.su

The species structure of the plankton community in the South Kuril region characterized significant species variety. On data of the plankton surveys 1991-96 the qualitative structure of the zooplankton in pacific waters of the Kuril Islands was submitted by the 70 species, in the Kuril waters of Okhotsk Sea zooplankton was submitted by the 64 species. Two groups were the most numerous: Copepoda - 36 species and Amphipoda - 8 species. The other groups are submitted by the few species.

The basis of the plankton is made by the representatives of the different systematic groups, but 4 groups have the greatest meaning on biomass and number: it is euphausiacea, copepoda, chaetognatha and amphipoda. Their share from general biomass of the plankton are 90%.

The most significant seasonal changes of plankton biomass are observed in the coastal pacific region. On by inter-annual data the quantity of the plankton decreases from summer to the autumn-winter season in this region in 5.1 times, in coastal Okhotsk Sea region - in 2.7 times, in oceanic Pacific - in 1.8 time.

The detailed analysis of the feeding zooplankton species in South Kuril area is carried out. Main trophic groups of the plankton are: predatory zooplankton and non-predatory zooplankton. In interannual aspect, the predatory plankton considerably dominated at 1992-94 years, however in 1995-96 its biomass has decreased considerably. The dynamics of the biomass predatory and non-predatory zooplankton give evidence about structural formation happening in the plankton communities.

9AM2000 W7-374 poster  
LONG-TERM TREND OF pCO<sub>2</sub> IN THE WESTERN NORTH PACIFIC

Kazuhiro Nemoto<sup>1</sup>, Takashi Midorikawa<sup>2</sup>, Akira Nakadate<sup>3</sup>, Kan Ogawa<sup>3</sup>, Takafumi Umeda<sup>3</sup>, Toshiya Nakano<sup>3</sup>, Masao Ishii<sup>1</sup> and Hisayuki Y. Inoue<sup>1</sup>

<sup>1</sup> Meteorological Research Institute, Nagamine 1-1, Tsukuba, Ibaraki 305-0052, Japan e-mail: knemoto@mri-jma.go.jp

<sup>2</sup> Hakodate Marine Observatory, Mihara 3-4-4, Hakodate, Hokkaido 041-0806, Japan e-mail: t-midorikawa@met.kishou.go.jp

<sup>3</sup> Japan Meteorological Agency, Otemachi 1-3-4, Chiyoda-ku, Tokyo 100-8122, Japan e-mail: a\_nakadate@met.kishou.go.jp

The partial pressure of carbon dioxide in air (pCO<sub>2</sub><sup>air</sup>) and surface waters (pCO<sub>2</sub><sup>sea</sup>) has been observed along 137°E in the western North Pacific, on board the R/V *Ryofu maru* of Japan Meteorological Agency in winter for 19 year since 1981. It was found that pCO<sub>2</sub><sup>sea</sup> increased significantly in nearly all latitudes, following the increases in pCO<sub>2</sub><sup>air</sup>. The annual growth rate of pCO<sub>2</sub><sup>sea</sup> averaged in the latitude of 3-30°N for the period of 1981-1999 was about 1.4 μatm y<sup>-1</sup>, which was lower than that (1.6 μatm y<sup>-1</sup>) in air. The year-to-year variations of pCO<sub>2</sub><sup>sea</sup> in low latitudes south of 8°N were associated with the oceanic conditions, such as the El Niño. The year-to-year variations of pCO<sub>2</sub><sup>sea</sup> in the latitude of 20-30°N were inversely related to those of temperature in surface waters, suggesting their linkage with those of the concentrations of dissolved inorganic carbon arisen from the interannually different surface mixed-layer depth in these latitude.

9AM2000 S4-173 oral  
**DISTRIBUTION AND ABUNDANCE OF JUVENILE SMALL PELAGIC FISHES AND SQUIDS IN THE NORTHWESTERN PACIFIC FROM A MIDWATER TRAWL SURVEY, 1996-2000**  
Hiroshi Nishida, Chikako Watanabe, Akihiko Yatsu, Ken Mori and Kiyoshi Kawasaki  
National Research Institute of Fisheries Science, Fukuura 2-12-4, Yokohama, Japan. 236-8648 e-mail: hnishi@nrifs.affrc.go.jp

Small pelagic fishes such as sardine (*Sardinops melanostictus*), anchovy (*Engraulis japonicus*), mackerels (*Scomber japonicus*, *S. australacicus*), and squid (*Todarodes pacificus*) are important fishery stocks in the Northwestern Pacific. While stock abundance of these species is probably affected by decadal regime shift in climates, estimation of year-to-year changes in recruitment levels is essential for stock assessment of these species in Japan, because of their short life span. Recent studies have shown that the recruitment levels of sardine population is determined by the mortality events in the Kuroshio-Oyashio transitional region (TR) and Kuroshio Extension (KE). On the basis of the similarities of spawning areas and seasons for these small pelagics and squid, a midwater trawl survey has been carried out in spring in order to estimate juvenile abundance of these species since 1996. Abundance of sardine, anchovy and mackerels was generally high in the warm waters in TR, and was positively correlated to krill density in KE. Distribution indices of these commercial species from the survey coincided with the results of VPA: sardine recruitment is declining since 1996, anchovy recruitment is at high level during 1996-2000, and strong year classes of mackerels were observed in 1996 and 2000. Factors affecting distribution and abundance will be discussed.

9AM2000 W5-350 oral  
**THE SIZE-FRACTION OF SUPPLIED Fe AND CHANGE IN THE CONCENTRATION OF Fe IN DIFFERENT SIZE FRACTION IN ONBOARD BOTTLE INCUBATION EXPERIMENTS**

Jun Nishioka<sup>1</sup>, Shigenobu Takeda<sup>1</sup>, C.S. Wong<sup>2</sup>, W. Keith Johnson<sup>2</sup> and Frank A. Whitney<sup>2</sup>

<sup>1</sup> Biology Department, Central Research Institute of Electric Power Industry, 1646 Abiko, Abiko-city, Chiba 270-1194, Japan  
e-mail: nishioka@criepi.denken.or.jp

<sup>2</sup> Institute of Ocean Sciences, P.O. Box 6000, Sidney, BC, Canada. V8L 4B2

To investigate size-fraction of supplied Fe in seawater and change the concentration in different size-fraction of Fe during phytoplankton growth in open ocean, onboard bottle incubation experiments were performed at Ocean Station PAPA (OSP) in September 1997 and 1998. Two Fe source were used for these experiments. Surface water sample enriched with FeCl<sub>3</sub> solution and enriched with deep water collected at 600 m depth were placed in 1-liter polycarbonate (PC) incubation bottles. These bottles were incubated with control treatment in onboard incubation bath for 5 or 6 days. In contrast to control treatment Chl. *a* concentration did not change significantly during incubation, Chl *a* concentration in Fe addition and deep water addition treatment increased significantly. These results suggest that ambient phytoplankton were under Fe-limited in OSP surface and phytoplankton was released from Fe-limitation by addition of Fe in deep water as same as FeCl<sub>3</sub> solution addition. These results also suggested that biologically available Fe were included in deep water. At the initial of each incubation experiments, the Fe concentration in small colloidal fraction (200 kDa-0.2 μm) increased significantly and comprised 86% of the total acid-labile Fe (unfiltered, detectable at pH3.2) just after FeCl<sub>3</sub> addition. In this treatments, regard the change in concentration of Fe size-fraction, small colloidal Fe decreased significantly during incubation period. Meanwhile, in deep water addition treatment, soluble species (< 200 kDa) increased just after deep water addition and comprised 53% of total acid-labile Fe, and decreased the most significantly during incubation period. These results demonstrate that size-fraction of supplied Fe in seawater and its net change during phytoplankton growth was different between different Fe sources.

9AM2000 S3-174 poster  
**INTERANNUAL VARIABILITIES IN ABUNDANCE OF *Sagitta elegans*, *S. scrippsae*, AND *Eukrohnia hamata* (CHAETOGNATHA) IN THE CENTRAL NORTH PACIFIC**

Koh Nishiuchi<sup>1</sup> and Tsutomu Ikeda<sup>2</sup>

<sup>1</sup> Fisheries Oceanography, Seikai National Fisheries Institute, Kokubu-machi 3-30, Nagasaki, Japan. 850-0951 e-mail: nishikou@srf.affrc.go.jp

<sup>2</sup> Biological Oceanography Laboratory, Faculty of Fisheries, Hokkaido University, 1-1 Minato-cho, 3-chome, Hakodate, Hokkaido, Japan. 041-5541 e-mail: tom@pop.fish.hokudai.ac.jp

Interannual variabilities in the abundance of three dominant chaetognaths (*Sagitta elegans*, *S. scrippsae*, and *Eukrohnia hamata*) in the central North Pacific (37°-51°N latitude along 180° longitude) were analyzed on samples collected with Norpac nets (0-150 m vertical tow) during summers of 1979-1998 (19 years). The entire sampling stations transect five oceanic subareas; Subtropical Current System (ST), Southern Transition Domain (TS), Northern Transition Domain (TN), Subarctic Current System (SA), and Alaska Current System (AS) from south to north. Ten out of fifteen species-subarea combinations (3 species x 5 subareas) showed a significant interannual variability in their time series abundance data (ANOVA,  $p < 0.05$ ). Among them, decadal time scale variations were apparent for *E. hamata* in the SA (Runs-test,  $p < 0.05$ ), and biennial time-scale (high in even-years and low in odd-years) was seen for *S. elegans* in the SA and AS. *S. scrippsae*, which occurred scarcely in the SA and AS, showed a long-term declining pattern in the ST (kendall's rank correlation,  $p < 0.05$ ). Correlation analysis between the abundance of the chaetognaths

and some environment variables revealed that the water temperature had significantly negative effects to the abundance of the three chaetognaths in southern subareas, especially in the ST. On the other hand, the effect of water temperature was not significant in the northern subareas. The abundance of *S. elegance* was negatively correlated with Pink Salmon CPUE in the SA ( $r=0.624$ ,  $p<0.05$ ). From the results of these and others, we conclude that the major attributes to the interannual abundance variabilities of the chaetognaths are physical and biological interactions in the southern and northern subareas, respectively.

9AM2000 FISp175 poster

**NORTH WESTERN PACIFIC SPAWNING AND FEEDING AREAS OF THREADFIN HAKELING, *Laemonema longipes***  
Takahiro Nobetsu<sup>1</sup>, Yasunori Sakurai<sup>1</sup>, Daiji Kitagawa<sup>2</sup>, Tsutomu Hattori<sup>2</sup>, Tomonori Hamatsu<sup>3</sup>

<sup>1</sup> Graduate school of Fisheries Science, Hokkaido University, 3-1-1 Minatocho, Hakodate, Hokkaido, Japan. 041-8611 e-mail: nobe@fish.hokudai.ac.jp

<sup>2</sup> Hachinohe Branch, Tohoku National Fisheries Research Institute, 25-259 Shimomekurakubo, Samecho, Hachinohe, Aomori, Japan. 031-0841

<sup>3</sup> Hokkaido National Fisheries Research Institute, 116 Katsurakoi, Kushiro, Hokkaido, Japan. 085-0802

Threadfin hakeling are widely distributed in the benthopelagic water of the continental slope from central Japan to the Bering Sea. Although commercially caught by bottom trawlers off of northern Japan, their seasonal migration route is not well known. This study examined spawning and feeding areas of threadfin hakeling based on changes in distribution and maturity.

Samples and data were obtained from bottom trawl surveys conducted by the Tohoku and Hokkaido National Fisheries Research Institutes, over the continental slope from depths of 120 m to 900 m. Gonad maturity was examined histologically and established using gonadosomatic index (GSI). Based on GSI and body length (BL) adult fish were determined to be over 35 cm.

From July to September adult fish were distributed off of eastern Hokkaido, while immature fish (<34 cm BL) were found off of Tohoku and in the Okhotsk Sea. From January until April maturing and ripe fish were found off of Tohoku and in the Okhotsk Sea, but not off of eastern Hokkaido. These results suggest that adult feeding grounds lie off of eastern Hokkaido and those of immature fish lie off of Tohoku and in the Okhotsk Sea. Although most fish migrated from eastern Hokkaido to the Tohoku region to spawn in spring, some may have used the Okhotsk Sea as an alternative spawning site.

9AM2000 W7-375 oral

**BIOGEOCHEMICAL STUDY AT OCEAN TIME SERIES STATION KNOT (44°N, 155°E) - RESULTS OF 1998-2000 SURVEY**

Yukihiro Nojiri<sup>1</sup>, Keiri Imai<sup>2</sup>, Nobuo Tsurushima<sup>3</sup>, Toshiro Saino<sup>4</sup> and Shuichi Watanabe<sup>5</sup>

<sup>1</sup> National Institute for Environmental Studies/CREST-JST, National Institute for Environmental Studies, Tsukuba, Ibaraki 305-0053, Japan e-mail: nojiri@nies.go.jp

<sup>2</sup> Japan Science and Technology Corporation

<sup>3</sup> National Institute for Resources and Environment

<sup>4</sup> Institute of Atmosphere and Hydrosphere Research, Nagoya University

<sup>5</sup> Graduate School of Environmental and Earth Sciences, Hokkaido University

Station KNOT (Kyodo North Pacific Ocean Time series, Kyodo is cooperative in Japanese) has been started its intensive phase of study from June 1998 and will be finished in October 2000. Systematic observation was done in 8 visits in 1998 (June-December), 9 visits in 1999 (May-October) by various research vessels. Seven visits in 2000 including winter cruise (January-July) have been done and two more visits are planned in October, 2000. Quality control for the core measurements, which include salinity, oxygen, nutrients, inorganic carbon species, chlorophyll and primary production, has been done intensively. The station locates at just north of sub-arctic front and is usually occupied by surface water of Oyashio origin having lower salinity than 33 pss. The seasonal amplitudes of nutrients (NO<sub>3</sub>, PO<sub>4</sub> and Si) and dissolved inorganic carbon were larger than the other ocean time series stations (sta. P, HOT and BATS). This indicates the larger biological production at the station. The 1999 time series started from middle May survey, which encountered intensive phytoplankton blooming near the station. High spatial variability in chlorophyll concentration and primary production was observed around station KNOT, however, the next May cruise did not meet this kind of phytoplankton blooming. The database of the time series observation is now being prepared for the synthesis of biogeochemical processes.

9AM2000 S7-176 oral  
**RELATIONSHIP BETWEEN THE JAPANESE SARDINE POPULATION AND SEA SURFACE TEMPERATURE IN THE KUROSHIO EXTENSION**  
 Masayuki Noto and Ichiro Yasuda  
 Tokyo University of Fisheries, 4-5-7 Konan, Minato-ku, Tokyo, Japan. 108-8477 e-mail: notoma@tokyo-u-fish.ac.jp

The population size of the Japanese sardine is known to vary drastically on interdecadal time scales. In the 20th century, there were two peaks in the 1930s and 1980s. To identify key areas, seasons and critical life stages in the recent population decline, the relationships between sea surface temperatures (SSTs) and stage-specific natural mortality coefficient from 1979 to 1994 were analyzed. Significant positive correlations were found between the natural mortality coefficient during the period from the post-larval stage to age-1 and the January-April SST in the Kuroshio Extension and its southern recirculation area (KESA: 30-35N, 145-180E). The population decline after 1988 possibly occurred as a result of the abrupt increase in SST since 1988 in the KESA region. Larval transport model experiments using ocean current and observed spawning data revealed that more than half of the released egg were transported to the KESA, indicating that the environment represented by the SST in the migration route affects on the sardine survival. An empirical biomass model using the SST-mortality relation and SST were successfully reproduced the sardine biomass fluctuation in 1957-1994. Winter SSTs in the KESA in 1854-1997 were reanalyzed using newly digitized Kobe-Collection because available SST data had been sparse before World War 2. The corrected SST shows that the abrupt increase in SST occurred in 1942 and 1988. The empirical biomass model with the corrected SST mostly reproduced the whole sardine catch variations in the 20th century.

9AM2000 S1-177 poster  
**DISTRIBUTION AND BIOLOGICAL CHARACTERS OF NEON FLYING SQUID, *Ommastrephes batramii*, IN RELATION TO WATER STRUCTURE OF THE SOUTH KURIL ISLANDS REGION**  
 Yury V. Novikov<sup>1</sup>, Eugene V. Slobodskoy<sup>1</sup> and Yoshikazu Nakamura<sup>2</sup>  
<sup>1</sup> Pacific Fisheries Research Centre (TINRO-Centre, 4 Shevchenko Alley, Vladivostok, Russia. 690600 e-mail: root@tinro.marine.su yunov@sti.ru  
<sup>2</sup> Hokkaido National Fisheries Research Institute, 116 Katsurakoi, Kushiro, Japan. 085 e-mail: yoshinak@hnf.affrc.go.jp

Neon flying squid distribution was investigated in dependence on thermic water structure on the base of the data of scientific catches of the squid and the oceanographic data obtained by Japanese R/V's *Tankai-Maru* and *Hokko-Maru* in the region 40.5-44.5 N, 145-152 E in late August - early September of 1994-1998.

Three main surface water masses were defined in the area, which were divided by 3 types of fronts. The Subtropic transformed water (STT) was observed usually in the southern and southwestern parts of the region southward from North Subarctic Front (NSAF). There was zone of Subarctic water (SA) in central part of the region between NSAF and Oyashio Front. The Oyashio water was observed in the northern and northeastern part of the region. In some cases, when the zone of SA water was very narrow, the combined Front of Oyashio + NSAF was observed in the western part of the region. It divided the STT and the Oyashio water.

Neon flying squid was met both in the warm STT and in a bit colder SA water (Table).

**Table: Occurrence of size groups of *Ommastrephes batramii* in different water masses; S - small-size group, L - large-size group, LL - extra large-size group.**

Water masses	Female, %			Male, %	
	S	L	LL	S	L
SA	31	64	5	29	71
STT	40	58	2	67	33

In the cold Oyashio water it was met very seldom. The greatest concentrations of the squid of both sexes were observed in the STT water and maximal catches were noted near NSAF. The squids of small-size (S) and large-size (L) groups have been observed in the STT water. In the SA water the squid concentrations were less dense than in STT waters, where the squid of L- and LL-groups prevailed. All caught individuals of LL-group were immature females.

9AM2000 S4-178 invited  
**CAN WE DISTINGUISH BETWEEN CLIMATIC EFFECTS ON EGG VERSUS FOOD LIMITED RECRUITMENT?**  
 Ron O'Dor  
 Biology Department, Dalhousie University, Halifax, NS, Canada. B3H 4J1 e-mail: odor@is.dal.ca

Environmental factors dramatically influence squid abundance, but the signal can be difficult to interpret because low recruitment can result from either low spawning success by parents or poor survival by offspring. To predict biology from climate we must understand when and where climatic influence is exerted. Fortunately, squid keep their own records in statoliths, which record age independent of growth, and pens (gladii), which record recent length growth directly. Studies on *Illex illecebrosus* show that

schools of squid exhibit coherent growth patterns and population dynamics within schools can be inferred from size-frequency relationships. Age data combined with elemental and isotope ratios in statoliths can link populations to specific spawning events. Thus, even limited samples of squid can reveal a great deal about the history of the population and the state of ecosystem, if analyzed carefully. Detailed studies of species such as *Ommastrephes bartramii* that interact with multiple current systems and have multiple annual cohorts across the Pacific have the potential to provide an index of biological condition with resolution approaching that satellites give us of climate. This powerful paradigm could likely be developed from a 'hind-casting' perspective as the gladii are well preserved in fixed or frozen material. Such life-history reconstruction can clarify the origins of climatic effects.

9AM2000 CCCCp343 oral  
**SUMMARY OF THE ICES WORKING GROUP ON NORTH ATLANTIC SALMON**

Niall Ó Maoiléidigh

Marine Institute of Ireland, Snugborough Road Abbotstown, Dublin 15, Dublin, Ireland, 00353 e-mail: niall.omaoleidigh@marine.ie

The ICES Working Group on North Atlantic Salmon reported to ICES and NASCO in 2000. This paper summarizes results of the WG report.

Run-reconstruction estimates of pre-fishery abundance of non-maturing 1SW salmon from southern areas of the North-East Atlantic have been volatile for the period 1971 to 1998. Three distinct periods are noted leading to an overall decline in the past 14 years. In 1996-98, it was estimated that even in the absence of all fisheries, the numbers of non-maturing recruits for the southern area were below the proposed spawning escapement reserve (SER). Non-maturing 1SW salmon from the northern stocks of the North-East Atlantic have declined since 1985, particularly in 1986-1987. Analysis of attainment of conservation limits (CL) in monitored rivers indicated variable status of salmon stocks in different rivers in the NEAC area. Some rivers have never or seldom achieved their CL over the past 10 years, while others have been consistently below their CL. Many rivers that have reached their CL in most years show a decreasing trend in escapement. It was also noted that there was no tendency to recover for those rivers with low escapement values.

For stocks originating in North America, the run-reconstruction estimate of pre-fishery abundance of non-maturing 1SW salmon for 1998 was 20% higher than in 1997, with these estimates being the lowest on record. In addition to the steady decline in non-maturing and maturing salmon over the last 10 years, maturing 1SW salmon (grilse) have become an increasingly large percentage of the North American stock complex. Returns to the important Gulf, Quebec and Scotia-Fundy production areas were either the lowest or second lowest of the 29 year time series for 1971 to 1999. The estimated returns and spawners to USA rivers in 1999 were 23% below the 1998 estimate and 32% and 52% below the 5 year and 10 year means respectively. Egg depositions were exceeded or equaled in only 37 of the 67 assessed rivers in Canada and were less than 50% of requirements in 15 other rivers. North American stocks remain low relative to the 1970s. The 1SW non-maturing component continues to be low with river returns and total production being the lowest recorded. In addition, returns in 1999 of maturing 1SW salmon (grilse) to North American rivers were very low. It is unlikely therefore that any improvement in 2SW salmon returns will occur in 2000.

The implications of these results are discussed in relation to quota setting and national management strategies in all Atlantic salmon producing countries.

9AM2000 W5-351 oral  
**IRON AND MANGANESE DISTRIBUTION IN THE SURFACE WATERS OF THE NORTH PACIFIC OCEAN AND THE BERING SEA**

Hajime Obata<sup>1</sup>, Eiichiro Nakayama<sup>2</sup>, Masahiro Maruo<sup>2</sup>, Michiaki Takano<sup>2</sup> and Yoshiyuki Nozaki<sup>3</sup>

<sup>1</sup> Oceanography Laboratories, University of Liverpool, Liverpool L69 7ZL, UK e-mail: obata@liverpool.ac.uk

<sup>2</sup> School of Environmental Science, The University of Shiga Prefecture, Hassaka, Hikone, Shiga 522-8533, Japan

<sup>3</sup> Ocean Research Institute, University of Tokyo, Nakano-ku, Tokyo 164-8639, Japan

The distributions of iron and manganese in the surface layers were investigated in the North Pacific Ocean and the Bering Sea. Samples were collected during the research cruise of *Hakuho-maru* (University of Tokyo), KH-99-3 (from 25 June to 22 June, 1999). Iron and manganese concentrations were determined with the automated chemiluminescence methods (Nakayama *et al.*, 1989, Obata *et al.*, 1993 and Obata *et al.*, 1997). Iron was depleted in 0-50 m all through the sampling stations, but the iron concentrations below 50 m showed contrasting distributions between the western and the eastern in the North Pacific Ocean, and the Bering Sea. To discuss the difference of the iron source between the stations, iron distributions were compared with those of manganese. As the residence time of manganese in surface layer is relatively long (5-19 yr, Landing and Bruland, 1989), manganese is suitable for a tracer of the supply of lithogenic substance. The relationship between nitrate and silicate in the surface layers also showed various patterns in each oceanic regime. Iron limitation is reported to affect the uptake ratio of silicate to nitrate by diatom (Takeda, 1998), and the supply of iron may influence the relationship between nitrate and silicate in surface layer.

9AM2000 S6-337 poster  
**MONITORING OF METHANE IN EASTERN SAKHALIN SHELF AND SLOPE OF THE OKHOTSK SEA**

Anatoly Obzhirov<sup>1</sup>, Anatoly Salyuk<sup>1</sup> and E. Suess<sup>2</sup>

<sup>1</sup> Pacific Oceanological Institute, 43 Baltiyskaya Street, Vladivostok, Russia. 690041 e-mail: pacific@online.marine.su

<sup>2</sup> GEOMAR, Kiel, Germany

Measurement of methane was begun in the Sea of Okhotsk on 1984. There were taken water column samples by Niskin's bottles. Methane was extracted from the samples via vacuum line and analyzed in the gas chromatograph on the board of ship. During last 3 years (1998-2000) methane was measured together with colleagues of GEOMAR (Germany) in different seasons (winter, spring, summer, autumn) in frame of KOMEX project.

As the result there were found the following:

1. Sharp increasing of methane concentration in 1988. This is connect with increasing siesmo-tectonic activity of faults in the Eastern Sakhalin shelf and slope of the Okhotsk Sea. Peak of activity was in 1995, when there was an earthquake in Neftegorsk of the Sakhalin.
2. Sources of methane are oil-gas deposits and destabilized gas hydrates.
3. Bubbles of methane migrates from sediment to water and forms sound- scattering body like flare. They come from bottom water up to about 300-500 m and some time distribute to surface water and with intermediate water layers to semi horizontal direction.
4. Methane concentration inside flare is more than 20000 nl/l and near flare ~ 1000-3000 nl/l.
5. Methane monitoring showed that the surface water on shallow areas are oversaturated with methane (more than 1000 nl/l) in Autumn and Spring seasons. In these seasons methane is more intensively emanate from surface water to atmosphere.
6. Anomaly of methane increases CO<sub>2</sub> as result of microbiological oxidation and shifts atmosphere methane balance to create greenhouse effect and global climate change.

9AM2000 S2-179 oral  
**FOOD AND FEEDING HABITS OF MARINE BIRDS IN THE WESTERN REGION OF THE NORTHERN NORTH PACIFIC**

Haruo Ogi

*Division of Marine Environment and Resources, Graduate School of Fisheries Science, Hokkaido University, 3-1-1 Minato-cho, Hakodate, Hokkaido, Japan. 041-8611*

The life histories of pelagic seabirds in the North Pacific consist of migration, reproduction, and food and feeding habits. Of these, the food and feeding habits of seabirds in the pelagic life phase have been remained mostly unknown. Recently, based on increasing environmental information from satellites, and biochemical and acoustic oceanographic methods, the seasonal distribution patterns of pelagic seabirds have become more easily studied than before.

Based on my past seabird studies, the main food items of seabird groups indigenous to the subarctic North Pacific can be divided as follows:

- |                             |   |
|-----------------------------|---|
| Small alcids                | - Invertebrate feeder (euphausiids, copepoda) |
| Large alcids                | - Invertebrate feeder                         |
|                             | - Fish feeder                                 |
|                             | - Squid feeder                                |
| Gulls                       | - Fish and invertebrate feeder                |
| Albatrosses                 | - Fish, fish egg, squid feeder                |
| Seasonal migrants in summer |   |
| Shearwaters and petrels     |   |
|                             | - Zooplankton feeder                          |
|                             | - Fish and jellyfish feeder                   |

In coastal areas of northern Japan in winter, the occurrence of the small alcids (Least and Crested Auklets) is quite sensitive to oceanographic front formation and zooplankton swarming on the sea surface. However, there is great interannual variation in the abundance of these alcids in these areas. The large alcids are skillful divers, and each species seems to have a preference for specific food organisms.

All seabird species indigenous to the subarctic North Pacific have to breed on land, and foraging sea areas do not extend far offshore. Therefore, pelagic areas are vacated. Shearwaters and petrels from the Southern Hemisphere use these sea areas for their temporary habitat in summer. Short-tailed Shearwaters migrate from Australia to the subarctic North Pacific following a route along which euphausiids are abundant. In contrast, sooty shearwaters migrate from the Southern Hemisphere following pelagic fish schools such as those of Pacific sauries and Japanese sardines which migrate from subtropical areas beyond the Subarctic Boundary to the middle part of the subarctic area.



In the western northern North Pacific, there are typical and unique currents and water masses, such as the Okhotsk Water, Oyashio Current, Western Subarctic Gyre, Subarctic Water, and Transition Area. Each of these has a unique biological production system and food chain from lower to higher trophic levels. Pelagic seabirds have the ability to use the seasonal biological events of these different water masses.

9AM2000 W7-376 oral  
**INVENTORY FOR JAPANESE CHEMICAL OCEANOGRAPHIC DATA (IJCD)**

Sachiko Oguma<sup>1</sup>, K. Goto<sup>2</sup>, M. Ishii<sup>3</sup>, T. Miyake<sup>4</sup>, A. Murata<sup>5</sup>, Y. Nojiri<sup>6</sup>, T. Ono<sup>7</sup>, T. Saino<sup>8</sup>, F. Shimano<sup>6</sup>, T. Suzuki<sup>1</sup>, Y. Tsurushima<sup>9</sup>, S. Watanabe<sup>10</sup> and Y.W. Watanabe<sup>9</sup>

<sup>1</sup> Marine Information Research Center, Japan Hydrographic Association, Mishima Bldg. 5F, 7-15-4, Ginza, Chuo-ku, Tokyo 104-0061, Japan e-mail: suzuki@mirc.jha.or.jp

<sup>2</sup> Kansai Environmental Engineering Center Co., Ltd.

<sup>3</sup> Meteorological Research Institute

<sup>4</sup> Japan Oceanographic Data Center

<sup>5</sup> Japan Marine Science and Technology Center

<sup>6</sup> National Institute for Environmental Studies

<sup>7</sup> Frontier Observational Research System for Global Change

<sup>8</sup> Nagoya University

<sup>9</sup> National Institute for Resources and Environment

<sup>10</sup> Hokkaido University

We have started to provide the inventory for our Japanese chemical oceanographic data. For the first step, CO<sub>2</sub> related data, TCO<sub>2</sub>, f(p)CO<sub>2</sub>, pH, TALK, nutrients, dissolved oxygen, and chemical tracers are focused to make the base of inventory. We have collected the observation cruises including those items, which were done by Japanese research vessels mainly in 1990s. Not only the cruises of projects, for example, KNOT (Kyodo Northwestern Pacific Ocean Time series), NOPACCS (North Pacific Carbon Cycle Study), some of the WOCE (World Ocean Cycle Experiment) cruises and so on, but also cruises done by government and university vessels were collected: Hakuho-maru (University of Tokyo); Hokusei-maru and Oshoro-maru (Hokkaido University); Mirai (Japan Marine Science and Technology Center). As the inventory data, dates, ship name, chief scientist, participate institute, project, data items, PIs, and data status are listed for each cruise. In the future, the inventory data will link directly with real observation data. The inventory of data in former decades will also be collected and published. At the meeting, we will introduce the IJCD web site which will be able to be used as a reference system of Japanese data.

9AM2000 MEQp180 oral  
**BIOMONITORING STUDY WITH PHYSIOLOGICAL BIOMARKERS USING FLUORESCENT MOLECULAR PROBES IN OYSTER, *Crassostrea gigas*. TRANSPLANTING EXPERIMENTS**

Jae Ryoung Oh<sup>1</sup>, Dmitry L. Aminin<sup>2</sup>, Irina G. Agafonova<sup>2</sup>, Seung-Kyu Kim<sup>1</sup>, Yeong Beom Shin<sup>1</sup> and Soo Hyung Lee<sup>1</sup>

<sup>1</sup> Korea Ocean Research and Development Institute (KORDI), Ansan P.O. Box 29, Seoul, Republic of Korea. 425-600 e-mail: jroh@sari.kordi.re.kr

<sup>2</sup> Pacific Institute of Biorganic Chemistry, Far East Division of RAS, Vladivostok, Russia. 690022

Two different approaches have been applied with a bivalve species in Korea coastal water for chemical pollutant monitoring experiments: a) Passive bio-monitoring, in which oysters, *Crassostrea gigas* were collected from two places which showed pollution gradients; The intracellular biomarker activities were studied and compared between each other; b) Active bio-monitoring, in which samples of commercially cultivated oysters were transplanted for biomonitoring from relatively clean site, Koje Island, to polluted site, Masan Bay; The changes of biomarker activities in the transplanted oysters have been monitored during 60 days.

Two sites of Korea south coast were selected for experiment: Koje Island and Masan Bay. It was shown that physiological status of animals collected in these places is quite different, and most of biomarkers investigated indicate that Masan area is more polluted compare to Koje Island.

Oyster transplanting experiment from Koje to Masan showed that the activity of all studied oyster intracellular biomarkers, namely lysosomal activity, esterase activity, double-stranded DNA content, biomembrane microviscosity and Ca<sup>2+</sup> concentration, has rapidly changed following oyster transplantation from clean place to polluted area. In most changes, the critical day was the 7th day after transplantation. At this day or immediately after, those activities were depressed maximally, or started to decrease sharply. At least, two parameters have shown evident but not completed remedy from environmental stress: intracellular double-stranded DNA content recovery on the 14th day, and intracellular Ca<sup>2+</sup> homeostasis recovery after the same period. These reflect their adaptations to the new environmental conditions.

Both approaches showed the high potential of those techniques for marine pollutant biomonitoring. These also indicates that oysters appear to be highly complied with requirement for an useful biomonitoring organism. From the other hand, intracellular

biomarkers studied with fluorescent molecular probes are very sensitive to the environmental pollution and could be applied to the monitoring of sea water contamination and provide information as an early warning signal to detect dangerous changes in environment.

9AM2000 W6-181 oral  
**APPROACHES TO DIETARY STUDY OF CETACEANS AND PROBLEMS IN THE ANALYSES OF STOMACH CONTENTS**

Hiroshi Ohizumi  
*National Research Institute of Far Seas Fisheries, 5-7-1 Orido, Shimizu, Shizuoka, Japan. 424-8633 e-mail: ohizumi@enyo.affrc.go.jp*

There are some ways to study feeding habits of cetaceans. Among several methods, stomach contents analysis is the most classic, but probably most informative way to know the food and feeding habits of cetaceans. Stomach contents analysis give us data about prey species, number of prey, prey size and the quantity of food ingested. Prey species composition enable us to infer foraging depth. Sometimes, stomach contents analysis is useful even for the ecology of the prey species. However, there are some shortcomings in the study by mean of analyzing stomach contents. The method of stomach contents analysis can be classified to steps such as sampling of stomachs, examination of the contents and evaluation of the results. There are some problems specific to each step. At the sampling, securing contents is the most important task, but sometimes vomiting and leak from the hole on the stomach cause loss of the samples. In examination of the contents, lack of information is the problem for identification of the prey species and estimation of the prey size. Even we could obtain some data about prey, absence of the information on the digestion time and accumulation of the digested remnants in the stomach interfere quantitative analysis of the ingested foods. In this presentation, the method of stomach contents analysis will be reviewed, and discuss how to deal with the problems.

9AM2000 POCp182 oral  
**NEAR-SURFACE CIRCULATION AND TIDAL CURRENTS OF THE OKHOTSK SEA OBSERVED WITH THE SATELLITE-TRACKED DRIFTERS**

Kay I. Ohshima<sup>1</sup>, Masaaki Wakatsuchi<sup>1</sup>, Yasushi Fukamachi<sup>1</sup> and Genta Mizuta<sup>2</sup>

<sup>1</sup> *Institute of Low Temperature Science, Kita-19, Nishi-8, Kita-ku, Sapporo, Hokkaido, Japan. 060-0819 e-mail: ohshima@lowtem.hokudai.ac.jp*

<sup>2</sup> *Graduate School of Environmental Earth Science, Hokkaido University, Kita 10 Nishi 5, Sapporo, Hokkaido, Japan. 060-0810 e-mail: mizuta@ees.hokudai.ac.jp*

Near-surface circulation of the Okhotsk Sea was observed with ARGOS drifters from August 1999 to February 2000. The drifters clearly revealed the existence of the southward boundary current off the east Sakhalin. This current is strongly bottom controlled and confined to the region shallower than 1000 m. The current consists of two cores: one exists near the coast (50-200 m depths) with typical speed of 0.3-0.4 m/s and the other around the shelf break (300-600 m depths) with typical speed of 0.2-0.3 m/s. Diurnal shelf waves are identified over the shelf of the northern part of east Sakhalin. Large amplification of diurnal tidal currents (order of 1.0 m/s) is observed at Kashevarov Bank along with the residual anticyclonic circulation over the bank. In the Kuril Basin the anticyclonic gyre is identified, although mesoscale eddy features are dominant in the basin. Just northwest of Bussol' Strait a quasi-steady anticyclonic eddy (diameter of about 100 km) is observed. Most of the drifters go out to the Pacific through Bussol' Strait within several months, suggesting that Bussol' Strait is the key strait for the water exchange between the Okhotsk Sea and the Pacific. Both diurnal and semidiurnal tidal currents are found to be enhanced around Bussol' Strait.

9AM2000 W6-183 oral  
**CONSIDERATION FOR MODELING TO INCORPORATE PREY CONSUMPTION BY MARINE BIRDS AND MAMMALS**

Hiroshi Okamura  
*National Research Institute of Far Seas Fisheries, 5-7-1, Orido, Shimizu, Shizuoka, Japan. 424-8633 e-mail: okamura@enyo.affrc.go.jp*

Some existing ecosystem models incorporating prey consumption by top predators are introduced. Availability and problems that will occur when their ecosystem models are applied into the western North Pacific are discussed.

9AM2000 S5-302 oral

**POSSIBLE CHANGES IN THE SUBSURFACE OCEAN STRUCTURE AND MIXED LAYER NUTRIENT LEVELS IN THE WESTERN SUBARCTIC PACIFIC DURING THE LAST DECADE**

Tsuneo Ono<sup>1</sup>, K. Tadokoro<sup>1</sup>, T. Midorikawa<sup>2</sup> and T. Saino<sup>1,3</sup>

<sup>1</sup> *Ecosystem Change Research Program, Frontier Research System for Global Change, Sumitomo Hamamatsu-cho bldg. 4F, 1-18-16 Hamamatsuyto, Minato-ku, Japan. 105-0013 e-mail: onot@frontier.esto.or.jp*

<sup>2</sup> *Hakodate Marine Observatory, 3-4-4 Mihara, Hakodate, Japan. 041-0806*

<sup>3</sup> *Institute for Hydrospheric-Atmospheric Sciences, Nagoya University, Nagoya, Japan. 464-8601*

Temporal change in the subsurface ocean structure in the western subarctic Pacific was investigated by using the historical hydrocast data of water temperature, salinity, dissolved oxygen, and nutrients observed by the several Japanese institutes during the period from 1968 to 1995. In the Oyashio area, the isopycnals of sigma theta =26.6 - 27.4 in winter seemed to have shoaled by over 100 m during the period from 1988 to 1995. Correspondently, the phosphate concentration on each isopycnal showed a significant increase after the year 1988. Such temporal increases of nutrients and AOU on the isopycnals of sigma theta =26.6 - 27.0 were also found in broader area of subarctic Pacific west of 170W when we compare the data of the WHP-P1 (observed in 1985) with those of the WHP-P1r (observed in 1999) Cruise. These temporal changes both in isopycnal depth and nutrient concentrations in each density surface imply that the upper ocean structure in the western subarctic Pacific has significantly changed after the year 1988. The influence of these changes in the subsurface layer to the nutrient level and primary productivity on the mixed layer will also be discussed.

9AM2000 W7-377 poster

**DISTRIBUTION OF DIC AND RELATED PROPERTIES IN THE NORTH PACIFIC ALONG 47°N MEASURED IN THE LATE 1990S**

Tsuneo Ono<sup>1</sup>, Y. Nakano<sup>2</sup>, M. Wakita<sup>2</sup>, T. Watai<sup>3</sup>, T. Fujimoto<sup>2</sup>, Y. Suzuki<sup>4</sup>, and Y.W. Watanabe<sup>5</sup>

<sup>1</sup> *Ecosystem Change Research Program, Frontier Research System for Global Change, Sumitomo Hamamatsu-cho bldg. 4F, 1-18-16 Hamamatsu-cho, Minato-ku, 105-0013 Japan e-mail: onot@frontier.esto.or.jp*

<sup>2</sup> *Graduate School of Environmental Earth Science, Hokkaido Univ. Sapporo 060-0810, Japan*

<sup>3</sup> *Center for Atmospheric and Ocean Studies, Graduate School of Science, Tohoku Univ. Sendai 980-8578, Japan*

<sup>4</sup> *Graduate School of Science, Shizuoka Univ. Shizuoka 422-8529, Japan*

<sup>5</sup> *National Research Institute for Resources and Environment, Tsukuba, Ibaraki 305-8569, Japan*

High-precision measurements of DIC and related properties along 47N line, or the same line as WHP-P1 observed in 1985, were carried out in 1999 (WHP-P1r). Distributions of DIC and TA were compared to those observed in 1985. A signal of the DIC increase due to solubility pump was observed in the upper 1500m of the water column. In addition, both AOU value and CFC ages observed in 1999 were found to increase in each isopycnals of sigma-theta <27.40 when compared to the data observed in 1985. This finding suggested that the hydrographic structure of subarctic North Pacific has been changed between 1985 and 1999, and this process might have been strongly affected to the DIC inventory in the water column in addition to the simple solubility pump process.

9AM2000 S7-184 oral

**SEASONAL VARIATION OF THE GROWTH AND MORTALITY OF PACIFIC SAURY (*Cololabis saira*) LARVAE IN THE NORTHWESTERN PACIFIC**

Yoshiaki Oozeki<sup>1</sup>, Hiroshi Kubota<sup>1</sup>, Ryo Kimura<sup>1</sup>, Yutaka Kurita<sup>2</sup>, and Yoshiro Watanabe<sup>3</sup>

<sup>1</sup> *National Research Institute of Fisheries Science, 2-12-4 Fukuura, Kanazawa-ku, Yokohama, Kanagawa-ku, Japan. 236-8648 e-mail: oozeki@nrifs.affrc.go.jp*

<sup>2</sup> *Tohoku National Fisheries Research Institute, Hachinohe Branch, Japan. 031-0841*

<sup>3</sup> *Ocean Research Institute, University of Tokyo, Japan. 164-8639*

Bottom-up control process from phytoplankton and zooplankton production to the recruitment of fishes is one of the main subjects in VENFISH (Comprehensive study of the variation of the oceanic environment and fish populations in the northwestern Pacific) program in Japan. One of the target species, Pacific saury (*Cololabis saira*) is widely distributed in the northwestern Pacific and the fluctuation in stock size is affected by the degree of reproductive success.

Spawning of the saury starts in September and continues until next June, shifting location of spawning grounds between the mixed-water region and the Kuroshio waters. Larval growth and mortality were analyzed on each seasonal cohort from the data sets of body length and age at sampling from 1990 to 1997. Growth rates were highest for the winter-spawned cohorts in the Kuroshio waters, and rates for the autumn- and spring-spawned cohorts in the mixed-water region were lower and more variable among years than the winter-spawned cohorts. Daily mortality rates, calculated from age composition in each season, were highest in the autumn- and lowest in the spring-spawned cohorts.

Individual growth trajectories were back-calculated from the otolith increment widths on specimens from 1992 to 1994, in order to clarify the environmental factors affecting on their growth. Recent growth rates at capture were significantly affected by zooplankton biomass and sea surface temperature.

9AM2000 S2-185 poster

**FEEDING HABITS AND FEEDING COMPETITION AMONG LARGE PREDATORY FISHES ON THE WESTERN BERING SEA CONTINENTAL SLOPE**

Alexei M. Orlov

Russian Federal Research Institute of Fisheries and Oceanography (VNIRO), 17 V. Krasnoselskaya, Moscow, Russia. 107140 e-mail: akrovmin@mx.iki.rssi.ru

On the basis of stomach contents analysis made during a research cruise aboard the Japanese trawler Kayomaru No.28 during summer 1997 in the western Bering Sea, the diets and feeding habits of large predatory fish are considered. A total of 3,002 stomachs of 16 fish species were examined, of which 1,783 contained food. Predators were represented by Pacific sleeper shark, *Somniosus pacificus* (151 stomachs examined/127 contained food), Alaska skate, *Bathyraja parmifera* (113/86), Matsubara skate, *B. matsubarae* (19/18), whitebrow skate, *B. minispinosa* (68/58), Pacific cod, *Gadus macrocephalus* (163/154) giant grenadier, *Albatrossia pectoralis* (263/129), sablefish, *Anoplopoma fimbria* (43/24), shortraker rockfish, *Sebastes borealis* (301/107), roughey rockfish, *S. aleutianus* (58/12), shortspine thornyhead, *Sebastolobus alascanus* (54/24), spinyhead sculpin, *Dasycottus setiger* (53/51), bigmouth sculpin, *Ulca bolini* (19/7), arrowtooth flounder, *Atheresthes stomias* (408/188), Kamchatka flounder, *A. evermanni* (446/181), Greenland turbot, *Reinhardtius hippoglossoides* (590/411), and Pacific halibut, *Hippoglossus stenolepis* (262/206).

Predators could be divided into several groups according to diet composition. Squids and groundfish eaters were the most numerous group, and were represented by Pacific sleeper shark, sablefish, bigmouth sculpin, arrowtooth and Kamchatka flounders, and Greenland turbot. Groundfish, squids, and large crustaceans were the base of the diets of Alaska, Matsubara and whitebrow skates, and Pacific halibut. Pacific cod differed from the other species in that they consumed groundfish, large crustaceans, cephalopods, and also various benthic organisms. Mesopelagic fishes, squids, and crustaceans were the most important dietary components of giant grenadier and shortraker rockfish. Roughey rockfish consumed mesopelagic fish and crustaceans. Large decapod crustaceans and fish were the most important prey items of shortspine thornyhead. All predators consumed fishery discards in significant amounts.

Possible feeding competition among the above 16 species of predatory fishes was investigated on the basis of comparisons of their dietary similarity and patterns of vertical and spatial distribution.

9AM2000 S3-186 oral

**LIFE CYCLE OF THE MESOPELAGIC COPEPOD *Paraeuchaeta elongata* OFF CAPE ESAN, HOKKAIDO, JAPAN (WESTERN SUBARCTIC PACIFIC)**

Koji Ozaki\* and T. Ikeda

Marine Biodiversity Laboratory, Graduate School of Fisheries Sciences, Hokkaido University, Hakodate, Japan. 041-0821

\*Presently at: Faculty of Applied Biological Science, Hiroshima University, 4-4 Kagamiyama 1 Chome, Higashi-Hiroshima, Japan. 739-8528 e-mail: ozaki@hiroshima-u.ac.jp

The life cycle pattern of the mesopelagic copepod *Paraeuchaeta elongata* was analyzed combining field population data over a two-year period with laboratory rearing data. While all copepodites occurred from depths greater than 100 m, their vertical distribution became deeper with the progress of the development. Early copepodites predominated in summer-winter, and late copepodites were numerous in spring. From population structure data, development time from copepodite stage 2 (C2) to adults (C6) was resolved as 9 month, with repetition of generations every year. In laboratory experiments, we raised successfully C6 specimens from eggs under near in situ temperature. The laboratory experiments provided precise development times of 27 days for eggs, 37 days for nauplii and 288 days for copepodites, making the total developmental time from eggs just spawned to C6 to be 352 days. Thus, generation times of this copepod estimated from field population analysis and laboratory experiments are consistent each other. We will discuss some unique features of developmental patterns of this mesopelagic copepod by comparing with those of shallow-living copepods in the light of adaptive significance to the mesopelagic environments.

9AM2000            S3-187            oral  
**VERTICAL DISTRIBUTION AND GENERATION TIME OF *Metridia pacifica* IN THE OYASHIO REGION, WESTERN NORTH PACIFIC OCEAN**  
Gadi Padmavati and Tsutomu Ikeda  
Hokkaido University, 3-1-1 Minato-cho, Hakodate, Hokkaido, Japan. 041-0821 e-mail: padma@fish.hokudai.ac.jp & tom@pop.fish.hokudai.ac.jp

Seasonal vertical distribution of *M. pacifica* was investigated at Site H in the Oyashio region during September 1996 through October 1997. Monthly samples were collected with a closing net (100  $\mu$ m mesh size) from five discrete depth strata between the surface and  $\leq$  2000 m. Early copepodite stages (C1-C4) were distributed largely in the upper 250 m. Vertical distribution of C5 differed with season; the upper 500 m during spring - early summer, and down to 2000 m during late summer - winter. For adults, a majority of males always resided below 250 m, and females in the upper 500 m. Day-night samplings during April 1997 showed that the adult females underwent a normal diel vertical migration, with day time peak at 150-250 m and night time peak in the upper 150 m. *M. pacifica* completed two generations per year in the Oyashio region. The first generation developed rapidly, while the second generation was characterized by a resting stage at C5 during summer to midwinter with a prolonged time (ca. 4~5 months) to develop to adults.

9AM2000            S2-188            oral  
**COMMUNITY INTERACTIONS BETWEEN SEABIRDS AND COASTAL PELAGICS: STARVATION OR SATIATION?**  
Julia K. Parrish<sup>1</sup>, Elizabeth Logerwell<sup>1</sup>, K. David Hyrenbach<sup>2</sup> and William J. Sydeman<sup>3</sup>  
<sup>1</sup> School of Fisheries, University of Washington, 1122 NE Boat Street, Box 355020, Seattle, WA 98195-5020, U.S.A. e-mail: jparrish@u.washington.edu  
<sup>2</sup> Scripps Institution of Oceanography, University of California San Diego, La Jolla, CA 92093, U.S.A.  
<sup>3</sup> Point Reyes Bird Observatory, 4990 Shoreline Highway, Stinson Beach, CA 94970, U.S.A.

In the California Current System (CCS), piscivorous seabirds, including Alcids, Procellariids, Larids, and Phalacrocorcids, are both resident and wintering visitors. On the shelf, on an annual basis, these seabirds comprise more than 3,600 metric tons of predatory biomass. Yearly energy requirements are species-specific, ranging from Brandt's cormorants (75 Kcal/gm/yr) to black-legged kittiwakes (200 Kcal/gm/yr). Excluding annual reproductive output, piscivorous seabirds demand 431 billion Kcal of energy. These seabirds extract energy from the coastal environment predominantly in the form of forage fishes, including Clupeids, Engraulids, Osmerids, Ammodytids, as well as juvenile Salmonids, Scorpaenids, Pleuronectids, and Gadids. Energy content of these prey items varies by a factor of 2.5, from Pacific cod (0.94 Kcal/gm) to eulachon (2.55 Kcal/gm). Therefore, depending on which prey species are consumed, seabirds eat 220-300 thousand metric tons of fish annually. Changes in the forage fish community, including the recent recovery of the Pacific sardine stocks may have dramatic effects on seabird consumption and forage fish population dynamics. Because sardine energy content is relatively high (second only to eulachon), upper trophic level predators should specialize on this species. Current fishery landings in the sardine fishery are estimated at 120,000 metric tons. If seabird energy demand was applied solely to sardines, consumption would roughly double the fishery take, or about 15-20% of the total age 1+ biomass of 1.58mmt. However, unlike anchovies, the former predominant species, sardines grow beyond the range of seabird prey size within the first year of life. Thus, a transition to sardines could negatively impact seabirds even though this prey species is richer in energy.

9AM2000            S7-189            oral  
**MAPPING FISHERIES ONTO MARINE ECOSYSTEMS: REGIONAL, OCEANIC AND GLOBAL INTEGRATIONS**  
D. Pauly, V. Christensen, R. Froese, A. Longhurst, T. Platt, S. Sathyendranath, K. Sherman and R. Watson  
Fisheries Centre, University of British Columbia, 2204 Main Mall, Vancouver, BC, Canada. V6T 1Z4 e-mail: villy@fisheries.com

Research on ecosystem-based fisheries management, marine biodiversity conservation, and other fields requires appropriate maps of the major natural regions of the oceans, and their ecosystems. It is proposed here that a classification system proposed by T. Platt and S. Sathyendranath and implemented by A.R. Longhurst, defined largely by physical parameters, and which subdivides the oceans into four biomes and 57 biogeochemical provinces (BGCPs), could be merged with the system of 50 Large Marine Ecosystems (LMEs) identified by K. Sherman and colleagues, which would represent subunits of the provinces. This arrangement enhances each of the systems, and renders them mutually compatible. For the LMEs, subprovinces are pragmatically defined to serve as a framework for the management of coastal fisheries, and other purposes, while the BGCPs have rigorous physical definitions, including borders defined by natural features. Moreover, incorporating the 50 defined LMEs into the framework of BGCPs will allow straightforward scaling-up of LME-specific flow estimates (including fisheries catches) up to basin and ocean scales. The combined mapping will allow the computation of GIS-derived properties such as temperature, primary production, etc., and their analysis in relation to fishery catch data for any study area. A further useful aspect of the proposed scheme is that it will enable us to quantify the EEZ of various countries in term of the distribution of marine features (e.g. primary production,

coral reef areas) so far not straightforwardly associated with different coastal states. Applications to shelf, coral reef and oceanic fisheries, and to the mapping of marine biodiversity are briefly discussed.

9AM2000 S6-190 invited  
**FACTORS INFLUENCING PHYTOPLANKTON COMPOSITION AT SHELF AND DEEP OCEAN SITES IN THE NE SUBARCTIC PACIFIC**

M. Angelica Peña

*Institute of Ocean Sciences, P.O. Box 6000, Sidney, B.C., Canada. V8L 4B2 e-mail: PenaA@pac.dfo-mpo.gc.ca*

The composition and size structure of planktonic communities have a significant impact on the export of carbon from the upper ocean. A better understanding of the factors controlling plankton composition is required to predict potential future responses of the carbon cycle to climate change. To aid in the identification of important processes regulating the abundance and composition of phytoplankton in the NE subarctic Pacific, we compare observations from the two-end members of an onshore-offshore transect, one in the open ocean (Ocean Station 'Papa') and one in the coastal ocean. Biological processes are substantially different at these sites as illustrated, for example, by the lack of nutrient depletion and Fe limitation at Station P while seasonal variability in nutrient and phytoplankton concentration occurs at the inshore site. Results are discussed to address the processes regulating phytoplankton abundance and composition at the two locations and to examine the observed differences in relation to environmental factors such as light, nutrients and mixed layer depth.

9AM2000 S7-191 poster  
**MESOSCALE SPATIAL DISTRIBUTIONS AND CONDITION OF JUVENILE PACIFIC SALMON AND COMPARISONS WITH ENVIRONMENTAL CONDITIONS OFF SOUTHERN BRITISH COLUMBIA DURING THE 1990S**

R. Ian Perry, Brent Hargreaves, David L. Mackas and Richard E. Thomson

*Pacific Biological Station, 3190 Hammond Bay Road, Nanaimo, B.C., Canada. V9R 5K6 e-mail: perryi@pac.dfo-mpo.gc.ca*

Recent studies have suggested that ocean conditions off the west coast of Vancouver Island changed during the 1990s, becoming generally warmer with zooplankton compositions more similar to those of northern California. At the same time, southern British Columbia stocks of Pacific salmon generally declined through the 1990s. The extent to which these events are related is a topic of vigorous debate. Studies on salmon from Barkely Sound and elsewhere in British Columbia suggest that most variation in marine survival rates occurs during their first marine year, a time when the fish are in the coastal fjords or on the continental shelf. In this study, we identify the mesoscale (10s to 100s of km) spatial distributions of juvenile salmon off the west coast of Vancouver Island, British Columbia, in the spring and fall of 1998 (an El Niño year). These distributions are compared with prevailing physical and biological oceanographic conditions to identify possible controlling factors. In addition, we identify the spatial variations in the feeding and condition of these juvenile salmon, to determine locations along the southern B.C. coast that may be critical for feeding and therefore growth of these juvenile salmon. Finally, we compare these results for El Niño conditions in the late 1990s with previous results from a similar study during the early 1990s.

9AM2000 W2-300 oral  
**EUPHAUSIIDS AS INDICATORS OF CHANGING OCEAN CONDITIONS IN THE OREGON UPWELLING ZONE**

William T. Peterson, Leah R. Feinberg and Julie E. Keister

*National Marine Fisheries Service and Cooperative Institute for Marine, Resource Studies, Hatfield Marine Science Center, 2030 S. Marine Science, Drive, Newport, OR 97365, U.S.A. e-mail: Bill.Peterson@noaa.gov*

*Euphausia pacifica* and *Thysanoessa spinifera* are the two dominant euphausiid species in this region. Under "normal" conditions, *E. pacifica* dominates offshore waters and *T. spinifera* shelf waters. It appears now that their dominance patterns can alternate depending upon physical conditions - *T. spinifera* dominate nearshore waters only during years of strong upwelling. In the 1990s when upwelling was weak, they were present in reduced numbers (from 1992-1998). The population has since rebounded such that from 1999 until present, they once again dominate shelf waters. On the other hand, *Euphausia pacifica* was the dominant species during the mid-1990s and especially so during the 1997-1998 El Niño period. Now, this species is found only in oceanic environments. We will discuss the possible implications of these species shifts on food chain interactions and trophodynamics of resident fish communities based on our own data as well on a review of the literature.

9AM2000 S7-301 oral  
**ECOSYSTEM CHANGE IN THE NORTHERN CALIFORNIA CURRENT -- RECENT SHIFTS IN COPEPOD, EUPHAUSIID AND PELAGIC FISH ABUNDANCE AND SPECIES COMPOSITION**

William T. Peterson, Julie E. Keister, Leah R. Feinberg and Robert Emmett  
*National Marine Fisheries Service and Cooperative Institute for Marine, Resource Studies, Hatfield Marine Science Center, 2030 S. Marine Science, Drive, Newport, OR 97365, U.S.A. e-mail: Bill.Peterson@noaa.gov*

Dramatic changes in copepod, euphausiid and pelagic fish species composition occurred in the summer of 1992 in the northern California Current. Subtropical neritic copepods such as *Calanus pacificus*, *Paracalanus*, *Ctenocalanus* and *Clausocalanus* came to share dominance with the local boreal species; the coastal euphausiid, *Thysanoessa spinifera* became less abundant in shelf waters and the oceanic species, *Euphausia pacifica* became common; warm water pelagic fishes such as juvenile sardines, jack mackerel and pacific mackerel became common in continental shelf waters. Presence of warm water species persisted for six years (1992-1998) in association with the six year period of El Niño-like conditions. Ecosystem structure began to change in late 1998 as evidenced by the disappearance of subtropical neritic copepods, a return of *Thysanoessa spinifera* to shelf waters and a decline in numbers of warm water pelagic fish. By this year (2000) the copepod community is now entirely subarctic in origin, *Euphausia pacifica* are found only in offshore waters, mackerel have disappeared from shelf waters, no juveniles sardines have been found (although adults remain somewhat common), and large numbers of anchovies have returned to the area. The latter point is significant since large numbers of anchovies have not been seen since the early 1980s. These collective observations beg the question: are we witnessing another climate regime shift or is this simply the manifestation of an extended La Niña?

9AM2000 POCp340 poster  
**HYDROLOGICAL PROCESSES IN COLD PERIOD OF YEAR IN THE TATAR STRAIT**

A.G. Petrov  
*Far Eastern Regional Hydrometeorological Research Institute (FERHRI), 24 Fontannaya Street, Vladivostok, Russia. 690600 e-mail: hydromet@online.ru*

The hydrological processes taking place in the Tatar Strait under the influence of surface water cooling and ice cover formation are studied in this work. Until now only the most common processes were considered owing to practically complete lack of observations on hydrological parameters. At the same time there is rather large number of observations in autumn-winter period (before occurrence of ice) and in spring (after moment of ice-clear water). In view of this we were forced to use indirect methods of analysis. Modifications of the hydrological parameters were calculated by processing their fields for initial and final phase of cooling. The maps, obtained by the differences, allow judging about intensity, directness and character of processes. The results of research about a possible amount of salt coming in the sea owing to ice formation are used as well. As initial data, numerous observations on 7 repeating sections in the Tatar Strait available in FERHRI (in number more than 350 sections) were used. As results of these investigations the stratified structure in a variety of hydrological characteristics was detected which is most clearly shown in the field of salinity. The subsequent analysis suggests the mechanism of formation of these layers. It is possible to assume that the reason of the layering formation is the fall-winter convection in a coastal zone, because they are more intensive here than in the open sea. The water, which is caused by a thermal convection (first phase of cooling), is a source of the first layer formation. The second layer is formed during development of the salinity convection. Thus the distribution of water occurs in a horizontal direction out from the shore. The process of cooling of a surface during a winter season is not homogeneous (monotonous). It causes the formation of multilayer structure. Thus, part of them penetrates to a greater depth probably by the effect of an adhesion to the bottom, by tidal action or by sinking of supercooled salty water lenses formed under ice in the open sea area, that is marked in the Arctic and Antarctic regions. Perhaps their significant part is spread to the south along the shore. The conducted analysis allows to make a preliminary conclusion that the basic water mass of the Tatar Strait cannot be the basis to form the Japan Sea deep and bottom waters. However, the possibility of their formation in southern areas of the Strait is not excluded, where the supercooled salty waters inflow with the currents. Also the available date does not allow the exact description of the bottom water characteristics in a deep-sea canyon.

9AM2000 POCp192 poster  
**INTERANNUAL VARIABILITY OF HYDROLOGICAL SITUATION IN THE NORTHWEST PART OF BERING SEA**

V.M. Petruk, E.O. Basyuk and G.V. Khen  
*Pacific Research Fisheries Centre (TINRO-Centre), 4 Shevchenko Alley, Vladivostok, Russia. 690600 e-mail: khengena@mail.primorye.ru*

Water circulation and thermohaline condition in Anadyr-Navarin region are analysed on the bases of complex expeditions on research vessels of TINRO-Center carried out for the last years (1994-1999). Depending of the type of general circulation in the northwest part of the Bering Sea the sharp interannual changes of hydrological condition are marked even on a small series of observations. The most cold on water temperature in central part of Anadyr Bay there were 1994 and 1999. At the same years waters on depth 50 m had considerably lower salinity in comparison with multiyear average meanings, in bottom layers the areas of waters with negative temperature were maximum - near 60 thousand square km. In the northwest part of the sea there was a

latitude circulation, that has stipulated weak influx of warm and saline waters in region bordering to the Anadyr Gulf. 1997 was the warmest for last 6 years. Salinity of subsurface layers was above of the norm. The area of bottom waters with temperature  $<0^{\circ}\text{C}$  was 1.3 thousand square km. Circulation in the northwest part of the Bering Sea was meridional. Navarin Current entering to Anadyr Gulf from the south was strongly developed.

**9AM2000 S9-318 invited**  
**CONCEPTS AND EXPERIENCES RELATED TO THE INTEGRATION OF AQUACULTURE INTO COASTAL MANAGEMENT**

Michael Phillips

*Network of Aquaculture Centres in Asia and the Pacific (NACA), P.O. Box 1040, Kasetsart Post Office, Bangkok 10903, Thailand*  
*e-mail: NACA@mozartinet.co.th*

This paper gives an overview of the environmental and social interactions of mariculture development in the coastal zone, based largely on experiences in the tropical Asian region. Following a description of the major interactions, the paper explores the different management strategies required for a sustainable development of mariculture which contributes to the well being of coastal people and effective environmental protection and rehabilitation, with reference to the recently prepared GESAMP guidelines on integration of mariculture into coastal zone management. The paper identifies activities required to support developing countries in the effective integration of mariculture into coastal area management plans and opportunities for scientific cooperation on this topic of growing regional and international importance.

**9AM2000 S1-193 oral**  
**THE TRANSITION ZONE CHLOROPHYLL FRONT IN THE NORTH PACIFIC AND IT'S INTERACTION WITH THE SUBARCTIC GYRE**

Jeffrey J. Polovina, Evan Howell, Donald R. Kobayashi and Michael P. Seki

*NOAA/NMFS, 2570 Dole Street, Honolulu, HI 96822-2396, U.S.A. e-mail: Jeffrey.Polovina@noaa.gov*

Pelagic ecosystem dynamics on all temporal scales may be driven by the dynamics of very specialized oceanic habitat. One such habitat is the basin-wide chlorophyll front located at the boundary between the low chlorophyll subtropical gyres and the high chlorophyll subarctic gyres. Global satellite maps of surface chlorophyll clearly show this feature in all oceans. In the North Pacific, the front is over 8,000 km long and seasonally migrates north and south about 1,000 km. In the winter this front is located at about  $30^{\circ}$ - $35^{\circ}\text{N}$  latitude and in the summer at about  $40^{\circ}$ - $45^{\circ}\text{N}$ . Since it seasonally spans the Transition Zone it is termed the Transition Zone Chlorophyll Front (TZCF). The TZCF represents a zone of surface convergence as cool, vertically mixed, high chlorophyll, surface water on the north side sinks beneath warm, stratified, low chlorophyll water on the south side. Satellite telemetry data on movements of loggerhead turtles and detailed fisheries data for albacore tuna show that both apex predators travel along this front as they migrate across the North Pacific. The front is easily monitored with ocean color satellite remote sensing. The position and gradient of the front varied substantially between the 1998 El Niño and the 1999 La Niña. For example, in the eastern Pacific from June to November 1999 the TZCF remained between  $40^{\circ}\text{N}$  and  $42^{\circ}\text{N}$  latitude while in 1998, during the same period, it moved steadily over 1,600 km from  $40^{\circ}\text{N}$  to  $47.5^{\circ}\text{N}$  and back down to  $40^{\circ}\text{N}$ . A change in the position of the TZCF between 1997 and 1998 appears to have altered the spatial distribution of loggerhead turtles.

**9AM2000 W4-194 oral**  
**INVESTIGATING MARINE ECOSYSTEM DYNAMICS WITH ECOSIM**

Jeffrey J. Polovina

*NOAA/NMFS, 2570 Dole Street, Honolulu, HI 96822-2396, U.S.A. e-mail: Jeffrey.Polovina@noaa.gov*

In the Northwestern Hawaiian Islands (NWHI) an Ecosim model was used to investigate impacts of lobster fishing on populations dynamics of the endangered Hawaii Monk Seal which feeds on lobster. This model was also used to investigate the impact of the 1989 regime shift on the NWHI ecosystem. Secondly an Ecosim model of the Eastern Tropical Pacific pelagic ecosystem was used to investigate ecosystem impacts due to ENSO variability and global warming. Lastly an Ecosim model of the central North Pacific was used to investigate ecosystem impacts of shark removals. Experiences with Ecosim in these applications will be discussed.



9AM2000 S1-195 poster

**CLIMATE VARIATION AND CHANGE IN THE EXTRATROPIC ASIAN - PACIFIC REGION IN THE XX CENTURY**

Vladimir Ponomarev<sup>1</sup>, Dmitrii Kaplunenko<sup>1</sup> and Hajime Ishida<sup>2</sup>

<sup>1</sup> *Pacific Oceanology Institute, 43 Baltiyskaya Street, Vladivostok, Russia. 690041 e-mail: archer@stl.ru, troliia@ocean.poi.dvo.ru*

<sup>2</sup> *Kanazawa University, Kanazawa, Japan*

Climatic tendencies of surface air temperature and precipitation in the mid-latitude Asia to the east off 55°E and in the Northwest Pacific marginal zone, named as Asia-Pacific region, are estimated for the different long-term periods of the 20<sup>th</sup> century. The climate variation is also estimated in the deep water of the Japan Sea situated in the area of huge winter temperature contrast. Both substantial centennial and semi-centennial warming in the large - scale areas of the mid-latitude band 40°-65° of the Asia is revealed from December to April with extended maximum in December and March. The semi-centennial/centennial cooling is found in the Central Asia and South Siberia in June-July/July-August, as well as in the certain areas of the Subarctic Marginal zone from August to October. Significant trends in precipitation were found mainly for the certain areas where air temperature and precipitation tendencies are in a good agreement.

The estimation of substantial warming with high significance level all the year round is marked over the Japanese Islands and Pacific coast of the Kamchatka Peninsula mainly from 1951/1963 to 1990, but not from 1951/1963 to 1998. Nevertheless, the water temperature increase in the Japan Sea deep water is continuing from 1970s up to 2000. The substantial large-scale regional climate warming in the previous period until 1990 resulted in the vertical stability increase in the intermediate and deep water, of the Japan Sea. It corresponds to ventilation reduction of the Japan Sea deep basins during warming period and also during cold winter 2000 due to increased vertical stability.

Estimation of centennial and 40/50 years tendencies of the monthly mean air temperature and precipitation in the extratropic Asian-Pacific Region manifest important details of the climate variation in Siberia, Central Asia, Northwest Pacific Marginal zone and in the Sea of Japan area particularly. The positive-negative climatic tendency alternations in space and time including annual cycle are discussed.

9AM2000 POCp196 oral

**THE "SUBARCTIC GYRE" IN THE JAPAN (EAST) SEA: NEW OBSERVATION EVIDENCE AND CURRENT SYSTEM SIMULATION**

Vladimir Ponomarev<sup>1</sup>, Olga Trusenkova<sup>1</sup>, Lynne Talley<sup>2</sup>, Vyacheslav Lobanov<sup>1</sup>, Sergey Sagalaev<sup>1</sup> and Andrey Scherbina<sup>2</sup>

<sup>1</sup> *Pacific Oceanology Institute, 43 Baltiyskaya Street, Vladivostok, Russia. 690041 e-mail: archer@stl.ru, troliia@ocean.poi.dvo.ru*

<sup>2</sup> *Scripps Institute of Oceanography, La Jolla, CA U.S.A.*

The present study is based on both observation oceanographic data analysis and numerical simulation of circulation processes focused on the subarctic area of the Japan Sea. The recent oceanographic conditions in the sea up to the near-bottom layer over the deep basin slopes are represented by the observations in spring 1999 cruises of R/V *Pavel Gordienko*, summer 1999 cruises of R/V *Roger Revelle* and R/V *Professor Khromov* as well as winter 2000 cruise of R/V *Professor Khromov* implemented in frame of the International Joint JES Project.

The first goal of this study is to outline some results of the oceanographic observations performed in 1999-2000 in the Japan (East) Sea, related to climate variation and change with emphasis on the new findings and observation evidence. The second goal is to simulate the Japan Sea circulation under different kinds of external atmospheric forcing and initial spatial density distribution using MHI 1997 nonstationary hydrodynamic model. This model was developed by N. Shapiro and E. Mikhaylova in 1992-1997 in Marine Hydrophysical Institute (MHI), Ukrainian Academy of Sciences, Sebastopol. Two major series of numerical experiments are implemented. The first series is the model spin up from realistic initial temperature and salinity distribution based on oceanographic observations in 1999. The second one is the long-term model run from horizontally homogeneous initial condition. Heat balance equation on the sea surface taken into account to calculate heat fluxes and simulate the interaction with the atmosphere in details. Comparison is made of the Japan Sea circulation patterns, temperature and salinity distribution simulated with the observation evidence mainly in the Northwest Japan Sea to the North off the Subarctic ("Polar") front. The simulated circulation patterns are confirmed by recent observation data, and some observation evidence can be explained by the modeling results. Some details of the observation findings and physical processes over the sea mounts and continental slope are discussed.

9AM2000            WS-361            oral  
**IRON-SIDEROPHORE RECEPTORS OF HETEROTROPHIC MARINE BACTERIA**

Neil M. Price, Julie Granger and Evelyn Armstrong

Department of Biology, 1205 Ave. Dr. Penfield, McGill University, Montreal, PQ, H3A 1B1, Canada e-mail: nprice@bio1.lan.mcgill.ca

Laboratory isolates of heterotrophic bacteria and field populations from low Fe waters of the ocean are able to take up <sup>55</sup>Fe from ferrioxamine B, a fungal siderophore (Granger and Price, 1999; Maldonado and Price, 1999). Rates of transport are up-regulated when ambient Fe concentrations are low, suggesting that the use of siderophore-bound Fe is an adaptation to overcome Fe-limitation. Using a non-denaturing PAGE assay, we have discovered that the laboratory strains produce outer-membrane receptors that bind ferrioxamine B when Fe is limiting growth. So far we have examined *Altermonas* sp., a clone isolated from waters near station P in the subarctic Pacific Ocean, and PWF3, a clone from the Gulf of Mexico. The receptor is absent from cells cultured in high Fe medium and is rapidly induced upon transfer to low Fe medium. Its apparent molecular weight is roughly 80 kD, similar in the size to other siderophore receptors from terrestrial and pathogenic bacteria. We are now characterizing the specificity of the receptor(s) by examining binding of other siderophores and inorganic Fe complexes. The method could be used to examine siderophore receptor expression in natural populations of bacteria before and during an iron fertilization experiment.

9AM2000            FISp197            oral  
**THE SIZE AND COMPOSITION OF DAILY RATION OF THE ATCA MACKEREL *Pleurogrammus azonus* IN PRIMORYE COASTAL WATERS (JAPAN SEA)**

O.I. Pushchina

Pacific Research Fisheries Centre (TINRO-Centre), 4 Shevchenko Alley, Vladivostok, Russia. 690600 e-mail: root@tinro.marine.su

Size and composition changes in daily ration of the atca mackerel were investigated using samples collected by ground trawling performed in South and North Primorye coastal waters at a depth of 15-300 m in different seasons from May to November 1994, 1996, and 1999. Feeding habits of two fish size groups were studied, the first of which comprised fry and maturing specimens 20-30 cm long, and the second, nubilous fish 30-40 cm long.

The atca mackerel passage from spring to summer rearing is accompanied with a migration of most fish from the lower boundary shelf zone to shallow waters and is characterized by a decrease of plankton fraction (Copepoda, Hyperiidia, Euphausiacea) and an increase of the content of invertebrate benthos, nekto-benthos (Echiurida, Pandalidae, Hippolytidae) and nekton (mainly Cottidae and Stichaeidae) in its food spectrum, which is most pronounced in 30-40-cm specimens. In adult atca mackerels' diet, the weight of fish component (including conspecific fry) is maximum at the end of spawning in October. During further migration into bottom waters, where the fish spend the winter, they again start feeding on plankton.

From May to July, the size of the atca mackerel's daily ration increases from 4.4 to 6.5% of body weight in 20-30-cm fish, and from 3.3 to 6.8%, in 30-40-cm fish. To the middle of October, the feeding intensity drops down to 4.1 and 4.4%, respectively. In the observation period, the daily food consumption became minimum in the second half of November (2.0 and 1.2%, respectively), as the fish reached the state of relative winter rest and passed to the maintaining ration.

9AM2000            S6-198            oral  
**RECENT CHANGES IN THE SURFACE CARBON BUDGET AT STN ALOHA IN THE SUBTROPICAL NORTH PACIFIC**

Paul D. Quay

School of Oceanography, University of Washington, Box 357940, Seattle, WA 98195, U.S.A. e-mail: pdquay@u.washington.edu

During the last two years, the salinity and dissolved inorganic carbon (DIC) concentration measured in surface waters at Station ALOHA in the subtropical N. Pacific (23°N 158°W) are the highest measured over the last 10 years. Even after normalizing the DIC to a constant salinity (DICs), the concentrations during the last two years are the highest ever. Additionally, the rate of  $\delta^{13}\text{C}$ -DIC decrease (and DICs increase) measured in surface waters at HOT since 1995 are double the rates measured between 1990 and 1995. The question is whether this accelerated DIC increase and  $\delta^{13}\text{C}$  decrease is the result of anthropogenic CO<sub>2</sub> uptake or some other process. The observed time trends of surface DICs and  $\delta^{13}\text{C}$  are compared to the trends predicted from accelerated uptake of anthropogenic CO<sub>2</sub> and a slowing in biological carbon export. The observed trends agree better with those predicted by a slowing of biological carbon export. Alternately, the time trends in surface salinity, DIC and  $\delta^{13}\text{C}$ -DIC measurements at Stn ALOHA can be explained by a southward migration of surface waters from ~4° north of Station ALOHA.

9AM2000 S5-200 oral

**DRIFTER OBSERVATIONS OF ANTICYCLONIC EDDIES OVER THE KURIL-KAMCHATKA TRENCH**

Alexander B. Rabinovich<sup>1,2</sup>, Richard E. Thomson<sup>2</sup> and Steven J. Bograd<sup>3</sup>

<sup>1</sup> Shirshov Institute of Oceanology, Moscow, Russia. 117851 e-mail: abr@iki.rssi.ru

<sup>2</sup> Institute of Ocean Sciences, Sidney, B.C., Canada. V8L 4B2 e-mail: ThomsonR@pac.dfo-mpo.gc.ca

<sup>3</sup> Scripps Institution of Oceanography, La Jolla, CA, 92093-0230, U.S.A. e-mail: bograd@bowfell.ucsd.edu

Groups of satellite-tracked surface drifters were deployed in the western North Pacific near the Kuril-Kamchatka Trench in the fall 1990 and late summer 1993. Drifter trajectories for both groups revealed large anticyclonic eddies centered over the axis of the trench, seaward of Bussol' Strait, the deepest strait connecting the Pacific Ocean and the Sea of Okhotsk. The physical characteristics of the eddies are estimated and their potential influence on the spread of North Pacific Intermediate Water into the Pacific is examined. Drifter 1315, deployed near the center of the eddy in 1990, remained in the eddy for over 40 days and made five loops at successively greater distances from the eddy center. Large-amplitude, storm-generated inertial oscillations were observed during the first two loops. The vorticity field in the eddy resulted in a Doppler "red-shift" of the inertial frequency (Kunze, 1985) such that the measured "effective" inertial period of 21 hours was roughly 4 hours greater than the nominal inertial period for this latitude (45°N). In 1993, a drifter was again retained in the eddy for about 40 days. This eddy had characteristics similar to those of 1990 eddy but was relatively devoid of significant high-frequency motions until the drifter's final half-loop. The extent and apparent persistence of KKT eddies suggests that they have a major impact on the transport dynamics of the East Kamchatka and Oyashio currents.

9AM2000 FISp201 oral

**DOES RAPT (RADIO ACOUSTIC POSITIONING TELEMETRY) TAGGING CHANGE SPAWNING BEHAVIOUR, A CHOKKA SQUID EXPERIMENT?**

Robin P. Rigby

Dalhousie University, Halifax, NS, Canada. B3H 4J1 e-mail Rigby@salmon.fish.hokadai.ac.jp

Radio Acoustic Positioning Telemetry (RAPT) analysis allows researchers to observe *in situ* behaviour with more accuracy and greater precision and continuity than ever before. However, the degree of reliability of each of these is unknown. By combining video observations with RAPT positions, the biological interpretations, and hence and understanding of the movement patterns observed can be made. This study examined behavioural changes during tagging experiments conducted over *Loligo vulgaris renaudii* egg beds on the South African shore. Behavioural changes depended on the sex, health and maturity of the specimen. Results suggest a delay period is necessary for the collection of accurate data: one day for large males, two days for small males and three days for spawning females.

9AM2000 POCp202 oral

**INTERACTIONS OF EKWC, NKCC WITH MESOSCALE EDDIES IN THE EAST (JAPAN) SEA**

Young Jae Ro, Sergey Smirnov and Yang Ho Choi

Department of Oceanography, Chungnam National University, Kung-dong 220, Yusung-ku, Taejon, Republic of Korea. 305-764 e-mail: royoungj@cnu.ac.kr

This study is based on the numerical modelling experiments of the East (Japan) Sea circulation based on POM-ES. The POM-ES has been used for the variety of numerical experiments to understand the general circulation characteristics and eddy generations in the East (Japan) Sea. In this study, we have experimented with diverse initial and boundary conditions of hydrography and in- and outflow to develop coastal boundary currents in the East (Japan) Sea, namely East Korea Warm Current (EKWC), Tsushima Warm Current (TWC), North Korea Warm Current (NKCC), Liman and Primoriye Current (LPC). The responses and sensitivities of the formation of EKWC, NKCC, TWC and LPC to those conditions will be presented. The mesoscale eddies in the East (Japan) Sea are understood to play crucial roles in shaping up the general circulation patterns as well as material and momentum fluxes. The roles of the mesoscale eddies are becoming even more important in interacting with local boundary currents listed above in developing as well decaying phases. These results will be presented through animated movies.

9AM2000 POCp203 poster

**MONTHLY CIRCULATION PATTERNS IN THE EAST CHINA SEA AND THE YELLOW SEA BASED ON THE CURRENT VECTORS ESTIMATED BY P-VECTOR METHOD**

Young Jae Ro, Sergey Smirnov and Yang Ho Choi

Department of Oceanography, Chungnam National University, Kung-dong 220, Yusung-ku, Taejon, Republic of Korea. 305-764 e-mail: royoungj@cnu.ac.kr

This study is focused on the circulation patterns in the East China Sea (ECS) and Yellow Sea (YS) inferred from the current vectors estimated by the P-vector method (Chu, 1998) using the GDEM dataset. These seas are drawing particular attentions from

LME (Largescale Marine Ecosystem) recently endorsed by UNDP. The Seas are peculiar in several aspects; shallow, large river runoff, significant tidal activities, under strong influence of Asian monsoon.

The Preliminary results will be presented as follows:

1. The annual mean circulation pattern of the Kuroshio and the TWC are well reproduced respectively in this region.
2. Maximal annual mean speed in the ECS and YS is around 3cm/sec with over 30 cm/sec in the Kuroshio region.
3. For the spring and summer period, the circulation pattern in the ECS are under strong influence of the Water diluted with the Yangtze River Runoff.
4. The cold water mass formed by the winter cooling in the northern region of the Yellow Sea is clearly shown and its behavior is pronounced as the southward movement in the following spring and summer season.
5. The cyclonic gyre in the surface layer of the Yellow Sea is in contrast with the anticyclonic gyre in the bottom waters.

9AM2000 S5-204 invited

#### THE MEAN AND TIME-VARYING MERIDIONAL TRANSPORT OF HEAT IN THE NORTH PACIFIC OCEAN

Dean Roemmich

*Scripps Institution of Oceanography, University of California, San Diego, 9500 Gilman Drive, Mail code 0230, La Jolla, CA 92093-0230, U.S.A. e-mail: droemmich@ucsd.edu*

As part of the World Ocean Circulation Experiment, a Pacific-wide network of High Resolution XBT/XCTD transects was established and maintained through the decade of the 1990s. These transects include coast-to-coast eddy-resolving temperature profiles plus sparse measurements of salinity. They span all of the warm water sphere from 30°C surface waters of the tropics down to 5°C or less at 800 m, and are used for estimating geostrophic upper ocean circulation and heat transport. Quarterly sampling along all lines, with TOPEX altimetric data used to resolve higher frequency fluctuations, permits estimation of seasonal-to-interannual variability. During the coming decade, a comprehensive Pacific observing system is planned through CLIVAR's Pacific Basin Extended Climate Study (PBECS). PBECS measurements will include the global Argo profiling float array plus improved measurement of air-sea fluxes and boundary current transports. Accurate closure of the oceanic heat and hydrological cycles and better understanding of the ocean's role in the coupled climate system are now within reach.

One XBT/XCTD route, from San Francisco to Taiwan, spans the North Pacific Ocean near the tropical/subtropical boundary, and is chosen to illustrate the interannual variability in heat transport. As of June 2000, 32 transects have been collected along this route since September 1991, with over 300 temperature profiles from each realization. The profile data, together with direct measurements of wind, are used to calculate the geostrophic and Ekman transports. The mean heat transport across the XBT section is  $0.77 \pm 0.12$  pW. The large number of transects enables a stable estimate of the mean field with realistic error bars based on the known variability. At this latitude, the North Pacific heat engine is a shallow meridional overturning circulation that includes warm Ekman and western boundary current components flowing northward, balanced by southward flow of cool thermocline waters (including Subtropical Mode Waters). A near-balance of geostrophic and Ekman transports holds in an interannual sense as well as for the time mean. The interannual range in heat transport was about 0.3 pW, with maximum values of about 1 pW occurring in early 1994 and early 1997. The mesoscale eddy field contributes significantly to the mean heat transport ( $0.09$  pW  $\pm$  0.01 due to eddies) and to its variability. Systematic tilt of the eddies, by about 0.7 degrees westward from 400 m to the sea surface, gives rise to their transport properties. Interannual fluctuations of the eddy field seem particularly important in controlling variability in equatorward flow of thermocline waters

9AM2000 S3-206 poster

#### DIVERSITY AND DENSITY CHANGES OF SIGNIFICANT TAXA ALONG THE BRITISH COLUMBIA COAST FROM 1990-99

Stephen J. Romaine

*Institute of Ocean Sciences, P.O. Box 6000, Sidney, B.C., Canada. V8L 4B2 e-mail: RomaineS@pac.dfo-mpo.gc.ca*

Since 1990 a cooperative zooplankton research monitoring program (COPRA) has been collecting both biological and physical data from a series of 19 stations in five significantly unique regions along about 1000 km of the British Columbia coastline.

Significant seasonal diversity index shifts for two of the southern COPRA regions, La Pérouse Bank and Strait of Georgia, have occurred over the last decade (1990-99). These increases were due in part to abundance and biomass shifts of ecologically important boreal shelf copepods. *Calanus marshallae*, the second largest contributor to biomass in the Northeast Pacific, has experienced lower concentrations over the latter half of the 1990s with the most significant drop during the El Niño event of 1997-98. Other boreal shelf copepods experienced similar changes in the latter half of the 1990s, but some taxa such as *Pseudocalanus* sp. effectively maintained their concentrations along the BC coast by shifting their distributions northwards into other COPRA regions during the El Niño event. Unusually high concentrations of Californian and oceanic copepods, such as *Paracalanus parvus* where noted along and inside the shelf break with concentrations peaking in 1998 and gradually returning to pre-El Niño densities observed in the earlier 1990s. Other Californian and oceanic taxa were also present in the latter half of the 1990s along

the BC coast, such as *Sagitta euneritica* and salps, causing local species to shift their distributions northward and/or compete for resources with these new species.

9AM2000 W3-207 invited

**A REVIEW OF THE USE OF INDIVIDUAL-BASED MODELS AS UPPER TROPHIC LEVEL MODELING TOOLS**

Kenneth A. Rose

*Coastal Fisheries Institute & Department of Oceanography and Coastal Sciences, Wetlands Resources Building, Louisiana State University, Baton Rouge, LA 70803, U.S.A. e-mail: karose@lsu.edu*

The individual-based modeling approach for simulating the population dynamics of upper trophic level biota is gaining popularity. Individual-based modeling has been used in many other fields, such as forest succession and astronomy. The recent popularity of the individual-based approach for modeling upper trophic level aquatic biota results in part from the lack of success of the more aggregate (e.g., age-structured) traditional modeling approaches, and the recognition that inter-individual variability can greatly influence population dynamics. I will discuss two general types of approaches (configuration and distribution) to individual-based modeling. I will then outline advantages and disadvantages of these approaches, focusing on the configuration approach. Several strategies for coupling individual-based configuration models of upper trophic levels to water quality and lower trophic levels will be discussed, and illustrated with examples. These strategies involve careful consideration of the different temporal and spatial dynamics of upper and lower trophic levels, and identification of important feedback linkages between the trophic levels. The individual-based approach offers many advantages for coupling of upper and lower trophic levels, and for predicting how environmental changes can cause cascading effects in marine ecosystems.

9AM2000 S7-208 oral

**ANALYSIS OF LOW FREQUENCY SIGNALS IN THE NORTHEAST PACIFIC COASTAL FRESHWATER DISCHARGE, SALINITY, TEMPERATURE AND SALMON PRODUCTION USING WAVELET TECHNIQUES**

Thomas C. Royer and Chester E. Grosch

*Center for Coastal Physical Oceanography, Old Dominion University, Norfolk, VA 23529, U.S.A. e-mail: royer@ccpo.odu.edu*

As part of GLOBEC retrospective studies in the Northeast Pacific Ocean, significant low frequency signals with periods ranging from 15 to about 50 years have been revealed in the coastal freshwater discharge, salinity, temperature and salmon production. The use of wavelet analysis allows the investigation of the possibility of the data showing regime shifts, of the sensitivity of the technique on the length of the record and of the assumption of a stationary time series. While the patterns of variability of these signals are similar, their strengths are very dependent on the length of the record especially on the beginning and end points. It is suggested that these signals might be linked together by decadal changes in the upper layer stratification that control the air-sea heat and salt exchanges and the horizontal advection. The connections between the Pacific Decadal Oscillation (PDO) and upper ocean conditions in the Northeast Pacific produce a stable configuration for either phase of this oscillation.

9AM2000 W5-352 oral

**DISSOLVED IRON SPECIATION IN SEAWATER**

Eden Rue and Ken Bruland

*Department of Ocean Sciences, 1156 High Street, University of California, Santa Cruz, CA 95064, U.S.A. e-mail: elrue@cats.ucsc.edu or bruland@cats.ucsc.edu*

The role of iron in limiting oceanic productivity and influencing community structure has been demonstrated for the high nitrate low chlorophyll (HNLC) waters of the subarctic Pacific, equatorial Pacific, the Southern Ocean, and even some coastal upwelling regimes. Recent observations suggest that the bulk of the dissolved iron in the open ocean is complexed with low concentrations of strong iron-binding dissolved organic ligands. In addition, results from the surface waters of the IronEx II enrichment experiment in the equatorial Pacific showed that within a day following the initial 2nM iron infusion, the total Fe(III)-binding ligand concentration increased by 400%. The stronger ligand class (L1) was produced most rapidly in response to increased iron levels and appeared to somehow be inducible, excreted and regulated. The strength of this L1 class was similar to that of commercially-available Fe(III)-binding compounds known as siderophores, as well as to that of siderophores produced by laboratory cultures of marine heterotrophic and photosynthetic bacteria. These results have led to numerous, and to date, not fully answered questions such as *are these iron-binding ligands siderophores? What organisms are producing these chelators and by what processes? Once produced, what are the mechanisms and rates involved in making these forms of iron biologically available?* Advances made towards addressing these questions, including the recent field efforts made by our research group to isolate, concentrate and structurally characterize iron-binding organic ligands from seawater, as well as recent laboratory experiments made by several research groups investigating the availability of a variety of iron chelators to different species of microorganisms will be discussed.

9AM2000 W2-209 oral  
**MODELLING ENVIRONMENTAL AND PREDATION-INDUCED VARIABILITY IN EUPHAUSIID RECRUITMENT:  
ITS DEPENDENCE AND IMPACT ON HERRING TROPHODYNAMICS**

Scott M. Rumsey

*Oregon State University; USGS, Forest & Rangeland Ecosystem Science Center, 3200 SW Jefferson Way, Corvallis, OR 97330,  
U.S.A. e-mail: Scott\_Rumsey@usgs.gov*

The interaction between predation and recruitment processes in determining the availability of euphausiid prey for adult Pacific herring, *Clupea pallasii*, was investigated. Variability in adult euphausiid abundance is influenced by environmentally induced variability in larval survivorship and recruitment, as well as by predation on early life-history stages. Mortality suffered during particular stages of the euphausiid larval ontogeny can disproportionately influence subsequent recruitment, and thus impact the availability of larger euphausiid prey for adult Pacific herring.

A simple ecosystem model was developed to simulate environmentally induced variability in the relative abundance of copepod and euphausiid prey for juvenile herring. A criterion maximizing the energetic intake of juvenile herring was used to govern the relative selection of copepod vs. euphausiid prey. The impact on euphausiid recruitment and population dynamics of juvenile herring prey-preference in a dynamic prey field was simulated. Although copepods often dominate the diets of juvenile Pacific herring in the Eastern Pacific, juvenile and larval euphausiids are often represented in stomach contents. The relative impact of environmentally induced recruitment dynamics and juvenile herring predation on euphausiid population dynamics is evaluated. Seasonal variability in copepod-prey abundance for juvenile herring may be compensated for by an expansion of prey-species choice and size selection. Although such foraging behavior may augment year-class strength in the short term, it may impact food availability for adult Pacific herring over greater temporal scales

9AM2000 POCp210 oral  
**SEASONAL VARIABILITY OF TEMPERATURE/SALINITY STRUCTURE ON REPEATED SECTIONS IN THE SEA  
OF OKHOTSK**

Nikolay A. Rykov

*Far Eastern Regional Hydrometeorological Research Institute (FERHRI), 24 Fontannaya Street, Vladivostok, Russia. 690600 e-mail: hydromet@online.ru*

The temperature and salinity variability in the upper 500 m layer along two sections in the Sea of Okhotsk is investigated. One section crosses the Sea of Okhotsk from Cape Elizabeth (Sakhalin) to 55°30'N, 155°30'E (Kamchatka Peninsula) and another one from Cape Terpenia (Sakhalin) to 51°30'N, 156°30'E (Kamchatka Peninsula). Observations along the sections were carried out from 1957-1959 to 1990 and were repeated 30 times each other. Data were averaged per three seasons (spring, summer and autumn) and extreme values as well as standard deviations were defined. Winter observations are absent.

Vertical temperature structure consists of upper seasonal thermocline, cool subsurface layer and warm intermediate water. Thermocline looks very sharp in summer. In autumn, it sinks lower and temperature inversions occur often. The core of cool layer is situated in average at 75-100 m depth and is sinked in eastern direction. The layer with temperature below zero occupies considerable northern part of the Sea of Okhotsk during each season. Eastern boundary of the cool layer in the southern part changes from 151°E in spring to 147°E in autumn.

Salinity structure is characterized by its monotonous increasing with depth. Fresh waters are observed in near coastal areas. In spring in different years, close to Cape Elizabeth salinity varies from 18 to 30 PSU due to ice melting. In this season salinity standard deviations reach 5.5 PSU. In summer, salinity varies from 13 to 30 PSU because of Amur River discharge. During all the seasons fresh waters are tracked near Sakhalin coast from surface to depth of 500 m. Salinity changes less near Kamchaka coast.

9AM2000 S6-211 oral  
**ANTHROPOGENIC CO<sub>2</sub> DISTRIBUTIONS IN THE PACIFIC**

Christopher L. Sabine and Richard A. Feely

*University of Washington, Joint Institute for the Study of the Atmosphere and Ocean, C/O NOAA/PMEL, 7600 Sand Point Way NE, Seattle, WA 98115, U.S.A. e-mail: sabine@pmel.noaa.gov*

As a part of the JGOFS synthesis and modeling project researchers have been working to synthesize the recently completed WOCE/JGOFS/NOAA global carbon survey data to better understand carbon cycling in the oceans. Working with international investigators we have compiled a Pacific Ocean data set with over 36,000 unique sample locations analyzed for at least two carbon parameters. These data are being used to estimate the distribution of anthropogenic CO<sub>2</sub> in the Pacific using the ΔC\* technique. The physical and geochemical makeup of the Pacific waters, however, poses a particular challenge for the anthropogenic calculations. This measurement-based approach requires a number of assumptions that will be examined with respect to the

Pacific. Preliminary estimates of the anthropogenic CO<sub>2</sub> distribution indicate that the largest inventories are in the subtropical South and North Pacific. These distributions will be discussed and compared with 3-D global carbon model estimates.

9AM2000 W7-378 oral  
**CARBON DISTRIBUTIONS IN THE INDIAN OCEAN**

Christopher L. Sabine

*University of Washington, Joint Institute for the Study of the Atmosphere and Ocean, c/o NOAA/PMEL, 7600 Sand Point Way NE, Seattle, WA 98115, U.S.A. e-mail: sabine@pmel.noaa.gov*

In the mid 1990s, several carbon measurement programs focused on the Indian Ocean, greatly increasing the existing carbon database for this basin. This study examines the combined CO<sub>2</sub> measurements from three major U.S. programs in the Indian Ocean: the global carbon survey cruises, conducted in conjunction with the World Ocean Circulation Experiment (WOCE), the NOAA Ocean-Atmosphere Carbon Exchange Study (OACES) Indian Ocean survey and the Joint Global Ocean Flux Study (JGOFS) Arabian Sea Process Study. The physical setting of the Indian Ocean as a basin primarily in the Southern Hemisphere, capped to the north by the Asian continent, makes the biogeochemistry of this region unique from other oceans. I will examine the large-scale distribution of both natural and anthropogenic carbon in the main Indian Ocean. What do these distributions tell us about carbon transport in the ocean? I will also present recent estimates of the seasonal variability of total CO<sub>2</sub>, total alkalinity, and pCO<sub>2</sub> in the main basin. The northern Indian Ocean is strongly affected by the seasonal monsoons. How do these changes compare to variability in the south Indian subtropical gyre region? These observations will be compared and contrasted with the Pacific.

9AM2000 S7-212 oral  
**CAN CHAETOGNATHS INFLUENCE THE FISH RECRUITMENT? - THEORETICAL APPROACH WITH THE PREY AND PREDATOR ENCOUNTER MODEL**

Hiroaki Saito

*Hokkaido National Fisheries Research Institute, 116 Katsurakoi, Kushiro, Hokkaido, Japan. 085-0802 e-mail: hsaito@hnf.affrc.go.jp*

Chaetognaths are the most dominant carnivorous zooplankton in marine ecosystem. Because fish larvae are adequate size as prey for chaetognaths, the predation rate on fish larvae has been investigated *in situ* in order to determine the influence of the predation on recruitment success of fish. In general, density of chaetognaths is in a same order of or 1-2 order higher than one of fish larvae. Thus, chaetognaths can collapse the fish population feeding on 0.01-1 fish larvae per day. However, most studies showed that the influence of the chaetognath predation on fish larvae was less important. In the present study, I attempt a theoretical analysis of the predation pressure on fish larvae using the prey and predator encounter theory. As a chaetognaths is an ambush predator and senses hydrodynamical signal of prey, the reaction distance (R) is dependent on prey size (r), prey swimming speed (v) and the threshold fluid velocity (u\*), and encounter rate coefficient ( $\beta$ : volume/time) is expressed as  $\beta = \pi(6\pi/3) r^2 v^2$ . I apply the equation on several fish nursery grounds and examine the influence of chaetognaths predation on fish recruitment.

9AM2000 W5-353 oral  
**EAST-WEST VARIABILITY OF PRIMARY PRODUCTION IN THE SUBARCTIC NORTH PACIFIC DERIVED FROM MULTI-SENSOR REMOTE SENSING DURING 1996-2000**

Sei-ichi Saitoh and Kosei Sasaoka

*Laboratory of Marine Environment and Resource Sensing, Graduate School of Fisheries Science, Hokkaido University, 3-1-1 Minato-cho, Hakodate, Hokkaido 041-8611, Japan e-mail: ssaitoh@salmon.fish.hokudai.ac.jp*

The two gyres in the subarctic North Pacific are known as Western Subarctic Gyre (WSG) in the NW subarctic, and Alaskan Gyre (AG) in the NE subarctic Pacific. Comparative studies on the primary production of the WSG and AG have been carried out in order to grasp the different effects of iron. Understanding the role of iron fertilization of HNLC (High Nutrients Low Chlorophyll) water, satellite monitoring of temporal-spatial variability of the chlorophyll *a* (chl *a*) distribution is very important.

Our objectives of this study are, to grasp the temporal and spatial variability of chl *a* distribution and primary productivity in the subarctic North Pacific, and to understand the mechanisms of chl *a* distribution during 1996-2000. We applied multi-sensor remote sensing data sets including ocean color (OCTS and SeaWiFS), sea surface temperature (SST) (AVHRR), sea surface height (TOPEX/Poseidon). Ocean color and SST images are applied to study interannual variability of primary productivity and front dynamics. Sea surface height is applied to study circulation, transport and eddies distribution. In addition to these satellite data sets, we generated estimated-nitrate map by the algorithm which employs satellite chl *a* and SST values. We attempt to calculate primary productivity by modified VGPM Model (Behrenfeld and Falkowski, 1997) using ocean color and SST satellite data sets. On the other hand, we examined estimation error of SeaWiFS in-water algorithm using bio-optical measurement data sets gathered by R/V *Mirai* and other research vessels. As a result, SeaWiFS in-water algorithm is working well in these regions with the error

of less than about 40%. East-west difference and year-to-year difference of primary production in the study area will be discussed.

9AM2000 S4-213 oral

**ANNUAL TO DECADAL STOCK FLUCTUATION OF *Loligo bleekeri* (CEPHALOPODA: LOLIGINIDAE) RESPONSES TO CHANGES SEAWATER TEMPERATURES NEAR THE SPAWNING GROUNDS: EFFECT OF LOW TEMPERATURE ON THE EMBRYONIC DEVELOPMENT**

Yasunori Sakurai<sup>1</sup>, Gyanne Lima<sup>1</sup>, Jun Yamamoto<sup>1</sup>, Hiromi Nakao<sup>2</sup> and Kingo Itoh<sup>3</sup>

<sup>1</sup> Graduate School of Fisheries Science, Hokkaido University, 3-1-1 Minato-cho, Hakodate, Hokkaido, Japan. 041 e-mail: sakurai@fish.hokudai.ac.jp

<sup>2</sup> Hokkaido Fisheries Expansion Office, Nemuro, Hokkaido, Japan

<sup>3</sup> Aomori Prefectural Fisheries Experimental Station, Ajigasawa, Aomori, Japan

*Loligo bleekeri* is the target of a major fishery near its spawning grounds in northern Japan. Annual catches in this region tend to be high when local sea temperatures are high and low when temperatures are low. The present study was conducted to determine if these fluctuations in adult stock size might be due to the effect of changing seawater temperatures near the spawning grounds on the developing embryos. In captive experiments, we first examined the effect of constant temperature on embryonic development at temperatures between 5 and 11°C. The results suggest that 7°C is the lowest temperature at which embryos develop normally. We then exposed developing embryos to temporary drops in temperature ("cold shocks") below this temperature minimum to examine the effect on embryonic development. When the shocks were small, embryos developed normally when exposed to temperatures below 6°C. However, large shocks caused many embryos to develop abnormally or to die. These and other observations on the importance of seawater temperatures near the spawning grounds on the stock size of *L. bleekeri* will be discussed.

9AM2000 S5-214 oral

**EXCHANGE OF DEEP AND BOTTOM WATERS IN THE KURILE BASIN, SEA OF OKHOTSK, WITH PACIFIC**

Anatoly Salyuk

Pacific Oceanological Institute, 43 Baltiyskaya Street, Vladivostok, Russia. 690041 e-mail: san@ocean.poi.dvo.ru

Vertical distribution of hydrographic and hydrochemical properties in Kurile Basin is characterized with slight monotonic increase of oxygen concentration and salinity and monotonic decrease of potential temperature from deep waters to bottom (~2500-3400 m). This can indicate on bottom water ventilation with cold waters containing more oxygen.

In the joint Russian-German cruise M/V *Marshal Gelovany* on project KOMEX in July-October 1999 we revealed that this process is continued now. On deep station Ge99-6-2 carried out in the central part of Kurile Basin the positive anomaly of oxygen content +4 mkM/kg in 90 m bottom layer has observed. This anomaly overlays the negative potential temperature anomaly -0.005 C in 30 m near bottom mixed layer with potential temperature 1.6025 C and potential density 27.692.

Historical data show even more pronounced temperature and oxygen anomalies in bottom waters with density about 27.7 in the central part of the Okhotsk Sea (Yasuoka, 1967, Russian expeditions of R/V *Vityaz* in the 1950, etc).

Usually waters with necessary source density 27.7 are situated on Pacific side of deepest Bussol straight about 200 m below its maximum sill depth (~2300 m). But they can periodically enter Okhotsk Sea in certain time intervals due to seasonal and inter year variability of water properties near Bussol straight.

The bottom water renewal time estimated on the basis of considering silica supply and oxygen consumption rates is ~200 years.

9AM2000 S6-331 poster

**SEASONAL CHANGE IN EFFECT OF SURFACE pCO<sub>2</sub> AND AIR-SEA EXCHANGE IN THE ARABIAN SEA**

Vedula V.S.S. Sarma

CEREGE, Europole de l'Arbois, BP 80, Cedex 4, 13545 Aix en Provence, France. e-mail: sarma@cerege.fr

Recent studies on biogeochemical cycling of carbon in the Arabian Sea, by Joint Global Ocean Flux Study (JGOFS), revealed that Arabian Sea is a source of carbon dioxide to the atmosphere throughout the year. The pCO<sub>2</sub> in euphotic zone and the surface mixed layer can be influenced by biological production/regeneration, and physical processes such as run-off, upwelling and winter convection. Contribution from each of these may change with season. In order to examine what makes surface waters of Arabian Sea supersaturated with respect to CO<sub>2</sub>, four processes have been identified. They are effects of biological processes, mixing, thermodynamics and fluxes. These processes show strong seasonal as well as spatial variability in the Arabian Sea. Hence, it is difficult to interpolate to the complete basin using the observed data sets to understand controlling factors of surface pCO<sub>2</sub> in the Arabian Sea. Therefore, based on the satellite, derived monthly averages of chlorophyll (SeaWifs), and SST data and water transports, derived using Modular Ocean Model, the effects of these processes have been computed.



The results show that significant seasonal variability is found in pCO<sub>2</sub> levels. During SW monsoon, coastal waters contain two contrasting regimes. pCO<sub>2</sub> levels of > 700 atm off the Oman, Somalia and SW coast of India driven by intense upwelling. Low levels of pCO<sub>2</sub> (<200 atm) are, however, found associated with monsoonal fresh water influx. These observations are in agreement with the observed data during JGOFS processes study. As a whole, physical and chemical processes seems to be controlling surface pCO<sub>2</sub> especially, mixing and thermodynamics whereas biological process seem to be significant during monsoon seasons. Effects of these processes in the rest of the Indian Ocean will also be discussed.

9AM2000 S6-215 poster

#### A THREE-DIMENSIONAL MODEL OF CARBON CYCLE IN THE UPPER LAYER OF THE NORTH PACIFIC

Yoshikazu Sasai and Motoyoshi Ikeda

Graduate School of Environmental Earth Science, Hokkaido University, N10W5, Sapporo, Hokkaido, Japan. 060-0810 e-mail: sasai@ees.hokudai.ac.jp

The surface oceanic pCO<sub>2</sub> shows spatial and temporal variations larger than the atmospheric counterparts, caused by the mixed-layer development and biological productivity. A three-dimensional ocean model including the bulk mixed-layer model are employed to simulate the seasonal variabilities of total carbon and nutrient in the mixed layer. The model is used also to determine the mean biogeochemical fields in the upper ocean which are established in a balance among air-sea flux, biological flux, and horizontal and vertical advectons. The model duplicates the seasonal variability of total carbon and phosphate in the mixed layer by specifying the difference in biological production between the eastern and the western regions during summer. The seasonal variability of air-sea carbon flux is controlled by the biological pump in spring and summer and vertical mixing to the mixed layer in winter along with the secondary effect of the Ekman upwelling which is stronger in winter. As the advection plays an important role to determine the mean biogeochemical fields, it is necessary to use the three-dimensional model. The advection effects in the subpolar region are mainly due to the Ekman upwelling, increasing carbon by transporting the high carbon from the lower layer. To the subtropical region, the large carbon in the subpolar region is transported by the southward Ekman flow. All three components are smaller in the subtropical region. In the mean balance, the biological pump is nearly canceled by the advection effects in the subpolar region, and the minor residual takes the atmospheric CO<sub>2</sub> to the ocean.

9AM2000 S7-216 poster

#### SEASONAL CHANGE OF PRIMARY PRODUCTION AROUND KUROSHIO EXTENSION

Katsuyuki Sasaki and Kiyoshi Kawasaki

National Research Institute of Fisheries Science, 2-12-4 Fukuura, Kanazawa-ku, Yokohama, Kanagawa, Japan. 236-8648 e-mail: katusa@nrifs.affrc.go.jp

We have been participating in the planning of Japan GLOBEC, namely VENFISH and in PICES meeting, we reported the primary production around Kuroshio Extension from April to June which had features to be high in the surface at April and in the surface plus subsurface at June. Moreover we suggest that the production at April will be new one and the production in surface at June regenerated one and that in subsurface new one. We here will report the seasonal change of the primary production, since we surveyed these production at April, June, August and November around Kuroshio Extension. We also will report the distribution of chlorophyll and nutrients. Our interest is what feature has the primary production close to the strong current of Kuroshio Extension. We will discuss what process effects to the production.

9AM2000 S1-217 oral

#### TRANSITION ZONE AS A NURSERY GROUND OF THE SUBARCTIC, TRANSITIONAL AND SUBTROPICAL MESOPELAGIC FISHES IN THE WESTERN NORTH PACIFIC

C. Sassa<sup>1</sup>, M. Moku<sup>1</sup>, K. Kawaguchi<sup>1</sup> and A. Balanov<sup>2</sup>

<sup>1</sup> Ocean Research Institute, University of Tokyo, 1-15-1 Minamidai, Nakanoku, Tokyo, Japan. 164-8639 e-mail: kawaguch@ori.u-tokyo.ac.jp

<sup>2</sup> Institute of Marine Biology, Russian Academy of Sciences, Vladivostok, Russia. 690041

Our recent studies revealed that most of the subarctic mesopelagic fishes spawn and spend their larval and/or juvenile stages in the transition zone between the Oyashio and Kuroshio fronts in the western Pacific. With the exception of *Leuroglossus schmidti*, their larvae rarely occur in the waters north of the Oyashio front off Japan and Russia. Furthermore, the transition zone is also a nursery ground for some transition and subtropical mesopelagic fish species, like *Myctophum asperum* and *Notoscopelus japonicus*, which spawn in the upstream region of the Kuroshio, southern Japan. Their larvae are advected into the transition zone by the Kuroshio, indicating the large scale spawning migration by these species. *Bathylagus ochotensis* is widely distributed in the subarctic Pacific including the Sea of Okhotsk and Bering Sea; it also spawns in the upstream region of the Kuroshio and its larvae are transported into the transition waters. This type of spawning and recruitment strategies were also adopted by Japanese sardine during its peak abundance in the late 1980s, while during the low abundance period it utilized the productive Japanese shelf and slope waters as a nursery ground. Considering the huge biomass of mesopelagic fish and their trophic role connecting major

zooplankton (crustaceans) with larger predators such as salmon, squids, sea birds and marine mammals in the high sea food web, the energy (biomass) transport through their spawning migration would be considerable among the subarctic, transitional, and subtropical oceanic ecosystems in the western Pacific.

9AM2000 POCp218 poster  
**LONG-TERM VARIABILITY OF A THERMAL REGIME IN THE TSUSHIMA CURRENT ZONE AS RESPONSE TO GLOBAL CLIMATE CHANGES**

A.V. Saveliev

*Far Eastern Hydrometeorological Research Institute (FERHRI), 24 Fontannaya Street, Vladivostok, Russia. 690600 e-mail: hydromet@online.ru*

The monthly averaged data records of water (tw) and air (ta) temperature collected from coastal stations of Japan was examined to study long-term variations of thermal conditions in Tsushima current zone. Data duration varied from 54 to 98 years. Apart from it, to analyse the connection between long-term evolution of examined characteristics and atmospheric large-scale processes the atmospheric circulation indexes of Vangengeim-Girs for the Northern Hemisphere for the period 1900-1997 was used.

The periods of 10-12, 4-4.5 and 2-2.5 years are found out in long-term variability of air and water temperature. These fluctuations occur on a background of the low-frequency tendencies. The long-term variability of ta and tw anomalies in the northern part of Tsushima current zone have clearly expressed seasonal differences as unidirectional positive tendency in cold period (XII-IV) and as a long-term climatic waves in warm period (VI-X). The long-term tendencies of ta and tw in the southern part of Tsushima current zone have not seasonal differences. Tendency of ta is similar to one in its northern part for cold period. On the contrary, tendency of tw is similar to one in its northern part for warm period. The climatic waves character of long-term variability of ta and tw is caused by large-scale changes of atmospheric circulation.

9AM2000 FISp219 poster  
**SPATIAL DISTRIBUTION OF PACIFIC COD (*Gadus macrocephalus*) AND ARCTIC COD (*Boreogadus saida*) IN THE OLUTORSKY GULF OF THE BERING SEA**

Andrew B: Savin

*Pacific Research Fisheries Centre (TINRO-Centre), 4 Shevchenko Alley, Vladivostok, Russia. 690600 e-mail: root@tinro.marine.su*

Pacific cod - mainly boreal species is widely spread in the shelf waters of the north Pacific. Arctic cod - arctic species penetrating into northern part of the Bering Sea. The southern boundary of its area in the western part of the sea is located in the Olutorsky Gulf. Both species refer to *Gadidae* and are commercial.

The researches were carried out in August 1999. The work enveloped water area between 59°00' - 60°20' N and 165°40' - 169°30' E. The spatial distribution of Pacific cod and Arctic cod, as well as the majority of rest species in the Gulf was determined by localization of two quasistationary hydrological eddies. In the west of Gulf - near Goven Peninsula it was placed an anticyclonic eddy, which warmed the bottom layer. In the east it was localized a cyclonic eddy which cooled a bottom layer.

Pacific cod was arranged in bottom layer of the greater part of Gulf up to depths of 220 meters. The densest concentration was localized in the area of anticyclonic eddy. On the contrary, in the area of cyclonic eddy the density of Pacific cod was insignificant. And only in area, adjacent Olutorsky Cape where the influence of cyclonic circulation weakened it was observed the raise of its concentration again.

The Arctic cod spread in bottom horizons up to depth of 129 meters. In contrast to Pacific cod, the densest concentrations were marked in the area of cyclonic circulation. In waters of anticyclonic circulation it occurred as individuals.

9AM2000 S1-220 oral  
**SPECIES COMPOSITION, BIOMASS AND DISTRIBUTION PATTERNS OF THE PELAGIC FISHES IN THE WESTERN AND EASTERN AREAS OF THE NORTH PACIFIC TRANSITION ZONE**

Vadim F. Savin and Konstantin A. Karyakin

*Pacific Scientific Research Fisheries Center (TINRO-Center), 4 Shevchenko Alley, Vladivostok, Russia. 690600 e-mail: tinro@marine.su*

Data of three complex surveys were analyzed. First survey was conducted in California transition area, second one - in the northwestern Pacific Ocean between 39°30'-43°00' N latitude and 146°30'-152°00' E longitude, and third one - in Honshu Island (Japan) waters beyond 12-miles zone boundary. Epipelagic planctivorous fishes, such as anchovy, sardine, chub mackerel, jack mackerel and saury aggregated in Transition zone, where their biomass reached 700 tons per km<sup>2</sup>, and they avoided both subtropical and subarctic waters in first and second areas. In these areas, biomass of mesopelagic fishes, predominantly myctophids decreases from more than 5 tons per km<sup>2</sup> in subarctic water to less than 0.5 ton in a subtropical region. It is possible,

that separation of main accumulations epipelagic and mesopelagic fishes is an accommodation for the fullest food base using. In coastal waters off Honshu, epipelagic fishes and myctophids abundance increased toward inshore area. In this case, feeding competition is absent due to a shift of dominant myctophid species. The subarctic myctophids (*Diaphus theta*, *Stenobrachius leucopsarus* and *Tarletonbeania crenularis*) had the most abundance among mesopelagic fishes in high seas. In coastal region benthopelagic species *Diaphus gigas* drawn up 83.4% of total myctophid biomass, and it preys commonly shrimp at the near-bottom layer. Large predators (pomfret, sharks, ribbonfish, neon flying squid) mostly concentrate into transitional and subarctic waters and they prey epipelagic and mesopelagic fishes intensively. All large predators spawn in subtropical waters and migrate for feeding in northern area in summer and autumn.

Seasonal distribution of neretic epipelagic fishes is different for eastern and western regions. Epipelagic fishes use Transition zone for feeding during summer and autumn in the western area but for spawning during winter and spring in the eastern one.

9AM2000 S5-221 oral  
**ANATOMY OF DECADEAL NORTH PACIFIC VARIABILITY**

Niklas Schneider, Arthur J. Miller and David W. Pierce

*Scripps Institution of Oceanography, University of California San Diego, La Jolla, CA U.S.A. e-mail: nschneider@ucsd.edu*

Decadal variability of the North Pacific simulated by a coupled ocean atmosphere model is investigated. It is expressed in weak spectral peaks at periods of 20 to 30 years of oceanic stream function, sea surface temperature and latent heat flux in the Kuroshio/Oyashio extension (KOE) region off Japan. The oceanic stream function anomalies are trapped in the upper 600 to 800 m and are dominated by the first baroclinic mode. The barotropic mode is highly correlated at a lead of 2 years and has amplitudes of 10 to 20% of the surface baroclinic signal.

Complex empirical orthogonal analysis is used to describe the basin-wide evolution of this variability. The decadal signal off Japan is initiated by Ekman pumping in the central North Pacific about five years earlier. The resulting anomalies of oceanic streamfunction are strengthened during the subsequent westward propagation and lead to anomalies of the western boundary transport. The forcing in the central North Pacific is associated with the canonical decadal temperature anomaly pattern, such that warm central and cool eastern Pacific anomalies lead to northward anomalies of western boundary transports. In the KOE region these anomalous western boundary transports lead to temperature anomalies that lag by five years and are of the same sign as those in central Pacific. In addition, the oceanic perturbation of the KOE surface heat budget is balanced by venting of heat to the atmosphere, primarily due to latent, and secondary due to sensible heat fluxes. Comparisons with available observations confirm the five year lag between SST anomalies in the central North Pacific and their occurrence in the KOE region, and the associated venting of latent heat to the atmosphere.

This anomalous forcing of the atmosphere in the KOE region is associated with local changes of precipitation such that warm KOE SST anomalies coincide with an increase of rain. Whether this atmospheric response closes a feedback loop to the forcing over the North Pacific remains unclear. The projections onto the initial wind stress forcing in the central Pacific are barely significant, and stochastic resonance is a possible explanation for the weak spectral peaks. However, even in this case, oceanic and atmospheric conditions in the KOE region and their possible biological ramifications are predictable based on observations of the oceanic conditions in the central Pacific.

9AM2000 FISp223 oral  
**SPECTRAL AND TIME SERIES ANALYSIS OF BRITISH COLUMBIA PACIFIC HERRING RECRUITMENT IN RELATION TO ENVIRONMENTAL VARIABLES**

Jake Schweigert and Jacqueline O'Connell

*Pacific Biological Station, 3190 Hammond Bay Road, Nanaimo, B.C. Canada. V9R 5K6 e-mail: schweigertj@pac.dfo-mpo.gc.ca*

Pacific herring is one of the predominant forage species along the North American coast of the North Pacific and its recruitment and population dynamics have been shown to be strongly influenced by climatic variability. We examined long-term fluctuations in Pacific herring recruitment in relation to variability in environmental factors using both spectral and cross spectral time series analysis of sea surface temperature, salinity, sea level, Aleutian low pressure index, atmospheric forcing index, river discharge, and Ekman transport. Results indicate significant spectral cross correlations with recruitment for a number of variables for each of the five major herring stocks at a few spectral frequencies. In most cases, the Aleutian low and atmospheric forcing are dominant factors in describing herring recruitment fluctuations. It remains to develop a model that incorporates these effects to provide accurate forecasts of recruitment based on these climatic indices.

9AM2000 W2-222 oral  
**TRENDS IN PACIFIC HERRING POPULATIONS OF BRITISH COLUMBIA**

Jake Schweigert

*Pacific Biological Station, 3190 Hammond Bay Road, Nanaimo, B.C., Canada. V8L 4B2 e-mail: SchweigertJ@pac.dfo-mpo.gc.ca*

Pacific herring populations within the west coast of Canada consist of five distinct stocks. Fluctuations in the abundance of these five stocks has been synchronous in the northern three and in the two southern populations. However, in recent years recruitment to the outer coast stocks has been reduced, possibly due to increased predation associated with warm water conditions. Recruitment to the Strait of Georgia has been unusually high for the past decade. It remains unclear whether the productivity is more strongly related to food availability or predation pressure in these areas. In this paper, I examine the available zooplankton time series in relation to herring survival and recruitment to these stocks.

9AM2000 S1-224 oral  
**SPATIAL AND TEMPORAL VARIABILITY OF LARGE SCALE FRONTS: IMPACTS ON THE LIFE HISTORY AND ECOLOGY OF SHORT-LIVED SPECIES IN THE CENTRAL NORTH PACIFIC TRANSITION ZONE**

Michael P. Seki

*Ecosystem & Environment Investigation, National Marine Fisheries Service, NOAA, Honolulu Laboratory, 2570 Dole Street, Honolulu, HI 96822-2396, U.S.A. e-mail: mseki@honlab.nmfs.hawaii.edu*

Large scale fronts and associated frontal zones in the open ocean have profound effects on the distribution of pelagic animals. These basin scale features form the boundaries that divide some of the large, core pelagic biogeographic provinces yet are also recognized as regions of convergence and where life forms on all trophic levels are concentrated and support feeding and spawning aggregations. In the North Pacific, the largest and most conspicuous of these systems are the Subarctic (SAFZ) and Subtropical (STFZ) Frontal Zones that bound the Transition Zone (NPTZ). Many of the NPTZ keystone species, including the Pacific pomfret, *Brama japonica*, and the flying squid, *Ommastrephes bartramii*, undergo extensive seasonal migrations northward during summer months to feed along the SAFZ and southward during the winter and spring to spawn in the STFZ. The strong affinity of these short-lived animals to the frontal zones, particularly with regards to spawning and ontogenetic growth at the STFZ, leave them vulnerable to prevailing climate and resultant Ekman convergence that drives the subtropical frontal system.

Information furnished by a recent series of hydrographic surveys through the STFZ and concurrent satellite remote sensing have enabled a detailed recharacterization of the structural patterns and coupling of the physics and the biology associated with the subtropical fronts during the spring when many of the NPTZ keystone species occupy the region. Large interannual variability in latitudinal position and intensity of the individual STFZ fronts was observed between survey years; conceivably, the very strong 1998 El Niño and subsequent 1999 La Niña may likely have had a large role in observed patterns.

Patterns of distribution and abundance and life history of seasonally migrating species are described with respect to the environment and discussed within the context of spatial and temporal variability of large scale fronts.

9AM2000 S4-225 oral  
**AN APPROACH OF DMSP/ OLS SATELLITE IMAGERY AND GIS TECHNOLOGY TO STUDY ON DYNAMICS OF PACIFIC SAURY MIGRATION**

Bambang Semedi, Sei-ichi Saitoh, Kunisaburo Yoneta and Hidedata Kiyofuji

*Graduate School of Fisheries Sciences, Hokkaido University, Minato cho 3-1-1, Hakodate, Japan. 041-8611 e-mail: bambang@salmon.fish.hokudai.ac.jp*

The OLS (Operational Linescan System) sensor of the DMSP (Defense Meteorological Satellite Program) satellite can observe the lights through visible-near infrared (VNIR) channel image in the night time such as light from fishing fleets of Pacific saury. OLS thermal infrared (TIR) channel image can observe the distribution of sea surface temperature. We analyzed fishing ground distribution of Pacific saury based on daily, 10 days, monthly and annually OLS visible image data set in Autumn, 1994, 1995 and 1996 to study on dynamics of Pacific saury migration. We employed GIS (Geographical Information System) technology to provide information on spatial analysis. Analysis image of OLS visible-near infrared showed that formation and intensity of fishing fleet lights were different from time to time. Many fishing fleets aggregated in the colder side of Oyashio fronts and cold streamers. Fishing fleet lights were mostly occurred in areas where the SST (Sea Surface Temperature) ranged 14-18°. This approach was useful to indicate the short-term change of fishing locations, the annual variability of fishing ground formation and the relationship between fishing ground distribution and oceanographic conditions such as SST and ocean fronts. Different with 1994 and 1996, in 1995 saury fishing grounds tended to distribute offshore. These results might assist to understand the dynamics of Pacific saury migration and to clarify their southward migration routes.

9AM2000 MEQp226 poster  
**INTERANNUAL VARIABILITIES IN THE REPRODUCTIVE STRATEGY OF *Laminaria japonica* (ARESCH) (PHAEOPHYTA), JAPAN SEA**  
Tatyana V. Shaposhnikova and Natalya V. Ivanova  
*Pacific Research Fisheries Centre (TINRO-Centre), 4 Shevchenko Alley, Vladivostok, Russia. 690600 e-mail: root@tinro.marine.su*

*Laminaria japonica* (Aresch), Phaeophyta is the traditional target and forms kelp with other macrophytes in the coastal waters of the Japanese Sea up to 50° N.L.

The habitat of species is conditionally differentiated for 3 main patches (southern, central, northern) characterized by peculiarities of *Laminaria japonica* growth and reproduction.

In the southern coast (41-43° N.L.) *Laminaria japonica* is characterized by a low degree of variability of morphological indications, early stopping of growth and short period of the reproductive tissue formation. Plants with morphological indications of the southern population but more prolonged period of reproductive tissue ontogenesis (3,5-4 months) occur in the central part of coast (43-46° N.L.). In the north (46-48° N.L.) *Laminaria japonica* is of high degree of morphological indications variability, long period of sporogenesis (4-5 months) at the background of continuing growth.

In 1997 it was revealed the backlog of zoospores appearance terms and reduction of reproductive tissue development period up to 2 months in the southern areas and early mass zoospores appearance and shortened ontogenesis term up to 2,2-3 months in the north.

Thus, in 1997 in the southern Primorye coast it has been formed *Laminaria* generation of bad harvest. In central and northern Primorye, the sharp decrease of stocks are not marked. The possibilities of *Laminaria japonica* population state forecasting on the base of complex analysis of interannual changes of coastal waters thermic and response reactions of ecosystems are discussed.

9AM2000 POCp227 oral  
**PRELIMINARY RESULTS OF DIRECT MEASUREMENTS OF THE CURRENTS IN THE LA PEROUSE (SOYA) STRAIT**

George V. Shevchenko<sup>1</sup> and Gennady A. Kantakov<sup>2</sup>

<sup>1</sup> *Institute of Marine Geology & Geophysics (IMGG), Russian Academy of Sciences, Yuzhno-Sakhalinsk, Russia. 693016 e-mail: sunami@sakmail.sakhalin.ru*

<sup>2</sup> *Sakhalin Research Institute of Fishery & Oceanography (SIFO), e-mail: okhotsk@tinro.sakhalin.ru*

The La Perouse (Soya) Strait and its adjacent areas are good fishing grounds, but understanding of dynamical processes has been very limited because current measurements has not been conducted. As part of the cooperative Russian-Japanese La Perouse Project, SIFO in 1996-1998 made several *in situ* experiments to measure parameters of the Tsushima and West-Sakhalin currents near Moneron Island.

To develop this project, SIFO installed 2 current meters here at 22 February 1999 at the horizons 15 and 45 meters. Duration of observations were about 4 month in the upper layer and about 6 month at the horizon 45 m. The maximal velocities is about 2,5 m/s (east-directed) and 2 m/s (west-directed currents).

Least square method had been used to estimate tidal harmonic constants. Tidal currents are mainly barotropic. Diurnal tidal O1 and K1 currents are predominate, their magnitudes are about 1 m/s.

Oscillations of residual currents were very strong: maximal east-directed velocities are about 1,5 m/s, and west-directed velocities were about 1 m/s. This moment of "turn back" of the Soya Current is very interesting, it connected with cyclone that crossed Hokkaido Island 5-6 March 1999.

We estimated the linear trends of residual currents. It is interesting, that east-directed component was increased during February-June with the average speed 0.5 (cm/s) /day, total change of the current velocity is more then 50 cm/s. Probably, this effect was connected with seasonal sea level changes in the Japan and Okhotsk Seas.

9AM2000 S1-228 poster  
**INFLUENCE OF OCEANOLOGICAL CONDITIONS ON FORMATION OF CONCENTRATIONS OF THE FEEDING JAPANESE FLYING SQUID (*Todarodes pacificus*) IN THE SOUTH KURIL REGION**  
Gennadiy A. Shevtsov and Yury V. Novikov  
*Pacific Research Fisheries Centre (TINRO-Centre), 4 Shevchenko Alley, Vladivostok, Russia. 690600 e-mail: root@tinro.marine.su*

Fluctuations in abundance and catches of *Todarodes pacificus* during feeding period, and variability of oceanological conditions in the south Kuril region have been studied.

Data from scientific trawl and jigger catches, and oceanographic data obtained by Russian and Japanese R/V's in the south Kuril region (144-151 E, 41-45 N) in August-September 1996-1999 were used. A technique designed in TINRO-Centre was applied for assessment of abundance and biomass of *T. pacificus*.

*T. pacificus* occurred in the transformed subtropical, subarctic waters and in small quantities in Oyashio water. The most dense aggregations and catches were observed in the subarctic water near the Oyashio front. Total number of the squid amounted 627 mln. individuals in 1996, 390 mln. - in 1997, 3 mln. - in 1998, 15 mln. - in 1999, and biomass - 119 th. t in 1996, 74 th. t - in 1997, 0.6 th. t - in 1998 and 1.6 th. t - in 1999.

Such a sharp decline in abundance and biomass, over two orders of magnitude, was probably related to variability in oceanological conditions, since the south Kuril region is an extreme of *T. pacificus* distribution area. Basing on oceanographic data in August-September 1996-1997, the Oyashio Current (especially its first branch) was well expressed and occupied a nearshore position. The transformed subtropical water was observed in the south of the region. Most of the area was occupied by the subarctic water, which is favorable for feeding and fishing for *T. pacificus* (mean CPUE was 25.1 individuals per jigging machine per hour in 1996, and 5.7 - in 1997; *Tankai maru*).

In 1998-1999 in connection with the approach of warm anticyclonic eddy and inflow of warm subtropical and transformed subtropical waters in southwestern part of the region, the zone of the subarctic water considerably reduced. The Oyashio Current was markedly depressed, and its first branch was weakly expressed or was totally absent. These conditions, probably, hindered penetration of the squid shoals into the region, and hence feeding concentrations of the squid were sparse (mean CPUE was 0.41 individuals per jigging machine per hour in 1998, and 0.34 - in 1999; *Tankai maru*).

9AM2000 S5-322 oral

#### SUBSURFACE CIRCULATION MEASURED WITH PALACE AND APEX FLOATS IN THE WESTERN SUBARCTIC REGION OF THE NORTH PACIFIC

Nobuyuki Shikama, Ikuo Kaneko and Takanori Iwao

*Oceanographic Research Department, Meteorological Research Institute/JMA, 1-1 Nagamine, Tsukuba, Ibaraki, Japan. 305-0052 e-mail: nshikama@mri-jma.go.jp*

Fifteen subsurface floats (ten PALACEs and five APEXs) were deployed in the Oyashio/Kuroshio mixed water region in 1998-99 to track the NPIW (North Pacific Intermediate Water). Following results are obtained.

1. Mean velocities, eastward at  $3.0 \pm 10.4$  cm/s and northward  $0.1 \pm 9.9$  cm/s, are obtained from the tracks of all floats. Meridional velocity variance is comparable with zonal one.
2. Three floats drifted northeastward along the Oyashio Front at depth of 410-490m with a maximum velocity of 17-20 cm/s, which is consistent with the geostrophic velocity referred to 1500 db calculated by Kono (1996).
3. After drifting along the Oyashio Front, one float are wandering about in the area 46-47N, 162-164E. This area corresponds to the core of the Western Subarctic Gyre according to the mean subsurface circulation based on the Hydrobase.
4. Five floats drifted along the Kuroshio with maximum velocities of 20-35 cm/s at 540-670m and 57 cm/s at 390m.
5. Only one float permanently crossed the Kuroshio from the mixed water region to the subtropical, trapped in a cold eddy.
6. Float velocities are compared with geostrophic ones at the time of deployment. Obtained correlation coefficient is 0.5-0.9.

9AM2000 POCp229 oral

#### DOES SEA ICE BRING HIGH PRIMARY PRODUCTION IN EARLY SPRING?

Ikutaro Shimizu, Jiro Seki, Yoshihiko Saito, Osamu Hiroi and Masaaki Aota

*National Salmon Resources Center, 2-4-1 Nakanoshima 2jo, Toyohira-ku, Sapporo, Hokkaido, Japan. 062-0922 e-mail: ikutaro@salmon.affrc.go.jp*

Nutrients and chlorophyll *a* concentrations in the north Nemuro Strait were determined to explain the relationship between sea ice and primary production in 1998 and 1999. The Nemuro Strait, a marginal sea of the southwestern Okhotsk Sea, covered with sea ice from January to March. During covered with sea ice nutrients (nitrate, phosphate and silicate) concentrations were higher than before sea ice coming alongside and after sea ice retreated. After sea ice retreated nutrients concentrations decreased and chlorophyll *a* concentration increased. The ratio of nutrients in the water under sea ice seemed like that of the Okhotsk Middle Cold Water (OMCW). These suggested that the water mass under sea ice, originated from OMCW, brought nutrients of high concentration utilized by phytoplankton after sea ice retreated. The integrated value of a spring bloom was greatly different between 1998 and 1999. In 1998 the peak of a bloom was higher and the period of a bloom was shorter than 1999. The retreat time of sea ice in 1999 (late April) was later than 1998 (early March). We thought that physical factors after sea ice retreated influenced the integrated value of a spring bloom. The relationships between a bloom and critical depth, nutrients, temperature and density were examined. In 1999 the density gradation in the water column was larger and the depth of mixed layer was shallower than 1998. The result suggested that the thickness of the upper mixed layer influenced on the integrated value of a phytoplankton bloom after sea ice retreated.

9AM2000 FISp230 poster  
**A DATA PROCESSING OF THE SEA BOTTOM SHAPE**  
Hyeon Ok Shin, Seung Chul Kim, Bo Kyu Hyang and Kyung Mi Kang  
Pukyong National University, Pusan, Republic of Korea. 608-737 e-mail: shinho@pknu.ac.kr

The data on the sea bottom shape is valuable information that is used to determine appropriation of set-net position and route of fishes or vessels, as well as construction of marine structure. This information was obtained by using the system that was composed of echo sounder, DGPS receiver, PC and surveying software. This study relates to the data processing of the sea bottom shape on surveyed area.

Raw data contains logging number as well as position and depth information, however, it needs compensation or edit because of several effect.

For depth data, the noises of bubble on sailing of vessel make abnormal data. In this case, it has to be corrected by comparing with recording sheet.

And for position data, the errors are occurred when DGPS mode changes to GPS mode. Positioning data has a curve exactly same as a wake of vessel, but if these errors occurs, it shows a different curve from the wake. Then we correct these errors to appropriate positioning values.

Tidal movement makes change of depth data. We got the sea level information of each hour with the sea level predicting system so that compensated the depth data.

In addition, there are another factors affecting the data like motion of vessel by rolling, pitching, heaving and change of sound velocity by sea temperature, salinity and depth degree. These should be compensated as well.

By using these methods, we could get contours of sea bottom about 5 fishing grounds in Namhae, Korea.

9AM2000 S6-231 poster  
**PLANKTONIC FOOD CHAIN DYNAMICS IN THE OYASHIO REGION, WESTERN SUBARCTIC PACIFIC**  
Akiyoshi Shinada, T. Ikeda and S. Ban  
Hokkaido University, Minatomachi 3-1-1, Hakodate, Hokkaido, Japan. 041-0821 e-mail: shinada@ihas.nagoya-u.ac.jp

Biomass of planktonic organisms, including autotrophs (cyanobacteria and phytoplankton) and heterotrophs (bacteria, heterotrophic nanoflagellates, micro-zooplankton and meso-zooplankton), phytoplankton growth and micro-zooplankton grazing were determined in July, October 1997, and January, March and May 1998 in the Oyashio region, western subarctic Pacific. The water column was stratified in July, October and May, and was well mixed in January and March. Phytoplankton biomass in the euphotic zone was high in October and May (138-418 mg C m<sup>-3</sup>) when diatoms (>10É m) dominated, but low in July, January and March (7.9-62.7 mg C m<sup>-3</sup>) when nano-phytoplankton (2-10É m) was abundant (63-81% of the total). Pico-phytoplankton (<2É m) was not abundant throughout the study period (<18% of autotroph biomass). Heterotrophic plankton biomass in the euphotic zone ranged from 27.6 to 248.8 mg C m<sup>-3</sup>. Bacterial biomass was high in July and May, though heterotrophic nanoflagellates were high only in July. Micro-zooplankton was abundant during the phytoplankton blooming period (October and May), in which naked ciliates were consistently the dominant component. Meso-zooplankton biomass was high only in May. Although phytoplankton growth rates ranged from 0.22 to 0.65 day<sup>-1</sup> without significant seasonal changes, micro-zooplankton grazing rates ranged from 0.09 to 0.57 day<sup>-1</sup> with micro-zooplankton composition, and size and quality of phytoplankton. Carbon flow diagrams within planktonic community, established from the data set including biomass, growth and grazing, suggests that primary production is channelled largely through the microbial food chain throughout the study period, and the grazing food chain is functional along with the microbial food chain only in spring diatom blooming period in May.

9AM2000 S7-232 poster  
**SELECTIVE FEEDING OF THE CALANOID COPEPOD *Calanus sinicus* ON THE NATURAL MICROPLANKTON ASSEMBLAGE, WITH SPECIAL REFERENCE TO MICROZOOPLANKTON**  
Tsuayoshi Shiotani and Shin-ichi Uye  
Graduate School of Biosphere Science, Hiroshima University, 1-4-4 Kagamiyama, Higashi-Hiroshima, Hiroshima, Japan. 739-8528 e-mail: tshio@hiroshima-u.ac.jp

The qualitative and quantitative aspects of feeding of the suspension-feeding planktonic copepod *Calanus sinicus* were investigated in ship-board experiments using natural microplankton assemblage from the Inland Sea of Japan and Ise Bay as food. *C. sinicus* ingested microplankton at rates from 1.7 to 28.8 µg C copepod<sup>-1</sup> d<sup>-1</sup>, which correspond to 2.1 to 32.7% of the body carbon. Among microplankton particles, diatoms were usually most dominant, followed by, in order, microzooplankton (i.e. naked ciliates, tintinnids and copepod nauplii) and dinoflagellates. Diatoms usually contributed the most and dinoflagellates constituted the least of the total ingested carbon. The contribution of microzooplankton ranged from 2 to 76%, and occasionally was higher than that of diatoms. Among microzooplankton groups, naked ciliates were usually the most dominant, comprising, on average,

74% of the ingested microzooplankton carbon. The selectivity of *C. sinicus* on these microplankton taxonomic categories was analyzed based on clearance rates on each group. Although *C. sinicus* demonstrated significant selectivity on naked ciliates over diatoms, it did not show any consistent selectivity among diatoms, dinoflagellates and microzooplankton, but fed on them rather non-selectively. Such a flexibility in the feeding of *C. sinicus* makes this copepod species utilize diverse food particles.

9AM2000 W7-379 poster  
**REGULATORY ASPECTS OF THE GROWTH AND CaCO<sub>3</sub> PRODUCTION OF MARINE COCCOLITHOPHORIDS BY NUTRIENT SUPPLY AND TEMPERATURE**

Yoshihiro Shiraiwa, Yoko Sugimoto-Hatano, Manami Sato and Joy M. Sorrosa  
*Institute of Biological Sciences, University of Tsukuba, 1-1-1 Tennoudai, Tsukuba, 305-8572 Japan e-mail: emilhux@biol.tsukuba.ac.jp*

Coccolithophorids are very important marine microorganisms for global carbon cycle because of their ability to fix a great amount of CO<sub>2</sub>. The algae possess two mechanisms for CO<sub>2</sub>-fixation, namely photosynthesis and calcification, and can occur in great abundance in the ocean. The most abundant species, *Emiliana huxleyi*, was frequently reported to occur in huge blooms, for example in Bering Sea (700 x 300 km and 50 m depth) in 1998. The mechanisms for inducing such blooms and its regulatory factors are strongly required to be solved. Therefore, physiological control of the growth and calcification of coccolithophorids was examined in *in vitro* study using *Emiliana huxleyi*. In the presence of high concentration of inorganic carbon sources stimulation of the coccolith production was observed, whereas the increase in cell number was suppressed to result in increase in cell volume. In contrast, at the seawater-level of inorganic carbons the coccolith-production was suppressed and the great increase in cell number of small and naked cells was observed. Such counter relationship between rapid growth of cells and high calcification was also observed when temperature and the concentration of nitrogen sources were changed. These results showed that the production of coccoliths is up-regulated by factors which increase in cell size, but is down-regulated by factors which induce rapid growth accompanying with the decrease in cell size. A model of the regulatory mechanism of cell growth and calcification will be presented to speculate physiological control of the blooms of *Emiliana* in the ocean.

9AM2000 MEQp233 oral  
**NEW DATA ON THE ANOMALOUS TRACE ELEMENT COMPOSITION OF COASTAL SEDIMENTS NEAR THE COPPER MINING DISTRICT (SANTA ROSALIA, B.C.S., MEXICO)**

Evgueni Shumilin<sup>1</sup>, Griselda Rodríguez-Figueroa<sup>1</sup>, Ofelia Morton Bermea<sup>2</sup>, E. Lounejeva Baturina<sup>3</sup>, F. Páez-Osuna<sup>4</sup>, D.Yu. Sapozhnikov<sup>5</sup> and Elizabeth Hernández<sup>2</sup>

<sup>1</sup> *CICIMAR-IPN, Av. IPN s/n, Col. Playa Palo de Sta. Rita. Apdo Postal 592, La Paz, B.C.S., México e-mail: eshumili@vmredipn.ipn.mx*

<sup>2</sup> *Institute of Geophysics, National Autonomous University of Mexico, Ciudad Universitaria, Mexico, D.F. C.P.04510*

<sup>3</sup> *Institute of Geology, National Autonomous University of Mexico, Ciudad Universitaria, Mexico, D.F. C.P.04510*

<sup>4</sup> *ICMyL UNAM, Estación Mazatlán, Sinaloa, México*

<sup>5</sup> *V.I. Vernadsky Institute of Geochemistry And Analytical Chemistry, Russian Academy of Sciences, Moscow, Russia*

Major and trace element concentrations within soils and coastal sediments of the Santa Rosalia mining district, collected in the autumn of 1997-98 were registered throughout ICP-MS and neutron activation analysis, which supplied the total concentrations of the ....elements. The anomalous levels of Cu, Co, Cr, Zn, Mn and Ba between others were found to be widespread in soils along the principal arroyos El Boleo, San Luciano and in coastal sediments directly in front of Santa Rosalia Harbor. being the result of the supplies from the natural erosion of volcanic rocks, which are outcropping in the area, and from de antropogenic activities (mining) that were present previously. The pattern of the distribution of Cu, Co, Zn and Ba in "spot" indicate the existence at least two point sources (Santa Rosalia and arroyo El Boleo) and the prevailing transport on contaminated sediments in southern direction along the shoreline.

9AM2000 W6-307 oral  
**CASE STUDIES FOR STOMACH AND SCAT ANALYSES: PINNIPEDS**

Elizabeth H. Sinclair, Anne York and George Antonellis  
*NOAA/National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115, U.S.A. e-mail: Beth.Sinclair@noaa.gov*

An analysis of prey remains from stomachs and colons of 43 northern fur seals illustrates the bias in basing diet studies on either stomachs or feces (scats) alone. This study arises from the much cited concern that prey remains might be variably concentrated in different chambers of the gastrointestinal (GI) tract according to type or size, and thus bias the interpretation of prey species, size, or age estimates based on scat remains alone. Preliminary results in this study indicate that both stomachs and scats, when viewed alone, potentially skew interpretation of the age class of fish consumed.



It is generally assumed that stomachs provide the best interpretation of predator diet, however scat analysis is a long-term tool in terrestrial predator-prey studies and has now been used in marine mammal trophic studies for over a decade. Diet studies based on fecal remains are limited in terms of providing volume and biomass estimates of prey consumed, but provide a reliable means of monitoring trends in predator diets. In addition, the need to euthenize animals for purposes of diet determination is alleviated.

The age distributions of walleye pollock (*Theragra chalcogramma*) from three chambers of the GI tracts of 43 adult female and juvenile northern fur seals (*Callorhinus ursinus*) were compared. Pollock ages were determined from otolith length to body length regressions after otolith lengths were corrected for wear. A repeated measure ANOVA (Wiener Experimental Design) was applied to examine the difference in otolith sizes between compartments averaged over individuals. The same test was applied to determine whether the quality of otoliths was equally spread among individual animals or was concentrated between a limited number of individuals.

This study is in the final stages of analysis and will be completed for presentation at the PICES workshop in October. Preliminary results establish the importance of examining prey remains from all chambers of the GI tract independently in freshly collected pinnipeds. For diet studies conducted on live animals, the study illustrates the value of combining collection techniques whenever possible (i.e. lavage with enema; scat with spewings) in order to provide a comprehensive representation of pinniped diet.

9AM2000 S3-234 poster  
**ONTOGENY AND PHYLOGENY OF APPENDAGES IN COPEPODID STAGES OF TORTANUS DERJUGINI SMIRNOV, 1935 (COPEPODA, CALANOIDA)**

Ho Young Soh, Hae-Lip Suh, Susumu Ohtsuka, Yang Ho Yoon and Sang Duk Choi  
*Faculty of Earth Systems & Environmental Sciences, 300 Yongbong-dong, Puk-gu Kwangju, Republic of Korea. 500-757 e-mail: hysoh@chonnam.ac.kr*

*Tortanus (Eutortanus) derjugini* Smirnov is partly redescribed from the estuarine system of Mankyung and Dongjin Rivers, western Korea. The present study has revealed that the species is common in Korean brackish waters. The fourth and fifth pedigers of *T. derjugini* are secondarily fused during molt to the adult. Homologies of segmentation, setation, and spinulation of the antennules and legs are also traced during the six copepodid stages. Antennular setation shows dimorphism first at CIV. Antennular compound segments are formed by secondary fusion during the molt to the adult. The exopod of leg 1 is divided into two segments without addition of any element during the molt into CII, while an inner seta on the segment is newly added during the molt into CIII. The pattern is different from those of *Drepanopus forcipatus* and *Oithona oculata* in which the division of the exopod is preceded by the formation of a spine, seta, or both occur at the same time. In the female leg 5 the segmentation and setation are not changed during the last three stages, while in that of the male some elements are suppressed during the final molt into the adult.

9AM2000 MEQp235 poster  
**RELATIONSHIP BETWEEN OIL EXPOSURE AND REPRODUCTIVE PARAMETERS IN FISH COLLECTED FOLLOWING THE EXXON VALDEZ OIL SPILL**

Sean Y. Sol, Lyndal L. Johnson, Beth H. Horness, Tracy K. Collier and John E. Stein  
*NOAA, NMFS, Environmental Conservation Division, 2725 Montlake Blvd. E., Seattle, WA 98112, U.S.A.*

Following the Exxon Valdez oil spill in 1989, the effect of oil exposure on reproductive parameters was investigated in wild populations of female dolly varden, yellowfin sole, and pollock. Exposure to oil was the highest in the first year of sampling and decreased in the subsequent years of sampling. Both positive and negative correlations between reproductive parameters and indices of exposure were detected to varying degrees for all three species. Reproductive parameters were not measured in the first year of sampling. For those parameters found to be significantly correlated to oil exposure, an exponential regression function was used to project reproductive parameters of fish sampled in the first year of the spill. A higher proportion of dolly varden sampled in 1989 were projected to have depressed plasma estradiol-17b compared to the fish sampled in 1990.

9AM2000 FISp236 poster  
**PECULIARITIES OF SEASONAL DYNAMICS OF FEEDING OF BLACK SEA URCHIN *Strongylocentrotus nudus***

Igor Yuryevich Soukhin  
*Pacific Research Institute of Fishery and Oceanography (TINRO-Centre), 4 Shevchenko Alley, Vladivostok, Russia. 690600 e-mail: root@tinro.marine.su*

In the period from April to August 1999, in Progulochnaya Bay, (Peter the Great Bay, Japan Sea) Black Sea urchin's peculiarities of feeding composition dynamics analysis was made. The digestion channel's content and the ratio of various species of algae in conditions of diverse algal communities at the capes and in the central part of the bay were examined. The Shannon-Winner's index of species diversity was calculated upon the results obtained.

Curves of dynamics' index of species diversity are of pronounced S-shape. The value of species diversity decreases within April-May, increases during May-July then its value decreases from July to August. The same tendency is common for all the test grounds, but one (the Skalysty Cape, high depth). Here a big amount of *Desmarestia* is in ration, which leads to decrease of species diversity index from May to August.

The species diversity growth within May-July, and its maximum before the spawning period, is of the largest interest. Unlike its decrease at August, it does not correlate to species diversity dynamics of algae. This period of time at different test grounds algal species diversity growth's decrease, or increase. It does not relate to increase of feeding intensity, which may have led to eating away the less preferable species. Our data let us consider that in July, before the spawning period, the black sea urchin changes its "spring" ration that is formed primarily by the *Ulva*, to "summer" one, the basic of which *Laminaria*, *Polysiphonia* and sometimes *Desmarestia* form.

In the algal communities the species diversity index does not have its maximum in July. The algae species ratio in those communities differs from it in the sea urchin's ration greatly, that relates to selective character of urchin's feeding. It is difficult to explain the changes in species diversity of nutrition exclusively by dynamics of development of algae in the benthic communities, even if we carry out analysis of phytomass' changes according to algae species. The *Ulva*'s share in the food allowances goes down basically along with the reduction of its phytomass, but the increase in consumption of *Polysiphonia* and *Desmarestia*, also occurs against a background of decline in their phytomasses.

Probably, the changes in feeding composition of the sea urchin are not exclusively determined by the dynamics of the algal communities. Evidently, there are another causes. Perhaps, the growth of species diversity in the period of time before spawning is necessary for accumulation of some substances in gonads, that are few or absent in the *Chlorophyta*, but are present in the *Rhodophyta* and *Phaeophyta*.

*Acknowledgments:* We would like to thank I.S. Gusarova for her material about algal communities.

9AM2000 W6-237 oral  
**ESTIMATING POPULATION SIZE OF SEABIRDS AT SEA**

Larry B. Spear

*H.T. Harvey & Associates, 906 Elizabeth Street, Alviso, CA 95002, U.S.A. e-mail: lspear@harveyecology.com*

Accurate estimates of the population size of seabirds are necessary for monitoring energy flow through marine systems. Monitoring of seabird population trends is also useful as these trends are good indicators of changes in ecosystem productivity and structure. Although seabirds are highly visible and thus relatively easy to survey, accuracy, as well as precision (and thus the ability to estimate population trends), when estimating abundance from at-sea survey data has been hampered by many factors. The primary problems affecting accuracy are: 1) bias due to flux, caused by the movement of flying birds (generally resulting in overestimation of true abundance); 2) too few observers conducting surveys at any given moment (usually resulting in undercounting); 3) the nonrandom distribution of seabirds at sea, coupled with nonrandom observer coverage of their pelagic ranges. Thus, at-sea surveys generally over-represent areas where abundance is atypical (i.e., either high or low). Finally, precision has been problematic because of the clustered nature of seabird distributions at sea, which results in high variances associated with abundance estimates. Inaccuracies in estimating abundance can be considerably reduced using 1) at least two observers on watch, and 2) a method of vector analysis (to deal with flux), which requires the recording of bird flight direction (relative to that of the ship) and knowledge of flight speeds. Analytical problems in the estimating of variance (related to the nonrandom, clumped distributions of seabirds at sea) can be vastly reduced through the use of generalized additive models (GAMs). Being model based, rather than sample based, inference from GAMs is not dependent on a random survey design. Compared to linear models, gains in precision are due to the fact that GAMs closely fit complex nonlinear functions in seabird density, while using only a few parameters (e.g. latitude, longitude, ocean depth).

9AM2000 S8-238 oral  
**PICES VANCOUVER HARBOUR PRACTICAL WORKSHOP RESULTS: ASSESSMENT OF CHEMICAL CONTAMINANT EXPOSURE AND EFFECTS IN ENGLISH SOLE**

Carla M. Stehr, Mark Myers, Dan Lomax, Richard Boyer, Sylvester Spencer and John Stein

*Northwest Fisheries Science Center, NOAA, 2725 Montlake Boulevard East, Seattle, WA 98112, U.S.A. e-mail: Carla.M.Stehr@noaa.gov*

The Practical Workshop held in Vancouver Harbour in the summer of 1999, provided an opportunity for scientists from PICES member countries to cooperatively study the ecological impacts of contaminants on benthic invertebrate and fish communities. As part of this workshop, our laboratory examined chemical concentrations in sediment, and in bile and liver of English sole. English sole is a benthic flatfish used extensively as a sentinel species for contaminant effects in North American west coast marine environments similar to Vancouver Harbour. Three industrial sites within Vancouver Harbour, and two reference sites within or near the Harbor were sampled. Sediment concentrations of aromatic hydrocarbons were higher at all three industrialized sites, and chlorinated hydrocarbons were higher at the two industrial sites closest to the inner Harbor. PCBs and HCBs in fish liver were

significantly higher at all three industrial sites compared to the control sites. English sole bile concentrations of aromatic hydrocarbon metabolites fluorescing at benzo[a]pyrene wavelengths (BaP FACs) were significantly higher at all three industrial sites compared to the reference sites. Histopathology of English sole liver was also examined as a biological marker of contaminant effects. Toxicopathic liver lesions were observed in 20 to 23% of the fish at each of the three industrial sites, while no lesions were observed at either of the two reference sites. Toxicopathic liver lesions were most strongly correlated with BaP FACs in the bile and aromatic hydrocarbons in sediment, consistent with the hepatocarcinogenicity and hepatotoxicity of high molecular weight polycyclic aromatic hydrocarbons.

9AM2000 S1-239 poster

**INTERANNUAL VARIABILITY OF EASTERN BERING POLLOCK (*Theragra chalcogramma*) RECRUITMENT AND DISTRIBUTION IN THE PERIOD NORTH PACIFIC CLIMATE SHIFT OF 1990S**

Mikhail A. Stepanenko and Alexander V. Nikolaev

*Pacific Fisheries Research Center (TINRO-Center), 4 Shevchenko Alley, Vladivostok, Russia. 690600 e-mail: root@tinro.marine.su mlstepanenko@mail.primorye.ru Nikolaev@mor-info.x400.rosprint.ru*

During last three years, great interannual variability has occurred in the physical environment over the Bering Sea.

By the end of 1990s great interannual variability has occurred in the oceanological environment over Bering Sea connected with climate shift in the North Pacific. In 1995-1997 sea temperature and ice extension were close to average. In 1998 SST decreased and ice extension was most significant for last 20 years but the depth temperature was closer to condition observed in the early 1980s. In contrast to 1997-1998, 1999 was extremely cold. The water column remained cold (- 0.5 - 1.0°C) until July and began to warm just middle summer but sea surface temperature was unusually cool in July-August. Sea ice appeared early and persisted into early summer.

In 2000 temperature and ice coverage in the eastern Bering Sea was close to the warm period in the 1977-1989.

Trend of increasing eastern Bering Sea pollock population is stable as result of relatively strong 1995-1997 year-classes. Abundance of 1996 year-class is 35% of total population abundance and 28% of the total biomass and combined abundance of 1995 and 1997 year-classes is 32.4% and biomass -18.5% relatively.

Annually significant part of eastern Bering Sea pollock population distribute in the northwestern shelf but in contrast previous years in 1999 scale of pollock feeding migration to the northwest was much less as average. The echo integration - trawl survey biomass estimation for 1999 is 3.30 mln.m.t. up to 27% from 1997. Total eastern Bering Sea pollock biomass is 6.87 mln.t. Abundance of 1998 and 1999 year-classes estimated below average according to survey preliminary data.

9AM2000 S5-240 oral

**DYNAMIC HEIGHT VARIATIONS OF THE KUROSHIO CURRENT SYSTEM**

Alice C. Stuart-Menteth, A. Ostrovskii and T. Yamagata

*Southampton Oceanography Centre, Empress Docks European Way, Southampton, Hampshire, United Kingdom, SO14 3ZH e-mail: astuart\_menteth@hotmail.com*

A reanalysis of hydrographic data from 1950-1998, concerned with the feasibility of the Kuroshio Observation Project (KOP), by Frontier Observational Research System for Global Change (Tokyo), is carried out. The principal data set is World Ocean Atlas 1998. Dynamic height maps of 0.5 degree resolution are produced for the Kuroshio current system with the aim to reveal the general dynamics characteristic of seasonal and decadal signals. Seasonal maps are presented along with maps for the Kuroshio large meander and non-meander years and for years before and after the reported climate shift in 1978. To estimate the strength of the signals, each of these maps are compared to the earlier result by Hasunuma and Yoshida (1978). Comparisons show that the long-term mean field is strongly biased by the summer signal and is also influenced by secular variability. The study reveals the importance of the dynamics east of Taiwan and suggests that the large meander events may be preceded by the emergence of a large anti-cyclonic eddy east of the island. The fluctuation of the dynamic height derived from ERS and TOPEX/POSEIDON altimetry data is also discussed. We highlight the need for more observations in the upstream Kuroshio region, in order to study the eddy - current interaction in closer detail, as envisaged by the KOP. A relationship between dynamic height and the vertical acoustic travel time, derived from the hydrographic data, is evaluated throughout the study area. It is shown that the signal-to-noise ratio is sufficient to get reliable data from the Inverted Echo Sounder observations planned for the KOP.

9AM2000 S1-241 oral  
**BEHAVIOR OF WARM STREAMERS AND SURFACE DRIFTERS IN THE KUROSHIO-OYASHIO TRANSITION REGION**

Takashige Sugimoto, Susana Sainz-Trapaga, Sachihiko Itoh and Hee Yong Kim  
*Ocean Research Institute, University of Tokyo, 1-15-1 Minamidai, Nakanoku, Tokyo, Japan. 164-8639 e-mail: sugimoto@ori.u-tokyo.ac.jp*

Warm streamers in the Kuroshio-Oyashio transition region play important roles not only in the northward migration of pelagic fish, but also northward larval transport in spring and summer. While cold streamers play in the southward migration of pelagic fish, as well as in the transport of cold, less saline and nutrient rich Oyashio water toward south. Behavior of these warm and cold streamers in the Kuroshio-Oyashio transition region were investigated by using trajectories of surface drifter and satellite thermal images.

It was found that (1) warm streamers from the ridge of the frontal wave detrained frequently northward from the ridge of the quasi-stationary meandered path of the Kuroshio Extension; (2) about a half of the surface drifters in the frontal zone detrained northward, whose rate is much higher than those which were expected in the main current region; (3) Warm-core rings in the transition region entrain warm streamers toward north, enhancing encounter rate of prey and predator.

9AM2000 S5-241 oral  
**A SERIES OF MID-DEPTH ZONAL FLOWS IN THE PACIFIC INDUCED BY WINDS**

Nobuo Suginohara and H. Nakano  
*Center for Climate System Research, University of Tokyo, 4-6-1 Komaba, Meguro-ku, Tokyo, Japan. 153-8904 e-mail: nobuo@ccsr.u-tokyo.ac.jp*

A series of mid-depth zonal flows in the Pacific is, for the first time, reproduced in a 1x1 degree, 40 vertical levels world ocean model. The spatial distribution of the zonal flows at 2500 m is remarkably similar to that seen in Reid's (1996) adjusted steric height map. And along 140 W, its latitudinal distribution is surprisingly identical to that derived from 3He measurements (Lupton, 1998), i.e., a series of the zonal flows is roughly symmetrical with respect to the equator; and it consists of an eastward flow at the equator, westward flows around 10 degrees, eastward flows around 20 degrees, and westward flows around 30 degrees. Effects of hydrothermal vents are not taken into consideration in the present model. It is demonstrated that most of its distribution is accounted for by wind-driven circulation which reaches down to several thousand meters even at low and middle latitudes. A formation mechanism of the mid-depth zonal flows as wind-driven circulation is simply explained by linear response theory with Rossby wave damping. Since zonal flows associated with thermohaline circulation at 2500 m are those of the inverse Stommel and Arons' pattern, i.e., they are westward at low and middle latitudes, the thermohaline circulation intensifies the westward flows but it weakens the eastward flows.

9AM2000 S3-243 poster  
**SEASONAL VARIATION OF TROPHIC RELATIONSHIPS BETWEEN MICRONEKTON AND MACROZOOPLANKTON OFF EASTERN JAPAN**

Hiroya Sugisaki  
*Tohoku National Fisheries Research Institute, 3-27-5 Shinhana-cho, Shiogama, Miyagi, Japan. 985-0001 e-mail: sugisaki@myg.affrc.go.jp*

Myctophid fish are abundant micronekton in oceanic area. Their diel vertical migration are well known feature. They feed on macrozooplankton, and they are important food for large fish and marine mammals. Therefore, the vertical migration and predator-prey relationships of myctophids potentially play an important part in the transfer of organic matters from productive euphotic zone to deeper layers. Since seasonal variation of primary production is clear off eastern Japan, the transportation of organic matters may show seasonal change, though the pathways of organic matters through the food web are still unknown.

Micronekton and macrozooplankton were sampled by MOCNESS, and the gut contents and natural abundances of carbon and nitrogen stable isotope ratios of dominant species were analyzed. The significant difference of carbon isotope ratio of organisms collected at epipelagic layers and mesopelagic layers during spring and summer was observed, while the difference was few during fall and winter. It means that the exchange of organic matters between epipelagic community and mesopelagic community during spring and summer was less than during fall and winter. Myctophids that ascent to epipelagic layers at night mostly consumed organic matters of epipelagic layers during spring and summer, though they seem to consume the organic matters in both epipelagic and mesopelagic layers during fall and winter. The epipelagic layers of study area are known as a nursery ground for commercial fish. The broad pathway of organic matters from primary production to myctophids may cause an impact for survival of larval fish.

9AM2000

S1-332

poster

**THE RELATIONSHIP BETWEEN THE OCEAN COLOR FROM THE SeaWiFS SATELLITE AND CHLOROPHYLL *a*, AND SUSPENDED SOLID IN THE CLEAR WATERS AND THE TURBIDITY WATERS AROUND KOREAN PENINSULA**

Young Sang Suh, Sam Guen Lee, Lee Hyun Jang and Hyun Ju Oh

National Fisheries Research & Development Institute, Kijang, Pusan, Republic of Korea. 619-900 e-mail: yssuh@nfrdi.re.kr

The consequent development of higher concentrations of phytoplankton changes the color from blue to green in the clear waters and the open sea (Case I waters, the eastern sea of Korea, the Kuroshio regions in the northeastern part of the East China Sea).

As one moves even closer to shore, the situation becomes much more optically complicated, with contributions not only from higher concentrations of phytoplankton, but also from sediments and dissolved materials from terrestrial and inland sources. The color often approaches yellow-brown in the turbidity waters (Case II waters, the western sea of Korea, the Yellow Sea, the northwestern part of East-China Sea near the Yangtze River).

However, the situation is somewhat more complicated, it is necessary to consider not only oceanographic, but also atmospheric calibration and validation to interpret the observations of the ocean from space.

In this study, we used SEABAM (SeaWiFS Bio-optical Mini-Workshop) algorithm to estimate the chlorophyll *a* distribution around the Korean waters using Orbview/SeaWiFS satellite data (McClain, 1997).

We studied to find out the relationship between the measured chlorophyll *a* and the estimated chlorophyll *a* from the SeaWiFS satellite data around Korean waters during October-December, 1999 and February-April, 2000.

The relationship between the measured chlorophyll *a* and the SeaWiFS chlorophyll *a* shows the following equations (1 and 2) in the Eastern Sea (Sea of Japan) and the Western Sea of Korea (the southeastern Yellow Sea).

$$\text{Chl} = 0.278\text{Ln}(X) + 0.67, R2 = 0.82 \text{ (Case I waters, the eastern sea of Korea)} \quad (1)$$

$$\text{Chl} = 0.241\text{Ln}(X) + 0.47, R2 = 0.74 \text{ (Case II waters, the western sea of Korea)} \quad (2)$$

In case of suspended solid of ocean color parameters, a suspended solid algorithm was composed with in-situ data obtained in study areas of Korean waters and remote sensing reflectance obtained from the ratio ( $nL_w(490\text{nm})/nL_w(555\text{nm})$ ) of the SeaWiFS wavelength bands.

The relationship between the measured suspended solid and the SeaWiFS band ratio shows in the following equations (3 and 4) in the eastern sea and the western sea of Korea.

$$\text{SS} = 0.191 \text{Ln}(X) + 2.11, R2 = 0.11, \text{ (Case I waters, the eastern sea of Korea)} \quad (3)$$

$$\text{SS} = -36.75 \text{Ln}(X) + 43.93, R2 = 0.82, \text{ (Case II waters, the western sea of Korea)} \quad (4)$$

9AM2000

FISp244

oral

**ANNUAL CHANGE OF THE SIZE IN EACH YEAR CLASS OF PACIFIC SAURY (*Cololabis saira*) ESTIMATED BASED ON THE HYALINE ZONE IN THE OTOLITH**

Satoshi Suyama<sup>1</sup>, Yutaka Kurita<sup>1</sup>, Yoshihiko Kamei<sup>2</sup>, Yoshiyuki Kajiwara<sup>2</sup> and Yasuhiro Ueno<sup>1</sup>

<sup>1</sup> Hachinohe Branch, Tohoku National Fisheries Research Institute, Same, Hachinohe, Aomori, Japan. 031-0841 e-mail: suyama@myg.affrc.go.jp

<sup>2</sup> Faculty of Fisheries, Hokkaido University, Japan

Pacific saury, *Cololabis saira*, is one of major pelagic fishes in the North Pacific and is also important species for commercial fisheries. The methods of the age and growth estimation of Pacific saury have not been established yet, although many studies were performed. The size composition of Pacific saury annually changes drastically. We examined the hyaline zone of otoliths and body sizes of Pacific saury collected during 1990 to 1999 in the North Pacific. We confirmed that the hyaline zone indicates the experience of wintering of the individual. Using the hyaline zone as the key of the age determination, we divided the fish into each year class. The annual size differences of each year class were significantly large. This suggests that the growth rate among the year classes fluctuated every year and may explain why drastic changes of annual size compositions occurred.

9AM2000 W7-380 poster

**METADATA FOR CO<sub>2</sub> AND RELATED OCEANOGRAPHIC DATA IN JAPAN**

T. Suzuki<sup>1</sup>, K. Goto<sup>2</sup>, M. Ishii<sup>3</sup>, T. Miyake<sup>4</sup>, A. Murata<sup>5</sup>, Y. Nojiri<sup>6</sup>, S. Oguma<sup>1</sup>, T. Ono<sup>7</sup>, T. Saino<sup>8</sup>, F. Shimano<sup>6</sup>, Y. Tsurushima<sup>9</sup>, S. Watanabe<sup>10</sup> and Y.W. Watanabe<sup>9</sup>

<sup>1</sup> Marine Information Research Center, Japan Hydrographic Association, Mishima Bldg. 5F, 7-15-4, Ginza, Chuo-ku, Tokyo 104-0061, Japan e-mail: suzuki@mirc.jha.or.jp

<sup>2</sup> Kansai Environmental Engineering Center Co., Ltd. (Kanso)

<sup>3</sup> Meteorological Research Institute (MRI)

<sup>4</sup> Japan Oceanographic Data Center (JODC)

<sup>5</sup> Japan Marine Science and Technology Center (JAMSTEC)

<sup>6</sup> National Institute for Environmental Studies (NIES)

<sup>7</sup> Frontier Observational Research System for Global Change (FORSGC)

<sup>8</sup> Nagoya University

<sup>9</sup> National Institute for Resources and Environment (NIRE)

<sup>10</sup> Hokkaido University

We constructed metadata (data about data) for CO<sub>2</sub> and related oceanographic data in the North Pacific region observed by Japanese oceanographic organizations in order to enlighten about the status and activity of chemical oceanography in Japan and distribute CO<sub>2</sub> and related data to researchers. The metadata includes not only inventory information but also the contents, quality, condition, and other characteristics of data in each cruise of Japanese research vessels. The bottle sampling data of recent research projects such as KNOT (Kyodo Northwestern Pacific Ocean Time series), NOPACCS (North Pacific Carbon Cycle Study), P1 and P2 lines revisit of WOCE (World Ocean Circulation Experiment), and the underway data by M/V *Skaugran* and *Alligator Hope* as monitoring project of Center for Global Environmental Research of NIES are available with the metadata through the Internet. In future the historical CO<sub>2</sub> and related data, especially observed by Universities, will be rescued and digitized from warehouses or bookshelves by mainly data management institute such as MIRC or JODC in cooperation with data originator.

9AM2000 S2-335 poster

**TEMPORAL VARIABILITY IN PREY CONSUMPTION BY BREEDING SEABIRDS IN THE CALIFORNIA MARINE ECOSYSTEM**

William J. Sydeman, Julie A. Thayer, and K.L. Mills

PRBO/Marine Science Division, 4990 Shoreline Highway, Stinson Beach, CA 94970, U.S.A. e-mail: wjsydeman@prbo.org

Seabirds are highly visible secondary and tertiary predators in marine ecosystems. Models of seabird prey consumption indicate that seabirds consume a large proportion of the available biomass of lower trophic-level organisms, particularly large zooplankton and the younger age classes of many pelagic fishes, and at rates comparable to marine mammals and human fisheries. However, empirical studies of interannual and longer-term variability of prey harvest are extremely rare. We have been studying prey consumption by locally breeding seabirds (families Laridae, Phalacrocoracidae, and Alcidae) in the California eastern boundary current system for 3 decades (1971–2000). Intraannual, interannual, and interdecadal variability in prey consumption for 4 alcid species (1 planktivorous and 3 piscivorous species) are described and related to changes in local oceanographic conditions and apparent prey availability. Long-term trends (declines and increases) in the consumption of certain prey species and size-classes of prey, and an apparent “regime-shift” in prey consumption in the late 1980s, have been revealed. Coupled with information on seabird population size and productivity (no. offspring to feed) one can estimate overall prey consumption values. Estimates of trophic impact by seabirds on mid trophic-level prey organisms will be significantly improved by determining seasonal, interannual, and decadal scale patterns of prey consumption by both resident and migratory birds.

9AM2000 S6-314 oral

**LONG TERM VARIATION OF CHL *a* CONCENTRATION, ZOOPLANKTON BIOMASS, AND THE HYDROGRAPHIC STRUCTURE IN THE OYASHIO WATER**

Kazuaki Tadokoro<sup>1</sup>, Toshiro Saino<sup>2</sup> and Takashige Sugimoto<sup>3</sup>

<sup>1</sup> Frontier Research System for Global Change, Summitomo Hamamatucho bldg. 4F, 1-18-16 Hamamatucho Minatoku Tokyo, Japan e-mail: denden@frontier.esto.or.jp

<sup>2</sup> Institute for Hydrospheric-Atmospheric Sciences Nagoya University, Furo-cho, Chikusa-ku, Nagoya, Aichi, Japan e-mail: tsaino@ihas.nagoya-u.ac.jp

<sup>3</sup> Ocean Research Institute University of Tokyo, 1-15-1 Minamidai Nakanoku Tokyo, Japan e-mail: sugimoto@ori.u-tokyo.ac.jp

Long term variation of plankton productivity in the Oyashio water was estimated by using oceanographic data collected by several Japanese research vessels and zooplankton data collected by Tohoku National Fisheries Institute. Chl *a* concentration was converted from Secchi Disc depth using the equation of Falkowski and Wilson (1992). The North Pacific climatic regime shift

occurred in 1976/77. Since its occurrence, SST and SSS in the Oyashio water decreased due to enhanced advection of cold and less saline waters from the Sea of Okhotsk and the northern part of the western subarctic North Pacific in Spring. This is contrasting to the eastern subarctic North Pacific where SST and SSS increased due to warm and saline surface water input from the south. It is well documented that the biological productivity of the eastern subarctic North Pacific increased since the 1976/1977 regime shift. However, it was observed, in the western subarctic North Pacific, that the Chl *a* concentration and zooplankton biomass decreased since mid 1970s in the Oyashio water. Recent studies indicated that the North Pacific climate entered into a new phase from 1989/90, and that the biological production (e.g. coho salmon and steelhead trout) synchronously decreased, while Chl *a* concentration of the Oyashio water increased since 1990. The possibility that the biological productivity regime in the Oyashio water in the western subarctic North Pacific is coupled with that of the eastern subarctic North Pacific will be discussed.

9AM2000 S7-245 poster  
**DOMINANT YEAR-CLASSES IN BROWN SOLE *Pleuronectes herzensteini***

Tetsuya Takatsu, Kazuo Imura and Toyomi Takahashi

Graduate School of Fisheries Sciences, Hokkaido University, 3-1-1 Minato, Hakodate, Hokkaido, Japan. 041-8611 e-mail: takatsu@fish.hokudai.ac.jp

To clarify recruitment variability of brown sole *Pleuronectes herzensteini* from year to year, age compositions, egg diameters, water temperatures, and larval food abundance in its spawning periods were investigated in Mutsu Bay. Immature and adult fish of brown sole was sampled with a Danish seine, an otter trawl net, and a small otter trawl net from June to October in 1977-1981, 1982-1992, and 1989-2000, respectively. Brown sole eggs, calanoid copepods, and *Oikopleura* spp. were collected by vertical hauls with a NORPAC net in April and June 1990-1998. Between 1977 and 2000, dominant year-classes of brown sole occurred in the cold springs of 1977, 1984, and 1991. Larger eggs of brown sole occurred in April 1991 than other years. Mean egg diameter showed a significantly negative correlation with mean water temperature at the spawning site in 1990-1998 ( $r=-0.76$ ,  $n=9$ ;  $P=0.018$ ), however no relationship with mean age of adult females (3+ and over). In June 1991, mean abundance of calanoid copepods and *Oikopleura* spp. was higher than other years. The match-mismatch hypothesis would be supported, and the larval size at the first feeding stage originated from large eggs and food abundance through their drifting and settling stages of larvae would be important for their survival. Low-water temperature might be a necessary, but not sufficient factor to cause the dominant year-classes.

9AM2000 S9-246 invited  
**WATER QUALITY CRITERIA TO MANAGE SUSTAINABLE AQUACULTURE IN JAPAN**

Kazufumi Takayanagi and Kazumasa Hirakawa

National Research Institute of Aquaculture 422-1 Nakatsuhamaura, Nansai, Mie, Japan. 516-0193 e-mail: kazufumi@nria.affrc.go.jp

Aquaculture production in Japan has been increasing since late 1950s and accounted for 20% of the total fisheries production in 1999. However, aquaculture in Japan may be confronting with environmental deterioration of aquaculture grounds caused by intensive fish culturing. In order to appropriately manage aquaculture activities and ensure sustainable aquaculture production, water quality criteria need to be established. Dissolved oxygen (DO) is the most fundamental parameter among them: oxygen is consumed not only by respiration of cultured fish but also by the bacterial degradation of organic matter. Therefore, the clarification of DO budget and DO variation mechanisms in the aquaculture grounds is essential for determining the appropriate capacity of fish farming and evaluating the assimilative ability of the pelagic ecosystem. By considering above, in "the Basic Guideline to Ensure Sustainable Aquaculture Production" established by the Minister of Agriculture, Forestry and Fisheries, DO has been chosen as the only indicator in water quality item. In this study, we will report some example of DO fluctuations in aquaculture grounds and suitable DO values for healthy growth of cultured fish. We will also discuss relationships between DO fluctuations in bottom waters and sediment sulfide concentration.

9AM2000 S2-247 oral  
**FOODS AND FEEDING HABITS OF CETACEANS, AND THEIR FOOD CONSUMPTION IN THE NORTH PACIFIC - ESPECIALLY WESTERN NORTH PACIFIC MINKE WHALES**

Tsutomu Tamura and Hiroshi Ohizumi

Institute of Cetacean Research, Tokyo Suisan Bldg.4-18, Toyomi-cho, Chuo-ku, Tokyo, Japan. 104-0055 e-mail: tamura@i-cetacean-r.or.jp

In the North Pacific, the cetacean species include 9 baleen whales and 32 toothed whales. Because cetaceans are top predators in the marine ecosystem and play an important role in the food web, it is important to understand their feeding ecology. The trophic role of cetaceans is particularly important as they are closely related with fisheries; cetaceans compete with man directly when they target as their food species of fish important in man's fisheries, or indirectly when cetaceans consume marine organisms that are

the prey of commercial species. I will briefly introduce the feeding ecology of cetaceans in the North Pacific. The contents of presentation are prey species, feeding type, feeding activity and prey consumption of cetaceans. Furthermore, I will introduce the recent interesting topic of competition between cetaceans and commercial fisheries.

For a concrete example, I will discuss the feeding ecology of western North Pacific minke whales *Balaenoptera acutorostrata* using data from 1994 to 1999 of JARPN (The Japanese Whale Research Program under Special Permit in the western North Pacific) surveys. The forestomach contents of 498 minke whales sampled in the western North Pacific from May to September between 1994 and 1999 were analyzed. Sixteen prey species consisting of 1 copepod, 4 euphausiids, 1 squid and 10 fishes were identified. I will briefly introduce the prey species, feeding type, feeding activity and prey consumption of minke whales.

9AM2000 S2-248 oral  
**PARTICLE INDUCED X-RAY EMISSION (PIXE) ANALYSIS OF TRACE ELEMENTS IN TEETH OF NORTHERN FUR SEALS**

Shino Tanaka, Nobuaki Arai, Wataru Sakamoto, Koji Yoshida, Norihisa Baba  
*Kyoto University, Kitashirakawa, Oiwake, Sakyou, Kyoto, Kyoto, Japan. 606-8502 e-mail: stanaka@kais.kyoto-u.ac.jp*

The northern fur seal *Collorhinus ursinus* is distributed widely in the northern North Pacific Ocean. They feed on squids and fish, especially epipelagic species. Levels of trace elements in calcified tissues of marine organisms differ according to the types of food consumed. For example, mammalian teeth are composed of hydroxyapatite  $\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$ , and contain three types of tissue, enamel, dentine and cementum. Since dentine and cementum are laid down constantly in layers throughout the life of an individual, trace elements in those layers, which are taken up from dietary sources under various physical and biological conditions, provide records of the past food habits of the animal. The trace elements in canine teeth of northern fur seals were analyzed by PIXE (Particle Induced X-ray Emission) to investigate impacts of regime shifts. Trace elements detected in the teeth included Ti, Cr, Mn, Fe, Cu, Br, Sr, Zn, As, Ni, Co and Zr (about 10-6600 ppm). No significant difference was detected between elemental concentration and the age or sex of an animal. Concentration patterns of eight elements (Mn, Fe, Br, Sr, Zn, As, Ni and Co) reflected the timing of regime shifts. Accurate statistical correlations were found in three elements, Mn, Fe and Zn, with high concentrations of these elements occurring during the period of high water temperature.

9AM2000 POCp249 oral  
**A METHOD TO MONITOR THE TOTAL VOLUME TRANSPORT OF THE SOYA WARM CURRENT USING COASTAL SEA LEVEL DATA**

Iori Tanaka and Akifumi Nakata  
*Hokkaido Central Fisheries Experimental Station, 238 Hamanaka-cho, Yoichi-cho, Yoichi-gun, Hokkaido, Japan. 046-8555 e-mail: tanakai@fishexp.pref.hokkaido.jp*

Since August 1995, volume transport of the Soya Warm Current had been tried to observe in the Soya Strait with ship mounted ADCP and moored current meters by the La Perouse Project for four years. From these data with coastal sea level data monitored at Wakkanai and Abashiri by the Japan Meteorological Agency, it becomes evidence that the Soya Warm Current is driven mostly by the sea level difference between the Sea of Japan and the Sea of Okhotsk. After August 1999, the observation line is shifted toward southeastward in the Sea of Okhotsk to observe, using the same method (ADCP), the total volume transport of the Soya Warm Current by Hokkaido Fisheries Experimental Station. A method to monitor the total volume transport of the Soya Warm Current using the coastal sea level data is now in construction, and the result will be presented at the meeting.

9AM2000 W2-251 oral  
**OIL, DISEASE AND FISHING AS FACTORS IN THE MULTIPLE COLLAPSES OF THE PRINCE WILLIAM SOUND HERRING POPULATION**

Gary L. Thomas and Richard E. Thorne  
*Prince William Sound Science Center, P.O. Box 705, Cordova, AK 99574, U.S.A. e-mail: loon@pwssc.gen.ak.us*

In 1993, the largest biomass of Pacific herring in history was predicted to return to Prince William Sound to spawn. Instead, there was a record low return. In the fall of 1993, we conducted an echointegration-purse seine assessment of the stock that confirmed the stock collapse to 20,000 MT. After a fall 1993 fishery, acoustic surveys showed the population to have further collapsed to 13,000 MT. With a moratorium on fishing, the population rebuilt to 23,000 MT and 38,000 Mt in the falls of 1995 and 1996, respectively. However, the acoustic surveys in the springs of 1998 and 1999 after reopening the commercial fishery showed the population to have collapsed again to about 17,000 MT. After test fishing in the spring of 1999, management cancelled the fishery. The spring survey 2000 showed the population to have fallen to a new, all-time low of 9,000 MT. Co-occurring with the collapses of the herring population in 1993 and 1997 were outbreaks of viral hemorrhagic septicemia. This suggests that the herring have a low immunity to disease after handling by fishing operations. Researchers have suggested the possibility of immune-system damage due to oil exposure in 1989. We present infrared observations of herring surfacing at night to replace air in their gas bladder as a plausible mechanism for oil exposure.



9AM2000 S7-252 oral  
**FROM GLOBEC-LIKE RESEARCH TO PHYSICAL-BIOLOGICAL NOWCAST-FORECASTING IN PRINCE WILLIAM SOUND, ALASKA**

Gary L. Thomas and Richard E. Thorne

*Prince William Sound Science Center, P.O. Box 705, Cordova, AK 99574, U.S.A. e-mail: loon@pwssc.gen.ak.us*

A GLOBEC-like program was implemented in Prince William Sound, Alaska, between 1993 and 2000. The objectives were to identify the dominant physical-biological features of the Sound, to develop new acoustic-optical techniques to assess ecosystem- and population-level changes, and to build numerical models to improve predictive capability. Between 1993 and 2000, we conducted 38 echointegration-purse seine/midwater trawl/plankton net surveys synoptically with an ecosystem-scale physical oceanography program to implement and verify a Princeton Ocean Model. We identified three dominant biomass in the pelagic ecosystem: walleye pollock, Pacific herring and Neocalanus copepods. Understanding the seasonal distributions of these dominant populations and identifying when they were the most contagious was key to making rapid, high-precision measurements of their biomass. The acoustic surveys of these dominant nekton and plankton populations also revealed repeatable distributional trends which correlate to physical structure. These results suggest that it may be necessary to measure the distribution of marine animal populations synoptically with ecosystem conditions to determine the physical-biological mechanisms that affect growth and survival. Furthermore, the scaling of physical and biological measurements proportional to the distribution of dominant nekton or plankton populations maybe a more efficient strategy to study marine ecosystem dynamics than that proposed by the original GLOBEC science plan. The results of this GLOBEC-like research and development program are being implemented as a nowcast-forecast system for Prince William Sound.

9AM2000 S2-253 poster  
**NOCTURNAL FEEDING BY STELLER SEA LIONS, HUMPBACK WHALES AND SEABIRDS ON HERRING AGGREGATIONS OVERWINTERING IN PRINCE WILLIAM SOUND, ALASKA**

Gary L. Thomas and Richard E. Thorne

*Prince William Sound Science Center, P.O. Box 705, Cordova, AK 99574, U.S.A. e-mail: loon@pwssc.gen.ak.us*

Since 1993, we have conducted echointegration-purse seine/midwater trawl surveys to assess the biomass of overwintering Pacific herring and walleye pollock in Prince William Sound, Alaska. Steller sea lions, humpback whales and seabirds were common in areas of herring schools, which is sharp contrast to areas where pollock aggregated which were relatively predator-free. Despite this co-occurrence of herring and the high numbers of piscivors, our daytime observations indicated little feeding activity until spawning in early spring. When we used infrared video during the nighttime acoustic surveys, we observed Steller sea lions, humpback whales and seabirds actively feeding on the herring schools. Steller sea lion pods were observed on the edge of the schools and often swam in a line, shoulder-to-shoulder, herding the herring. Humpback whales often were observed moving parallel to the line of Steller sea lions. Seabirds showed a positive correlation with herring density along transects, but gulls appeared to be limited to areas where sea lions were feeding or where herring were flipping at the surface. The near-surface vertical distribution of the herring at night best explains this winter feeding behavior. These observations suggest that herring is the primary forage fish used by these marine piscivors in Prince William Sound during the winter/early spring period.

9AM2000 W5-354 oral  
**PHYSICAL PROCESSES AFFECTING THE DISTRIBUTION OF IRON-FERTILIZED OCEAN WATER IN THE NORTH PACIFIC**

Richard E. Thomson

*Fisheries and Oceans Canada, Institute of Ocean Sciences, P.O. Box 6000, Sidney, BC, Canada. V8L 4B2 e-mail: ThomsonR@pac.dfo-mpo.gc.ca*

Modification of the upper ocean occurs through a variety of physical processes including wind and buoyancy forcing, advection, and turbulent diffusion. Proposed iron fertilization sites in the northwest and northeast Pacific are regions of marked upper ocean stratification, slow eastward flowing surface currents, and moderately weak turbulent dissipation. Mean surface currents in the region range from 1-5 cm/s (approx. 1-4 km/day) while the mean horizontal eddy viscosity ranges from roughly  $1.5 \times 10^7$  cm<sup>2</sup>/s in the meridional direction to  $2.5 \times 10^7$  cm<sup>2</sup>/s in the zonal direction. Decorrelation time scales for mesoscale (10 to 100 km) motions are around 2 to 3 days over associated spatial scales of 15 to 30 km. Although tidal currents are weak (diurnal and semidiurnal velocities are of order 1 cm/s) passing atmospheric fronts can generate strong (approx. cm/s), rapidly varying currents of 16-hour period that persist for several days to a week. These currents, combined with turbulent wind mixing and surface buoyancy (heat) flux, lead to short-term (< 1 day) variability in the surface mixed layer depth and to the formation of seasonal pycnoclines above the permanent pycnocline (approx. 100 m depth). The experimental sites may be impacted by packets of internal tidal waves formed near the Aleutian Islands and by the passage of westward propagating mesoscale eddies generated along the west coast of North America. Coupled ocean-atmosphere circulation models can assist in the retrospective analysis of the iron plume dispersion but presently lack the spatial and temporal resolution for accurate experimental design and prediction.

9AM2000            S4-254            oral  
**THE EFFECTS OF CLIMATE/OCEANIC CHANGES ON POPULATION DYNAMICS OF PACIFIC SAURY (*Cololabis saira*) IN THE NORTHWESTERN PACIFIC**  
Yongjun Tian, Taturo Akamine and Maki Suda  
*Marine Bioecology Division, National Research Institute of Fisheries Science, Fukuura 2-12-4, Kanazawa-Ku, Yokohama, Japan.*  
236-8648 e-mail: yjtian@nrifs.affrc.go.jp

The effects of changes in oceanic and climate environment on the population dynamics of Pacific saury (*Cololabis saira*) in the Northwestern Pacific were investigated. Catches of large and medium size saury, which are supposed spawned in Kuroshio waters in winter and in Mixed-water region in spring respectively, were used as abundance indices to relate to climate indices and sea surface temperature (SST). Although both the large and medium size saury exhibit large interannual variations in abundance, their trends are different. The large size saury has a strong positive correlation with SST in Kuroshio waters in winter, whereas the medium size saury shows relative high correlations with SST in Mixed-water region and Oyashio waters in July and in autumn. It seems that the survival rate of saury in the early life stage is largely determined by SST. And a significant negative correlation was found between the large size saury and the Southern Oscillation Index (SOI) with a lag of one year, while there is no relation between the middle size saury and the ENSO events. The Sub-tropical High Pressure Index (Sub High) in winter (summer) also has a positive (negative) correlation with large (medium) size saury compared with the mid- and high latitude atmosphere indices. The above results suggest that population dynamics of Pacific saury are influenced by climate/oceanic changes over the North Pacific from equatorial to mid- and high latitudes, however the sub-tropical environments have more strong effects compared with sub-arctic climate.

9AM2000            S6-255            poster  
**FORMATION OF CARBONATE CONCRETION IN METHANE VENTING AREA ON SEAFLOOR**  
Pavel Ya. Tishchenko<sup>1</sup>, A.N. Derkachev<sup>1</sup>, G.Yu. Pavlova<sup>1</sup>, E. Suess<sup>2</sup>, K. Wallmann<sup>2</sup>, G. Bohrmann<sup>2</sup> and J. Greinert<sup>2</sup>  
<sup>1</sup> *Pacific Oceanological Institute, 43 Baltiyskaya Street, Vladivostok, Russia. 690041 e-mail: tpavel@ocean.poi.dvo.ru*  
<sup>2</sup> *GEOMAR, Kiel, Germany*

Methane venting area is mostly attractive for study of alternative development of life in sea (without photosynthesis). Because chemosynthesis by means of bacteria can be regarded as primary production. One of the main feature of the methane venting area is occurrence of autigenic carbonate concretion.

Mineralogical and petrographic investigations were carried out for sediment cores LV28-20 and LV28-21 recovered from northeastern part of Sakhalin Slope of the Okhotsk Sea. The composition of the sediment pore water provided useful information for interpreting the main carbon sources for carbonate precipitation. It was shown that in spite of similar geochemical environments, LV28-21 contains autigenic carbonates just above methane gashydrate and LV28-20 no has any gashydrate and calcium carbonate.

We suggested the mechanism of calcium carbonate formation which explains paragenesis of methane gashydrate and calcium carbonate precipitation.

9AM2000            W5-355            oral  
**FUNDAMENTAL DIFFERENCES IN THE IRON ACQUISITION SYSTEMS AMONG PHYTOPLANKTON**  
Charles G. Trick  
*Department of Plant Sciences, The University of Western Ontario, London, ON, Canada. N6A 5B7 e-mail: cyano@julian.uwo.ca*

Laboratory and shipboard "grow-out" experiments have provided the foundation of our understanding of how different members of the phytoplankton community access "free iron" versus iron bound in natural or artificial ligands. While the mechanism(s) is not fully established, these laboratory and natural population experiments have provided insights into how different members of a community compete for iron supplied either as a xenosiderophore-iron complex or as a ligand-iron complex. We make the distinction between known siderophores added to the system (xenosiderophores, in this case) and the natural ligands that have been isolated and/or described by the van den Berg and Rue/Bruland research groups. To investigate the role of each of these iron-organic complexes on the shaping of the phytoplankton community, natural populations were exposed to increasing levels of organic iron complexing agents during three recent cruises. The growth and composition of the population was monitored to assess the impact of individual ligands on the eukaryotic and prokaryotic communities. Flow cytometric analysis offered unique insights into the effects of a range of levels of available iron on the phytoplankton community from contrasting oceanographic regimes, including HNLC area and the oligotrophic central gyres.

9AM2000 W6-256 oral  
**ESTIMATING PREY CONSUMPTION BY MARINE MAMMALS IN THE NORTH PACIFIC**

Andrew W. Trites

*Marine Mammal Research Unit, Fisheries Centre, University of British Columbia, 2204 Main Mall, Vancouver, BC, Canada.  
V6T 1Z4 e-mail: trites@zoology.ubc.ca*

One of the fundamental, but elusive, questions posed about marine mammals is how much food do they consume? For the past five years, researchers in my laboratory have been developing bioenergetic models for marine mammals that range from simple equations (with few parameters) to detailed energy budgets (with many parameters).

The detailed models consider day of year, and estimate the amount of prey that individual age and sex classes consume. Our Steller sea lion model, for example, indicates that a young growing animal requires about 14% of its body weight per day, which is twice the energy required by a mature female. Total estimated consumption by 61,000 Steller sea lions in the Gulf of Alaska and Aleutian Islands is 365 thousand tons. This is about 6 tons per individual per year, or roughly 16 kg per day (primarily consisting of walleye pollock and Atka mackerel).

Most species of marine mammals have not been studied adequately enough to generate detailed estimates of food consumption and energy requirements. To that end, we have been deriving generalized equations to estimate mean biomass for all species of marine mammals, as well as refining earlier estimates of feeding rates and basal metabolism for inadequately studied species. We estimate that the 84 species of marine mammals inhabiting the Pacific Ocean consume about 150 million tons of prey, which is about three times higher than commercial landings. However, a large fraction (>60%) of their food consists of deep-sea squids and very small deep-sea fishes not harvestable by humans.

9AM2000 CCCCp257 oral  
**COMPARATIVE STUDY ON THE LIFE HISTORIES OF *Neocalanus cristatus*, *N. plumchrus*, *N. flemingeri* AND *Eucalanus bungii* IN THE SUBARCTIC PACIFIC**

Atsushi Tsuda, Hiroaki Saito and Hiromi Kasai

*Hokkaido National Fisheries Research Institute, 116 Katsurakoi, Kushiro, Hokkaido, Japan. 085-0802 e-mail: tsuda@hnf.affrc.go.jp*

Three species of *Neocalanus* and *Eucalanus bungii* are dominant zooplankton across the subarctic Pacific and act as a trophic link between the primary production and higher trophic organisms such as pelagic fish. We have been investigated the life histories of these copepods in the Oyashio region. These copepods are all ontogenetic migrators and utilize surface production from early spring to summer and descend to the deeper layer for overwintering and reproduction. However, timing of spawning, egg production, timing of occurrence to the surface water, development rate, lipid accumulation, vertical habitat, overwintering stages, life span and body size are different for each copepod. We have reviewed these characteristics with some local variation of them. In conclusion, one of the prominent characteristics of their life-cycle strategies of dominant copepods in the subarctic Pacific is considered to damp the short-term variability of the food availability with the competition between species. *Neocalanus* copepods realize the damping by egg production by lipid reserves (functional damping), while *E. bungii* do that by having multiple overwintering stages (numerical damping).

9AM2000 W5-358 oral  
**ZOOPLANKTON RESPONSE TO NUTRIENT INPUT**

Atsushi Tsuda<sup>1</sup> and Shigenobu Takeda<sup>2</sup>

<sup>1</sup> *Hokkaido National Fisheries Research Institute, 116 Katsurakoi, Kushiro, Hokkaido, 085-0802, Japan e-mail: tsuda@hnf.affrc.go.jp*

<sup>2</sup> *Biology Department, Central Research Institute of Electric Power Industry, 1646 Abiko, Abiko-city, Chiba 270-1194, Japan*

The rolls of grazers (microzooplankton and mesozooplankton) and remineralizer (bacteria and heterotrophic nanoflagellates) were estimated during a nutrient enrichment experiment using a mesocosm. The primary production increased about 11 times during the initial 3 day, and the grazing rate by zooplankton also increased 7.4 times. The primary production exceeded the grazing rate during the initial 5 days, after that, almost balanced rates were observed. The biomass peaks of bacteria and HNF (heterotrophic nanoflagellates) were observed after the decline of phytoplankton bloom. Bacterial production and HNF grazing gradually increased from the beginning to the end of the experiment. The contribution of microzooplankton in the grazing was largest during the initial 7 days, and the response to the phytoplankton growth was fastest. Heterotrophic dinoflagellates were the most dominant component of microzooplankton, but naked ciliates showed fastest growth responding the phytoplankton production. Over all, the contribution of the microzooplankton grazing was the largest as the loss processes of phytoplankton. Their response to the phytoplankton growth was very quick, and they remove about 50% of the primary production constantly. Thus, naked ciliates and heterotrophic dinoflagellates were the most plausible organisms to realize the steady state of phytoplankton concentration in the ocean.

The western subarctic Pacific is characterized by relatively high standing stocks of phytoplankton and mesozooplankton. Moreover, dominance of diatoms and almost absence of haptophytes characterize the phytoplankton community of the western subarctic ocean. The expected difference response by lower trophic organisms between the east and west to the iron addition will be discussed.

9AM2000 W5-356 oral

**PREDICTION OF PHYSICAL BEHAVIOR OF RELEASED IRON BY RANDOM WALK SIMULATION DURING THE IRON FERTILIZATION EXPERIMENT IN THE NORTH PACIFIC**

Daisuke Tsumune, Norikazu Nakashiki, Shigenobu Takeda and Jun Nishioka

*Environmental Science Department, Central Research Institute of Electric Power Industry, 1646 Abiko Abiko-shi Chiba, 270-1194, Japan e-mail: tsumune@criepi.denken.or.jp*

At an iron fertilization experiment, it is important to predict a behavior of released iron in the surface water. Its behavior is complex because of both physical and biogeochemical processes. Simultaneous sulfur hexafluoride (SF<sub>6</sub>) tracer release experiment is useful to understand the physical behavior of released iron. The behavior of SF<sub>6</sub> is controlled by only physical process. Random walk simulation was employed to predict the physical behavior of released SF<sub>6</sub> in seawater. The random walk simulation is one of the particle tracking methods. Particles move by advection and diffusion in random walk simulation. Stratification, oceanic current and diffusion coefficient were considered as the physical conditions in this simulation. These conditions were set by typical values observed in the northwest and northeast Pacific. Influence of initial patterns of released SF<sub>6</sub> on the behavior was also considered in the simulation to find the efficient released pattern of iron and SF<sub>6</sub>. Time scales of this study were 4-5 days, 2 weeks and 1 month. This simulation acquired spatial scales that depend on time scales. As a result of this simulation, we would like to propose items of observation for simultaneous SF<sub>6</sub> tracer release experiment. We also performed random walk simulation on ocean general circulation model in the north Pacific. We understood that water mass moved from northwest Pacific to northeast Pacific by advection in several years. It suggests that the release of large amount of iron and SF<sub>6</sub> in the northwest Pacific affect the conditions in the northeast Pacific in several years.

9AM2000 S6-258 oral

**THE CARBONATE SYSTEM OF THE NORTH PACIFIC STUDIED WITH DISSOLVED INORGANIC COMPONENTS**

Shizuo Tsunogai, Masahide Wakita and Shuichi Watanabe

*Marine and Atmospheric Geochemistry Lab., Graduate School of Environmental Earth Science, Hokkaido University, Kita 10, Nishi 5, Kita-ku, Sapporo, Hokkaido, Japan. 060-0810 e-mail: mag-hu@ees.hokudai.ac.jp*

We have studied the carbonate system of the North Pacific, determining total carbonate, pH, alkalinity as well as other water properties for water collected chiefly in the western North Pacific every year from 1991. In the northern North Pacific including the Bering Sea, CO<sub>2</sub> is escaped first from the upwelled deep water at the surface, but the amount is less by about 60 micromol/kg than that expected from the increase in preformed nutrients, indicating the substantial increase in total CO<sub>2</sub>. This should be due to the increase in the atmospheric CO<sub>2</sub>. After the nutrients in the upwelled deep water has been uptaken by biological activity, the water absorbs much atmospheric CO<sub>2</sub>. This is partly due to high alkalinity of the water. The water dissolving much atmospheric CO<sub>2</sub>, however, does not remain in the northern Pacific. Rather it flows out as the North Pacific Intermediate Water.

9AM2000 W7-381 poster

**SEASONAL VARIATION OF OCEANIC CARBON DIOXIDE SPECIES AT THE WESTERN SUB-ARCTIC PACIFIC TIME SERIES SITE (KNOT) 1998-2000**

Nobuo Tsurushima<sup>1</sup>, Keiri Imai<sup>2</sup>, Yukihiko Nojiri<sup>3</sup> and Shuichi Watanabe<sup>4</sup>

<sup>1</sup> *National Institute for Resources & Environment, 16-3 Onogawa, Tsukuba, Ibaraki, 305-8569, Japan e-mail: tsurun@nire.go.jp*

<sup>2</sup> *Japan Science and Technology Corporation, c/o National Institute for Environmental Studies, 16-2 Onogawa, Tsukuba, Ibaraki 305-0053, Japan e-mail: imai.keiri@nies.go.jp*

<sup>3</sup> *National Institute for Environmental Studies, 16-2 Onogawa, Tsukuba, Ibaraki 305-0053, Japan e-mail: nojiri@nies.go.jp*

<sup>4</sup> *Graduate School of Environmental Earth Science, Hokkaido University, Sapporo 060-0810, Japan e-mail: swata@ees.hokudai.ac.jp*

The oceanic carbon dioxide species (total dissolved inorganic carbon (TDIC), alkalinity, pH, fugacity of CO<sub>2</sub>) have been measured at the western sub-arctic Pacific time series site KNOT (44°N, 155°E) from 1998. The concentrations of TDIC in the surface mixed layer were decreased in spring-summer season, and were 1980 and 1987 μmol/kg in August 1998 and 1999, respectively. These were mainly due to the biological production. The concentrations of TC were increased in fall-winter season, and were 2071 and 2094 μmol/kg in December 1998 and February 2000, respectively. These were mainly due to the vertical mixing and entrainment of deeper water to the surface. This change of TC (107 μmol/kg) is larger than that of HOT (<20 μmol) or BATS (40-50 μmol/kg). The seasonal variability of normalized alkalinity (total alkalinity added nitrate concentration and normalized to

salinity 35) was smaller than 7  $\mu\text{eq./kg}$ . This fact suggests that production or decomposition of calcium carbonate is not significant factor for surface carbonate chemistry. The ratios of increase or decrease of TDIC to that of phosphate ( $\Delta\text{C}/\Delta\text{P}$ ) were more than 500 in the summer-fall seasons in 1998 and 1999. These values are significantly higher than Redfield ratio. This fact suggests that much of atmospheric  $\text{CO}_2$  invaded into the seawater in the summer-fall season, when seawater  $\text{pCO}_2$  shows annual minimum. The  $\Delta\text{C}/\Delta\text{P}$  is 100 and 75 in the spring-summer season in 1998 and 1999, respectively, suggesting that atmospheric  $\text{CO}_2$  invasion in this season is less significant than that of summer-fall season, when is the heating period. The different atmospheric  $\text{CO}_2$  invasion in the spring-summer season and summer-autumn season may be related to the difference in the wind velocity and delta  $\text{pCO}_2$ .

9AM2000 S5-259 oral  
**DISTRIBUTION AND FORMATION OF THE MESOTHERMAL STRUCTURE (TEMPERATURE INVERSIONS) IN THE NORTH PACIFIC SUBARCTIC REGION**

Hirofumi Ueno and Ichiro Yasuda

*Department of Earth and Planetary Science, Graduate School of Science, University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo, Japan. 113-0033 e-mail: ueno@aos.eps.s.u-tokyo.ac.jp*

The distribution and formation of mesothermal structure (temperature inversions) in the North Pacific subarctic region are investigated through analysis of climatological and WOCE and SAGE hydrographic data. It is suggested that the heat and salt that maintain the mesothermal water and thus the halocline in the density range of 26.7-27.2 sigma-theta are transported as a cross-gyre flow from the transition domain just east of Japan, where the waters are influenced by the subtropical gyre water mass, to the eastern subarctic region. Along the transport route the isopycnal potential temperature and thus salinity are well conserved. In the western subarctic gyre, the Bering Sea, and the northern Gulf of Alaska, the temperature reaches its minimum at the surface in winter and the areal coverage agrees well with the distribution of the mesothermal structure. In the southeastern part of the zonally distributed mesothermal structure in the area of 170°E-150°W and 45°-50°N, where the winter sea surface temperature is higher than that in the deeper layer, dichothermal water is formed by subsurface intrusion of the low-temperature and low-salinity water that outcropped in the previous winter over the warm and saline water transported from the transition domain.

9AM2000 S8-260 poster  
**LIPID CLASS AND FATTY ACID COMPOSITION OF MUSSEL, *Mytilus trossulus*, IN VANCOUVER HARBOR**

Seiichi Uno, J. Yun, M. Kaneniwa, J. Koyama, H. Yamada and K. Ikeda

*National Research Institute of Fisheries & Environment of Inland Sea, 2-17-5 Maruishi, Ohno, Saeki, Hiroshima, Japan. 739-0452 e-mail: secuno@nrf.affrc.go.jp*

The lipids in shell fish was divided broadly into two categories, which are depot fat in liver and lipid tissue, which is mainly composed by ingredients triglycerids, and tissue lipid in the tissue composed by mainly phospholipids (PL) and cholesterol. The investigation of composition for lipid and fatty acid, which composes lipid, is important on the physiological study. Furthermore, PCBs and other organochlorine contaminants are known to be accumulated in lipid tissue, and the information for the composition of lipid is helpful to explain the mechanism on the accumulations of these chemicals. In present study, the compositions of lipid and fatty acid of mussel, *Mytilus trossulus*, in Vancouver Harbor were investigated. Each one hundreds mussel were randomly sampled in seven points at the side of West Vancouver, and the compositions of lipids and fatty acid were determined with Iatroscan TLC and GC/MS, respectively. As the result, the main compositions in lipid were triglycerides (10-23%), free fatty acid (24-37%), sterol (4-7%) and PL (36-53%). The rates of fatty acid could be increased in transportation and storage until analysis. From another attempt by TLC, PL was composed with phosphatidylethanolamine (PE), ceramide 2-aminoethylphosphonate, phosphatidylserine (CAEP), phosphatidylserine (PS), lysophosphatidylethanolamine (LPE), phosphatidylcholine (PC), and lysophosphatidylcholine (LPC) and those rates in PL were CAEP+PS+LPE, 28-55%, PC, 11-25%, and LPC, 4-9%. Of the fatty acids, 16:1 n-11, 16:1 n-9, 20:5 n-3, and 22:3 n-3 accounted for over 50% of total.

9AM2000 S8-261 oral  
**ORGANOCHLORINE AND POLYAROMATIC HYDROCARBON RESIDUES IN BIVALVES AT VANCOUVER HARBOR**

Seiichi Uno, J. Koyama and H. Yamada

*National Research Institute of Fisheries & Environment of Inland Sea, 2-17-5 Maruishi, Ohno, Saeki, Hiroshima, Japan. 739-0452 e-mail: secuno@nrf.affrc.go.jp*

Since bivalves have wide distribution, extensive population, filtering habits, and ability to accumulate organic contaminants, analysis of chemicals in the soft tissue of bivalves is useful as an index of contamination in the aquatic environment. In this study, organochlorine and polyaromatic hydrocarbon (PAH) residues in mussel, *Mytilus trossulus*, and other few species were investigated in 9 site at the site of West Vancouver Harbor. In sampling site, the highest total PCB and PAH residues in mussel were observed at Cates Park (sampling station I-4) and those were more than 7 ng/g and 200 ng/g, respectively. On the other

hand, the lowest concentrations were detected at near the thermal generating station (I-5B) for PCBs, about 0.3 ng/g and for PAHs, 50 ng/g, respectively. Since the distributions pattern of total PCBs and PAHs among sampling site were similar, it was suggested that both contaminants were accumulated in mussel through same accumulation process. IUPAC 138 and 153 and phenanthrene, fluoranthene, and pyrene had higher contribution to total PCBs and PAHs, respectively. The concentrations of total PCB residues in other 6 species of bivalves were higher level than mussel. Specially, that in *Crassostrea gigas* caught at near Port Moody (I-6) was about 60 times as much as that in mussel. However, total PAH residues in those except for *C. gigas* were lower concentrations (15 ~ 75%) than that in mussel. Total PAHs in only *C. gigas* was about twice concentration as much as mussel. In this study, several organochlorine pesticide residues in bivalves will be also determined and examined about the difference for distribution among sampling sites and species.

9AM2000            S8-360            poster  
**ORGANOCHLORINE AND POLYAROMATIC HYDROCARBON RESIDUES IN ENGLISH SOLE, *Pleuronectes vetulus*, AT VANCOUVER HARBOR**  
Seiichi Uno, J. Koyama and H. Yamada  
National Research Institute of Fisheries and Environment of Inland Sea, 2-17-5, Maruishi, Ohno, Saeki, Hiroshima 238-0316,  
Japan e-mail: secuno@nmf.affrc.go.jp

Since the persistent contaminants are mostly accumulated in aquatic organisms by biomagnification and those concentrations tend to be much higher in upper trophic level of the food chain. In this study, organochlorine and polyaromatic hydrocarbon (PAH) residues in muscle, gonad and liver of English sole, *Pleuronectes vetulus*, which occupies upper trophic level in the food chain, were investigated in 5 sites at West Vancouver Harbor. The concentrations of total PCBs in muscle and gonad were similar among the sites. However, that concentration in liver was about 50-300 times than those in muscle and gonad. The total PCBs in liver of sole caught at Burrard Yarrows (sampling station T-11B) was over 1000 ng/g. IUPAC 138 and 153 had the highest contributions to total PCBs, and those concentration were roughly similar each other in all samples. The concentrations of total PAHs were similar among organs of fish in front of Pacific Environment Institute. In other sampling station, that in liver was several times than those in muscle and ovary and that in liver was about 180 ng/g at Gibsons Howe Sound (T-50). Individual PAH in muscle and ovary was detected under 10 ng/g. On the other hand, that in several liver samples were over 10 ng/g for dibenzothiophen, phenanthrene, fluoranthene, and pyrene. In this study, several organochlorine pesticide residues and PAH metabolites will be also determined and examined the difference of their concentrations among organs.

9AM2000            S3-313            poster  
**CONCERNING THE POSSIBILITY OF PREDICTION OF FEEDING BASE OF NEKTON (SIZED STRUCTURE AND NUMBER OF SOME MASS SPECIES OF A ZOOPLANKTON**  
A.F. Volkov  
Pacific Research Institute of Fisheries & Oceanography (TINRO-Center), 4 Shevchenko Alley, Vladivostok, Russia. 690600 e-mail: volkova@mail.primorye.ru

The prediction of a common status of the communities of zooplankton (number, biomass) with a forecast-time interval even from one quarter up to a half-favour, till now is represented by the almost insoluble task, since the majority of sorts of a zooplankton have a life duration in limits of year.

However, in the Okhotsk Sea among the most mass different sorts there are some with a life span of 2-3 years, which besides exists there as an independent population. There are two species of euphausiids (*Thysanoessa raschii* and *Th. longipes*), that dominate in power supply of many species of nekton, therefore it is extremely important to have performances about the tendency in their development.

The analysis of sized frame *Th. raschii* on characteristic districts shows presence, as common seasonal features (shift of modal group to the right in winter), and regional difference linked to features of space frame of populations, including, and with layout of centers of reproduction.

Puberal animals (42%) of *Th. raschii* predominated during spring 1998 but in 1999 the number fine animals increased 4 times, dominated specimens in length 10-15 mm, and the share large was sank to 18%. Thus, for one year there was a sharp rejuvenescence of a composition, and it meant a good perspective. Owing to intensive press from the side walleye pollock and herring by 2000 the number was sank on 20-25 of %. But in spring 1999-2000 the puberal part was numerous (more than 50%), saving number at a level of 1999 therefore is probable.

The number *Th. longipes*, too has increased: from 1998 to 2000. More than 10 times, thus, the share juvenile specimens (up to 15 mm) now constitutes 70%, and it shows a good status of a population for summer - autumn 2000.

9AM2000 S5-263 oral  
**CROSS - EQUATORIAL FLOW OF THE NW PACIFIC AND ITS EFFECTS ON THE HURRICANES OCCURRENCE OVER SOUTHERN HEMISPHERE**

Jingyi Wang

National Research Center for Marine Environmental Forecasts, No.8 Da Hui si, Haidian District, Beijing, People's Republic of China. 100081 e-mail: yc\_lan1@yahoo.com

Winds at every 5 degrees point from 100E to 180E over the equator at 850hpa and 200hpa in the winter of NW Pacific for 1995-1999 have been separated into U (Zonal wind) and V (meridional wind). The V component has been used to represent cross-equatorial flow. We obtained that as during the northern summer, there are also several regions in which the cross - equatorial flow are very strong during the northern winter, but the flow directions are different. In the northern winter, lower-level winds blow from north to south. For simplicity, we call them as cross - equatorial flow channels. Three channels are located at 100E - 110E, 140E - 150E and 165E - 175E. Power spectrum analysis of the wind flowing through every channel showed that intensity variations of channels exist two kinds of periods. One is about 4-5 days, and other is about 10-13 days. The locations of the cross - equatorial flow are almost the same during the northern winter and summer. But the channel at about 100E - 110E is the most stable one during the northern winter. Generally channels of cross - equatorial flow at higher troposphere are not as clear as those at lower level. So the cross - equatorial flow is mainly present at lower troposphere. The disturbances over the Southern Hemisphere are very active in the regions affected by this cross - equatorial flows.

9AM2000 S3-265 invited  
**A REVIEW OF CURRENT ZOOPLANKTON STUDIES IN CHINA GLOBEC**

Rong Wang

Marine Ecology Laboratory, Institute of Oceanology, 7 Nanhai Road, Qingdao, Shandong, People's Republic of China. 266071 e-mail: wangrong@ms.qdio.ac.cn

In Bohai Sea a total of 94 species of zooplankton and 17 taxa of larva was recorded, dominated by shelf water and neritic species. The peak season was in spring and summer. In May and June *Calanus sinicus* was the major component. From July to September *Labidocera euchaeta*, *Sagitta crassa* and *Noctiluca miliaris* were the major components. The small copepods, *Paracalanus parvus*, *Paracalanus crassirostris*, *Acartia biflosa*, and *Oithona similis*, were dominant from May through October. *Euphausia pacifica* and *Parathemisto gracilipes* could penetrate into Bohai Sea from the North Yellow Sea during wintertime. Analysis of samples collected in 1958/59, 1983/84, 1992/93 and 1997/99 showed no significant inter-annual changes in dominant species in different season.

Zooplankton feeding of different size groups were measured by gut pigment contents evacuation method and dilution method. Egg production rate and hatching rate of *Calanus sinicus*, *Paracalanus parvus*, *Centropages mcmurricchi*, *Labidocera euchaeta*, and *Labidicer bipinnata*, were also measured *in situ*.

*Calanus sinicus* is the target species in our Yellow Sea and East China Sea program. The peak season of its population was in late spring and early summer and decreased dramatically when the water temperature higher than 25°C. The results of a cruise conducted last September showed that its population shrink back to the Yellow Sea Cold Water Mass, where the temperature is less than 10°C, below the strong thermocline. In YSCWM it remained a high population density, as high as 2000 ind/m<sup>3</sup> in near bottom layer, and the enzyme activity of protease, amylase and Alkaline phosphatase were normal. There is a significant negative correlation between temperature and enzyme activity in summer.

9AM2000 MEQp262 oral  
**EFFECTS OF DREDGING SEDIMENT MUD IN THE CHANGJIANG ESTUARINE AREA ON THE SPAWNING AND EMBRYONIC DEVELOPMENT AND Zn ion TO THE TOXICITY OF THE LARVAL DEVELOPMENT OF THE CHINESE CRAB *Eriocheir sinensis***

Yunlong Wang<sup>1</sup> Zhaoli Xu<sup>1</sup> Yongxu Cheng<sup>2</sup> and Yaqu Chen<sup>1</sup>

<sup>1</sup> East China Sea Fisheries Institute, Chinese Academy of Fisheries Science, 300 Jungong Road, Shanghai, People's Republic of China. 200090 e-mail: yq\_chen@citiz.net

<sup>2</sup> Shanghai Fisheries University, Shanghai, People's Republic of China. 200090

The plans to dredge the sediment clay in estuarine area of Changjiang River may result in the finely sediment suspending, this may have effects on the larval development of Chinese crab *Eriocheir sinensis*. On the other hand, sediment clay suspending may introduce elevated metal concentrations, especially Zn to the benthic environment and pose a toxicological hazard to marine life, such as the larval of *Eriocheir sinensis*. But this study shows that there are no significant differences in the spawning, egg survival, larval hatching and embryonic development of Chinese crab *Eriocheir sinensis* after exposure to the largest high concentration (8g/l) dredging suspending sediment mud and control environment.

The result of the toxicity of Zn to larval demonstrated that after 24h or 36h exposed in the assay medium of Zn ion, especially the concentration of Zn over 190ug/l, the high mortality of the larval in different stages (contained Zoa I, Zoa II and Zoa IV) was found, which demonstrated that the toxicity of Zn ion to the early larval, but no influence on the megalopa in development and molt.

9AM2000 MEQp264 poster  
**EFFECTS OF DREDGING SUSPENDED MUD ON THE LARVAL DEVELOPMENT AND MOLT OF CHINESE CRAB *Eriocheir sinensis***

Yunlong Wang<sup>1</sup> Zhaoli Xu<sup>1</sup> Yongxu Cheng<sup>2</sup> and Yaqu Chen<sup>1</sup>

<sup>1</sup> East China Sea Fisheries Institute, Chinese Academy of Fisheries Science, 300 Jungong Road, Shanghai, People's Republic of China. 200090 e-mail: yq\_chen@citiz.net

<sup>2</sup> Shanghai Fisheries University, Shanghai, People's Republic of China. 200090

Effects of dredging suspended mud on the larval (zoea and megalopa) development and molt of Chinese crab *Eriocheir sinensis* was studied. The concentration of suspended dredging mud is 0,2,4,8,16,32,and 64g/l in experiment. The result shows that with the increase of concentration of suspended dredging mud (especially >8g/l), the molt cycle of zoea I was postponed when compared with controlled. No effects of suspended dredging mud on the zoea IV and megalopa development and molt were founded. This differences for effects of suspended dredging mud on early larval and later larval may be resulted from the difference in the feeding modes, food-size niches and food-size selectivity

9AM2000 W3-266 invited  
**COUPLING LOWER AND HIGHER TROPHIC LEVEL MODELS IN MARINE ECOSYSTEMS: AN OVERVIEW**

Daniel M. Ware

Adjunct-Professor, Department of Earth and Ocean Sciences, University of British Columbia. Mailing address: 3674 Planua Road, Nanaimo, B.C., V9T 1M2. Canada. e-mail: ware\_mrc@island.net

Significant advances in modelling the dynamics of lower trophic levels in marine ecosystems (i.e. the microbial food web, and large phytoplankton and zooplankton) have occurred in the last decade. Progress has also been made in linking the production of higher trophic level organisms (e.g. squid, fish, seabirds, and marine mammals) to lower trophic level production models. Since lower and higher trophic level organisms function on different time and spatial scales within the ecosystem, successful coupling requires getting a number of things right - or just about right. In this context, the necessity for critical information about the diet, the functional response, growth efficiencies, large-scale seasonal movements of migratory species, and the impact of climate variability on these processes are discussed. For some marine ecosystems, we have enough biological and stock assessment knowledge to begin using coupled models as primitive diagnostic tools to assess the current productivity of the ecosystem, and some key organisms within it. The development of a successful prognostic capability requires getting a number of other things right, such as recruitment dynamics, dispersal and behavioural changes in predator-prey interactions. Examples of some recent applications of these ideas are discussed.

9AM2000 S1-267 poster  
**DECADAL CHANGE IN ABUNDANCE OF SURFACE MIGRATING MYCTOPHID FISHES IN THE KUROSHIO REGION DURING 1957-1994**

H. Watanabe and K. Kawaguchi

Ocean Research Institute, University of Tokyo, 1-15-1, Minamidai, Nakanoku, Tokyo, Japan. 164-8639 e-mail: kawaguch@ori.u-tokyo.ac.jp

The Japanese Fisheries Agency has conducted egg and larval surveys of Japanese sardine over the past four decades. During 1957-1994, nighttime neuston sampling was conducted at an average of 83 stations each year in the Kuroshio and adjacent waters off Japan. A total of 7914 myctophids was collected at 1357 stations and changes in abundance were analyzed. Of the ten species collected, four species (*Myctophum asperum*, *Symbolophorus evermanni*, *M. nitidulum* and *Centrobranchus brevirostris*) accounted for 91.2% of the total catch in number. Three of the four species showed a prominent peak abundance in 1971, possibly due to high recruitment success and low mortality of adults which may have been supported by the high zooplankton abundance in 1971. Japanese sardine recruitment was also high in 1971-72 when the population rebound started and the Kuroshio regime also shifted from cold to warm conditions. Other smaller changes in abundance of each species were mostly explained by the yearly fluctuation of the Kuroshio flow volume and the biogeographical pattern of each species; increased flow volume resulted in increased abundance of tropical species and decreased abundance of temperate species, but no change in the pan-Kuroshio species.



9AM2000 W6-268 oral  
**SEABIRDS AS A PLATFORM FOR MONITORING MARINE ENVIRONMENT WITH BIOTELEMETRY TECHNIQUES**

Yutaka Watanuki<sup>1</sup>, A. Takahashi<sup>2</sup>, K. Sato<sup>2</sup> and A. Kato<sup>2</sup>

<sup>1</sup> *Lab. Animal Zoology, Graduate School of Agriculture, Hokkaido University, Sapporo, Hokkaido, Japan. 060-8589 e-mail: ywata@res.agr.hokudai.ac.jp*

<sup>2</sup> *National Institute of Polar Research, Japan*

Seabirds are integrated, cheap but presumably biased indicators of marine environment. Long-term changes in their diet, breeding success, meal delivery and pollutant level of body tissue have been known to reflect large-scale trends of fish stock, sea water temperature and marine pollution etc. As seabirds have been known to quickly adjust their foraging behaviour to rapid changes in prey stock, at sea foraging behaviour is believed to be a most direct and short-term indicator. Recently, a measurement of foraging behaviour of seabirds with telemetry and bird-borne data-logger techniques begins to give us new information. With these, we can collect information on marine physical environment also. Here, I will show two examples; 1) vertical water temperature sampling by thick-billed murre diving to deeper than 100 m and 2) estimate of CPUE in Adelie penguin foraging in variable sea-ice conditions.

9AM2000 W5-357 oral  
**Fe DYNAMICS DURING IRONEX II: THE PREMATURE LOSS OF Fe AVAILABILITY WITHIN THE ENRICHED PATCH DURING THE PHYTOPLANKTON BLOOM**

Mark L. Wells

*School of Marine Sciences, University of Maine, Libby Hall, Orono, ME 04469-5741, U.S.A. e-mail: mlwells@maine.edu*

Iron enrichment in surface waters during IronEx II was partitioned into dissolved ( $<0.4 \mu\text{m}$ ), colloidal ( $> 1 \text{ kDa} - 0.4 \mu\text{m}$ ) and soluble ( $< 1 \text{ kDa}$ ) size fractions using cross flow filtration to better delineate the proportion of iron directly accessed by phytoplankton. While the initial mesoscale enrichment increased dissolved iron concentrations within the patch by two orders of magnitude ( $\sim 2 \text{ nM Fe}$ ), soluble iron concentrations only doubled above ambient levels to  $\sim 40 \text{ pM Fe}$ . Repeat infusions had little measurable impact on soluble iron concentrations in the patch, the bulk of the additions instead residing in the colloidal phase. The return of soluble iron concentrations to ambient levels coincided with a dramatic increase in Chl *a*, indicating that biotic demand was responsible for the disappearance of soluble iron. Early in the bloom the draw down of silicic acid increased relative to nitrate, suggestive that the developing bloom was experiencing iron stress. But the estimated diffusional flux of iron to the cell surface, taking into account the elongate shape of the pennate diatoms, indicates that these cells should not have experienced iron stress if the soluble phase was readily accessible. Instead, these findings suggest that the bulk of the organically complexed soluble and colloidal iron was unavailable for rapid uptake by diatoms. Overall, these results demonstrate that very small, continuous increases in iron flux could initiate and maintain large diatom blooms in HNLC regions, but that large iron infusions quickly become kinetically inert and cannot support continued rapid phytoplankton growth.

9AM2000 W3-269 invited  
**LOWER TROPHIC LEVEL MODELS IN OCEANIC ECOSYSTEMS: STATUS OF THE NEMURO LTL MODEL AND SUGGESTED EXTENSIONS**

Francisco E. Werner<sup>1</sup> and David Eslinger<sup>2</sup>

<sup>1</sup> *Marine Sciences Department, CB# 3300, University of North Carolina, Chapel Hill, NC 27599-3300, U.S.A. e-mail: cisco@email.unc.edu*

<sup>2</sup> *Coastal Remote Sensing Program, NOAA Coastal Services Center, 2234 South Hobson Avenue, Charleston, SC 29405-2413, U.S.A. e-mail: Dave.Eslinger@noaa.gov*

A Lower Trophic Level (LTL) model developed during the LTL Nemuro Workshop of January 2000 is described. Attention is focused on a point model version that maximizes the ability to undertake sensitivity analyses. Case studies at three locations in the North Pacific are detailed (off the Kuroshio, Station Papa and the Bering Sea). The dependence on key parameters is explored through the examination of the model's behavior in multi-year simulations. Extensions that include the incorporation of a microbial loop component are also discussed. Finally, aspects of the implementation of similar LTL models in related GLOBEC activities in the North Atlantic, Southern Ocean and Eastern Boundary Current Systems will be discussed.

9AM2000 S7-305 poster

**EL NIÑO RELATED VARIATIONS IN NUTRIENT AND CHLOROPHYLL DISTRIBUTIONS OFF OREGON: CAUSES AND CONSEQUENCES**

Patricia A. Wheeler and Holly L. Corwith

*College of Oceanography, Oregon State University, Corvallis, OR 97331-5503, U.S.A. e-mail: pwheeler@oce.orst.edu*

As part of the NOAA-NSF supported Northeast Pacific Pacific GLOBEC program we have been studying the distribution of nutrients and chlorophyll off the coast of Oregon. Data from 1997-1999 allows the comparison of seasonal variations during the strong 1997-1998 El Niño with more normal seasonal distributions during 1998-1999. Maximum nutrient supplies and chlorophyll standing stocks were observed during the seasonal upwelling period (Aug/Sept 98, Jul/Sept 99). In comparison, both nutrients and chlorophyll standing stocks were severely depressed during the 1997 summer sampling, and nitrate availability appeared to limit primary production. Usually winter conditions result in intermediate nutrient levels, and primary production is limited by light availability. During the 1997-1999 winter and spring, the enhanced poleward flow of the California Undercurrent and the Davidson Current resulted in the movement of warm, high salinity water as far north as Oregon. This poleward moving southern water was lower in nutrients. Thus, El Niño conditions have two direct effects on nutrient supply: 1) reduced upwelling results in severe nitrogen limitation during the normal upwelling season, and 2) poleward movement of warm, high salinity, low nutrient water during the winter. The latter effect may result in moderate nutrient limitation during the spring transition. We will compare these changes with results of Peterson *et al.* (2000) for zooplankton abundances and species distributions. This comparison will illustrate the dramatic differences in the response time and recovery of phytoplankton and zooplankton to El Niño effects on nutrient supply via upwelling and alongshore currents.

9AM2000 S7-270 poster

**NUTRIENT AND PRODUCTIVITY RELATIONSHIPS TO PHYSICAL PROCESSES ON THE GULF OF ALASKA SHELF**

Terry E. Whittedge, Amy R. Childers and Dean A. Stockwell

*School of Fisheries & Ocean Sciences, University of Alaska Fairbanks, P.O. Box 757220, Fairbanks, AK 99775-7220, U.S.A. e-mail: terry@ims.uaf.edu*

The northern Gulf of Alaska (GOA) is a highly productive downwelling ecosystem but the mechanisms for providing nutrients that sustain primary productivity are largely unknown. The Gulf of Alaska Long Term Observation Program (LTOP) during the initial phase of the GLOBEC program measured the cross-shelf seasonal and interannual variations of biogenic nutrients and productivity in relation to the region's physical structure. Water samples from the Seward Line transect provided profiles of nitrate, ammonium, silicate and phosphate from the inner, mid and outer shelf regions thus encompassing both the Alaskan Coastal Current and the Alaskan Stream. This data provides insight into the source and transport of nutrients on the GOA shelf and helps explain the high levels of productivity in this unusual region and to assess the food environment to the grazing communities.

The nitrate, silicate and phosphate profiles and transects revealed distinct differences between the end of winter 1988 and the end of winter 1999. Nitrate concentrations in March 1999 were 30-50% higher than March 1998. The shelf waters were much warmer and fresher throughout spring 1998 with respect to spring 1999. Available nutrients were severely depleted in both summers in 1998 and 1999 and subsequently were replenished during the fall and winter. In mid-April 1999 enhanced nutrient and chlorophyll levels were found over the inner shelf and the shelf break regions that may be related to the passage of a long-lived eddy along the shelf break.

9AM2000 FISp271 poster

**DEVELOPMENT OF FISHING GEAR MATERIALS AND ACCESSORIES DATABASE SOFTWARE**

Sungjae Won, C.W. Lee, J.H. Lee, B.J. Cha, H.Y. Kim and Y.S. Lee

*Pukyong National University, Pusan, Republic of Korea e-mail: hykim@mail1.pknu.ac.kr*

Designing fishing gear is the process of determining technical specifications and drawings for fishing gear to satisfy specified characteristics involved in producing fishing gear. In particular, the selecting of fishing gear materials and accessories is the principal phase to determine the dynamic property of fishing gear, catching performance and the cost of production in the concrete. Hence one must consider understanding the characteristics of fishing gear materials and corresponding them to the using condition of fishing gear.

So this paper used the database of fishing gear materials and accessories with a computer and development of database software to apply with the computer aided fishing gear design system. For construction of the database, fishing gear materials were divided into four parts, twine, rope, netting and rigging accessories such as float, sinker, block and doors. Detail standards, shape, capacity and manufacturers for each item were expressed in the database program. Some examples of the database are presented.

9AM2000 W5-385 oral

### IRON DISTRIBUTION IN THE NORTHEAST PACIFIC OCEAN

C.S. Wong<sup>1</sup>, Shigenobu Takeda<sup>2</sup>, Keith Johnson<sup>1</sup>, Jun Nishioka<sup>2</sup> and Nes Sutherland<sup>1</sup>

<sup>1</sup> Climate Chemistry Laboratory, Institute of Ocean Sciences, P.O. Box 6000, Sidney, BC, Canada. V8L 4B2 e-mail: wongcs@pac.dfo-mpo.gc.ca

<sup>2</sup> Biology Department, Central Research Institute of Electric Power Industry, 1646 Abiko, Abiko City, Chiba 270-1194, Japan

We present some preliminary results on the spatial distribution of iron in the Northeast Pacific Ocean, being conducted under a collaborative project between IOS and CRIEPI. Reactive Fe (defined operationally as the Fe released from unfiltered seawater adjusted to pH 3.2) and other forms of Fe (e.g. filtered or in different size fractions) was measured using a chemiluminescence technique on board the CSS Tully inside a positive pressured plastic enclosure with HEPA-filtered air. Seawater samples for the surface were collected by hand from a Zodiac boat, for 10 m, 25 m and 40 m by all teflon pump, and 50-1,000 m by pre-cleaned 30 L Go-Flow samplers. The study area covered Line P (48.5°N, 126°W to 50°N, 145°W) and Line Z (47°N, 145°W to 59.5°N, 145°W). Intercalibrations were made between IOS, CRIEPI and Obata, and compared with John Martin's profile in 1987. The vertical profiles of reactive Fe for cruise 9815 showed high Fe up to 2 nM at 100 m at coastal Station P04, much lower Fe at about 1 nM below 600 m at Station P12, and for the offshore stations P16, P20 and P26 (Station P) in the HNLC waters, Fe values were about the same, with < 0.1 nM in the upper 100 m and slightly increased value of 0.8 nM at depths from 200 to 1,000 m.

Horizontal surface Fe distribution in the summer of 1997 showed a high coastal reactive Fe at 0.75 nM and much lower distribution of <0.15 nM further offshore. At Station P16 (at 136°W), there is marked increase to 0.35 nM and for stations at 143°W and 145°W a smaller increase to 0.2 nM, indicating possible transport of Fe-rich waters either vertically or by eddies. In June 2000, Fe was measured for samples pumped from a clean batfish system, basically showing the patchiness of surface Fe distribution.

The supply of iron to the subarctic NE Pacific, a HNLC region, may come from iron-rich coastal waters and upwelled deep water, and aeolean dust transport. Eddies formed on the edge of the continental shelf of Alaska and west coast of Canada may transport iron-rich waters from the coast to iron-poor open-ocean waters. In a June 2000 cruise, profiles of reactive iron down to 600 m depth, were measured outside, near the edge and in the center of an eddy situated about 200 km off the Queen Charlotte Islands on the west coast of Vancouver Island. In the surface 100 m, outside iron at about 0.2 nM was about twice as high as values outside or at the edge. However, at 150-600 m, reactive Fe at about 2 nM was found inside this coastal eddy which was twice as high as the outside and edge values. The results were discussed with oceanographic features in the NE Pacific Ocean.

9AM2000 S2-272 poster

### TOO MANY SHARKS IN THE NEARSHORE WATERS OF THE EASTERN GULF OF ALASKA?

Bruce A. Wright and Lee B. Hulbert

National Marine Fisheries Service, NOAA, 11305 Glacier Highway, Juneau, AK 99801, U.S.A. e-mail: Bruce.Wright@noaa.gov

The predominant shark species in near-shore Alaska waters, spiny dogfish sharks (*Squalus acanthias*), Pacific sleeper sharks (*Somniosus pacificus*), and salmon sharks (*Lamna ditropis*) have dramatically increased in abundance in the eastern Gulf of Alaska (GOA) and Prince William Sound (PWS) in the 1990s. Spiny dogfish are well represented in the pelagic trawl pollock fishery and in longline fisheries for sablefish, halibut, and Pacific cod. Sleeper sharks are one of the few sharks found in polar waters year-round. National Marine Fisheries Service and International Halibut Commission researchers in Alaska have caught specimens in the 6 meter range. Alaska Department of Fish and Game sablefish survey data indicate an increasing trend in sleeper shark abundance. Diet data for spiny dogfish, Pacific sleeper sharks, and salmon sharks will be presented. Reasons for increases in shark abundance in the GOA will also be presented.

9AM2000 W7-382 oral

### SENSITIVITY OF ANTHROPOGENIC CO<sub>2</sub> UPTAKE TO PARAMETERIZATIONS OF MESOSCALE TRACER TRANSPORTS IN A 3-D MODEL OF THE NORTH PACIFIC

Yongfu Xu<sup>1</sup>, Fumiyasu Nishibori<sup>1</sup>, Shigeaki Aoki<sup>2</sup> and Koh Harada<sup>2</sup>

<sup>1</sup> Kansai Environmental Engineering Center Co. Ltd., 1-3-5 Azuchi-machi, Chuo-ku, Osaka 541-0052, Japan

<sup>2</sup> National Institute for Resources and Environment, Tsukuba, Ibaraki 305-8569, Japan

It has been estimated from the model that the global ocean is absorbing anthropogenic CO<sub>2</sub> of about 2 GtC/yr with an uncertainty of about 40%. Some researchers have argued that the North Pacific may be a larger sink. Although there is no significant formation of deep waters by overturn of surface waters to great depths in the North Pacific, formation of North Pacific Intermediate water (NPIW) is considered to play an important role of transporting tracers. We designed a series of five different numerical experiments to examine the sensitivity of anthropogenic CO<sub>2</sub> uptake to parameterizations of mesoscale tracer transports. The five cases include (1) HOR with the horizontal diffusivity of  $2 \times 10^7$  cm<sup>2</sup>/s, (2) GM1 with the same isopycnal ( $A_{iso}$ ) and thickness ( $A_{th}$ ) diffusivities of  $2 \times 10^7$  cm<sup>2</sup>/s, (3) GM2 with  $A_{iso} = A_{th} = 1 \times 10^7$  cm<sup>2</sup>/s, (4) GM3 with  $A_{iso} = 5 \times 10^7$  cm<sup>2</sup>/s and  $A_{th} = 1 \times 10^7$  cm<sup>2</sup>/s, and (5) GM4 with  $A_{iso} = 1 \times 10^7$  cm<sup>2</sup>/s and  $A_{th} = 5 \times 10^7$  cm<sup>2</sup>/s. The purpose of this work is to explore the mechanism of

generating significant differences in the uptake and storage of anthropogenic CO<sub>2</sub> in the subpolar and subtropical regions between the five cases. Simulated results from the five cases show that the North Pacific has taken up 20.5 to 23.7 GtC of anthropogenic CO<sub>2</sub> released by human activities from 1800 to 1997 and maintained 84% to 91% of the absorbed CO<sub>2</sub> by the end of 1997. Increasing isopycnal diffusivity considerably increases the uptake in the subpolar region from GM2 to GM3, while increasing thickness diffusivity reduces this uptake from GM2 to GM4. The difference between the five cases can be qualitatively explained by the difference of physical fields.

9AM2000      MEQp273      oral  
**STUDYING ON IMPACT OF SUSPENDED SANDS OF DREDGING MUD ON GROWTH OF TWO SPECIES OF PHYTOPLANKTON IN CHANGJIANG RIVER ESTUARINE AREA**

Zhaoli Xu<sup>1</sup> Cuiping Yi<sup>1</sup> Xinqing Shen<sup>2</sup> Zhi Cao<sup>1</sup> Yunlong Wang<sup>1</sup> and Yaqu Chen<sup>1</sup>

<sup>1</sup> East China Sea Fisheries Institute, Chinese Academy of Fisheries Science, 300 Jungong Road, Shanghai, People's Republic of China. 200090 e-mail: yq\_chen@citiz.net

<sup>2</sup> Shanghai Fisheries University, Shanghai, People's Republic of China. 200090

Experimental results show that suspended sand of dredging mud has ability of inhibiting growth of *Nannochloropsis oculata* and *Chaetoceros muelleri*. When sand amount is lower 3g/L and lasting 96 hours, growing speed rate of these algae reduce about 20-30% once the stopping of dredging operation the suspended sands sink and water become clear quickly. The algae growth recovers and to be gradually in a normal status.

9AM2000      MEQp274      poster  
**THE IMPACT OF SUSPENSION FROM CHANGJIANG DIPPING OUT AND SUSPENDED MUD LIQUID ON HYDROBIOS**

Zhaoli Xu, Jiawu Xu, Qi Yuan, Mei Jiang and Yaqu Chen

East China Sea Fisheries Institute, Chinese Academy of Fisheries Science, 300 Jungong Road, Shanghai, People's Republic of China. 200090 e-mail: yq\_chen@citiz.net

The water sample was made suspended and dipping-out liquid by the mixing dredging spoil mud and seawater as a ratio of 1:4. The water was used in the tests of growing and poisoning by rearing *Chlorella saccharophila* and *Daphnia magna*. The results showed:

1. The growth of *Chlorella saccharophila* could be limited by the 90% or 100 dipping-out liquid (96hEC was 87%) or 100% suspended liquid (96hEC was 99.5).
2. Each value of 72hEC and 96hEC for the suspended liquid and 96hEC for the dipping-out liquid are 67.07%, 50.10% and 87.57%.

It could be thought that mud's dipping and suspending have no poison action to the aquatic organism, so that it cannot bring a harmful action on organism in Changjiang setuary.

9AM2000      MEQp275      poster  
**THE STUDY ON ASSEMBLAGE DENSITY OF COPEPOD DOMINANTS IN PLUME FRONT ZONE OF CHANGJIANG RIVER ESTUARINE AREA**

Zhaoli Xu, Qi Yuan, Mei Jiang, Yunlong Wang and Yaqu Chen

East China Sea Fisheries Institute, Chinese Academy of Fisheries Science, 300 Jungong Road, Shanghai, People's Republic of China. 200090 e-mail: yq\_chen@citiz.net

The paper deals with measures of copepod dominant assemblage density for the plume front zone of Changjiang River estuary in both rainy and dry seasons. Dominant species should meet their dominant value (Y)≥0.1. These dominants are *Calanus sinicus*, *Labidocera euchaeta*, *Centropages dorsispinatus*, *Acartia pacifica*, *Schmackcria polosia* in rainy season; *Calanus sinicus*, *Labidocera euchaeta*, *Tortanus vermiculus*, *Sinocalanus tenellus* and *Eucalamus subcrassus* in dry season. It is found that individuals of Copepod have clearly assemble figure in the brackish water. This has been confirmed by the study on dominant space distribution characters of plume front zone in Changjiang River estuary, applying index of assemblage density. The value of assemblage density in brackish water is higher than that in seashore and lower than in off-sea shore.

9AM2000 S6-315 poster  
**INTERANNUAL VARIABILITY OF SURFACE CHLOROPHYLL *a* AND PRIMARY PRODUCTION IN THE JAPAN SEA OBSERVED BY SATELLITE REMOTE SENSING**

Keiko Yamada<sup>1</sup>, Joji Ishizaka<sup>2</sup>, Sei-ichi Saitoh<sup>3</sup> and Motoaki Kishino<sup>4</sup>

<sup>1</sup> Graduate School of Science and Technology, Nagasaki University, 1-14 Bunkyo, Nagasaki, Japan. 852-8521

<sup>2</sup> Faculty of Fisheries, Nagasaki University, 1-14 Bunkyo, Nagasaki, Japan. 852-8521 e-mail: ishizaka@net.nagasaki-u.ac.jp

<sup>3</sup> Faculty of Fisheries, Hokkaido University, Japan

<sup>4</sup> Physical Chemical Research Institute, Japan

It is known that phytoplankton blooming appears in spring and fall in the Japan Sea. Objective of this study is to describe interannual variability of surface chlorophyll *a* concentrations in the Japan Sea by satellite remote sensing data, and to study the mechanism. We used OCTS and SeaWiFS data from November 1996 to November 1999 for chlorophyll *a* and additionally AVHRR data for SST.

Spring bloom occurred from March to May. Images of OCTS and SeaWiFS showed that spring bloom moved from south to north in southern part of the Japan Sea, and moved from north to south along the Russian coast. The former in 1998 appeared earlier than other years, and it corresponds to development of the thermocline in the area. The latter in 1999 appeared later than other years, and it seems to correspond to the melt of sea ice at the Mamiya strait. Fall bloom occurred in November and December, and the magnitude of the blooms became larger for later years. We will also discuss about interannual variability of primary production in the Japan Sea.

9AM2000 S3-276 oral  
**THE DEVELOPMENTAL PATTERN AND MATURATION OF THE HYPERIID AMPHIPOD *Primno abyssalis* IN THE OYASHIO REGION, WESTERN SUBARCTIC PACIFIC**

Yuichiro Yamada<sup>1</sup>, Tsutomu Ikeda<sup>1</sup> and Atsushi Tsuda<sup>2</sup>

<sup>1</sup> Marine Biodiversity, Graduate School of Fisheries Science, Hokkaido University, 3-1-1 Minato-cho, Hakodate, Hokkaido, Japan. 041-8611 e-mail: cha@fish.hokudai.ac.jp

<sup>2</sup> Hokkaido National Fisheries Institute, Japan. 085-0802

The segment number of the pleopod rami (SNPR) is known as an index of instar number for hyperiid amphipods. Based on SNPR, we analyzed instar number and development/ maturation patterns of *Primno abyssalis*, a hyperiid amphipod abundant in the mesopelagic zone of the Oyashio region. SNPR of newly hatched juveniles in female's marsupia was 1 (Instar 1), and oldest instars in which no secondary sexual characters (shape of antenna 1 for males, and development of oostegites for females) developed were 9 (Instar 9). Development of immature sexual characteristics were seen in Instar 7-13 for females (small oostegite) and Instar 9-11 for males (enlarged basal segment of antenna 1). Instars 12-17 and 9-11 acquired maturation conditions of females (fully developed oostegite) and males (long multi-articulate antenna 1), respectively. The largest mature specimen was 19.8 mm for females and 10.4 mm for males. From these results, combined with time-series data of their population structures, we will discuss on life cycle of *P. abyssalis* in the Oyashio region.

9AM2000 S4-277 oral  
**DISTRIBUTION OF EARLY STAGES OF THE OMMASTREPHID SQUID *Todarodes pacificus* NEAR THE OKI ISLANDS (SEA OF JAPAN)**

Jun Yamamoto<sup>1</sup>, Shinya Masuda<sup>2</sup>, Kazushi Miyashita<sup>1</sup>, Ryosuke Uji<sup>2</sup> and Yasunori Sakurai<sup>3</sup>

<sup>1</sup> Faculty of Fisheries, Hokkaido University, Hakodate, Hokkaido, Japan. 041-8611 e-mail: yamamoto@salmon.fish.hokudai.ac.jp

<sup>2</sup> Tottori Prefecture Fisheries Experiment, Sakaiminato, Tottori, Japan. 648-0046

<sup>3</sup> Graduate School of Fisheries Science, Hokkaido University, Hakodate, Hokkaido, Japan. 041-8611

MOCNESS (Multiple Opening Closing Net and Environmental Sampling System) and an ROV (Remotely Operated Vehicle) were used to examine the distribution of the early life stages of Japanese common squid (*Todarodes pacificus*) in the Sea of Japan near the Oki Islands, a known spawning ground of this species. The MOCNESS was used to sample at 14 stations through 5 depth layers between 0-100 m depth. The largest catches of hatchling-sized (ca. 1-mm-ML) paralarvae occurred in the surface layer (0-25 m depth), and paralarval mantle lengths increased with increasing sampling depth, suggesting that paralarvae gradually descend in the water column as they grow. The ROV was used at 4 stations to search for egg masses near the pycnocline (75-150m depth), which is where these masses are presumed to occur, but none were observed. These and further observations on paralarval abundance and distribution will be discussed.

9AM2000 W3-387 oral

**NEMURO MODEL FOLLOW UP**

Yasuhiro Yamanaka, Naoki Yoshie, Masahiko Fujii and Michio J. Kishi

Hokkaido University, Graduate School of Environmental Earth Science, Sapporo, Hokkaido, 060-0810 Japan e-mail: galapen@ees.hokudai.ac.jp

Ecological part in our coupled physical-ecological model is based on NEMURO model with new four compartments, calcite, calcium, total carbon, and total alkalinity, in order to represent carbon cycle associated with biological productivity. C/N Ratio is assumed with Redfield ratio, 106/16. Partial pressure of carbon dioxide, pCO<sub>2</sub>, in the ocean are calculated with air-sea gas exchange under chemical equilibrium from total carbon and total alkalinity. The model was applied to marine observed stations, A7 or KNOT. The primary production in our model shows strongly spring bloom of diatom, PL, and shows large daily variations from summer to winter. These are good agreement with observed features. The model pCO<sub>2</sub> shows extra highest pCO<sub>2</sub> in the late winter due to winter deep convection, second minimum of pCO<sub>2</sub> after spring bloom, slightly increasing during summer due to warm temperature, minimum pCO<sub>2</sub> in autumn. These are typical seasonal variation of pCO<sub>2</sub> observed in the Western Subarctic Pacific Ocean.

9AM2000 S8-278 oral

**HARMFUL ALGAE SURVEY IN VANCOUVER HARBOUR**

Tian Yan

Institute of Oceanology, Chinese Academy of Sciences, Qingdao, Shandong, People's Republic of China. 266071 e-mail: tianyan@ms.qdio.ac.cn

Harmful algae survey in Vancouver Harbour included toxin contents of shellfish, ARTOX test and cyst distribution. Samples collected during May 23 to June 8, 1999 in Vancouver Bay. 1. Shellfish samples have been collected for algal toxin analysis. About 500g whole mussels *Mytilus edulis* were collected at each intertidal sampling site to study algal toxin distribution in Vancouver Bay. Clam samples were also got from some intertidal beach (*Ruditapes philippinarium*, *Venerupis staminea*) and from benthic trawling (*Clinocardium nuttallii*, *Yoldia* sp.). Samples were processed immediately after collected and put into deep freezer for later lyophilizing. PSP of each sample will be analyzed using HPLC. 2. Standard Artemia Toxicity Test (ARTOX) has been performed to detect harmful microalgae in Vancouver Bay. Main species of macroalgae at each sampling site were collected. Attached microalgal cells were scraped from macroalgae and concentrated for ARTOX. Positive results of sample from Longsdale Quay indicated that toxic algae such as Heterosigma or DSP producer *Prorocentrum lima* might be present in the water. 3. Replicate sediment core samples have been collected from three sampling sites within Vancouver Harbour. The surficial sediment of each core was incubated using phytoplankton growth medium and optimal light conditions for approximately 3 weeks. Subsamples were collected every few days and preserved in Lugol's Solution. These samples will be analyzed for phytoplankton abundance and composition. The germination of potentially harmful phytoplankton will be documented.

9AM2000 FISp279 poster

**THE INTERANNUAL CHANGES OF BIOLOGICAL CHARACTERS ON WALLEYE POLLOCK, *Theragra chalcogramma*, IN THE ALEUTIAN BASIN OF THE BERING SEA**

Takashi Yanagimoto and Akira Nishimura

Hokkaido National Fisheries Research Institute, 116 Katsurakoi, Kushiro, Hokkaido, Japan. 085-0802 e-mail: yanagimo@hnf.affrc.go.jp

Biological characters of walleye pollock, *Theragra chalcogramma*, were examined in order to elucidate the population dynamics in the Aleutian Basin of the Bering Sea during winter. Historical samples collected in 1989, 1993, 1996, and 1999 were used to analyze the horizontal distributions, size compositions, length-weight relationship, spawning, parasite infection, and the growth.

Horizontal distributions of spawning pollock become narrow year by year and main group of spawning pollock moved from the Bogoslof Islands area to the Four Mountains Islands area. Mean fork length increased gradually from 480mm in 1989 to 560mm in 1999. Age compositions showed that 1978 year class was the most dominant until 1993, and it began to decrease from 1996.

The portion of 1989 year class increased from 1996 instead of 1978 year class. It was suggested that the growth of 1989 year class was better than that of 1978 year class.

No significant difference was observed in the length-weight relationships and parasite infections by each year. GSI peaks by year moved from first February to middle March, it was considered that the spawning period is delayed year by year. Fecundity versus length gradually increased year by year. It was clear that these changes of biological characters occurred with decrease of pollock biomass.

9AM2000           MEQp280           oral  
**DISTRIBUTION OF ORGANOPHOSPHORUS PESTICIDES IN SOME ESTUARINE ENVIRONMENTS OF KOREA**  
Dong-Beom Yang, Jun Yu, Dong-Ho Lee, Kyung-Tae Kim  
*Korea Ocean Research & Development Institute (KORDI), Ansan P.O. Box 29, Seoul, Republic of Korea. 425-600 e-mail: dbyang@kordi.re.kr*

To study the distribution of organophosphorus pesticides which are extensively used in Korean agriculture, surface sea water samples taken from 4 coastal areas during May and August 1997 and sediment samples were collected from two coastal areas in August 1997. These samples were analyzed using a Gas Chromatography/Nitrogen Phosphorus Detector (GC/NPD). In August the most commonly found organophosphorus pesticides in the surface waters of Kunsan area were IBP < S-Benzyl O,O-diisopropyl phosphorothioate > ( $m=432.5 \text{ ng l}^{-1}$ ) and EDDP < O-ethyl S,S-diphenyl phosphorodithioate ( $m=37.4 \text{ ng l}^{-1}$ ) which are largely used between June and September to prevent rice blast disease. In Danghang Bay dry fields located near the mouth of the estuary seemed to affect the concentrations of certain organophosphorus pesticides in the surface waters. Since organophosphorus pesticides applied in the watershed are rapidly decomposed while being transported along freshwater streams, watershed size is not proportional to the concentrations of these pesticides in the coastal waters. Pesticides concentrations measured in August were compared with those in May. IBP concentrations in coastal waters were about an order of magnitude higher in August than in May. Temporal and geographical distribution of individual organophosphorus pesticides is likely to be affected by types of agricultural practices in the watershed. Chloropyrifos was the most important of the organophosphorus pesticides in the sediments of the study area because of its persistent nature and high affinity to particulates.

9AM2000           S1-281           oral  
**DECADAL CHANGES IN ABUNDANCE OF DOMINANT PELAGIC FISHES AND SQUIDS IN THE NORTHWESTERN PACIFIC OCEAN SINCE THE 1970S, WITH NOTES ON THE IMPACT OF THE LARGE-SCALE DRIFTNET FISHING DURING 1978-1992**  
Akihiko Yatsu, Kazuya Nagasawa and Tokio Wada  
*National Research Institute of Fisheries Science, Fukuura 2-12-4, Kanazawa-ku, Yokohama, Kanagawa, Japan. 236-8648 e-mail: yatsua@nrifs.affrc.go.jp*

Since the 1950s, 2-6 millions of tons of small pelagic fishes have been harvested annually by the Japanese commercial fisheries in the Northwestern Pacific with quasi-decadal alternations in dominant species: chub mackerel in the 1970s, Japanese sardine in the 1980s, Pacific saury and Japanese common squid in the early 1990s. Similar changes were also detected in stomachs of sympatric mink whales and predatory fishes, such as Pacific pomfret and blue shark. Biomass of Japanese sardine in the 1980s was over 10 million tons, which is significantly higher than those of other small pelagics owing to their omnivorous feeding habitat, i.e., preying on both zooplankton and phytoplankton. Following the stock fluctuation of Japanese sardine, Pacific pomfret biomass changed though mink whales biomass probably did not, owing to the difference in their turnover rates. Available information indicates the collapse of Japanese sardine stock was caused from the drastic decline in the recruitment success, which in turn is attributed to environmental shifts rather than overfishing. During 1978-92, large-scale driftnet fishing harvested annually 152000-357000 tons off neon flying squid and other pelagic species such as albacore, Pacific pomfret, salmon shark and blue shark. Abundance of these species was low during the intensive fishing period. After 1992, shorter-life species recovered first among similar-habitat species. We will discuss possible links among regime shift, species alternation of small pelagics and intensive fishing.

9AM2000           S6-282           poster  
**PHYTOPLANKTON CROP ESTIMATED FROM THE UPPER MIXED LAYER DEPTH AND LIGHT INTENSITY IN THE WESTERN WATERS OF KYUSHU, JAPAN**  
Katsumi Yokouchi, K. Okamura, K. Kitani, S. Ohshimo and M. Tokimura  
*Seikai National Fisheries Research Institute, 3-30 Kokubumahi, Nagasaki, Nagasaki, Japan. 850-0951 e-mail: tokimura@snf.affrc.go.jp*

In order to determine the dynamics of plankton in the western waters of Kyushu, Japan, vertical profile data of chlorophyll and temperature from 1951 to 1990 were quoted from the JODC homepage. Chlorophyll concentration seasonally fluctuated much larger in the continental waters than in Kuroshio waters. Seasonal change in chlorophyll in the continental shelf waters showed a typical pattern in the temperate waters with peaks in spring and autumn. The observed annual cycles of chlorophyll were compared with a modelled system involving interactions among nutrients, phytoplankton and herbivorous zooplankton in the upper mixed layer, based on a annual changes of the observed mixed layer depth and the calculated surface light intensities. The annual cycle of modelled phytoplankton crop showed a similar tendency in observation based on the averaged JODC data. The upper mixed layer depth was defined as the depth with one degree centigrade lower than the surface temperature. The upper mixed layer depth in January to March decreased sharply in the middle of 1970s. Long-term fluctuation of phytoplankton was estimated with the model for lack of sufficient data. Modelled phytoplankton crop at daily intervals showed the large fluctuation in the middle of 1970s, when composition of pelagic fish like sardine, chub mackerel, and jack mackerel changed dramatically. Long-term

variations in sea surface temperature and fish resources are now being examined to evaluate the relationship to the inter-annual and annual cycles of plankton as food for fish.

9AM2000 S3-283 oral

***Euphausia pacifica* (EUPHAUSIACEA: CRUSTACEA) OF THE YELLOW SEA I. SPATIAL DISTRIBUTION**

Won Duk Yoon and Gyung Soo Park

West Sea Fisheries Research Institute, 98-36, Buksung-dong 1ga, Jung-gu, Incheon, Republic of Korea. 400-201 e-mail: wdyoon@haema.nfrda.re.kr

Spatial distribution of *Euphausia pacifica* of the Yellow Sea was investigated with the samples collected bimonthly for a year (from June, 1997 to April, 1998) using a conical net (mouth size 1 m, mesh size 500  $\mu$ m) hauled vertically. They were identified to the developmental stages (adult, furcilia, calyptopis) and spatial distribution patterns were described in relation to the environmental factors (temperature, salinity, dissolved oxygen, chlorophyll *a*, and nutrients).

In June, adults were abundant in the neritic and central areas. Furcilia were evenly distributed, whereas calyptopis were absent in the northern area. All types of *E. pacifica* were absent in the coastal areas. In August and October, adults were abundant in the neritic and central areas, and furcilia and calyptopis seemed avoid the central area. In December, the distribution of all the developmental stages was bifurcate: one in the outer neritic and the other in the coastal area. Furcilia and calyptopis were relatively scarce in the southern area. In February, adults were evenly distributed, whereas furcilia and calyptopis were nearly absent in the southern area. In April, spatial distribution patterns were similar with those of February. Scarcity of calyptopis in the southern area was accentuated.

Correlation and principal component analysis revealed that the distribution patterns were closely related with the variation of temperature and that those of furcilia and calyptopis were strongly influenced by adult concentration and chlorophyll *a*. The mechanism, or scenario, of the variation in spatial distribution of *E. pacifica* in the Yellow Sea was discussed.

9AM2000 S3-306 poster

***Euphausia pacifica* (EUPHAUSIACEA: CRUSTACEA) OF THE YELLOW SEA II. ALLOMETRIC RELATIONSHIP**

Won Duk Yoon and Yoon Lee

West Sea Fisheries Research Institute, 98-36, Buksung-dong 1ga, Jung-gu, Incheon, Republic of Korea. 400-201 e-mail: wdyoon@haema.nfrda.re.kr

*Euphausia pacifica* were collected at summer (August 1997) and winter (February, 1998) in the eastern Yellow Sea. Total (TL); carapace (CL) and 6<sup>th</sup> segment length (SL), and dry (DW) and ash free dry weight (AFDW) were measured for each individual.

Variations in length and weight were statistically significant according to the sampling times indicating heterogeneity of the population in view of the allometric characteristics. In summer CL (2.13 mm in average) and SL (1.07 mm) represented 31.7% and 15.9% of TL (6.72 mm), respectively, and SL 50.2% of CL. AFDW (2.9 mg) represented 80.6% of DW (3.6 mg). Winter populations were slightly larger but lighter than the summer one. CL (2.42 mm) and SL (1.50 mm) represented 31.97 and 16.51% of TL (7.57 mm), respectively, SL 51.91% of CL, and AFDW (1.7 mg) 73.91% of DW (2.3 mg). Pairs of length and weight for each sampling times were all expressed in linear equation. The slopes and intercepts of the allometric relationships between length and weight were variable with sampling times, and an analysis of covariance approved its statistical difference. Hence application of an allometric relationship, based on measurements of length and weight from one set of collection, could bias the results derived, such as biomass used in studies of population dynamics. The consequences of this application as well as the choice of length and weight measurements, representative for the *E. pacifica* population, were discussed.

9AM2000 S3-284 poster

**SECONDARY PRODUCTION OF *Synchelidium lenorostralum* (CRUSTACEA, AMPHIPODA) IN A SANDY SHORE, SOUTHERN KOREA**

Ok Hwan Yu, Ho Young Soh and Hae-Lip Suh

Department of Oceanography, College of Natural Sciences, Chonnam National University, Kwangju, Republic of Korea. 500-757 e-mail: okyu@chonnam.chonnam.ac.kr

Secondary production of the amphipod *Synchelidium lenorostralum* was measured in a sandy shore of Dolsan Island, southern Korea, on the basis of monthly samples from June 1996 to July 1997. Secondary production was estimated by size-frequency method. Maximum biomass was recorded in April. Biomass of the breeding periods was higher in the spring than that in the fall. Annual secondary production of *S. lenorostralum* was 1.06 g DW m<sup>-2</sup> yr<sup>-1</sup> with an annual P/B ratio of 5.74. Secondary production of *S. lenorostralum* fell within the range observed for other amphipods in an intertidal sandy shore, whereas P/B ratio was higher than ratio recorded previously. We suggest that the high abundance and P/B ratio of *S. lenorostralum* in a sandy shore may constitute an important role by linking primary producers into higher carnivores.



9AM2000

S6-327

poster

**THE PRODUCTION PARAMETERS OF PHYTOPLANKTON IN THE JAPAN SEA IN WINTER AND SPRING 2000**S.P. Zakharkov<sup>1</sup>, V.B. Lobanov<sup>1</sup>, B.G. Mitchell<sup>2</sup> and L.N. Sovetnikova<sup>1</sup><sup>1</sup> *Pacific Oceanological Institute, 43 Baltiyskaya Street, Vladivostok, Russia. 690041 e-mail: pacific@online.marine.su*<sup>2</sup> *Scripps Institution of Oceanography, University of California, San Diego, La Jolla, CA 92093-0218, U.S.A. e-mail: gmitchell@ucsd.edu*

The phytoplankton production is main factor decreasing concentration of mobile carbon in ocean and atmosphere. Hence its estimation is necessary to understand carbon cycle and its dynamics. In this study we examine the production parameters of phytoplankton in the Japan Sea during winter-spring period. The samples for pigments and primary production were taken at the 38th cruise of R/V *Professor Khromov* implemented in February 22 - March 23, 2000. Phytoplankton pigments were determined by spectrophotometric method in 103 samples and the chlorophyll *a* concentration was defined also by fluorescence method in 252 samples. The comparison of results by both methods for 81 parallel samples agreed very well with correlation coefficient of 0.957. Thus the fluorescence may be used to estimate chlorophyll *a* concentration in certain cases. The primary production was determined by the method of delayed fluorescence calibrated by 14-C radiocarbon method. Satellite images of sea ice, water temperature and color obtained from NOAA AVHRR and SeaWiFS scanners for the period of the cruise were also examined. Distribution of phytoplankton were typical of winter for the most part of the Japan Sea. Phytoplankton concentrations were low and evenly distributed in the upper convective layer. In winter the development of phytoplankton and primary production in the Japan Sea is limited by the availability of light and hence controlled by the vertical mixing depth. Phytoplankton bloom with chlorophyll *a* concentration up to 4-5.75 mg/m<sup>3</sup> was observed at the surface layer at coastal area off Peter the Great Bay and north-eastern Prymorye where shallow pycnocline was formed below the surface fresh layer caused by ice melting. In the central part of the Japan Sea mesoscale phytoplankton variability was caused by anticyclonic eddies. These chlorophyll *a* concentrations at the sea surface varied from 0.16 to 1.78 mg/m<sup>3</sup> at the eddies of frontal zone area and from 0.15 to 0.48 mg/m<sup>3</sup> over central part of Japan Basin. The south-western area of the sea located off the Korean peninsula and influenced by the Tsushima current waters was characterized by another vertical distribution of phytoplankton. Highest values of chlorophyll *a* (0.8 -1.7 mg/m<sup>3</sup>) were observed not at the surface but at the depth of 15 to 100 m which may be explained by consumption of nutrients at the surface typical for final phase of a spring bloom.

9AM2000

W7-383

poster

**DISTRIBUTIONS OF ΔPCO<sub>2</sub> AND CO<sub>2</sub> FLUXES IN THE NORTHERN NORTH PACIFIC: RESULTS FROM A COMMERCIAL VESSEL IN 1995-1999**Jiye Zeng<sup>1</sup>, Yukihiko Nojiri<sup>2</sup>, Yasumi Fujinuma<sup>2</sup>, Paulette P. Murphy<sup>3</sup> and C.S. Wong<sup>4</sup><sup>1</sup> *Global Environmental Forum (GEF), c/o. NIES, 16-2 Onogawa, Tsukuba, Ibaraki, 305-0053, Japan e-mail: zeng@nies.go.jp*<sup>2</sup> *National Institute for Environmental Studies (NIES), 16-2 Onogawa, Tsukuba, Ibaraki, 305-0053, Japan*<sup>3</sup> *National Oceanographic Data Center, National Oceanic and Atmospheric Administration, 1315 East-West Highway, Silver Spring, MD 20910, USA*<sup>4</sup> *Institute of Ocean Sciences (IOS), P.O. Box 6000, Sidney, B.C., Canada. V8L 4B2*

Monthly distribution maps were constructed for ΔpCO<sub>2</sub> (ocean minus atmosphere) in the northern North Pacific (north of 35°N) using data taken from the cargo vessel M/S *Skaugran* between March 1995 and March 1999. The data set includes a total of 68 crossings in all seasons and about one million pCO<sub>2</sub> records. The monthly distribution maps provide the detail of ΔpCO<sub>2</sub> change due to biological activity, cooling-warming effect, and vertical mixing. Seasonal flux maps of CO<sub>2</sub> were constructed from ΔpCO<sub>2</sub> maps and monthly wind velocities. The integrated net annual absorption of CO<sub>2</sub> by the monitoring area of 1.4×10<sup>7</sup> km<sup>2</sup> is 0.24 Gt-C yr<sup>-1</sup>. Seasonality of ΔpCO<sub>2</sub> showed large differences within the high latitude zone (45°N-55°N) and mid latitude zone (35°N-45°N). Summer decrease and winter increase of ΔpCO<sub>2</sub> were observed with the peak to peak amplitude higher than 100 μatm near the Alaska Peninsula, South Bering Sea, and off Kuril Islands. The largest annual net sink in the observation area is off Japan. The winter evasion of CO<sub>2</sub> in the western part of the high latitude zone is significant. Thus South Bering Sea and off Kamchatka islands are the net annual source of CO<sub>2</sub>. The net annual absorption is mainly driven by the autumn and winter decrease of ΔpCO<sub>2</sub> in the mid latitude zone. The CO<sub>2</sub> flux in the whole monitoring region is close to neutral in summer due to small wind, even though ΔpCO<sub>2</sub> near the Alaska Peninsula is very low (up to -100 μatm), and ΔpCO<sub>2</sub> off California coast high (up to 35 μatm).

9AM2000 W7-384 oral  
AN INTRODUCTION TO AN OCEANIC CO<sub>2</sub> DATABASE FOR THE NORTH PACIFIC

Jiye Zeng<sup>1</sup>, Yukihiro Nojiri<sup>2</sup> and Yasumi Fujinuma<sup>2</sup>

<sup>1</sup> *Global Environmental Forum (GEF), c/o. NIES, 16-2 Onogawa, Tsukuba, Ibaraki, 305-0053, Japan e-mail: zeng@nies.go.jp*

<sup>2</sup> *National Institute for Environmental Studies (NIES), 16-2 Onogawa, Tsukuba, Ibaraki, 305-0053, Japan*

The database project was initiated by the ship-of-opportunity monitoring project for CO<sub>2</sub> in the air and seawater of the North Pacific. The monitoring project was started in March 1995 by the collaborative efforts of the National Institute for Environmental Studies, Japan, and the Institutes of Ocean Sciences, Canada. Millions of records of CO<sub>2</sub> and other oceanic parameters have been collected by M/S *Skaugran* and M/V *Alligator Hope*, the two commercial cargo carriers participated in the CO<sub>2</sub> monitoring. A database is being constructed to help scientists gain inside views of those data quickly and conveniently. The database server is connected a web server so that users can query and retrieve data using popular web browsers and generate graphics online for a quick view of data. The database will be expended to include data relevant to CO<sub>2</sub> studies from other monitoring projects.

9AM2000 S5-285 oral  
MODIFICATION OF THE INTERMEDIATE WATER IN THE WESTERN SUBARCTIC GYRE

Igor A. Zhabin

*Pacific Oceanological Institute, 43 Baltyskaya Street, Vladivostok, Russia. 690043 e-mail: pacific@online.marine.su*

The East Kamchatka/Oyashio currents region is important for ventilation (cooling and freshening of the Intermediate Water of the North Pacific. CTD data collected in 1990-1992 during four Russian-Canadian-U.S.A. expeditions are used for study of Intermediate Water modification in the western boundary currents region of Subarctic Pacific.

The T-S analysis, dynamic topography and properties distribution at isopycnals show that modification of the upper part of intermediate layer (26.7-27.0 sigma-theta) occurs due to enhanced mixing along the east coast of Kamchatka and water exchange with the Okhotsk Sea through the Kuril Straits. The deep portion of intermediate layer between isopycnals 27.0-27.4 sigma-theta is modified in the area around central Kuril Islands only as result of outflow from Okhotsk Sea through the Bussol' and Kruzenshtern Straits. The modified waters flows along the Kuril Islands as the coastal branch of the Oyashio. Thus the Oyashio Water is mixture of the Okhotsk Sea and Pacific Subarctic waters. The cold and fresh East Kamchatka Slope Water can be ventilated due to strong winter cooling, ice formation and eddy activity.

9AM2000 S4-289 oral  
ASSESSMENT OF PACIFIC SARDINE (*Sardinops melanosticta*) STOCK IN KOREAN WATERS, IN CONSIDERATION OF THE RELATIONSHIP BETWEEN RECRUITMENT AND THE OCEAN ENVIRONMENTAL FACTORS

Chang Ik Zhang<sup>1,2</sup>, Jae Bong Lee<sup>2</sup> and Young Min Choi<sup>3</sup>

<sup>1</sup> *Dept. of Marine Production Management, Pukyong National University, Pusan, Republic of Korea. 608-737 e-mail: cizhang@dolphin.pknu.ac.kr*

<sup>2</sup> *UR Interdisciplinary Program of Fisheries and Oceanography, Pukyong National University, Pusan, Republic of Korea. 608-737*

<sup>3</sup> *National Fisheries Research & Development Institute, 408-1 Shirang-ri, Kijang-up, Kijang-gun, Pusan, Republic of Korea. 619-900*

Variability in the level of recruitment of marine fisheries resources is often attributed to environmental conditions on larval supply, while in other cases the recruitment level is determined during the juvenile phase as a result of biological processes. Decadal-scale regimes of Pacific sardine (*Sardinops melanosticta*) abundance has been observed in the worldwide coastal waters, including Korean waters. Thus, incorporating environmental factors in stock assessment is important, especially for the pelagic stocks, which are sensitive to changes in environmental conditions. Assessment methodology for Pacific sardine stock is presented, considering the relationship between the recruitment of sardine and the oceanographic environmental factors at spawning seasons, February-May. The method is based on spawning biomass and recruitment relationship (SRR) model, but it makes different assumptions about correlations between recruitment and environmental factors, such as sea surface temperature (SST) around spawning grounds and winter Pacific Decadal Oscillation (PDO) in the previous year. The methodology was applied to the sardine stock which was exploited by the Korean large purse seine fishery in Korean waters. Modified SRR models with environmental factors for the 1975-1999 fishing seasons are presented, focusing on estimates of acceptable biological catch (ABC).

9AM2000 S4-287 poster  
**AGE DETERMINATION AND ESTIMATION OF GROWTH PARAMETERS USING OTOLITHS OF SMALL YELLOW CROAKER, *Pseudosciaena polyactis* IN KOREAN WATERS**  
Chang Ik Zhang<sup>1</sup>, Man Woo Lee and Kyum Joon Park  
Dept. of Marine Production Management, Pukyong National University, Pusan, Republic of Korea. 608-737 e-mail: cizhang@dolphin.pknu.ac.kr

A methodology for determining age by otolith of small yellow croaker, *Pseudosciaena polyactis*, was developed. A thin section method was chosen to be suitable for age determination because the otolith had a three-dimensional shape and thus it was not possible to read the otolith rings on the surface. The clear rings were identified on the vertical-axis cross-sectioned otoliths. The relationship between total length and total weight and the growth parameters were estimated with error structure to endow with accuracy. In the relationship between total length and total weight, a multiplicative error structure was assumed because variability in growth increased as a function of the length, and the estimated equation was  $W=0.0049*L^{3.2153}$ . The variability in growth was constant as a function of the age, revealing an additive error structure. The von Bertalanffy growth parameters were obtained from a nonlinear regression as  $L_{\infty}=37.11$  cm,  $K=0.20$  and  $t_0=-1.8$

9AM2000 FISp290 poster  
**A STUDY ON THE MULTI-SPECIES ASSESSMENTS IN KOREAN FISHERIES**  
Chang Ik Zhang<sup>1</sup>, Young Il Seo<sup>1</sup>, Sung Il Lee<sup>1</sup> and Myoung Ho Shon<sup>2</sup>  
<sup>1</sup> Pukyong National University, Pusan, Republic of Korea. 608-737 e-mail: cizhang@dolphin.pknu.ac.kr  
<sup>2</sup> National Fisheries Research & Development Institute, Pusan, Republic of Korea. 619-900

This paper presents some case studies of multi-species fisheries in Korean waters. Multi-species fisheries were divided into two types: multi-species by a single fishery and single species by multiple fisheries. For the case of the multi-species by a single fishery, a multi-species yield-per-recruit model was applied to the Korean pair trawl fishery, which exploits demersal fishes such as, hairtail (*Trichiurus lepturus*), small yellow croaker (*Pseudosciaena polyactis*), white croaker (*Argyrosomus argentatus*) and pomfret (*pampus echinogaster*). The overall optimum fishing mortality (F0.1) value for the multi-species was estimated and compared to the spawning potential ratio (F<sub>x</sub>%) values estimated from the spawning biomass-per-recruit model. The seemingly unrelated regression (SUR) model was used to estimate maximum sustainable yield (MSY) and fishing mortality at MSY (FMSY) of multi-species by a single fishery, which took into consideration the possibility of correlation among the catch data of individual species. Optimum harvest levels were compared for the above two approaches. The second case is single species by multiple fisheries, and as an example of this case small yellow croaker which are caught by Korean pair trawl and stow net fisheries was selected. This approach uses standardized fishing efforts for the fisheries and some data for the economic analysis, and then estimates MSY, optimum yield (Y0.1), maximum economic yield (MEY) and optimum effort (E-opt).

9AM2000 FISp288 poster  
**STOCK ASSESSMENT OF THE KOREAN SCALLOP, *Chlamys farreri* IN THE ADJACENT WATERS AROUND WANDO, KOREA**  
Chang Ik Zhang<sup>1</sup>, Kwang Ki Park<sup>1</sup>, Tae Gu Kang<sup>2</sup>, Sun Kil Lee<sup>1</sup> and Cheol Su Kim<sup>3</sup>  
<sup>1</sup> Dept. of Marine Production Management, Pukyong National University, Pusan, Republic of Korea. 608-737 e-mail: cizhang@dolphin.pknu.ac.kr  
<sup>2</sup> Ulsan Regional Maritime Affairs and Fisheries Office, Ulsan, Republic of Korea. 680-050  
<sup>3</sup> Pusan Metropolitan City, Pusan, Republic of Korea. 611-735

This study is to estimate population ecological parameters, including growth parameters, age at 50% maturity, survival rate, instantaneous coefficients of natural and fishing mortalities, and age at first capture, and to conduct stock assessment of the Korean scallop, *Chlamys farreri* in the adjacent waters around Wando, Korea. The von Bertalanffy growth parameters estimated from a non-linear regression were  $SH_{8734}=117.4$ mm,  $K=0.61$ , and  $t_0=-0.017$ . The age at 50% maturity was 0.21 year with the shell height of 18.3mm, and spawning occurred twice a year, that is, June~July and October. Annual survival rate (S) of the Korean scallop was determined to be 0.23 (Var(S)=0.0004). The estimated instantaneous coefficient of natural mortality (M) was 0.45/year. From the estimates of S and M, the instantaneous coefficient of fishing mortality (F) was calculated as 1.04/year. The age at first capture (t<sub>c</sub>) was estimated as 1.0 year by the Pauly's length-converted catch curve method. An yield-per-recruit analysis showed that the current yield-per-recruit of about 30.2g with F=1.04/year, where the age at first capture (t<sub>c</sub>) was 1.01 year, was lower than the maximum possible yield-per-recruit of 37.1g. Yield-per-recruit and spawning biomass-per-recruit were estimated under various harvest strategies based on F<sub>max</sub>, F0.1, F35% and F40%. The current biomass of the Korean scallop was 154,600 metric tons (mt). The acceptable biological catch (ABC) was estimated to be 44,800 mt.

9AM2000 S3-286 poster  
**SHORT TIME DYNAMICS OF CILIATE ABUNDANCE IN THE BOHAI SEA, CHINA**

Wuchang Zhang and Rong Wang  
*Marine Ecology Department, Institute of Oceanology, Chinese Academy of Sciences, 7 Nanhai Road, Qingdao, People's Republic of China. e-mail: w.c.zhang@usa.net*

The ciliate community in the Bohai Sea, China was studied from 23 September to 7 October 1998. A hurricane struck the study area between the two grid station investigations, which were six days apart.

Six tintinnid species (*Favella panamensis*, *Leptotintinnus nordqvisti*, *Tintinnopsis butschlii*, *T. karajacensis*, *T. Radix* and *Wangiella dicollaria*) were identified. The total ciliate abundance in the surface layer ranged between 20-1500 ind.l<sup>-1</sup>. The surface biomass varied from 0 to 12.3 µg C l<sup>-1</sup>. The water column biomass appeared to be 0-136 mg C m<sup>-2</sup>.

At the first grid station investigation, the *Tintinnopsis karajacensis* dominate in the warm, low salinity waters at the Huanghe River Mouth. Aloricate ciliate sp.1 dominated in the cold, high salinity waters in the Northwest and the Bohai Strait. At the second grid station investigation, the *T. Karajacensis* almost disappeared. The aloricate ciliate sp.1 also decreased drastically. A smaller aloricate ciliate sp.2 dominated at the Bohai Strait. The sharp decrease of the ciliate abundance may be caused by the disturbance of the hurricane.

At the anchor stations and the drift station, the total ciliate abundance co-varied with temperature. The drastic change of the ciliate community in hours was probably due to the change of the watermass. It was warned that indicating the seasonal evolvement of the ciliate community by one or two investigations might be misleading.

9AM2000 POCp291 poster  
**SEASONAL VARIATION OF THE DICHOTHERMAL LAYERS IN THE NORTHERN PART OF THE OKHOTSK SEA FROM MAY TO OCTOBER**

I.A. Zhigalov  
*Pacific Research Fisheries Centre (TINRO-Centre), Laboratory of Fisheries Oceanography, 4 Shevchenko Alley, Vladivostok, Russia. 690600 e-mail: root@tinro.marine.su*

The analysis was executed on the basis of modern base of oceanological data of the Okhotsk Sea including more than 66000 stations, performed from 1932 to 1998. The data located to the north from 51°N were used from this base. Than average quantities of temperature and salinity were calculated for trapeze 1(2(of latitude and longitude. Statistical T-S diagrams were constructed on the base of the average long-term data of the dichothermal layers for May, June - August, August, and October. Further the areas with close T-S properties marked out.

In May the separation of types of waters was caused mainly by the difference of significances of minimum temperature of the sea changing from -1.7 up to 0.6°C. The main range of modifications of salinity and temperature was within the limits of 32.9 - 33.2 psu and -1.7.. -0.5°C. 84% from square of northern part of the sea was occupied of waters with such characteristics in a nucleus of dichothermal waters.

In June - August at the temperature minimum temperature and salinity changed within a wide range from a freezing point to 1.0°C, salinity - from 32.8 up to 33.6 psu. The very salty waters located in the central part of a Shelikov Gulf, it is connected with repeated carrying-out of ice during ice-forming, formation and submersion of very cold and salty waters. The waters with low salinity at the temperature located to the east of Sakhalin.

In October the square occupied by waters with temperature -1.7...-0.5(Ñ and salinity 32.9 - 33.2 psu has decreased up to 30% (of the square of the northern part of the Okhotsk Sea).

9AM2000 S9-292 invited  
**RECENT PROGRESS IN ENVIRONMENTALLY SOUND MARICULTURE IN CHINA**

Ming-Jiang Zhou  
*Institute of Oceanology, Chinese Academy of Sciences, Qingdao, Shandong, People's Republic of China. 266071*

China launched a special program focused on Environmental Sound Mariculture in 1996 in her 9<sup>th</sup> "Five Year's Plan" to deal with many problems caused by overgrowing and less planned mariculture industry and try to find proper methods to develop the mariculture industry in an environmentally sound and sustainable way. 4 sub-tasks were set up in the program aiming 4 different types of mariculture along Chinese coast: Task 1-"Bay mariculture system", Task 2-"Pond based mariculture system", Task 3-"Tide zone based system", and Task 4-"Coastal shallow sea system". Task 1 was planned to focus on whole mariculture system developed in some selected bays. Task 2 would work particularly on shrimp ponds. Task 3 would give most interests to clams maricultured in the area. And Task 4 was devoted to the scallop industry and the fish cage industry in northern and southern areas respectively. Achievements were seen from these 4 different tasks after nearly 5 years effort both in academic and economic sense. This report will introduce, review and discuss the program and its progress made.

9AM2000 POCp293 oral  
**UPWELLING/DOWNWELLING IN PETER THE GREAT BAY (JAPAN SEA): IMPLICATION FOR CROSS-SHELF EXCHANGE**

Yury I. Zuenko

*Pacific Fisheries Research Center (TINRO-Center), 4 Shevchenko Alley, Vladivostok, Russia. 690600 e-mail: root@tinro.marine.su*

Primitive empirical model of wind-driven water transport was constructed on the background of frequent observations of wind and thickness of upper mixed layer. The model and the observations show the prevalence of downwelling in coastal area in summer when south winds dominate, and upwelling in autumn when the monsoon has changed. It causes the thickening of mixed layer in summer and rising the thermocline in autumn.

Downwelling is accompanied by warm, salt and low-nutrients surface water transport from the open sea to the coast. But its influence on plankton abundance is vague. Both boreal and subtropical species are concluded to have considerable local origin in coastal zone so far as fluctuations of their abundance weren't related with water transport across the shelf.

Upwelling is accompanied by invasion of cold, salt and high-nutrients deep water on shallow depths and by offshore transport of cold (in late autumn) low salinity coastal water. Plankton succession in coastal zone is possibly independent on its state in the open sea when upwelling but is influenced by upwelling-induced change of water structure and properties.

Note that upwelling and downwelling have opposite influence on coastward flows of all properties with exclusion the salinity: it heightened because of both processes.

All cross-shelf flows were estimated quantitatively.

9AM2000 W3-294 oral  
**COUPLING OF DIFFERENT TROPHIC LEVELS IN MARINE ECOSYSTEM MODELS**

Vladimir I. Zvalinsky

*Pacific Oceanological Institute, 43 Baltyskaya Street, Vladivostok, Russia. 690041 e-mail: biomar@mail.ru*

Flux coupling of different trophic levels is the very important problem in marine ecosystem models. Such coupling realizes by light-dependence and nutrient incorporation functions for autotrophic and grazing functions for heterotrophic ecosystem compartments. All these functions are the Michaelis-Menten rectangular hyperbola, empirical exponent equations or different combinations of these functions (Platt, *et al.*, 1980; Fasham, *et al.*, 1995; Oguz *et al.*, 1996; Kawamiya *et al.*, 1997; PICES Lower Trophic Level Modelling Nemuro Workshop, 2000). But these functions are not very good reflect the real biological processes and most of them substantially differ (to 1.8 times) from experimental dependencies, especially in conditions of low and moderate values of light intensity, nutrient and food concentrations.

We developed the approach, which allows describe the biological processes as coupled cyclic processes (based on their inner enzymatic mechanism). The dependencies are the non-rectangular hyperbola in the simplest case. There are three main parameters determine the character of dependencies: substrate constant (generalized analogy of the Michaelis constant) and two generalized kinetic constants one of which determines the substrate (food) incorporation (capture) rate, the other one the substrate (food) processing rate. This approach allows describe the simultaneous rate dependence on several competitive or non-competitive substrates (prey types) too. The analysis shows the high degree adequacy developed models to real biological processes. Different trophic levels can be coupled with using of these models.

9AM2000 S4-295 poster  
**WALLEYE POLLOCK (*Theragra chalcogramma*) POPULATION ORGANIZATION ECOLOGICAL BASES**

Larisa M. Zverkova

*Sakhalin Research Institute of Fisheries & Oceanography, 196 Komsomolskaya Street, Yuzhno-Sakhalinsk, Russia. 693023 e-mail: zverkova@tinro.sakhalin.ru*

Walleye pollock is characterized an ecological features row that need to be taken into account during his population organization analysis. 1) Long-time (up to 3-5 months) spawning, pelagic eggs. 2) Long-time ontogenetic planktonic stage during embrional-larvae development. 3) High migration activity for the adult species.

1, 2 features are the inhabitation adaptation through existing currents. The feature 3 is reflected possibility of spatial isolation between populations, i.e. distance between spawning regions what is prevailed activity migration radius of main part of species among each population.

Genetic isolation of the population arises due mechanisms which are limited the panmixia. For the walleye pollock features 1-3 are provided the realization gens flow; significant migration radius breaks isolation of the spawning areas; linkage between spawning areas is established and kept during and results of the egg-embrional stage drift.

# Index of Authors

Author Name:	Paper #:	Page #:			
<b>A</b>					
× Abell, Jeff	S6-062	p.28	Borisovets, E.E.	FISp023	p.11
Abo, Katsuyuki	S9-001	p.1 <sup>23</sup>	Bornhold, Elizabeth A.	S3-024	p.11
Addison, Richard F.	S8-002	p.1 <sup>23</sup>	Botsford, Louis W.	S7-342	p.66
Agafonova, Irina G.	S8-012	p.6-2 <sup>8</sup>	Bower, John R.	S4-025	p.11
	MEQp003	p.1 <sup>23</sup>	Boyd, Phillip W.	S6-081	p.38
	MEQp005	p.2 <sup>34</sup>		S6-308	p.12
	MEQp180	p.89 <sup>11</sup>		W5-347	p.38
Akamine, Tatro	S4-254	p.122 <sup>44</sup>	Boyd, W.S.	W5-392	p.66
Alexander, Vera	S3-004	p.2	Boyer, Richard	S2-020	p.10
Allen, Susan E.	S6-091	p.42	Bragina, Irina Y.	S8-238	p.114
Aminin, Dmitry L.	MEQp003	p.1	Brander, Keith	S3-026	p.12
	MEQp005	p.2	Bravo-Sierra, Ernesto	S7-341	p.12
	MEQp180	p.89	Bregman, Ju.E.	S3-149	p.70
Andreev, Andrey	S5-006	p.3	Briese, Robin	FISp023	p.11
Andreeva, Valentina V.	MEQp007	p.3	Brodeur, Richard D.	S7-153	p.71
	MEQp048	p.22		CCCCp169	p.82
Antonelis, George	W6-307	p.112	Bruland, Ken	S1-028	p.13
Aoki, Shigeaki	W7-382	p.131	Brykov, Valery A.	S3-027	p.13
Aota, Masaaki	POCp229	p.110	Budaeva, Valentina D.	W5-352	p.101
Arai, Mary N.	S3-008	p.2		S9-029	p.14
Arai, Nobuaki	S2-248	p.120		POCp030	p.14
Armstrong, Evelyn	W5-361	p.98	Bukin, Sergey D.	S1-031	p.14
Asanuma, Ichio	S6-083	p.40	Bulatov, N.V.	S9-128	p.60
	W7-367	p.45		S3-032	p.15
	W7-370	p.46		S5-054	p.24
Aubrey, D.G.	POCp053	p.24	<b>C</b>		
Aydin, Kerim Y.	FISp297	p.4	Cao, Zhi	MEQp273	p.132
	S2-298	p.4	Carlson, Craig A.	S6-014	p.7
	S3-027	p.13		W7-389	p.7
	W4-299	p.4	Carter, Melissa	S7-304	p.17
Azumaya, Tomonori	S7-009	p.5	Cass-Calay, Shannon L.	S2-033	p.15
			Cha, Bongjin J.	FISp271	p.130
				S4-035	p.15
				S4-122	p.56
			Cha, Hyung Kee	S4-034	p.16
			Chai, Fei	S6-036	p.16
				W7-361	p.17
<b>B</b>			Chao, Yi	S6-036	p.16
Baba, Norihisa	S2-248	p.120		W7-361	p.17
	W6-333	p.54	Checkley, Jr. David M.	S7-304	p.17
Baek, Chul In	S4-046	p.20	Chen, Chen-Tung Arthur	S6-039	p.17
Baier, Christine T.	CCCCp169	p.82		S6-040	p.18
	S3-010	p.5	Chen, He Ting	S9-316	p.69
Bakun, Andrew	S7-011	p.5	Chen, Houng-Yung	FISp038	p.18
Balanov, A.	S1-217	p.105	Chen, Jay	S8-041	p.18
Balch, Barney	S6-075	p.35	Chen, Shang	S9-042	p.18
Ban, S.	S6-231	p.111	Chen, Yaqu	MEQp262	p.127
Bandiera, Stelvio M.	S8-012	p.6		MEQp264	p.128
Barange, Manuel	S7-013	p.6		MEQp273	p.132
Barber, Richard T.	S6-036	p.16		MEQp274	p.132
	W7-361	p.17		MEQp275	p.132
Basyuk, E.O.	POCp192	p.95	Chen, Yuh-ling Lee	S3-037	p.19
Bates, Nicholas R.	S6-014	p.7	Cheng, Yongxu	FISp038	p.18
Bates, Nicholas R.	W7-389	p.7		MEQp262	p.127
Baytaluk, Alexey A.	S4-015	p.7		MEQp264	p.128
	S4-016	p.8	Cherniawsky, Josef Y.	S1-051	p.23
Beamish, Richard J.	S1-017	p.8		W5-346	p.23
Beattie, Alasdair	S7-153	p.71	Chernoivanova, Ludmila A.	FISp043	p.19
Belan, Tatyana A.	S8-018	p.9	Childers, Amy R.	S7-270	p.130
	S8-336	p.49	Cho, Ji-Young	S9-044	p.20
Belayev, Vladimir A.	S1-019	p.9		S9-137	p.65
Bengtson, John	W6-333	p.54	Cho, Kyu Dae	S4-089	p.42
Bertram, Douglas F.	S2-020	p.10	Cho, Sung H.	S3-144	p.68
	S7-155	p.72		S3-145	p.68
Bidigare, Robert R.	S6-112	p.52	Choi, Jae-Suk	S9-045	p.20
Bizikov, Vjacheslav A.	S4-021	p.10		S9-137	p.65
Boehlert, George W.	S7-049	p.22	Choi, Kwang-Sik	S9-104	p.49
	S7-082	p.39	Choi, Sang Duk	S3-234	p.113
Bogdanovsky, A.A.	S9-128	p.60			
Bograd, Steven J.	S5-200	p.99			
Bohrmann, G.	S6-255	p.122			
Boltnev, Alexander I.	S2-022	p.10			







Kawano, Takeshi	W7-367	p.45	Kubota, Hiroshi	S7-184	p.91
Kawasaki, Kiyoshi	W7-370	p.46	Kudo, Isao	W5-348	p.63
	S4-173	p.84		W5-349	p.64
	S5-130	p.61	Kuma, Kenshi	W5-349	p.64
	S7-216	p.105	Kumamoto, I.	S5-006	p.3
Kawasaki, Tsuyoshi	S7-116	p.55	Kurita, Yutaka	FISp244	p.117
Kayeriama, Masahide	S1-108	p.50		S7-184	p.91
	S1-165	p.80	Kuroda, Hiroshi	W3-388	p.59
	S3-093	p.43			
Kazumasa, Hirakawa	S7-301	p.95	Kusakabe, Masashi	S5-006	p.3
Keister, Julie E.	W2-300	p.94		S6-083	p.40
	MEQp164	p.80		W5-349	p.64
Kelley, John J.	POCp133	p.62	Kuzin, Victor I.	POCp135	p.64
	MEQp164	p.80		S5-136	p.64
Kennish, J.M.	S6-063	p.28 ×	Kwon, B.K.	S4-122	p.56
Key, R.M.	W7-364	p.29	Kwon, Eun-Hee	S9-137	p.65
	POCp192	p.95			
Khen, Gennady V.	S4-117	p.55	<b>L</b>		
Kidokoro, Hideaki	FISp288	p.139	Laake, Jeffrey L.	W6-138	p.65
Kim, Cheol Su	S9-104	p.49	Lamb, M.F.	S6-063	p.28
Kim, Dong-Sung	S4-123	p.55		W7-364	p.29
Kim, Doo Nam	S1-241	p.116	Lapko, Victor V.	S2-298	p.4
Kim, Hee Yong	FISp271	p.130		W4-139	p.65
Kim, Hung Y.	S4-122	p.56		W5-386	p.66
	S4-118	p.56	Law, Cliff S.	W5-392	p.66
Kim, Jin-Yeong	S4-123	p.55	Lawrence, Cathryn A.	S7-342	p.66
Kim, Joo Il	MEQp280	p.135	Lee, C.W.	FISp271	p.130
Kim, Kyung-Tae	S9-124	p.56		S4-035	p.15
Kim, Mi-Jung	FISp120	p.57	Lee, Dong-Ho	S4-122	p.56
Kim, Sen-Tok	FISp230	p.111	Lee, J.H.	MEQp280	p.135
Kim, Seung Chul	MEQp180	p.89	Lee, Jae Bong	FISp271	p.130
Kim, Seung-Kyu	S7-119	p.57	Lee, K.	S4-046	p.20
Kim, Suam	S3-110	p.51		S6-063	p.28
Kim, Woong-Seo	S3-311	p.58	Lee, Kitack	W7-364	p.29
	S4-122	p.56		S6-141	p.67
Kim, Y.B.	FISp121	p.58		W7-140	p.67
Kim, Yeong Hye	S4-123	p.55	Lee, Man Woo	S4-287	p.139
Kim, Yeong Seung	S7-184	p.91	Lee, Sam Guen	S1-332	p.117
Kimura, Ryo	FISp166	p.81	Lee, Soo Hyung	MEQp003	p.1
Kimura, Shingo	S1-125	p.58		MEQp005	p.2
	S1-017	p.8	Lee, Sun Kil	MEQp180	p.89
King, J.R.	S4-161	p.77	Lee, Sung Il	FISp288	p.139
Kinoshita, Takahiro	S6-098	p.47	Lee, Y.S.	FISp290	p.139
Kishi, Michio J.	W3-338	p.73	Lee, Yoon	FISp271	p.130
	W3-387	p.134		S3-144	p.68 ×
	W3-388	p.59		S3-145	p.68
	W7-365	p.31		S3-306	p.136
	S6-315	p.133	Leising, Andrew W.	S6-142	p.67
Kishino, Motoaki	FISp175	p.85	Letelier, R.M.	S6-112	p.52
Kitagawa, Daiji	FISp166	p.81	Levings, Colin D.	S8-143	p.68
Kitagawa, Takashi	S6-282	p.135		S8-336	p.49
Kitani, K.	S4-126	p.59	Lim, Donghyun	S3-144	p.68
Kiyofuji, Hidetada	S4-225	p.108		S3-145	p.68
	S4-289	p.138	Lima, Gyanne	S4-213	p.104
Knap, Anthony H.	S6-014	p.7	Limsakul, Atsamon	S6-075	p.35
	W7-389	p.7	Lindström, Ulf	S2-146	p.69
	S7-127	p.59	Lipsen, Michael	S6-081	p.38
Kobari, Toru	S1-193	p.96		W5-347	p.38
Kobayashi, Donald R.	W2-312	p.60	Liu, Ching-Lin	S6-040	p.18
Kobayashi, Tokimasa	S9-128	p.60	Liu, Hong Bin	S9-316	p.69
Kochergin, I.E.	S6-310	p.61	Livingston, Patricia A.	S2-298	p.4
Koike, Isao	S5-130	p.61		W6-147	p.69
Komatsu, Kosei	S7-129	p.61	Lo, Nancy C.H.	S4-118	p.56
	FISp131	p.62	Lo, Wen-Tseng	S3-148	p.69
Konishi, Kenji	S8-336	p.49			
Koo, Bon Joo	S9-104	p.49	Lobanov, Vyacheslav B.	POCp196	p.97
	W7-372	p.75		S6-327	p.137
Körtzinger, Arne	S3-132	p.62	Logerwell, Elizabeth	S2-188	p.93
Kotori, Moriyuki	S8-260	p.125	Lomax, Dan	S8-238	p.114
Koyama, J.	S8-261	p.125	Longhurst, A.	S7-189	p.93
	S8-360	p.126	López Tachiquín, L.F.	S3-149	p.70
Krapivin, Vladimir F.	POCp133	p.62	Lounejeva Baturina, E.	MEQp233	p.112
Krovnnin, Andrei S.	S7-326	p.63	Lowry, Lloyd	W6-333	p.54
Kruse, Gordon H.	S7-134	p.63			

Lu, BeiWei	CCCCp150	p.70			
<b>M</b>					
Ma, Yan	POCp328	p.71			
	S9-042	p.18			
Mackas, David L.	CCCCp150	p.70 <sup>92</sup>			
	S2-020	p.10			
	S3-024	p.11			
	S7-191	p.94			
	W5-348	p.63			
Maita, Yoshiaki	POCp030	p.14			
Makarov, V.G.	S9-128	p.60			
	POCp152	p.71			
Man'ko, Alexander N.	S7-153	p.71			
Martell, Steven J.	W5-351	p.87			
Maruo, Masahiro	S4-277	p.133			
Masuda, Shinya	S6-309	p.72			
Matear, Richard	W7-367	p.45			
Matsueda, Hidehadzu	W7-369	p.45			
	S7-129	p.61			
Matsukawa, Y.	W7-370	p.46			
Matsumoto, Kazuhiko	FISp154	p.72			
Matsushita, Yukiko	S1-017	p.8			
McFarlane, G.A.	S7-155	p.72			
McKinnell, Skip	S6-062	p.28			
Mecking, Sabine	W3-338	p.73			
Megrey, Bernard A.	S7-085	p.40			
Meguro, Toshimi	W7-372	p.75			
Meincke, Jens	W7-371	p.73			
Metzl, N.	W7-389	p.7			
Michaels, Anthony F.	S5-302	p.91			
Midorikawa, Takashi	W7-368	p.45			
	W7-374	p.83			
Miller, Arthur J.	S5-221	p.107			
	S7-156	p.74			
Miller, Charles B.	S3-296	p.74			
Millero, F.J.	S6-063	p.28			
	W7-364	p.29			
Mills, K.L.	S2-335	p.118			
Minobe, Shoshiro	S1-157	p.74			
Mintrop, Ludger	W7-372	p.75			
Mitchell, B.G.	S6-327	p.137			
Mitsudera, Humio	S5-359	p.75			
Miyake, T.	W7-376	p.89			
	W7-380	p.118			
Miyao, Takashi	S6-098	p.47			
Miyashita, Kazushi	FISp094	p.43			
	S4-277	p.133			
	W6-325	p.75			
Miyashita, Tomio	POCp066	p.31			
Mizuta, Genta	POCp158	p.76			
	POCp182	p.90			
	S7-156	p.74			
Moisan, John	S5-136	p.64			
Moiseev, Valery M.	S4-159	p.76			
Mokrin, Nikolay M.	S1-217	p.105			
Moku, M.	S9-160	p.77			
Montani, Shigeru	CCCCp150	p.70			
Moore, Douglas	S2-088	p.41			
Morgan, K.	W6-087	p.41			
	S4-161	p.77			
Mori, Ken	S4-173	p.84			
	S7-085	p.40			
Morita, Kentaro	S8-084	p.40			
Morita, Masatoshi	MEQp233	p.112			
Morton Bermea, Ofelia	FISp162	p.77			
Moukhametov, I.N.	FISp162	p.77			
Moukhametova, O.N.	S7-326	p.63			
Moury, G.P.	FISp094	p.43			
Mukai, T.	S7-304	p.17			
Mullin, Michael M.	W1-323	p.79			
Mundy, Phillip R.	W7-367	p.45			
Murata, Akihiko	W7-376	p.89			
	W7-380	p.118			
			Murphy, James M.	W7-391	no pg.
			Murphy, Paulette P.	S4-025	p.11
				W7-373	p.79
				W7-383	p.137
			Myers, Katherine W.	FISp297	p.4
				S1-108	p.50
				S1-165	p.80
				S8-238	p.114
			Myers, Mark		
			<b>N</b>		
			Nadtochy, Victoria V.	S3-163	p.79
			Nagai, Hideki	W7-368	p.45
			Nagasawa, Kazuya	S1-028	p.13
				S1-281	p.135
				S3-008	p.3
				S7-009	p.5
				S7-119	p.57
			Naidu, Sathy A.	MEQp164	p.80
			Naito, Yasuhiko	FISp154	p.72
			Nakabayashi, Shigeto	W5-349	p.64
			Nakadate, Akira	W7-374	p.83
			Nakamura, Megumi	S1-108	p.50
				S1-165	p.80
				S1-177	p.86
			Nakamura, Yoshikazu	S5-241	p.116
			Nakano, H.	W7-374	p.83
			Nakano, Toshiya	W7-377	p.91
			Nakano, Y.	S4-213	p.104
			Nakao, Hiromi	W5-356	p.124
			Nakashiki, Norikazu	POCp249	p.120
			Nakata, Akifumi	FISp166	p.81
			Nakata, Hideaki	S1-125	p.58
				S7-129	p.61
			Nakata, K.	S3-167	p.81
			Nakata, Kaoru	W1-092	p.43
				S6-067	p.32
			Nakatsuka, Takeshi	W5-351	p.87
			Nakayama, Eiichiro	S2-168	p.81
			Napazakov, V.V.	CCCCp169	p.82
			Napp, Jeffrey M.	S3-027	p.13
				W2-170	p.82
			Naumenko, Nikolai I.	W3-171	p.83
			Navrotsky, Vadim V.	S7-153	p.71
			Nayar, Tarun	S3-172	p.83
			Naydenko, Svetlana V.	POCp135	p.64
			Nazarov, Vladimir V.	W7-156	p.74
			Nelson, Douglas J.	POCp152	p.71
			Nelezin, Alexander D.	W7-367	p.45
			Nemoto, Kazuhiro	W7-368	p.45
				W7-374	p.83
				S1-239	p.115
			Nikolaev, Alexander V.	W7-382	p.131
			Nishibori, Fumiyasu	S3-093	p.43
			Nishida, Hiroshi	S4-173	p.84
				W5-348	p.63
			Nishida, Takaaki	FISp279	p.134
			Nishimura, Akira	S7-113	p.53
				W5-350	p.84
			Nishioka, Jun	W5-356	p.124
				W5-385	p.131
				S3-174	p.84
			Nishiuchi, Koh	S7-113	p.53
			Nishiyama, Tsuneo	FISp175	p.85
			Nobetsu, Takahiro	W7-365	p.31
			Nojiri, Yukihiko	W7-366	p.44
				W7-373	p.79
				W7-375	p.85
				W7-376	p.89
				W7-380	p.118
				W7-381	p.124
				W7-383	p.137
				W7-384	p.138
			Norcross, Brenda L.	W2-338	p.30
			Noriki, Shin-ichiro	S6-067	p.32

Noto, Masayuki	S7-176	p.86	Petrov, A.G.	POCp340	p.95
Novikov, Yury V.	S1-177	p.86	Petruk, V.M.	POCp192	p.95
	S1-228	p.109	Phillips, Michael	S9-318	p.96
Nozaki, Yoshiyuki	W5-351	p.87	Pierce, David W.	S5-221	p.107
			Pinchuk, Alexei I.	CCCCp050	p.22
<b>O</b>				CCCCp169	p.82
Ó Maoiléidigh, Niall	CCCCp343	p.87	Platt, T.	S7-189	p.93
Obata, Hajime	W5-351	p.87	Plotnikov, Vladimir V.	POCp151	p.70
Obzhirov, Anatoly	S6-337	p.88	Polovina, Jeffrey J.	S1-086	p.41
O'Connell, Jacqueline	FISp223	p.107		S1-193	p.96
O'Dor, Ron	S4-178	p.86	Ponomarev, Vladimir	POCp196	p.97
Ogawa, Kan	W7-374	p.83		S1-195	p.97
Ogi, Haruo	FISp154	p.72		W4-194	p.96
	S2-179	p.88	Price, Neil M.	W5-361	p.98
Oguma, Sachiko	W7-376	p.89	Pushina, O.I.	FISp197	p.98
	W7-380	p.118	Putov, V.F.	S9-128	p.60
	S4-034	p.16			
Oh, Chul Woong	S1-332	p.117	<b>Q</b>		
Oh, Hyun Ju	MEQp003	p.1	Quay, Paul D.	S6-198	p.98
Oh, Jae Ryoung	MEQp005	p.2			
	MEQp180	p.89	<b>R</b>		
	S9-104	p.49	Rabinovich, Alexander B.	S5-200	p.99
Ohizumi, Hiroshi	S2-247	p.119	Radchenko, Vladimir I.	S2-168	p.81
	W6-181	p.90		S2-298	p.4
Ohshima, Kay I.	POCp066	p.31		W4-139	p.65
	POCp099	p.47	Rand, P.S.	S1-321	p.39
	POCp158	p.76	Rigby, Robin P.	FISp201	p.99
	POCp182	p.90	Riser, Stephen C.	POCp053	p.24
	S6-282	p.135	Ro, Young Jae	POCp202	p.99
Ohshimo, S.	S3-234	p.113		POCp203	p.99
Ohtsuka, Susumu	W6-183	p.90	Rodríguez-Figueroa, G.	MEQp233	p.112
Okamura, Hiroshi	S6-282	p.135	Roemmich, Dean	S5-204	p.100
Okamura, K.	W7-370	p.46	Romaine, Stephen J.	S3-206	p.100
Okano, Hirofumi	S1-125	p.58	Rose, Kenneth A.	W3-207	p.101
Okazaki, Yuji	S5-302	p.91	Royer, Thomas C.	S7-208	p.101
Ono, Tsuneo	S6-063	p.28	Royle, Dennis J.	MEQp048	p.22
	W7-364	p.29	Rue, Eden	W5-352	p.101
	W7-376	p.89	Rumsey, Scott M.	W2-209	p.102
	W7-377	p.91	Rybalko, S.I.	S9-128	p.60
	W7-380	p.118	Ryder, J.L.	S2-020	p.10
Oozeki, Yoshioki	S7-184	p.91	Rykov, Nikolay A.	POCp210	p.102
Orlov, Alexei M.	S2-185	p.92			
	S7-326	p.63	<b>S</b>		
	S6-309	p.72	Sabine, Christopher L.	S6-063	p.28
Orr, Jim	S5-240	p.115		S6-211	p.102
Ostrovskii, A.	S3-186	p.92		W7-364	p.29
Ozaki, Koji				W7-378	p.103
				POCp196	p.97
<b>P</b>			Sagalaev, Sergey	S5-302	p.91
Padmavati, Gadi	S3-187	p.93	Saino, Toshiro	S6-075	p.35
Páez-Osuna, F.	MEQp233	p.112		S6-314	p.118
Park, Eun-Ok	S3-047	p.21		W7-366	p.44
Park, Gyung Soo	S3-283	p.136		W7-375	p.85
Park, Jong Hwa	S4-046	p.20		W7-376	p.89
	S4-089	p.42		W7-380	p.118
Park, Jung Youn	FISp121	p.58	Sainz-Trapaga, Susana	S1-241	p.116
	S9-124	p.56	Saito, C.	S5-006	p.3
	FISp288	p.139			
Park, Kwang Ki	S4-287	p.139	Saito, Hiroaki	CCCCp257	p.123
Park, Kyum Joon	S3-144	p.68		S7-212	p.103
Park, Kyung S.	S9-078	p.37	Saito, Shu	W7-367	p.45
Park, Yong C.	S2-188	p.93		W7-368	p.45
Parrish, Julia K.	S7-189	p.93		W7-370	p.46
Pauly, D.	S6-255	p.122	Saito, Yoshihiko	POCp229	p.110
Pavlova, G. Yu	S1-028	p.13	Saitoh, Sei-ichi	FISp094	p.43
Pearcy, William G.	S2-146	p.69		S4-126	p.59
Pedersen, Torstein	S6-190	p.94		S4-225	p.108
Peña, M. Angelica	S6-063	p.28		S6-067	p.32
Peng, T.-H.	W7-361	p.17		S6-315	p.133
	W7-364	p.29		W5-353	p.103
Perry, R. Ian	S4-073	p.33	Sakamoto, Wataru	S2-248	p.120
	S7-191	p.94	Sakano, Hiroyuki	S7-085	p.40
Peterson, William T.	S7-301	p.95	Sakurai, Yasunori	FISp094	p.43
	W2-300	p.94			

	FISp131	p.62			S3-284	p.136
	FISp175	p.85	Sol, Sean Y.		MEQp235	p.113
	S2-097	p.47	Sorrosa, Joy M.		W7-379	p.112
	S4-126	p.59	Soukin, Igor Yuryevich		FISp236	p.113
	S4-213	p.104	Sovetnikova, L.N.		S6-327	p.137
	S4-277	p.133	Spear, Larry B.		W6-237	p.114
Salyuk, Anatoly	S5-214	p.104	Spencer, Silvester		S8-238	p.114
	S6-337	p.88	Stabeno, Phyllis, J.		S1-321	p.39
Samatov, A.D.	MEQp007	p.3	Stehr, Carla M.		S8-238	p.114
Sapozhnikov, D. Yu	MEQp233	p.112	Stein, John E.		MEQp235	p.113
Sarma, Vedula V.S.S.	S6-331	p.104			S8-238	p.114
Sasai, Yoshikazu	S6-215	p.105	Steinberg, Deborah K.		S6-014	p.7
Sasaki, Katsuyuki	S3-167	p.81			W7-389	p.7
	S7-129	p.61	Stepanenko, Mikhail A.		S1-239	p.115
	S7-216	p.105	Stockwell, Dean A.		S7-270	p.130
Sasaoka, Kosei	W5-353	p.103	Stuart-Menteth, Alice C.		S5-240	p.115
Sassa, C.	S1-217	p.105	Suda, Maki		S4-254	p.122
Satanabe, S.	W7-376	p.89	Suess, E.		S6-255	p.122
Sathyendranath, S.	S7-189	p.93			S6-337	p.88
Sato, K.	W6-268	p.129	Sugawara, Toshikatsu		S6-083	p.40
Sato, Manami	W7-379	p.112	Sugimoto, Takashige		S1-125	p.58
Savchenko, Aleksey V.	MEQp076	p.135			S1-241	p.116
Saveliev, A.V.	POCp218	p.106	Sugimoto-Hatano, Yoko		S6-314	p.118
Savin, Andrew B.	FISp219	p.106	Suginohara, Nobuo		W7-379	p.112
Savinykh, Vadim F.	S1-220	p.106	Sugisaki, Hiroya		S5-241	p.116
Sawabe, Tomoo	S3-109	p.51			S3-027	p.13
Scherbina, Andrey	POCp196	p.97	Suh, Hae-Lip		S3-243	p.116
Schneider, Niklas	S5-221	p.107			S3-047	p.21
Schweigert, Jake	FISp223	p.107			S3-234	p.113
	W2-222	p.108			S3-284	p.136
	POCp229	p.110	Suh, Young Sang		S1-332	p.117
Seki, Jiro	S1-193	p.96	Suterland, Nes		W5-385	p.131
Seki, Michael P.	S1-224	p.108	Suyama, Satoshi		FISp244	p.117
	S4-225	p.108	Suzuki, T.		W7-376	p.89
Semdei, Bambang	FISp290	p.139			W7-380	p.118
Seo, Young Il	S3-047	p.21	Sydemann, William J.		W7-377	p.91
Seon, Seo-Kyoung	MEQp048	p.22			S2-188	p.93
Sergusheva, Olga O.	MEQp226	p.109			S2-335	p.118
Shaposhnikova, Tatyana V.	S4-016	p.8				
Shelekhov, V.A.	MEQp273	p.132	<b>T</b>			
Shen, Xinqing	S7-189	p.93	Tadokoro, Kazuaki		S5-302	p.91
Sherman, K.	POCp114	p.53			S6-314	p.118
Shevchenko, George V.	POCp227	p.109	Takahashi, A.		W6-268	p.129
	S1-228	p.109	Takahashi, T.		W7-140	p.67
Shevtsov, Gennadiy A.	CCCCp169	p.82	Takahashi, Toyomi		S7-245	p.111
Shiga, Naonobu	S3-095	p.44	Takano, Michiaki		W5-351	p.87
	S5-322	p.110	Takatsu, Tetsuya		S7-245	p.111
Shikama, Nobuyuki	MEQp005	p.2	Takayanagi, Kazufumi		S9-246	p.119
Shim, Won Joon	W7-376	p.89	Takeda, Shigenobu		W5-350	p.84
Shimano, F.	W7-380	p.118			W5-356	p.124
	POCp229	p.110	Talley, Lynne D.		W5-358	p.123
Shimizu, Ikutaro	S8-084	p.40	Tamura, Tsutomu		W5-385	p.131
Shimizu, Makoto	FISp230	p.111	Tanaka, Iori		POCp196	p.97
Shin, Hyeon Ok	S9-137	p.65	Tanaka, Shino		S2-247	p.119
Shin, Hyun-Woung	S9-104	p.49	Tang, Qi-Sheng		POCp249	p.120
Shin, Sang-Ho	MEQp003	p.1	Terazaki, M.		S2-248	p.120
Shin, Yeong Beom	MEQp005	p.2	Thayer, Julie A.		S7-330	p.36
	MEQp180	p.89	Thimngan, Mike		S3-010	p.5
	S6-231	p.111	Thomas, Gary L.		S2-335	p.118
Shinada, Akiyoshi	S7-009	p.5			S7-304	p.17
Shiomoto, Akihiro	S7-232	p.111	Thomson, Richard E.		S2-253	p.121
Shiotani, Tsuyoshi	S8-084	p.40			S7-252	p.121
Shiraishi, Hiroaki	W7-379	p.112	Thorne, Richard E.		W2-251	p.120
Shiraiwa, Yoshihiro	POCp133	p.62			S5-200	p.99
Shirasawa, Kunio	FISp290	p.139			S7-191	p.94
Shon, Myoung Ho	MEQp233	p.112			W5-354	p.121
Shumilin, Evgueni	MEQp303	p.35			S2-253	p.120
	W6-307	p.112			S7-252	p.121
Sinclair, Elizabeth H.	S1-177	p.86			W2-251	p.120
Slobodskoy, Eugene V.	POCp202	p.99			S4-254	p.122
Smirnov, Sergey	POCp203	p.99			S6-255	p.122
	MEQp303	p.35			S9-001	p.1
Smith, R.	S3-047	p.21			W7-367	p.45
Soh, Ho Young	S3-234	p.113			W7-370	p.46

Tokimura, M.	S6-282	p.135	Watanabe, Chikako	S4-173	p.84
Tomoyuki, Take	S9-001	p.1	Watanabe, H.	S1-267	p.128
Trick, Charles G.	W5-355	p.122	Watanabe, Shuichi	S6-258	p.124
Trites, Andrew W.	W6-256	p.123		W7-375	p.85
	W6-333	p.54		W7-376	p.89
Trusenkova, Olga	POCp196	p.97		W7-380	p.118
Tsuchiya, Kotaro	S4-161	p.77		W7-381	p.124
Tsuda, Atsushi	CCCCp257	p.123	Watanabe, Y.	S6-063	p.28
	S3-276	p.133		W7-364	p.29
	W5-358	p.123	Watanabe, Y.W.	W7-376	p.89
Tsumune, Daisuke	W5-356	p.124		W7-377	p.91
Tsunogai, Shizuo	S6-258	p.124		W7-380	p.118
Tsurushima, Nobuo	W7-366	p.44	Watanabe, Yoshiro	S7-184	p.91
	W7-375	p.85	Watanuki, Yutaka	W6-268	p.129
	W7-381	p.124	Watson, R.	S7-189	p.93
Tsurushima, Y.	W7-376	p.89	Weingartner, Thomas J.	CCCCp050	p.22
	W7-380	p.118	Welch, David W.	S2-020	p.10
Tsutsumi, Hiroaki	S9-160	p.77		S3-008	p.3
				S7-119	p.57
<b>U</b>			Wells, Mark L.	W5-357	p.129
Udea, Hiroshi.	FISp154	p.72	Werner, Francisco	W3-269	p.129
	S1-108	p.50	Wheeler, Patricia A.	S7-305	p.130
	S1-165	p.80	Whitledge, Terry E.	S7-270	p.130
Ueno, Hiromichi	S5-259	p.125	Whitney, Frank	S6-308	p.12
Ueno, Yasuhiro	FISp244	p.117		W5-350	p.84
	S1-028	p.13	Windom, H.	MEQp303	p.35
Uji, Ryosuke	S4-277	p.133	Won, Sungjae	FISp271	p.130
Umeda, Takafumi	W7-374	p.83		S4-122	p.56
Uno, Seiichi	S8-084	p.40	Wong, C.S.	S6-063	p.28
	S8-260	p.125		S6-308	p.12
	S8-261	p.125		W5-350	p.84
	S8-360	p.126		W5-385	p.131
	S7-232	p.111		W7-364	p.29
Uye, Shin-ichi				W7-373	p.79
				W7-383	p.137
				S2-272	p.131
<b>V</b>			Wright, Bruce A.		
Varela, Diana	S6-081	p.38			
Varlamov, S.M.	S9-128	p.60	<b>X</b>		
Victorovskaya, G.I.	FISp023	p.11	Xu, Jiawu	MEQp274	p.132
Volkov, A.F.	S3-313	p.126	Xu, Yongfu	W7-382	p.131
			Xu, Zhaoli	MEQp262	p.127
				MEQp264	p.128
				MEQp273	p.132
				MEQp274	p.132
				MEQp275	p.132
				S3-037	p.19
<b>W</b>			<b>Y</b>		
Wada, Tokio	S1-281	p.135	Yabuki, Keizo	S7-077	p.37
Wakatsuchi, Masaaki	POCp066	p.31		W2-312	p.60
	POCp099	p.47			
	POCp158	p.76	Yamada, H.	S8-260	p.125
	POCp182	p.90		S8-261	p.125
	POCp324	p.34		S8-360	p.126
	S6-067	p.32	Yamada, Harumi	FISp166	p.81
Wakita, Masahide	S6-258	p.124	Yamada, Keiko	S6-315	p.133
	W7-377	p.91	Yamada, Yuichiro	S3-276	p.133
Walker, R.V.	S1-108	p.50	Yamagata, T.	S5-240	p.115
	S1-165	p.80	Yamamoto, Jun	FISp094	p.43
Walker, Robert	FISp297	p.4		S4-213	p.104
Wallace, Douglas W.R.	W7-372	p.75	Yamanaka, Yasuhiro	S4-277	p.133
Wallman, K.	S6-255	p.122		W3-387	p.134
Walters, Carl J.	S7-153	p.71	Yamauchi, K.	W7-365	p.31
Wang, Bing-Jye	S6-040	p.18	Yan, Tian	FISp094	p.43
Wang, Jingyi	S5-263	p.127	Yanagimoto, Takashi	S8-278	p.134
Wang, Rong	S3-079	p.37	Yang, Dong Beom	FISp279	p.134
	S3-265	p.127	Yano, Toshihiko	MEQp280	p.135
	S3-286	p.140	Yasuda, Ichiro	W7-368	p.45
Wang, Shu-Lun	S6-040	p.18		S5-130	p.61
Wang, Yunlong	MEQp262	p.127		S5-259	p.125
	MEQp264	p.128		S7-176	p.86
	MEQp273	p.132		S1-281	p.135
	MEQp275	p.132	Yatsu, Akihiko	S4-173	p.84
	S3-037	p.19			
Wanninkhof, R.	S6-063	p.28			
	W7-140	p.67			
	W7-364	p.29			
Ware, Daniel M.	W3-266	p.128			
	W3-338	p.73			
Watai, Y.	W7-377	p.91			

Yi, Cuiping	MEQp273	p.132	<b>Z</b>		
Ylitalo, Gina M.	MEQp106	p.50	Zakharkov, S.P.	S6-327	p.137
Yokouchi, K.	S6-282	p.135	Zeng, Jiye	W7-383	p.137
Yoneta, Kunisaburo	S4-126	p.59		W7-384	p.138
	S4-225	p.108	Zhabin, Igor A.	S5-285	p.138
Yoon, Won Duk	S3-144	p.68	Zhang, Chang Ik	FISp288	p.139
	S3-145	p.68		FISp290	p.139
	S3-283	p.136		S4-046	p.20
	S3-306	p.136		S4-287	p.139
Yoon, Yang Ho	S3-234	p.113		S4-289	p.138
York, Anne	W6-307	p.112	Zhang, Qinghua	POCp328	p.71
Yoshida, Koji	S2-248	p.120	Zhang, Wuchang	S3-286	p.140
Yoshie, Naoki	W3-387	p.134	Zhang, X.	MEQp164	p.80
Yoshimura, Takeshi	W5-348	p.63	Zheng, Jie	S7-134	p.63
Yu, Jun	MEQp280	p.135	Zhigalov, I.A.	POCp291	p.140
Yu, Ok Hwan	S3-284	p.136	Zhou, Ming-Jiang	S9-292	p.140
Yuan, Qi	MEQp274	p.132	Zhu, Ming-Yuan	S9-042	p.18
	MEQp275	p.132	Zuenko, Yury I.	POCp293	p.141
Yun, J.	S8-260	p.125		S3-163	p.79
			Zvalinsky, Vladimir I.	W3-294	p.141
			Zverkova, Larisa M.	S4-295	p.141

# PICES Acronyms

BASS Task Team	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
F-R	Fundraising Committee
GC	Governing Council
IFEP	Iron Fertilization Experiment Panel
MBMAP	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 <i>Subarctic gyre processes and their interaction with coastal and transition zones: physical and biological relationships and ecosystem impacts</i>
S2	Session 2 - BIO Topic Session on <i>Prey consumption by higher trophic level predators in PICES regions: implications for ecosystem studies</i>
S3	Session 3 - Joint BIO / CCCC Topic Session on <i>Recent progress in zooplankton ecology study in PICES regions</i>
S4	Session 4 - FIS Topic Session on <i>Short life-span squid and fish as keystone species in North Pacific marine ecosystems</i>
S5	Session 5 - POC Topic Session on <i>Large-scale circulation in the North Pacific</i>
S6	Session 6 - Joint POC / BIO Topic Session on <i>North Pacific carbon cycling and ecosystem dynamics</i>
S7	Session 7 - CCCC Topic Session on <i>Recent findings and comparisons of GLOBEC and GLOBEC-like programs in the North Pacific</i>
S8	Session 8 - MEQ Topic Session on <i>Environmental assessment of Vancouver Harbour: results of an international workshop</i>
S9	Session 9 - MEQ Topic Session on <i>Science and technology for environmentally sustainable mariculture in coastal areas</i>
SB	Science Board
TCODE	Technical Committee on Data Exchange
W1	Workshop 1 - MONITOR Workshop on <i>Progress in monitoring the North Pacific</i>
W2	Workshop 2 - REX Workshop on <i>Trends in herring populations and trophodynamics</i>
W3	Workshop 3 - MODEL Workshop on <i>Strategies for coupling higher and lower trophic level marine ecosystem models</i>
W4	Workshop 4 - BASS Workshop on <i>Development of a conceptual model of the Subarctic Pacific basin ecosystem(s)</i>
W5	Workshop 5 - IFEP Planning Workshop on <i>Designing the iron fertilization experiment in the Subarctic Pacific</i>
W6	Workshop 6 (BIO / MBMAP) - <i>The basis for estimating the abundance of marine birds and mammals, and the impact of their predation on other organisms</i>
W7	Workshop 7 - CO <sub>2</sub> Data Synthesis Symposium
WG	Working Group