# PICES-2012

# Effects of natural and anthropogenic stressors in the North Pacific ecosystems: Scientific challenges and possible solutions

North Pacific Marine Science Organization

PICES

October 12-21, 2012
Hiroshima, Japan

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The views and terms expressed in the abstracts collected here are those of the contributing scientists under their responsibilities and do not necessarily represent the views of the Organization (PICES). Some abstracts were edited for language, clarity and style, and any errors that were introduced were done so inadvertently. Some abstracts have not been edited and have been printed in the condition they were received. In all cases, scientific content, geographic names and data were not edited.

Abstracts for oral presentations are sorted first by session and then by presentation time. Abstracts for posters are sorted by session and then by paper ID number. Presenter name is in bold-face type and underlined.

# Notes for Guidance

The 2012 Annual Meeting of the North Pacific Marine Science Organization (PICES) is held October 12–21, 2012, at the International Conference Center Hiroshima, Japan. The meeting is hosted by the Government of Japan, in cooperation with the Fisheries Research Agency (FRA) and PICES Secretariat. Local arrangements are made by the National Research Institute of Fisheries and Environment of Inland Sea (FEIS) of FRA.

### Presentations

In order to allow the sessions to run smoothly, and in fairness to other speakers, please note that all presentations are expected to adhere strictly to the time allocated. All authors should designate about 5 minutes for questions. Authors can download their presentations straight to the computer where their session/workshop will be held.

***Important:*** Please rename your files - time-name.ppt (*e.g.* 0900-Smith.ppt, 1530-Kim.ppt).

If complications occur due to incompatibilities between PCs and Macs, Macintosh owners may use their own computers to make presentations.

### Posters

Posters will be on display in the conference hall "Himawari" from October 16 (a.m.) until the end of the "Wine and Cheese" Poster Session on the evening of October 18, when poster presenters are expected to be available to answer questions.

### Internet access

Internet access via wireless LAN will be available. A few desktop computers will also be available for participants.

### Social activities (*see map p. xii*)

*October 15, Monday (18:30-20:30)*

**Welcome Reception**

The Welcome Reception for all participants and registered guests will be held at the International Conference Center Hiroshima, rooms "Dahlia 1 and 2".

*October 16, Tuesday (18:30-20:30)*

**Sports Events**

"Futsal" (main event) and "Ken-Dama". Both events will be held at the small arena of the "Hiroshima Prefectural Sports Center".

*October 17, Wednesday (19:00-21:00)*

**Extravaganza Dinner**

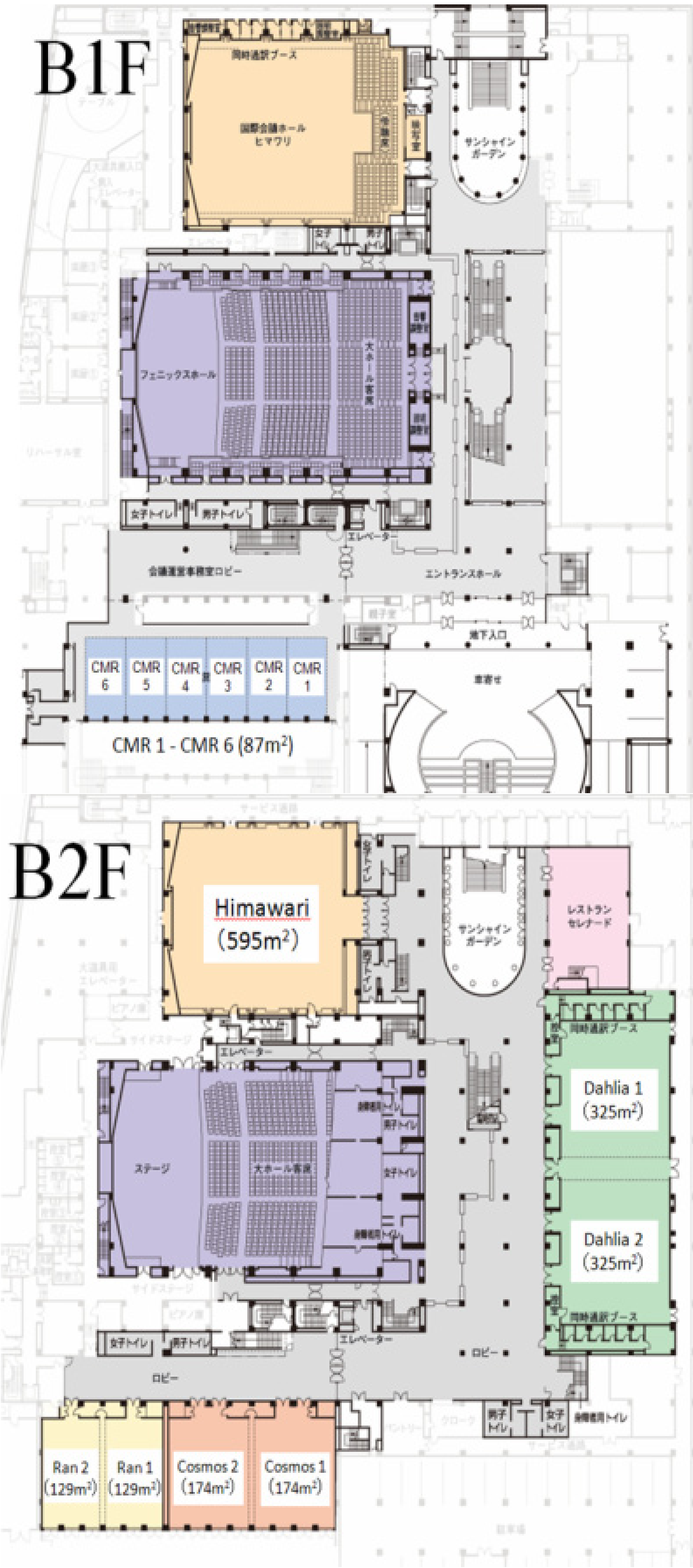
This will be held at the Mitakiso Restaurant. Tickets are CAD$130 each. Seating is very limited. Please check with Ms. Christina Chiu at the Registration Desk for tickets.

*October 18, Thursday (18:00-20:30)*

**Wine & Cheese Poster Session Reception**

The "Wine & Cheese" Poster Session at the meeting venue will allow participants to roam around the poster displays and chat with presenters while sipping beer or wine and nibbling on hot and cold hor d'oevres.

# International Conference Center Floor Plan


B1F
同時通訳ブース
国際会議ホール
ヒマワリ
サンシャイン
ガーデン
フェニックスホール
大ホール客席
女子トイレ
男子トイレ
エレベーター
会議運営事務室ロビー
エントランスホール
地下入口
車寄せ
CMR 6
CMR 5
CMR 4
CMR 3
CMR 2
CMR 1
CMR 1 - CMR 6 (87m²)
B2F
Himawari
(595m²)
サンシャイン
ガーデン
レストラン
セレナード
エレベーター
ステージ
大ホール客席
同時通訳ブース
Dahlia 1
(325m²)
Dahlia 2
(325m²)
女子トイレ
男子トイレ
ロビー
Ran 2
(129m²)
Ran 1
(129m²)
Cosmos 2
(174m²)
Cosmos 1
(174m²)

# Meeting Timetable

**Friday, October 12**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 09:00<br>12:30 | BIO<br>**W1**<br>(CMR 4) | BIO<br>**W2**<br>(CMR 2) | BIO<br>**W3**<br>(CMR 3) | ESSAS/<br>PICES<br>**W4**<br>(Cosmos 1) | BIO<br>**W5**<br>Day1<br>(CMR 1) | MEQ<br>**W6**<br>Day1<br>(Ran 1) | SCOR/<br>PICES<br>**W7**<br>Day 1<br>(Cosmos 2) | **S-HD**<br>Meeting<br>(CMR 5) | **SG-MP**<br>Meeting<br>(CMR 6) | **WG-27**<br>Meeting |
| 14:00<br>18:00 | | | | | | | | | | |

**Saturday, October 13**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 09:00<br>12:30 | **S-CCME**<br>Meeting<br>(Cosmos 1) | **AP-MBM**<br>Meeting<br>(CMR 2) | **WG-21**<br>Meeting<br>(CMR 3) | **WG-24**<br>Meeting<br>(CMR 4) | BIO<br>**W5**<br>Day2<br>(CMR 1) | MEQ<br>**W6**<br>Day2<br>(Ran 1) | SCOR/<br>PICES<br>**W7**<br>Day 2<br>(Cosmos 2) | **WG-28**<br>Meeting<br>(CMR 5) | **WG-29**<br>Meeting<br>(CMR 6) |
| 14:00<br>18:00 | | | | **S-CC**<br>Meeting<br>(CMR 4) | | S-HAB<br>Meeting<br>(Ran 1) | | | |
| 18:00<br>20:00 | **AP-CPR Meeting**<br>(CMR 1) | | | | | | | | |

**Sunday, October 14**

| | | | | | | |
|---|---|---|---|---|---|---|
| 09:00 | **FUTURE Science Program Meeting**<br>(Ran 1) | | | | | |
| 12:30 | **Science Board Meeting***<br>(Ran 1) | | | | | |
| 14:00 | **AP-AICE**<br>Meeting<br>(CMR 1) | **AP-COVE**<br>Meeting<br>(CMR 2) | **AP-SOFE**<br>Meeting<br>(CMR 3) | **AP-CREAMS**<br>Meeting<br>(CMR 4) | **WG-26**<br>Meeting<br>(CMR 5) | **S-HAB**<br>Meeting<br>(CMR 6) |
| 18:00<br>19:30 | **BIO**<br>Meeting<br>Day 1<br>(CMR 1) | **FIS**<br>Meeting<br>Day 1<br>(CMR 2) | **MEQ**<br>Meeting<br>Day 1<br>(CMR 3) | **MONITOR**<br>Meeting<br>Day 1<br>(CMR 4) | **POC**<br>Meeting<br>Day 1<br>(CMR 5) | **TCODE**<br>Meeting<br>Day 1<br>(CMR 6) |

**Monday, October 15**

| | |
|---|---|
| 09:00<br>10:00 | **Opening Session**<br>(Himawari) |
| 10:30<br>17:00 | **Science Board Symposium (S1)**<br>(Himawari) |
| 18:30<br>20:30 | **Welcome Reception**<br>(Dahlia 1 & 2) |

**Tuesday, October 16**

| | | | | |
|---|---|---|---|---|
| 09:00<br>17:30 | **S5**<br>(Cosmos 1) | **S11**<br>(Dahlia 1) | **S14**<br>(Dahlia 2) | **POC Paper Session**<br>(Cosmos 2) |
| 18:00<br>21:00 | **Sports Events** | | | |

**Wednesday, October 17**

| | | | | | | |
|---|---|---|---|---|---|---|
| 09:00<br>12:30 | **S4**<br>(Cosmos 2) | **S6**<br>(Dahlia 2) | **S8**<br>(Cosmos 1) | **S13**<br>(Dahlia 1) | **F&A Meeting***<br>(Ran 1) | |
| 14:00<br>18:00 | **BIO**<br>Meeting<br>Day 2<br>(CMR 1) | **FIS**<br>Meeting<br>Day 2<br>(CMR 2) | **MEQ**<br>Meeting<br>Day 2<br>(CMR 3) | **MONITOR**<br>Meeting<br>Day 2<br>(CMR 4) | **POC**<br>Meeting<br>Day 2<br>(CMR 5) | **TCODE**<br>Meeting<br>Day 2<br>(CMR 6) |
| 19:00<br>21:00 | **Extravaganza Dinner (limited tickets)** | | | | | |

**Thursday, October 18**

| | | | | |
|---|---|---|---|---|
| 09:00<br>17:30 | (09:00-12:30) **S2**<br>(Cosmos 1) | **S3**<br>(Dahlia 1) | **S7**<br>(Dahlia 2) | **FIS Paper Session**<br>(Cosmos 1) |
| | (14:00-17:30)<br>**BIO Paper Session, Day 1**<br>(Cosmos 1) | | | |
| 18:00<br>20:30 | **Poster Session Reception**<br>(Himawari) | | | |

| | | | | |
|---|---|---|---|---|
| **Friday, October 19** | | | | |
| 09:00 | **S9**<br>(Cosmos 2) | **S10**<br>(Dahlia 2) | **S12**<br>(Dahlia 1) | **BIO Paper Session, Day 2**<br>(Cosmos 1) |
| 12:30<br>14:00 | **Closing Session****<br>(Dahlia 1) | | | |
| 15:00<br>18:00 | **Science Board Meeting***<br>(Ran 1) | | | |
| **Saturday, October 20** | | | | |
| 09:00<br>17:00 | **Science Board Meeting***<br>(Ran 1) | **Governing Council Meeting***<br>(Cosmos 2) | **W8 Workshop**<br>(Cosmos 1) | |
| **Sunday, October 21** | | | | |
| 09:00<br>17:00 | **Governing Council Meeting***<br>(Cosmos 2) | | | |

* Closed Session

** Award-winning scientists (Best Oral/Poster presentations) will be announced during the Closing Session

## Sessions/Workshops

| | |
|---|---|
| S1 | Effects of natural and anthropogenic stressors in the North Pacific ecosystems: Scientific challenges and possible solutions |
| S2 | Range extension, toxicity and phylogeny of epiphytic dinoflagellates |
| S3 | Challenges in understanding Northern Hemisphere ocean climate variability and change |
| S4 | Monitoring on a small budget: Cooperative research and the use of commercial and recreational vessels as sampling platforms for biological and oceanographic monitoring |
| S5 | Social-ecological systems on walleye pollock and other commercial gadids under changing environment: Inter-disciplinary approach |
| S6 | Environmental contaminants in marine ecosystems: Seabirds and marine mammals as sentinels of ecosystem health |
| S7 | Jellyfish in marine ecosystems and their interactions with fish and fisheries |
| S8 | Linking migratory fish behavior to End-to-End models II |
| S9 | Ecological functions and services associated with marine macrophyte communities as indicators of natural and anthropogenic stressors in nearshore zones of the North Pacific |
| S10 | Ecosystem responses to multiple stressors in the North Pacific |
| S11 | Effects of natural and artificial calamities on marine ecosystems and the scheme for their mitigation |
| S12 | Advances in understanding the North Pacific Subtropical Frontal Zone Ecosystem |
| S13 | Risk management in coastal zone ecosystems around the North Pacific |
| S14 | Changing ocean biogeochemistry and its ecosystem impacts |
| BIO-P | BIO Paper Session |
| FIS-P | FIS Paper Session |

| | |
|---|---|
| POC-P | POC Paper Session |
| GP | General Poster Session |
| W1 | Identifying critical multiple stressors of North Pacific marine ecosystems and indicators to assess their impacts |
| W2 | Secondary production: measurement methodology and its application on natural zooplankton community |
| W3 | The feasibility of updating prey consumption by marine birds, marine mammals, and large predatory fish in PICES regions |
| W4 | Subarctic–Arctic interactions |
| W5 | Comparison of multiple ecosystem models in several North Pacific shelf ecosystems (MEMIP-IV) |
| W6 | The contrasting cases of HABs in the eastern and western Pacific in 2007 and 2011 |
| W7 | Global patterns of phytoplankton dynamics in coastal ecosystems |
| W8 | Recruitment of juvenile Japanese eel (*Anguilla japonica*) in eastern Asia |

# Meetings

## Committees

| | |
|---|---|
| **BIO** | Biological Oceanography Committee |
| **FIS** | Fishery Science Committee |
| **MEQ** | Marine Environmental Quality Committee |
| **MONITOR** | Technical Committee on Monitoring |
| **POC** | Physical Oceanography and Climate Committee |
| **TCODE** | Technical Committee on Data Exchange |

## Advisory Panels

| | |
|---|---|
| **AP-CPR** | Advisory Panel on the Continuous Plankton Recorder Survey in the North Pacific<br>(*reports to MONITOR Committee*) |
| **AP-CREAMS** | Advisory Panel for a CREAMS/PICES Program in East Asian Marginal Seas<br>(*reports to MONITOR and POC Committees*) |
| **AP-MBM** | Advisory Panel on Marine Birds and Mammals<br>(*reports to BIO Committee*) |

## FUTURE Science Program Advisory Panels

| | |
|---|---|
| **AP-AICE** | Advisory Panel on Anthropogenic Influences on Coastal Ecosystems |
| **AP-COVE** | Advisory Panel on Climate, Oceanographic Variability and Ecosystems |
| **AP-SOFE** | Advisory Panel on Status, Outlooks, Forecasts, and Engagement |

## Sections

| | |
|---|---|
| **S-CC** | Section on Carbon and Climate<br>(*reports to BIO and POC Committees*) |
| **S-CCME** | Section on Climate Change Effects on Marine Ecosystems<br>(*reports to BIO, FIS and POC Committees*) |
| **S-HAB** | Section on Ecology of Harmful Algal Blooms in the North Pacific<br>(*reports to MEQ Committee*) |
| **S-HD** | Section on Human Dimensions of Marine Systems<br>(*reports to Science Board*) |

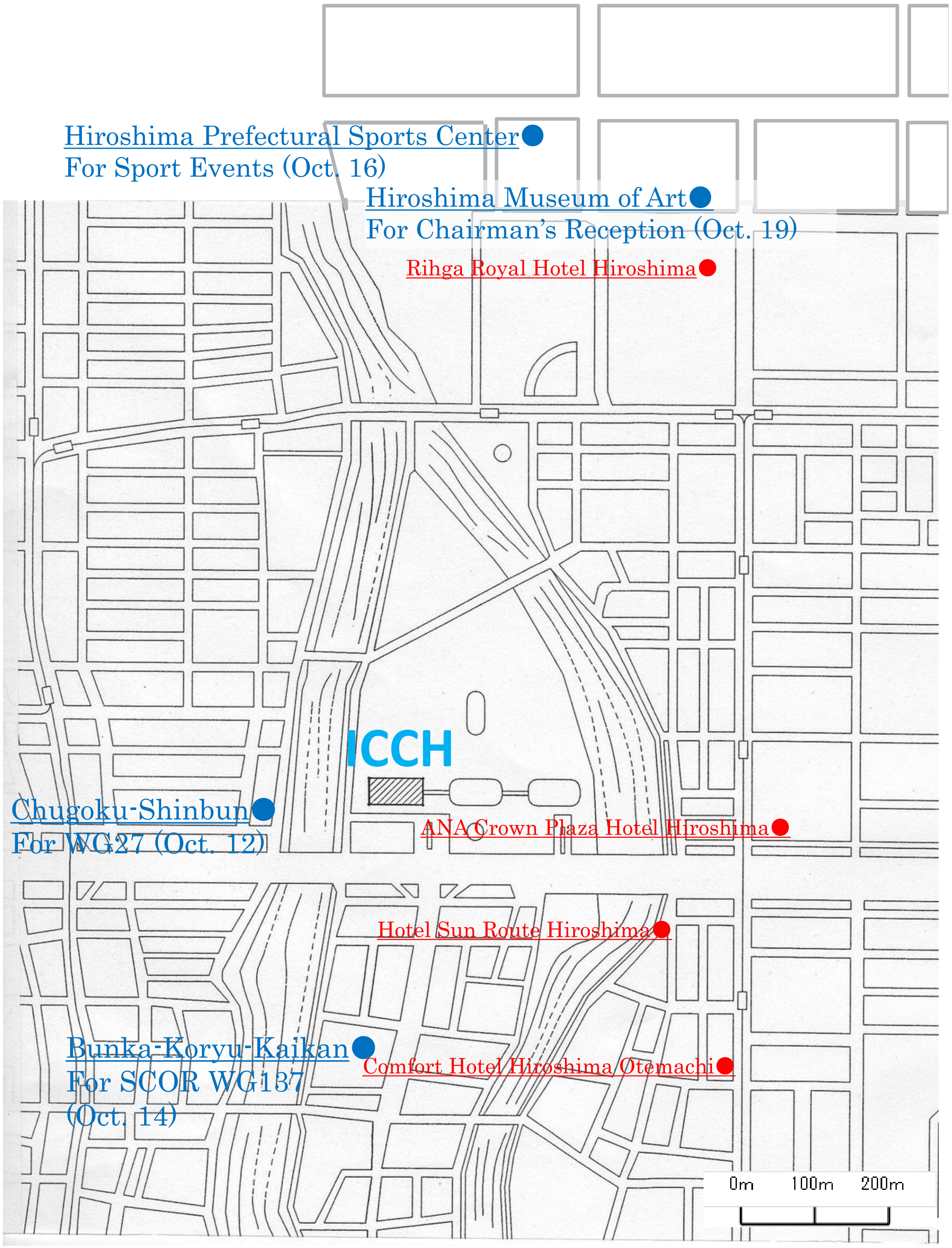
## Study Group

| | |
|---|---|
| **SG-MP** | Study Group on Marine Pollutants<br>(*reports to Science Board*) |

## Working Groups

| | |
|---|---|
| **WG-21** | Working Group on Non-indigenous Aquatic Species<br>(*reports to MEQ Committee* ) |
| **WG-24** | Working Group on Environmental Interactions of Marine Aquaculture<br>(*reports to FIS and MEQ Committees*) |
| **WG-26** | Working Group on Jellyfish Blooms around the North Pacific Rim: Causes and Consequences<br>(*reports to BIO Committee*) |
| **WG-27** | Working Group on North Pacific Climate Variability and Change<br>(*reports to POC Committee*) |
| **WG-28** | Working Group on Development of Ecosystem Indicators to Characterize Ecosystem Responses to Multiple Stressors<br>(*reports to BIO and MEQ Committees*) |
| **WG-29** | Working Group on Regional Climate Modeling<br>(*reports to POC Committee*) |

# Map of the International Conference Center Area


Hiroshima Prefectural Sports Center●
For Sport Events (Oct. 16)
Hiroshima Museum of Art●
For Chairman's Reception (Oct. 19)
Rihga Royal Hotel Hiroshima●
ICCH
Chugoku-Shinbun●
For WG27 (Oct. 12)
ANA Crown Plaza Hotel Hiroshima●
Hotel Sun Route Hiroshima●
Bunka-Koryu-Kaikan●
For SCOR WG137
(Oct. 14)
Comfort Hotel Hiroshima Otemachi●
0m
100m
200m

# Keynote Lecture

## Resilience and sustainability of the human-ocean coupled system – Beyond the Great East Japan Earthquake

Tokio **Wada**

Fisheries Research Agency, Queen's Tower B 15F, 2-3-3 Minato Mirai, Nishi-ku, Yokohama, Japan 220-6115. E-mail: wadat@affrc.go.jp

Human well-being depends on ocean ecosystems. On the other hand, human activities including fisheries, affect the structure and functions of ocean ecosystems. Natural phenomena, such as global climate changes, typhoons, storm surges, and tsunamis, also affect the ecosystem structure and functions. To achieve the sustainable use of various services from ocean ecosystems, we need to understand the ecological resilience and capacity to various disturbance factors and to adjust human activities within this capacity. To foster ecosystem resilience to natural disturbances is also the purpose of managing actions on the ocean and its living resources. In other words, we must consider that human society and the ocean ecosystem form a coupled system and it should be adjusted completely and simultaneously.

Through the activities of the Census of Marine Life (CoML) and the discussions in the COP10 of the Convention on Biological Diversity (CBD) in Nagoya in 2010, the importance of maintaining biodiversity has been recognized to achieve the sustainable use of ecosystem services. It is also acknowledged that intermediate human disturbance will stimulate the succession and renewal of ecosystems and contribute to the maintenance of biodiversity. The Japanese concept of *"satoyama"* means a plural ecosystem including various habitats, such as secondary forests, paddy fields, grasslands, waterways, and reservoirs which are made and maintained by the activities of agriculture and forestry. This is an example of the coupled system of human society and nature used to conserve the biodiversity and to maintain the ecosystem services under a particular anthropogenic disturbance.

While coastal ecosystems are rich in diversity due to their interaction with the adjacent land, topographic futures, and hydrographic conditions, they are vulnerable and susceptible to human activities and natural disruptions. In the Japanese coastal fisheries management system, in order to spread and reduce the fishing pressure, the use of fishing grounds is temporally and spatially regulated through the granting of fishing rights amongst fishers. Activities for maintaining the ecosystem structure and functions, such as the restoration of tidal flats and seaweed beds, artificial stocking of juveniles, and development of coastal forests are also an important part of the Japanese fisheries management system. Therefore, the coastal fishery and coastal ecosystem in Japan are another example of the coupled system of human society and nature.

The enormous earthquake and subsequent tsunami that occurred on March 11, 2011 was a great calamity for the peoples and industries on the Pacific coast of the Tohoku region of Japan. Fisheries in this region were severely damaged. The earthquake and tsunami was a millennial scale disturbance for the ocean ecosystems along the Pacific coast of this area. In the offshore waters, subsidence and uplift of the seafloor occurred in a wide area around the epicenter. Along the coast, landforms and submarine topography were greatly changed by land subsidence due to the earthquake, and a large expanse of tidal flats was lost. Many seaweed beds collapsed and a large number of benthic organisms disappeared due to the tsunami. However, in the offshore waters, there was no significant difference in the migration and distribution patterns of fishes before and after the earthquake. In addition, the recovery of the seaweed beds was generally fast, and the benthic faunas have also recovered quickly. In this respect, the lethal damage from the earthquake and tsunami to the marine life was not so large, and it is suggested that the resilience of the ecosystems is fairly strong. On the other hand, the lost tidal flats and changed coastal topography appears difficult to recover naturally. These topographical changes will affect the physical, chemical, and biological processes of the coastal ecosystems, and they can lead to an ecological succession. Therefore, we need to monitor the succession carefully, and to consider ways to adapt to the succession by regulating our activities, or by using artificial measures to mitigate the ecological impacts.

As one of the effects of this earthquake and tsunami, large amounts of radioactive substances leaked into the North Pacific Ocean from the Fukushima Dai-ichi Nuclear Power Plant. The concentration of the radioactive substances, mainly $^{134}$Cs and $^{137}$Cs, in seawater decreased to a not detectable level within several months, even in the waters around the power plant. The radioactive contamination in the living resources of the waters off the Tohoku region has also declined to not detectable or quite low levels with time. However, in some areas, the concentrations in submarine sediments and some benthic organisms still remain at relatively high levels. We will continue to monitor the radioactive substances and examine their movement in the ocean ecosystems. In addition, a lot of debris was released by the tsunami and has been drifting across the Pacific Ocean, and some has already reached the Hawaiian Islands and coast of North America. Since the debris can affect the ecology of highly migratory species and coastal ecosystems, the systematic monitoring and ecological studies on the debris are the key issues for entire the North Pacific Ocean.

Lastly, I would like to express my sincere thanks for the warm sympathy and strong aid from the PICES member countries and from all over the world in response to the terrible disasters of the Great East Japan Earthquake.

# Schedules
# and
# Abstracts

# S1 Science Board Symposium
# Effects of natural and anthropogenic stressors in the North Pacific ecosystems: Scientific challenges and possible solutions

***Co-Convenors**: Sinjae Yoo (SB), Atsushi Tsuda (BIO), Elizabeth Logerwell (FIS), Hiroya Sugisaki (MONITOR), Kyung-Il Chang (POC), Toru Suzuki (TCODE), Thomas Therriault (AICE), Hiroaki Saito (COVE), Robin Brown (SOFE), Igor Shevchenko (Russia), Fangli Qiao (China)*

***Invited Speakers**:*
*Benjamin Halpern (University of California Santa Barbara, USA)*
*Kitack Lee (Pohang University of Science and Technology, Korea)*
*William Li (Bedford Institute of Oceanography, DFO, Canada)*
*Reiji Masuda (Kyoto University, Japan)*
*Hans Paerl (The University of North Carolina at Chapel Hill, USA)*
*Ian Perry (Pacific Biological Station, DFO, Canada)*
*Hiroaki Saito (Tohoku National Fisheries Research Institute, FRA, Japan)*
*Xuelei Zhang (First Institute of Oceanography, SOA, China)*

Human society depends on ocean ecosystems to meet many of its needs. The availability of marine ecosystem services to humans is important to sustain coastal communities and to ensure human health and well-being. Global warming, shoreline development, pollution, eutrophication, overfishing, non-indigenous species, and intensive mariculture are examples of anthropogenic stressors that affect marine ecosystems. These stressors can act alone or in combination to alter the structure, function, and productivity of marine ecosystems. Consequently, the potential for decline in the ability of the ocean to provide essential ecosystem services, as a result of synergies in natural and anthropogenic stressors, is a serious concern for human society. To advance ecosystem-based management and to mitigate the influence of stressors, there is a need to develop improved understanding of the mechanisms of change in marine ecosystems. Improved understanding of ecosystem structure, function, and resilience will aid the development of practical methods to maintain and monitor ecosystem health. These are challenging issues for marine science and PICES will continue to promote research to address these issues through FUTURE.

## Monday, October 15 (10:30-18:30)

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| 10:30 | **Tokio Wada (Keynote)**<br>Resilience and sustainability of the human-ocean coupled system – Beyond the Great East Japan Earthquake |
| 11:15 | **Hans W. Paerl, Kedong Yin, James E. Cloern, Paul J. Harrison, Jacob Carstensen and Todd D. O'Brien**<br>Global patterns of phytoplankton dynamics in coastal ecosystems: Utilizing long-term data to distinguish human from climatic drivers of ecological change (S1-8359), Invited |
| 11:40 | **Benjamin S. Halpern**<br>The Ocean Health Index: Global assessment and future priorities (S1-8663), Invited |
| 12:05 | **William K.W. Li and Nancy Shackell**<br>Ecosystem change in the North Atlantic: Impacts, vulnerabilities, and opportunities (S1-8395), Invited |
| 12:30 | ***Lunch*** |

14:00 **R. Ian Perry and Diane Masson**
Understanding ecosystem structure, function, and change in the Strait of Georgia, Canada: A human-dominated marine ecosystem (S1-8611), Invited

14:25 **Kitack Lee, Tae-Wook Kim, Raymond G. Najjar, Hee-Dong Jeong and Hae Jin Jeong**
The anthropogenic impacts on ocean nutrients and carbon systems in the marginal seas of northwestern Pacific Ocean (S1-8809), Invited

14:50 **Anne Hollowed**
Projecting future status and trends of commercial fish and fisheries under shifting management strategies and climate change (S1-8605)

15:10 **Yury I. Zuenko**
Ecosystem reconstruction of the Japan/East Sea under recent climate change: Lowered productivity *vs* enhanced efficiency (S1-8550)

15:30 **Jilong Wang, Jilong Li and Wenbo Yang**
Impact of major climatic factors on biomass of the main commercial fishes in east China seas (S1-8456)

15:50 ***Coffee/Tea Break***

16:10 **Reiji Masuda**
Underwater visual census as a tool to monitor coastal ecosystems: Seasonal and interannual fluctuations, effect of thermal discharge from power stations, and recovery from the tsunami disaster (S1-8629), Invited

16:35 **Xuelei Zhang, SL Fan, Y Li, S Fang, MZ Fu, W Zheng, RX Li, ZL Wang and MY Zhu**
The onset and development of green algal tide in the Yellow Sea (S1-8660), Invited

17:00 **Hiroaki Saito, Takaomi Kaneko and Mitsutaku Makino**
Marine ecosystem responses to sporadic perturbation: Their processes, social impact and possible solutions (S1-8621), Invited

17:25 **Staci Massey Simonich**
Is trans-Pacific atmospheric transport and deposition of persistent organic pollutants (POPs) to the North Pacific Ocean significant? (S1-8511)

17:45 **Catharina J.M. Philippart, Martin J. Baptist, Taco de Bruin, Bruno J. Ens, Lucien Hanssen, Folkert de Jong and Frans J. Sijtsma**
Sensing marine life and livelihoods at the seashore – An integrated monitoring network and data portal for the Wadden Sea, a coastal UNESCO World Heritage site (S1-8502)

18:05 **Takeo Kurihara, Kengo Suzuki, Gyo Itani, Masatsugu Iseda, Tomoyuki Nakano, Satomi Kamimura Koji Seike, Takenori Sasaki, Hideki Takami and Susumu Chiba**
Comparison of the mollusk assemblage in Japan before *vs.* after the Great Tohoku Earthquake (S1-8544)

18:25 *Discussion*

18:30 *Session Ends*

## S1 Posters

S1-1 **Victor F. Bugaev**
Effects of pink salmon (*Oncorhynchus gorbuscha)* stock abundance on the growth of sockeye salmon (*Oncorynchus nerka)* from Kamchatka River in the ocean

S1-2 **Sangjin Lee**
NOWPAP Medium-term Strategy to address marine and coastal environment issues in the Northwest Pacific Ocean

S1-3 **Yulia S. Chernyshova and Tatyana Shpakova**
Size-age structure of Japanese scallop (*Mizuhopecten yessoensis*) from Alexandrovsky Bay, Japan Sea in 2009–2011

S1-4 **Anna S. Vazhova, Denis P. Kiku, Andrey P. Chernyaev and Lidiya T. Kovekovdova**
Assessment of petroleum hydrocarbons and heavy metals in estuarine areas of the rivers of Peter the Great Bay (Japan/East Sea)

S1-5 **Lidiya T. Kovekovdova and Denis P. Kiku**
Metals in bottom sediments of Peter the Great Bay (Japan/Est Sea)

S1-6 **Anatoliy L. Drozdov, Galina V. Moyseychenko, Konstantin A. Drozdov and Tatyana S. Vshivkova**
Bioassessment of ecological conditions of rivers, estuaries and marine areas around Vladivostok-city: Amurskiy and Ussuriiskiy Gulfs of the Sea of Japan

S1-7 **Vladimir M. Shulkin, Tatyana Yu. Orlova, O.G. Shevchenko and Inna V. Stonik**
River runoff as a reason for the seasonal and interannual variability of coastal phytoplankton blooms and hydrochemical characteristics in the northwestern part of the East/Japan Sea

S1-8 **Kuninao Tada, Miho Kayama, Naoto Hirade, Hitomi Yamaguchi, Supaporn Yamaguchi, Kazuhiro Harada, Minoru Tanda, Munehiro Fujiwara, Kazuhiko Ichimi and Tsuneo Honjo**
Decrease of surface water nutrient concentration and nutrient flux from the sediment in Harima-Nada, Eastern Seto Inland Sea, Japan

S1-9 **Alla A. Ogorodnikova**
A system of biotic indices and impact – Response indicators of hydraulic activity on marine bioresources

S1-10 **Dmitry Galanin, Sergey Dubrovsky, Viktor Sergeenko, Tatyana Shpakova and Yulia S. Chernyshova**
Current state of the scallop *Mizuhopecten yessoensis* (Jay, 1856) resources of the Sakhalin-Kuril region (Okhotsk Sea)

S1-11 **Hyeong Kyu Kwon, Han-Soeb Yang, Seok Jin Oh, Ju Chan Kang and Chang Geun Choi**
Phytoremediation: Novel approach to remediate eutrophic coastal sediment using light-emitting diodes (LEDs) and benthic microalgae (BMA)

S1-12 **Machiko Yamada, Mayuko Otsubo, Yuki Tsutsumi, Chiaki Mizota, Kuninao Tada and Paul J. Harrison**
Effect of fresh water on species diversity of the genus *Skeletonema* (Bacillariophyceae) in coastal and brackish waters

S1-13 **Marisol Garcia-Reyes and William J. Sydeman**
Wavelet decomposition of upwelling: Forcing and ecosystem response

S1-14 **Larissa A. Gayko**
Influence of climate change on the development of mollusks on marine farms (Possyet Bay, Japan/East Sea)

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|---|---|
| S1-15 | **Shang Chen and Tao Xia**<br>Technical directives for marine ecological capital assessment: Introduction and application in China seas |
| S1-16 | **Anna S. Vazhova and Andrey P. Chernyaev**<br>Content of polycyclic aromatic hydrocarbons (PAHs) in sediments of Amur Bay (Peter the Great Bay, Japan/East Sea) |
| S1-17 | **Talgat R. Kilmatov**<br>Changes in natural environment capacities due to climatic trends and possible migration of manpower on the western shore of the North Pacific |
| S1-18 | **Tamara G. Ponomareva and Polina A. Sokolova**<br>The Amur River estuary system |
| S1-19 | **Min-bo Luo and Yun-long Wang**<br>Community macrobenthos response to engineering in Hangzhou Bay, China |

# S1 Session Oral Presentations

### October 15, 11:15 (S1-8359), Invited

## Global patterns of phytoplankton dynamics in coastal ecosystems: Utilizing long-term data to distinguish human from climatic drivers of ecological change

Hans W. **Paerl**[1], Kedong Yin[2], James E. Cloern[3], Paul J. Harrison[4], Jacob Carstensen[5] and Todd D. O'Brien[6]

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[5] National Environmental Research Institute, Aarhus University, Denmark
[6] National Marine Fisheries Service—NOAA, Silver Spring, MD, 20910, USA

Phytoplankton biomass and community structure have undergone dramatic changes in coastal ecosystems over the past several decades in response to climate variability and human disturbance. These changes have short- and longer-term impacts on global carbon and nutrient cycling, food web structure, productivity and fisheries resources. There is a need to identify the underlying processes and measure rates at which they alter coastal ecosystems on a global scale. To address these needs, the Scientific Committee on Ocean Research (SCOR) formed Working Group 137 (WG 137), "Global Patterns of Phytoplankton Dynamics in Coastal Ecosystems: Comparative Analysis of Time Series Observations" (http://wg137.net/). WG 137 has been examining case studies that illustrate patterns of change contained in multi-decadal phytoplankton series. Drivers of phytoplankton biomass and composition operate on time scales from days to decades. Human nutrient enrichment and changes in grazing (*e.g.*, effects of invasive grazers) strongly impact phytoplankton production, composition, bloom intensities and duration. Altered freshwater discharge, hydrologic modifications and large storms are additionally-important drivers; sometimes overwhelming the ecological impacts of nutrients. Warming of surface waters that has intensified stratification, reduced vertical mixing and is favorable to thermophilic phytoplankton groups (*e.g.*, cyanobacteria) is also implicated in driving changes in phytoplankton community structure. To address these fundamental questions WG 137 is using data compiled from research and monitoring programs spread across five continents. The wealth of information in these data sets provides an unprecedented opportunity to develop a global analysis of the dynamics and status of ecosystems where land and sea meet.

### October 15, 11:40 (S1-8663), Invited

## The Ocean Health Index: Global assessment and future priorities

Benjamin S. **Halpern**[1,2]

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Recent development of the Ocean Health Index offers a flexible, quantitative and comprehensive tool for assessing the condition of the natural and human dimensions of marine ecosystems. The Index assesses the sustainable delivery of 10 widely-held public goals for healthy oceans, using measures of the current status, relative to a reference point, and likely future state to quantify these goals. I will present results and lessons learned from the initial global assessment and discuss future priorities and opportunities to refine and expand the Index.

**October 15, 12:05 (S1-8395), Invited**

## Ecosystem change in the North Atlantic: Impacts, vulnerabilities, and opportunities

William K.W. **Li** and Nancy Shackell

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The driving forces of climate change and economic activity exert pressures on North Atlantic ecosystems in the form of altered hydrodynamics and intensified resource use. The state of the trophic structure and its functional resilience are impacted by warmer waters, altered boundary currents, greater freshwater contribution, impeded vertical mixing, lower dissolved oxygen, increased acidity, and decreased biological buffering capacity. The pathways of these effects lead to vulnerabilities and opportunities in at least three tiers of increasing complexity. First, species may change via physiology, phenology, distribution, and adaptation. Second, interactions may change via competition, predation, parasitism, commensalism, mutualism, and size-selective exploitation. Third, communities may change via extirpation, invasion, and connectivity. Responding to ecosystem change by mechanistic attribution of effect to cause seems intractable because the driving forces are coupled and because there is no common biological response to any single driving force. An alternative might be a decision-making approach that combines algorithmic knowledge based on logical deduction with experiential knowledge based on social and historical context.

**October 15, 14:00 (S1-8611), Invited**

## Understanding ecosystem structure, function, and change in the Strait of Georgia, Canada: A human-dominated marine ecosystem

R. Ian **Perry**[1] and Diane Masson[2]

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The Strait of Georgia is arguably the most human-dominated marine system in Canada, with approximately 75% of the population of BC living along its shores. Given its rich and diversified ecosystem as well as the current and anticipated environmental and human pressures, the Strait of Georgia was chosen as the location for Fisheries and Oceans Canada's Pacific Ecosystem Research Initiative. The overall objective of the Initiative was to establish the bases for the management of ecosystem - human interactions in an integrative framework. Within this initiative, several projects were conducted to asses the current state of the ecosystem as well as to address the impacts of climate variability and human pressures on ecological processes in the Strait. This presentation summarises and integrates the findings from these projects and describes how the Strait of Georgia works, potential future pressures, and tools for managing human interactions with this system in an ecosystem context. Features that are important for controlling the productivity of the Strait include the exchange of materials and animals with outside waters, the bathymetric characteristics of the Strait, and the support of pelagic over demersal fish production. Potential future stressors include legacy contaminants and climate change. Tools to assist with management in an ecosystem context include ecosystem indicators, prediction of productivity shifts, and the use of probabilistic methods such as Bayesian networks. This Initiative provides an example of the type of integrated regional program that can contribute towards the goals of the PICES FUTURE project.

### October 15, 14:25 (S1-8809), Invited

## The anthropogenic impacts on ocean nutrients and carbon systems in the marginal seas of northwestern Pacific Ocean

Kitack **Lee**[1], Tae-Wook Kim[1], Raymond G. Najjar[2], Hee-Dong Jeong[3] and Hae Jin Jeong[4]

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Rapid growth in human population and industrial activity has led to increases in the concentrations of pollutant nitrogen species throughout the environment. However, the changes that result from anthropogenic nitrogen deposition into coastal and marginal seas have yet to be fully explored. In this study we investigated the impact of atmospheric nitrogen deposition on nutrient availability in the East Asian marginal seas, located downstream of the populated and industrialized Asian continent. To do so, we analyzed oceanic data collected during the last 30 years in the East China Sea, East/Japan Sea and Pacific coast of Japan, and atmospheric data collected during 2000s in the Korea and Japan. The relative abundance of nitrate over phosphorus (N*) in seawater has increased significantly in the study area over the period since 1980. The increasing trends in seawater N* progressively decreased moving eastward, which was consistent with general wind direction from China to Japan. The increase in seawater N* was mainly driven by increasing nitrate concentrations rather than decreasing phosphorus concentration. Atmospheric nitrogen deposition had a high temporal correlation with the seawater N* values ($r$=0.74-0.88), except in selected areas wherein riverine nitrogen load may be of equal importance. Our results indicate the increase in seawater nitrate abundance was most likely due to deposition of pollutant nitrogen from atmospheric sources. The increase in seawater nitrate abundance caused by atmospheric deposition and riverine input has switched extensive parts of the study area from being nitrogen-limited to phosphorus-limited.

### October 15, 14:50 (S1-8605)

## Projecting future status and trends of commercial fish and fisheries under shifting management strategies and climate change

Anne **Hollowed**

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Recent reviews of the global status of commercial fish and fisheries reveal several factors that contribute to the achievement of sustainable fisheries. These factors include leadership, social capital and incentives as well as a commitment to the collection and assessment of high quality information on the fished populations. It is not clear how the governance structures that contribute to sustainable fisheries will work under changing climate conditions. In this paper current information on expected impacts of climate change on the Eastern Bering Sea and Barents Sea marine ecosystems is synthesized to provide potential scenarios for future distribution and abundance of commercially important fish stocks. These scenarios are used to project future bottlenecks that may emerge from the current governance structures that evolved to manage sustainable fisheries. This synthesis demonstrates the need to evaluate future harvest strategies within the context of multiple stressors.

**October 15, 15:10 (S1-8550)**

## Ecosystem reconstruction of the Japan/East Sea under recent climate change: Lowered productivity *vs* enhanced efficiency

Yury I. **Zuenko**

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Ecosystem models and examples of the Japan/East Sea ecosystem show that recent decreases of annual primary production resulting from winter warming and weakened convection do not inevitably cause a decrease of higher trophic level productivity and biomass. In fact, the total biomass of zooplankton and biomass of many fish and squid species became higher, supposedly because of less mortality, and species diversity became higher, too. So, the ecosystem is changing in direction from a high-productive but low-effective subpolar ecosystem to a low-productive but high-effective subtropical ecosystem. Possible ecosystem response to changes of the timing of phytoplankton blooms is discussed, as well.

**October 15, 15:30 (S1-8456)**

## Impact of major climatic factors on biomass of the main commercial fishes in east China seas

Jilong Wang[1], Jilong Li[2] and Wenbo **Yang**[2]

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Recently, the impact of climate on marine fishes has gained more and more attention. But the study of the influence of climate change is also in the primary stage. East China seas belong to continental shelf waters, which are made up of the Bohai Sea, the Yellow Sea and the East China Sea. Climatic factors such as SST, winter and summer monsoon, typhoon and runoff and others, impact the ocean current system which is in a dynamic state at all times. We analyzed the correlation of major climatic factors (monsoon, typhoon, SST, runoff) with the residual and the ratio of major commercial fishes in east China seas from 1956-1984. The results show that different climatic factors have different impacts. Monsoon, typhoon and SST have a negative influence on pelagic fishes, but these factors have a positive impact on demersal fishes (all the P-values of the correlation coefficients were below 0.05). Because of differences in depth, upper waters change more significantly than deeper waters. Pelagic fish encounter the direct impacts of the dynamics of the environment and demersal fish encounter indirect impacts of transformation of the food web from climate change. The range of the time lags which have continuity was from 0 to 5 year for several years.

**October 15, 16:10 (S1-8629), Invited**

## Underwater visual census as a tool to monitor coastal ecosystems: Seasonal and interannual fluctuations, effect of thermal discharge from power stations, and recovery from the tsunami disaster

Reiji **Masuda**

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Visual census using SCUBA is an inexpensive method to monitor shallow coastal ecosystems with minimal invasive impact on the environment. I have conducted a twice-a-month underwater visual census in Maizuru, Sea of Japan to record subtidal fish assemblages. Fish abundance and species richness showed consistent seasonal fluctuations for the last ten years with a strict dependence on bottom water temperature. Species to species analysis, however, revealed that the abundance of each species fluctuated substantially interannually. The diversity of fishes is suggested to be a key factor to sustain the consistency of the fish assemblage. Visual censuses of fish assemblages were also conducted in areas along thermal discharges, one from a coal-fired and another from a nuclear power station, during the winter season (2004-2012). The fish assemblage along the thermal discharge from the nuclear power station had a significantly higher number of warm-water fish species, yet they disappeared

immediately after the total suspension of the power station in February 2012. Visual census was also applied to monitor the recovery of fish assemblages after the tsunami disaster in Kesennuma, Miyagi Prefecture. In two months after the tsunami, only a few juveniles of fish were found. Fish species and abundance increased along with the recovery of the *Sargassum* bed; the average fish density increased ca. 20 times in one year from the first observation. In conclusion, underwater visual census, although limited in depth, time and area, can be an efficient tool to monitor environments and provide insights for the understanding of ecosystems.

**October 15, 16:35 (S1-8660), Invited**

## The onset and development of green algal tide in the Yellow Sea

Xuelei **Zhang**, SL Fan, Y Li, S Fang, MZ Fu, W Zheng, RX Li, ZL Wang and MY Zhu

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The emerging "green tide" formed by the filamentous green algae has repeatedly occurred in the Yellow Sea since 2007. These green tides were massive and drawn serious concerns for their threats upon landing beaches and aquaculture. Effective counter measures, however, lacks as the argument goes on about the green tides' very source. We have conducted studies to address this issue with field surveys, laboratory and field experiments, and drifter tracking. The results indicated that the major causal species was *Enteromorpha prolifera*. In the mid-spring when the season ended for raft culture of the red algae *Porphyra*, the mechanically detached and discarded *E. prolifera,* one of the fouling algae of the *Porphyra* culture, apparently was favored in the new niche, became dominant in the drifting algal mat in the sea surface, and developed into huge biomass of floating green algae, the green tide. We suggest to collect and treat *E. prolifera* at the very site where the algae are discarded based on our preliminary comparison of the eco-economical impacts of treatment at the onset *vs.* at the arriving of the green tide.

**October 15, 17:00 (S1-8621), Invited**

## Marine ecosystem responses to sporadic perturbation: Their processes, social impact and possible solutions

Hiroaki **Saito**[1], Takaomi Kaneko[2] and Mitsutaku Makino[2]

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Biomass and composition of food-web components and their phenology in a marine ecosystem show year-to-year variation. A part of the variation is a result of the ecosystem response to sporadic perturbation events such as eddy intrusion, dust event, extra nutrient discharge after typhoon, *etc.* In many cases, the variation is almost reset by physical processes such as winter mixing. Seasonal physical processes in marine ecosystems are significant components of ecosystem resiliency to perturbation. The impact of perturbation to the ecosystem and society is more serious when it changed biomass and/or components of long-lived organisms. For example, once corals are breached by a week of hot days, it takes years to decades to recover the ecosystem productivity and also tourism of the region. Winter-time wind field shift in the central North Pacific in mid 1980s induced fish-species alternation off Japan, impacted the sardine-fishery related industry and regional economy of the landing port. If such an ecosystem regime shift cycle is long enough, the industry and society are able to adapt to the pseudo-fixed situation. But, the shift to the other state, often caused by sporadic perturbation, would induce more serious damage than unstable ecosystem because of larger investment based on the expectation to stable ecosystem. It is hard to predict the future sporadic perturbation, but further understanding on the change of marine ecosystem, such as detailed processes of marine ecosystem response to each perturbation, critical slow down in prior to the regime shift, finding precursor of perturbation event, *etc.*, is essential to minimize the social impact of the ecosystem change.

**October 15, 17:25 (S1-8511)**

## Is trans-Pacific atmospheric transport and deposition of persistent organic pollutants (POPs) to the North Pacific Ocean significant?

Staci Massey **Simonich**

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China is now the world's largest emitter of some persistent organic pollutants (POPs), including polycyclic aromatic hydrocarbons (PAHs) and some pesticides. In addition, modeling studies predict the outflow and deposition of these POPs to surrounding Asian countries, as well as the North Pacific Ocean, and the trans-Pacific atmospheric transport of PAHs and pesticides has been measured at remote sites in the Pacific Northwestern U.S. Although it is likely a significant sink for these persistent, bioaccumulative and toxic pollutants, few studies have investigated the atmospheric deposition and flux of POPs to the North Pacific Ocean. This talk will summarize the state of the science on POP deposition to the North Pacific Ocean, estimate the significance of this deposition through mass balance calculations and identify future research needs.

**October 15, 17:45 (S1-8502)**

## Sensing marine life and livelihoods at the seashore – An integrated monitoring network and data portal for the Wadden Sea, a coastal UNESCO World Heritage site

Catharina J.M. **Philippart**[1], Martin J. Baptist[2], Taco de Bruin[3], Bruno J. Ens[4], Lucien Hanssen[5], Folkert de Jong[6] and Frans J. Sijtsma[7]

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Knowledge is key to the sustainable management of seas and oceans. This knowledge should be reliable, founded on promptly accessible information and sufficiently broad to integrate ecological and socio-economic analyses. Despite extensive efforts by a suite of organisations to gather this knowledge, it is often not possible to answer overarching questions because not all data are accessible or comparable, essential parameters were not measured and tools for the integration of knowledge are lacking. The 'Wadden Sea Long-Term Ecosystem Research' (WaLTER) project is setting up an integrated monitoring plan for the main environmental and socio-economic issues relevant to the Wadden Sea, a coastal sea and UNESCO World Heritage site. The project started with mapping the needs for knowledge by polling all major stakeholders. The questions resulting from this survey are then converted to essential monitoring variables (EMVs) using conceptual ecological and socio-economical models. Existing data from current monitoring are made accessible via a central data portal, using EU-SeaDataNet technology, and analysed to assess the interactions between sampling effort and reliability of the results. Based on this information, an integrated monitoring network for all relevant abiotic, biotic and socio-economic factors will be designed in close interaction with all major stakeholders, improving the alignment between the existing research and monitoring programmes, filling the gaps in the current monitoring network, and making the data more readily accessible.

**October 15, 18:05 (S1-8544)**

## Comparison of the mollusk assemblage in Japan before *vs.* after the Great Tohoku Earthquake

Takeo **Kurihara**[1], Kengo Suzuki[1], Gyo Itani[2], Masatsugu Iseda[3], Tomoyuki Nakano[4], Satomi Kamimura[5,] Koji Seike[6], Takenori Sasaki[7], Hideki Takami[8] and Susumu Chiba[9]

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The 2011 Tohoku Earthquake triggered a tsunami and subsidence, which especially damaged the Tohoku region in Japan. To investigate the impact on marine organisms, we compared the Pacific intertidal malacofauna before *vs.* after the quake. We compared density data averaged across 7 quadrat surveys during 1978 to 2006 to density data in 1 survey in 2012. All data were collected on 19 rocky shores (3 in Tohoku region + 2 in the northern region + 14 in the southern region). Analyses of 183 species (11 Polyplacophora + 130 Gastropoda + 42 Bivalvia) revealed the following patterns. I) Vertical range averaged across all individuals in each class: Polyplacophora and Gastropoda descended after the quake in Tohoku (median: -2.1 and -0.9 cm, respectively) less greatly than in other regions (-3.0 and -4.5 cm, respectively). Whereas Bivalvia markedly descended in Tohoku (-21.9 cm) compared to other regions (-6.7 cm). II) Density summed across species in each class: Polyplacophora slightly increased (median: +3.8 $m^{-2}$) and Gastropoda somewhat decreased (-0.8 $m^{-2}$) after the quake in Tohoku compared to other regions (Polyplacophora: -0.8, Gastropoda: +145.9). In contrast, Bivalvia remarkably decreased in Tohoku (-441.8 $m^{-2}$) compared to other regions (-58.2 $m^{-2}$). III) Species composition dissimilarity before *vs.* after the quake: Czekanowski dissimilarity coefficient was greater in Tohoku (median: 0.79) than in other regions (0.67). These data suggest that the subsidence lowered (I) the vertical range of immobile Bivalvia and thus (II) the density in the intertidal zone, which translated into (III) considerable species composition change biased toward Polyplacophora and Gastropoda in Tohoku region.

**October 14 (FUTURE-8657)**

**Will be presented at the joint meeting of FUTURE Advisory Panels**

## The many faces of the sea: Planning and implementing marine ecosystem science in a changing world

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Scientists, managers and policy-makers have long recognized the need for ecosystem science, yet defining and implementing it is not a straightforward endeavor. Large, interdisciplinary programs have become critical tools for tackling complex ecosystem questions, such as those linked to changing oceanic conditions, loss of sea-ice, changes in subsistence use of ocean resources and ecosystem-based management. Over the last five years, the North Pacific Research Board (http://www.nprb.org) has planned and successfully implemented two large integrated ecosystem research programs — one in the Bering Sea and one in the Gulf of Alaska. These integrated efforts involve more than one hundred principal investigators from more than 30 institutions, and include most major marine science disciplines (climate, physical and chemical oceanography; plankton; fishes; seabirds; marine mammals; humans; traditional knowledge and economics; and ecosystem modeling). From these programs, others may gain insights into the intricacies of integrated ecosystem studies, and their unique partnerships and program structures, the development and evaluation of fieldwork-informed ecosystem models, and their applications to management. The oceans are changing in complex, non-linear ways and it is imperative that scientists, managers, stakeholders, policy-makers and the public work together to understand these changes. We will review different strategies for implementing and managing applied ecosystem science research as one contribution towards the sustainable use of our oceans.

# S1 Session Poster Presentations

## S1-1

### Effects of pink salmon (*Oncorhynchus gorbuscha)* stock abundance on the growth of sockeye salmon (*Oncorynchus nerka)* from Kamchatka River in the ocean

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Pink salmon stock abundance from West and East Kamchatka affects the growth of sockeye salmon from Kamchatka and Bristol Bay. Ocean growth of sockeye salmon has been analyzed on scale structures of 2.3 age individuals from the “A” stock and 1.3 age individuals from the “E” group, the most abundant in the Kamchatka River system. The “A” stock spawns in the basin of Azabachye Lake, while the “E” group spawns in the lower and middle reaches of the Kamchatka River and under-yearlings emigrate into Azabachye Lake to over-winter. Reliable correlations between pink salmon abundance and sockeye salmon growth have been revealed based on data for the 1985-2010 but no correlations have been revealed using the total temporal data. We demonstrate variations in scale radii, computed using body size and annual increments of Kamchatka River sockeye salmon (“A” stock and “E” group) for the second year of growth in the ocean (when variations are maximal compared other years) depending on the abundance of East Kamchatka pink salmon. The demonstration shows a wave-like behavior in correlations, when in particular periods of increasing pink salmon abundance the relationship is positive, negative and positive again (in some cases). Such behavior provides evidence to support the assertion of different (in their signs) competitive interactions between these species and other species of Pacific salmon, predetermined by complex influences of existing predictors in some periods of fluctuating abundance of pink salmon at sea.

## S1-2

### NOWPAP Medium-term Strategy to address marine and coastal environment issues in the Northwest Pacific Ocean

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The Action Plan for the Protection, Management and Development of the Marine and Coastal Environment of the Northwest Pacific Region (NOWPAP) was adopted in September 1994 as part of the UNEP Regional Seas Programme. Four member states of NOWPAP are the People’s Republic of China, Japan, the Republic of Korea and the Russian Federation. To fulfill the goal, the 2012-2017 NOWPAP Medium-term Strategy (MTS) was developed in line with UNEP MTS and approved at the 16th NOWPAP Intergovernmental Meeting in 2011. In the poster, details of NOWPAP 2012-2017 MTS are described under five themes: 1) Integrated coastal and river basin management; 2) Regular assessments of the state of the marine environment; 3) Pollution prevention and reduction, including harmful substances, hazardous waste and marine litter; 4) biodiversity conservation (including invasive alien species); and 5) climate change.

## S1-3

## Size-age structure of Japanese scallop (*Mizuhopecten yessoensis*) from Alexandrovsky Bay, Japan Sea in 2009–2011

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Japanese scallop is one of the most important commercial species of hydrobionts. They are located along the northern boundary of the Japan Sea (52º02' N) in Alexandrovsky Bay. This region is not developed by the fishery, so scallop are less studied there. Diving collections of Japanese scallop obtained from Alexandrovsky Bay during the 2009–2011 summer seasons were used to estimate size-age composition.

The majority (55.5%) of catches in 2009 were age 5-6 years with shell heights from 130 to 150 mm. In 2010, the majority (69.8%) were age 5-7 years with shell heighst from 130 to 150 mm . In 2011, the 6-8 year-old species with shell heights of 140-160 mm made up the majority (76.4%) of the catch . The relative abundance of juveniles in catches was very small during these three years (1.5 to 3%). The interannual changes in size and age structure of Japanese scallop in Alexandrovsky Bay were similar.

Thus, in Alexandrovsky Bay during 2009-2011 there has been an increase in mean size and age of Japanese scallop that, perhaps, is related to the inequality of recruitment and the instability of colonies in this region.

## S1-4

## Assessment of petroleum hydrocarbons and heavy metals in estuarine areas of the rivers of Peter the Great Bay (Japan/East Sea)

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The consequences of anthropogenic activities of appear in estuarine ecosystems of rivers. Water highly contaminated with various chemical compounds, including heavy metals (HM), pesticides and petroleum hydrocarbons (PH), flows into these areas in river discharge. Mixing of marine and freshwater determines the distribution of elements in terrigenous sediments. Compounds of metals and PH accumulate in the sediments of estuaries, where the mixing zone of river and sea waters froms a "sedimentation trap".

The content of PH and HM was determined in the sediments of the river basins of Peter the Great Bay in 2011. Samples of sediments were taken in the river, estuarine and marine areas of the Razdolnaya, Gladkaya, Suhodol and Artemovka Rivers. The highest content of PH (47.5–112.8mg/kg) was detected in the samples from the estuaries, which confirms the effectiveness of capture of pollutants in the zone of geochemical barrier. High values of PH (20.0–90.7mg/kg) were recorded in sediments from the river side. In samples from the offshore portion of the studied areas PH varied within 4.2–25.1mg/kg. The contents of all heavy metals and metalloids (Cu, Zn, Fe, Mn, Ni, Cr, Co, Pb, Cd, Se, As) in sediment samples by the estuaries of the Suhodol and Artemovka Rivers was higher in comparison with other samples.

The results of correlation analysis (0.6-0.8) showed dependence of some HM and PH on the sampling zone sampling, regardless of the ecological status of rivers.

## S1-5

## Metals in bottom sediments of Peter the Great Bay (Japan/Est Sea)

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In accordance with the assessment and forecast of the effects of pollution of the Far East seas, current levels of elements (As, Cd, Co, Cr, Cu, Hg, Mn, Ni, Pb, Se, Zn) in bottom sediments of Peter the Great Bay were determined. Measurement of the metal concentration was determinated with an atomic absorption spectrophotometer “Shimadzu” 6800, with the flame and graphite furnace atomizer method of analysis.

River flow input played a major role in the distribution of terrigenous elements in the metals in bottom sediments and in arsenic in bottom sediments as well. The maximum levels of accumulation were in the estuarine, heavily silted areas, and there was a gradual decrease in concentrations in the open bay. Average concentrations of Cd, Cr, Cu, Hg, Ni, Pb, Zn in the bottom sediments in 2011 do not differ from the period from 1982 -2002.

It has been observed that Cr, As, and Cu concentrations in Ussurisky Bay, and Hg concentrations in the open sea are all within the range that can have negative effects on aquatic organisms. There are only a small number of places with an elevated content of toxic metals in bottom sediments.

## S1-6

## Bioassessment of ecological conditions of rivers, estuaries and marine areas around Vladivostok-city: Amurskiy and Ussuriiskiy Gulfs of the Sea of Japan

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The estimation of the ecological conditions of the rivers flowing into Amurskiy and Ussuriiskiy Gulfs of the Sea of Japan, was done with the use of invertebrate bioindicators. Bioassessment of marine waters was based on a sea urchin embryo biotest of sea water and bottom sediments in different areas of the Peter Great Bay of the Sea of Japan.

The tests gave good results for drawing conclusions about the quality of rivers and streams, as well as the marine environment. The suitability of this method for the estimation of the water quality of freshwater and marine ecosystems was tested. The bioassessments showed areas of clean and polluted conditions and thus zones of transformation of contaminated substances were revealed. The most polluted area was the Murav’inaya Bay of the Ussuriiskiy Gulf and the estuary of Razdo’naya river of the Amurskiy Gulf. The cleanest waters were in the Narva River, its estuary and the corresponding bay of the Amurskiy Gulf, into which the Narva river flows.

We concluded that bottom sediments were more toxic than the water column. In the estuary zone where river flow is mixed with salt water from the open part of the bay there was chemical transformation of pollutants. The toxicity was particularly high in this area.

### S1-7

## River runoff as a reason for the seasonal and interannual variability of coastal phytoplankton blooms and hydrochemical characteristics in the northwestern part of the East/Japan Sea

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Temporal variability of ecosystem characteristics could be a clue for understanding the factors controlling the present situation and future trends in coastal sea areas. River runoff is one of the most important stressors of the coastal ecosystem. This factor was studied in the Razdolnaya River and Amursky Bay, Sea of Japan. It was shown that river runoff determines the seasonal variation of suspended matter, COD, silicates, Fe, Mn, Cu, Ni and significantly affects the concentration of nitrates. Contrariwise advection of sea water is the main source of phosphate and dissolved forms of Zn and Cd. The growth of phytoplankton in autumn-winter results in a gradual decrease in the concentration of silicates and phosphates. In the spring and summer increase in phytoplankton biomass continues to affect the variability of phosphates and nitrates, and compensates the influence of river runoff. In addition, it is the level of phytoplankton biomass, rather than variations in river flow, that determines the interannual variability of the concentration of nitrates and phosphates in coastal waters of the Amursky Bay: the lower content of nutrients was observed at the enhanced level of phytoplankton biomass. The relationship between river runoff variability and the time and intensity of phytoplankton blooms will be analyzed.

### S1-8

## Decrease of surface water nutrient concentration and nutrient flux from the sediment in Harima-Nada, Eastern Seto Inland Sea, Japan

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From the 1960s onwards, when Japan achieved high economic growth, the Seto Inland Sea was heavily eutrophicated due to serious water pollution by industrial effluent and urban wastewater. The result was a high occurrences of red tides. Since the Law for Conservation of Environment of the Seto Inland Sea was enacted in 1973, water quality has gradually improved. Since 1990, however, nutrient concentrations in seawater have decreased considerably, which has raised a new problem. With the recent Dissolved Inorganic Nitrogen (DIN) decrease, Nori (*Porphyra*) yield has declined. The fisheries yield of species such as sardine and short-neck clam has also been affected negatively. We investigated the causes of the nutrient decrease by examining the nutrient concentration of surface water in the eastern part of the Seto Inland Sea. We also surveyed the content of organic matter in the surface sediments and nutrient upward fluxes from the sediments across the overlying water-sediment interface. Our results showed that the organic content and the horizontal distributions in surface sediments were similar to those of 30 years ago. On the other hand, the nutrient fluxes were quite low compared with fluxes examined about 10 and 30 years ago in the same area. In this study, we suggest that the decrease of nutrient upward flux is an important factor for the recent nutrient decrease in the surface seawater in the Seto Inland Sea.

## S1-9

## A system of biotic indices and impact – Response indicators of hydraulic activity on marine bioresources

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This paper describes a system of biotic indices (BI), presenting in the aggregated form the tie-in spot productivity of hydraulic objects in Peter the Great Bay, integrating impact indicators (III), integrating response indicators (IRI) – bioresources loss restoration. Indices were calculated by rationing and aggregating BI, characterizing zone bioproductivity. III and IRI were applied to evaluate the impact of hydraulic activity on marine bioresources. III are impact specific characteristics of hydraulic activity (kg / hectare). Integral indicators IRI are specific characteristics of bioresources loss restoration and compensation in thousands ruble/ hectare and the amount of fry hydrobionts (thousand specimen / hectare). Biotic indices in Peter the Great Bay ranged from 0.001 to 0.875. Correlation analysis was conducted between indicators and the complex index. Pearson correlation analysis detected a significant correlation between III and BI at R = 0.85; for $IRI^1$ and BI at R = 0.84; for $IRI^2$ and BI at R = 0.89. III and IRI in impacted zones were ten times lower than indices in productive areas. Indices and indicators are prepared for environmental impact evaluation and nature conservation measures at the pre-project and design phases.

## S1-10

## Current state of the scallop *Mizuhopecten yessoensis* (Jay, 1856) resources of the Sakhalin-Kuril region (Okhotsk Sea)

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The maximum total biomass of natural scallop in the Sakhalin-Kuril region was observed in the 1960s. Then the fishery was conducted by a scallop-drag everywhere. Annual catch was approximately 5000 t.

The analysis of diving research results of previous years and data in the literature has shown that borders of distribution near Sakhalin island and southern Kuril islands were unchanged over the past 100 years. Some cycles of change of biological characteristics of scallop in this time were noted. More often the scallop fishery was the cause of these changes. The fishery almost did not exist during the last 5 years. The length-weight and age of scallop in all regions is increasing. In South Kuril Strait (43°), Aniva Bay (46°) and Terpenya Bay (49°) in the catch mollusk of 5-9 years, Aleksandrovsky bay (52°) - 8-13 years was be. The linear growth during the last 1-2 years in southern areas was greater than in northern areas. For the last 3 years, scallop of the northern population from Terpenya Bay had the greatest annual gain. For the last 7 years scallop in the north continued to grow, and in southern areas the growth was not observed.

During the last 10 years, population size and total biomass of scallop in the southern areas decreased by a factor of 10. In northern areas growth of biomass only was observed.

On the northern border of the distribution a condition of inhabitancy of various populations of scallop essentially influence its basic biological characteristics. The fishery is not always the primary defining factor a size of the scallop population and total biomass of scallop in Sakhalin-Kuril region.

### S1-11

## Phytoremediation: Novel approach to remediate eutrophic coastal sediment using light-emitting diodes (LEDs) and benthic microalgae (BMA)

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In a semi-enclosed bay located in the South Sea of Korea, the input of pollutants from terrestrial sources frequently causes environmental pollution problems such as eutrophication, harmful algal blooms and hypoxia. To improve these problems, civil engineering methods such as dredging and aeration have been used. However, these methods have led to secondary problems such as silt diffusion, prohibition of agricultural work, treatment of contaminated dredged sediment, and high costs. Therefore, ideal restoration methods should be eco-friendly methods that can effectuate a sufficient amount of self-purification of the natural environment and are less invasive than dredging. Benthic microalgae (BMA) are important photosynthesis organisms in sediments of the coastal zone. However, BMA in an enclosed bay remain suppressed due to the interrupted penetration of sediments by highly suspended matter. Further, LEDs are used in diverse applications, because they consume low power, have a long operational life, are eco-friendly, and can emit light of various single wavelengths. Recently, blue and red LEDs have been used in the cultivation of land plants. However, the use of LEDs in the ocean, except as fishing lamps, is extremely limited. To remediate eutrophic coastal sediments, we have developed a method using BMA and LEDs in combination. This method involves the installation of LEDs, which does not facilitate the growth of harmful algae, but encourages the growth of BMA. The photosynthetic performance of BMA in response to LEDs can be an important key to eco-friendly sediment remediation. In the present study, a novel phytoremediation method using BMA and LEDs is introduced.

### S1-12

## Effect of fresh water on species diversity of the genus *Skeletonema* (Bacillariophyceae) in coastal and brackish waters

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*Skeletonema costatum* sensu lato (s.l.) is among the important primary producers in many marine ecosystems. A recent identification method based on rDNA and fine morphological analyses, however, has led to a proposal to partition *S. costatum* (s.l.) into eight species and the genus *Skeletonema* into 11 species. We used this identification method to study the diversity of vegetative cells and their links with germinated benthic resting cells of *Skeletonema* in several Japanese coastal and brackish water ecosystems in which *S. costatum* (s.l.) and *Skeletonema subsalsum* had been reported to dominate the phytoplankton. We identified only *S. costatum* sensu stricto (s.s.) among all 21 vegetative strains isolated from three brackish water ecosystems in which salinities were less than 6.4: Toyama Bay, tidal points of the Chikugo River, and a regulating pond in Isahaya Bay. We isolated seven vegetative species, including *S. japonicum* and the *S. marinoi-dohrnii* complex, from three bays in which salinities ranged from 18.0 to 32.7: Tokyo, Osaka, and Dokai Bays. Only 12 of the 569 strains from these three bays included *S. costatum* (s.s.). All 45 strains survived and germinated from sediments of the regulating pond of Isahaya Bay were *S. costatum* (s.s.) as pelagic forms. We isolated germinated *Skeletonema* from sediments of three higher salinity bays which yielded 315 strains of five species, among which only four strains were identified as *S. costatum* (s.s.). These results reveal that among *Skeletonema* species, *S. costatum* (s.s.) is best adapted to low-salinity brackish waters that are strongly impacted by river discharge.

## S1-13

### Wavelet decomposition of upwelling: Forcing and ecosystem response

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Variation in upwelling is usually quantified at the monthly, seasonal, or annual scale, but upwelling occurs in nature at the synoptic scale of days. Moreover, it is through sequences of upwelling and wind-relaxation events, the first bringing nutrients into the euphotic zone and the latter allowing nutrients to be consumed and passed to higher trophic levels, that upwelling drives productivity of Eastern Boundary Current Systems. In this study, we analyze changes wind forcing and ocean response at different time scales, but focusing on events, using wavelet analyses to decompose 30 years of daily buoy data from northern California. We quantify the response of ocean, including nutrient input, based on water temperature. Significant trends in upwelling-wind events are found from April to June, with larger changes for strong events and no change for relaxation or downwelling events. SST however, only showed trends at interannual/decadal scales. Non-linear patterns of response in the ecosystem, including changes in Chl-*a* concentrations, krill, and possibly forage fish (anchovy, *Engraulis mordax*) indicate the potential costs of upwelling intensification and warming in this region.

## S1-14

### Influence of climate change on the development of mollusks on marine farms (Possyet Bay, Japan/East Sea)

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Global climate warming influences the development of Japanese scallop *Patinopecten (Mizuhopecten*) *yessoensis*. In this paper the short- and long-term ecological effects of hydrological parameters considered to influence Japanese scallop are considered. All four periods in development of Japanese scallop were compared for the periods 1970–1990 and 1999-2011. The duration itself was not changed but maximum and minimum durations decreased. Average long-term productivity rose from 476-601 specimens/m$^2$ to 791 specimens/m$^2$.

## S1-15

### Technical directives for marine ecological capital assessment: Introduction and application in China seas

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The Marine Ecological Capital (MEC) concept is developed based on natural capital and ecosystem service theories. MEC are marine ecological resources that provide benefits for human society. It consists of marine living organisms and their habitat (the whole marine ecosystem). The value of MEC includes not only the value of standing stocks of marine ecological resources but also the value of marine ecosystem services. Marine ecosystem services are benefits humans obtain from marine ecosystems, which consist of four key services -- provisioning, regulating, cultural and supporting services. In 2012, the State Oceanic Administration of China (SOA) published its national standard "Technical Directives for Marine Ecological Capital Assessment" to guide the assessment of marine ecological resources, ecosystem services, and ecological compensation fee at national, province and local levels.

The assessed coastal waters cover 19.31*10$^4$km$^2$ in China Seas, which provided 1,034.18 billion CNY of ecosystem services in 2008 and supported 1,740 billion CNY of marine industrial output. The average value per square km of coastal waters was 5.57 million CNY of ecosystem services per year. In 2008, the Bohai Sea's coastal waters

provided 215.24 billion CNY of ecosystem services, the Yellow Sea's coastal waters provided 328.86 billion CNY, the East China Sea's coastal waters provided 191.48 billion CNY, while the South China Sea's coastal waters provided 298.60 billion CNY.

The service value of China's coastal ecosystems showed the following spatial patterns: (1) from onshore to offshore, service value decreased gradually; and (2) high values resulted from maricultural and recreational areas.

## S1-16

## Content of polycyclic aromatic hydrocarbons (PAHs) in sediments of Amur Bay (Peter the Great Bay, Japan/East Sea)

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Polycyclic aromatic hydrocarbons (PAHs) in marine waters are conditioned by both natural and anthropogenic factors. The ratio of fluoranthene + pyrene to phenanthrene + chrysene concentrations is used as the index of technogenic PAHs; anthropogenic PAHs dominate if the index value is 1. The ratio of fluoranthene to fluoranthene + pyrene is used as the "pyrogenicity" index; the PAHs of pyrogenic origin prevail if the index value is 0.5.

Samples of bottom sediments were taken in Amur Bay (Peter the Great Bay, Japan/East Sea) in 2011. Total concentrations of identified PAHs ranged from 6 to 600 ng/g dry weight in bottom sediments of Amur Bay. In the eastern coastal area of the Bay concentrations were 3-4 times higher than in open areas. More than 60% of all these PAHs in sediments were carcinogenic. Percentage of benzo(a)pyrene was insignificant and did not exceed 1% of the PAHs content (occurrence of benzo(a)pyrene was 85%). "Technogenic" PAHs prevailed in sediments from the central and eastern parts of Amur Bay. Mass fraction of the "heavy" PAHs formed as a result of pyrolytic processes was 48%.

Research of pollution of Amur Bay by common hydrocarbons of bottom sediments showed that coastal areas of Vladivostok, experiencing the maximum human pressure, are the most polluted areas of the Bay.

## S1-17

## Changes in natural environment capacities due to climatic trends and possible migration of manpower on the western shore of the North Pacific

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The western shore of the North Pacific has a decreasing population density along its South-North axis. At the same time, the northern extent has large reserves of natural and mineral resources. Presently, there is a tendency to increase the capacity for habitation in the northern part and to decrease it in the southern part due to current climatic factors. A mathematical model to optimization labor resources is developed and the total gross output maximization for the region is determined. The production function takes into account the limited capacity of the natural environment. Two optimization scenarios are developed, one that maximizes labor resources and the other to maximize natural resources. The production function takes into account differences in labor productivity in each region. Analytical estimates of possible migration between regions and possible variations owing to climatic trends are considered.

## S1-18

## The Amur River estuary system

Tamara G. Ponomareva and Polina A. **Sokolova**

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The Amur River estuary system consists of a low stream 238 km long, part of the Amursky Liman and adjacent areas of the Sea of Okhotsk and the Sea of Japan. Water runoff is one of the most important factors forming the hydrological regime of the Amur River estuary. From 1975 to 1982 Amur River runoff was highly influenced by human economic activities, in particular the construction of the Zeya Hydroelectric Power Station. The period of damming controlled by the Zeya Reservoir (1983-2002) caused a slight reduction in maximum water discharge (August-September period) and more significant increase in minimum depth within the estuary.

Water level fluctuations in the estuary are characterized by variability due to changing tides. High tide within the near-shore zone comes two meters higher than pre-dam levels. The range of a tide wave advancing upriver during flood periods reaches 200 km inland while during low water periods it can reach 300 km upstream.

Moving alluvium material in the Amur River estuary contains sand fractions having 0.05-2.00 mm granularity. Due to stream speed reductions below critical speeds, moving alluvium fractions with definitive granularity stop their movement. These speeds change from 0.32 m/s for alluvium with 0.05 mm granularity to 1.0 m/s for alluvium with 2.0 mm granularity.

## S1-19

## Community macrobenthos response to engineering in Hangzhou Bay, China

Min-bo **Luo** and Yun-long Wang

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The Hangzhou Bay ecosystem supports various fish, shrimp, and crab species and includes the famous Zhoushan Fishing Ground. In recent years, a series of ocean engineering projects started in Hangzhou Bay and were put into use. Benthos has direct or the indirect ecosystem relationships with Hangzhou Bay, including impacts on most physical and chemical processes. From 2001 to 2011, an oceanographic comprehensive survey of 20 sampling sites was carried out in waters around the area of Yangshan Islands in Hangzhou Bay (30°32'~30°50'N, 121°53'~122°17'E) during the February, May and August, representing winter, spring and autumn seasons respectively. Communities had obvious responses to these ocean engineering projects.

# S2 MEQ Topic Session
# Range extension, toxicity and phylogeny of epiphytic dinoflagellates

***Co-Convenors**: William Cochlan (USA) and Satoshi Nagai (Japan)*

***Invited Speakers**:*
*Masao Adachi (Kochi University, Japan)*
*Teina Rongo (Florida Institute of Technology, USA)*
*Patricia Tester (National Ocean Service, NOAA, USA)*
*Takeshi Yasumoto (National Research Institute of Fisheries Science, Japan)*

Ciguatera fish poisoning is a growing food-borne illness that is common in tropical waters, where poisoning numbers are poorly known but estimated to range from 50,000 to 500,000 cases per year. The incidence of ciguatera is on the rise, and appears to correspond to disturbances in the environment such as nutrients released into coastal waters, land-use changes, or warmer coastal waters. Indeed, the flagellates, *Gambierdiscus and Ostreopsis*, that can produce ciguatoxin- or palytoxin-like compounds, appear to be spreading to more temperate latitudes, including the waters of PICES member countries. To gain better insight to this new issue, we invite papers addressing benthic dinoflagellate taxonomy, evidence for range extension, descriptions of standardized sampling programs; assays for assessing toxicity, and sentinel products to alert public health officials to ciguatera risk. The goal of the session is to formulate a better understanding of environmental conditions fostering the prevalence of ciguatoxin-producing organisms in new geographical regions.

### Thursday, October 18 (9:00-12:50)

| | |
|---|---|
| 09:00 | ***Introduction by Convenors*** |
| 09:05 | **Takeshi Yasumoto**<br>Toxins and other bioactive compounds produced by epiphytic dinoflagellates (S2-8498), Invited |
| 09:35 | **Masao Adachi, Takamichi Yoshimatsu, Haruka Iwamoto, Tomohiro Nishimura and Haruo Yamaguchi**<br>Effect of temperature change on the dominant species of *Gambierdiscus* in Japan - From a non-toxic species to a toxic species? (S2-8372), Invited |
| 09:55 | **Takuo Omura and Yasuwo Fukuyo**<br>*Gambierdiscus* in the mainland of Japan (S2-8695) |
| 10:15 | **Charles G. Trick and Danielle Beausoleil**<br>HABs and Ciguatera Fish Poisoning: Emerging methodological perspectives (S2-8824) |
| 10:35 | ***Coffee/Tea Break*** |
| 11:00 | **Teina Rongo and Robert van Woesik**<br>Ciguatera poisoning and climate oscillations in Rarotonga, southern Cook Islands (S2-8330), Invited |
| 11:30 | **Marina S. Selina, Tatiana V. Morozova, Nellya G. Litvinova and Tatyana Yu. Orlova**<br>Toxic epiphytic dinoflagellates in Peter the Great Bay, Sea of Japan, Russia (S2-8386) |
| 11:50 | **Changkyu Lee, Taegyu Park and Youngtae Park**<br>Geographic distribution of benthic dinoflagellates along Korean coasts (S2-8827) |
| 12:10 | **Patricia A. Tester and R. Wayne Litaker**<br>Accidental taxonomists and the resurgence of *Gambierdiscus* research (S2-8826), Invited |
| 12:40 | *Comments and Discussion* |
| 12:50 | *Session Ends* |

## S2 Poster

| | |
|---|---|
| S2-1 | **Seung Ho Baek**<br>Occurrence of epiphytic dinoflagellate *Gambierdiscus* spp. in the uninhabited Baekdo Islands and Seopsom Island in the vicinity of Seogwipo, Jeju Province, Korea |

# S2 Session Oral Presentations

### October 18, 09:05 (S2-8498), Invited

## Toxins and other bioactive compounds produced by epiphytic dinoflagellates

Takeshi **Yasumoto**

National Research Institute of Fisheries Science, 2-12-4 Fukuura, Kanazawa, Yokohama, 236-8648, Japan. E-mail: yasumotot@affrc.go.jp

Among epiphytic/benthic dinoflagellates, those belonging to the genera *Gambierdiscus*, *Ostreopsis*, and *Prorocentrum* are the representative flagellates known to produce toxins that pose a serious health risk to humans. The typical example is ciguatera fish poisoning (CFP) in which the causative toxins produced by *G. toxicus* accumulate in fish through the food chain. Despite the global occurrence of *Gambierdiscus* spp. and widespread incidents of CFP, only a few strains from the South Pacific region have been confirmed to produce causative toxins named ciguatoxins. The extremely rare occurrence of these toxic strains versus the vast numbers of nontoxic strains tested poses quite an intriguing question. The toxin profiles of fish vary regionally and species specifically. Obviously, toxins undergo metabolic oxidation in fish. Based on the toxin profile in fish, *G. toxicus* from Okinawa and Amami differ distinctly from *G. toxicus* found in Miyazaki. Besides ciguatoxins, *Gambierdiscus* spp. produce gambierol, gambieric acids, and maitotoxin; a group of toxins termed ladder-shaped toxins after their contiguous cyclic ether structure. The structural diversity of toxins produced by *Ostreopsis* spp. and *Prorocentrum lima* will be also discussed.

### October 18, 09:35 (S2-8372), Invited

## Effect of temperature change on the dominant species of *Gambierdiscus* in Japan - From a non-toxic species to a toxic species?

Masao **Adachi**[1], Takamichi Yoshimatsu[1], Haruka Iwamoto[1], Tomohiro Nishimura[1,2] and Haruo Yamaguchi[1]

[1] Kochi University, Monobe Otsu-200, Nankoku, 783-8502, Kochi, Japan. E-mail: madachi@kochi-u.ac.jp
[2] The United Graduate School of Agricultural Sciences, Ehime University, 3-5-7 Tarumi, Matsuyama, 790-8566, Ehime, Japan

Sporadic but regular occurrences of ciguatera fish poisoning (CFP) are reported in the subtropical area (relatively ‘high’ temperature environment) of Japan, whereas CFP is rare in the temperate area, such as the main island of Japan (‘moderate’ temperature environment). Our previous study on phylogeography and mouse toxicity of the genus *Gambierdiscus* from Japan clarified that the toxic *Gambierdiscus* sp. type 1 and the non-toxic type 2 were predominant among assemblages of *Gambierdiscus* spp. in the subtropical area and the temperate area, respectively, which suggests that *Gambierdiscus* sp. type 1 is a main agent of CFP in the subtropical area of Japan. The present study examined the effects of temperature on growth of the two types of *Gambierdiscus*. The results showed that the type 1 and the type 2 are adapted to the high temperature condition and the moderate temperature condition, respectively. Taking into account their growth characteristics, distribution, and the sea surface temperature of the areas in which they are distributed, sea surface temperature may play a key role in their distribution. We conclude that sea temperature increase resulting from global warming could play a crucial role in changing a dominant species from a non-toxic species to a toxic species in the main island of Japan.

### October 18, 09:55 (S2-8695)

## *Gambierdiscus* in the mainland of Japan

Takuo **Omura**[1] and Yasuwo Fukuyo[2]

[1] Laboratory of Aquatic Science Consultant Co., LTD., Meishin Bldg., Kamiikedai, 1-14-1 Ota-ku, Tokyo, 145-0064, Japan
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[2] Asian Natural Environmental Science Center, University of Tokyo, 1-1-1 Yayoi, Bunkyo-ku, Tokyo, 113-8657, Japan

Geographical distribution of benthic dinoflagellates, especially those responsible for ciguatera fish poisoning (CFP), *Gambierdiscus* spp., and those associated with them, (*e.g.*, *Ostreopsis*), appear to be expanding in the western Pacific. In Japan, for example, CFP has been endemic for a long time in Okinawa, the most southern islands having a tropical climate. However, in recent years several food poisoning cases, suspected as CFP, have occurred after eating Spotted knifejaw caught by surf fishing at several cities facing the Pacific Ocean in the temperate area of Japan. In order to clarify the mechanisms of this apparent distribution shift, a comparison of the growth-physiological and genetic characteristics among clonal culture strains from various areas is necessary, together with an evaluation of morphological taxonomic criteria conventionally used.

Field observation studies of the distribution of *Gambierdiscus toxicus,* the causative organism of CFP, were conducted in the Pacific coast region in Japan (Ishigaki Island, Wakayama Prefecture, Shizuoka Prefecture, Chiba Prefecture and Hachijo Island). *G. toxicus* was observed at all the research areas, although cell numbers were not high and relatively rare. It was determined that the distribution of this species is not limited to tropical and subtropical regions, but also occurs in temperate regions. Culture strains were established from Wakayama Prefecture and Hachijo Island for comparison of their growth-physiological characteristics. The strain from Wakayama could survive for one month or more at a low temperature (15°C), whereas a culture strain from Tahiti could not survive at this temperature demonstrating that this species has several ecotypes.

### October 18, 10:15 (S2-8824)

## HABs and Ciguatera Fish Poisoning: Emerging methodological perspectives

Charles G. **Trick**[1] and Danielle Beausoleil[2]

[1] Department of Biology, Western University, London, ON, N6A 5B7, Canada. E-mail: trick@uwo.ca

[2] Department of Pathology, Western University, London, ON, N6A 5B7, Canada

Recently, more attention is being paid to the increasing global burden of ciguatera fish poisoning (CFP) in order to develop appropriate strategies for intervention, especially in endemic areas such as the South Pacific Islands. In this presentation we provide a comprehensive review of the studies and literature regarding the nature of CFP such as occurrence rates, hospital records, treatment, diagnosis, toxicology analyses and climate considerations. General conclusions have been made: much of the previous research on CFP has been characterized by inequalities and/or linear patterns of methodological and experimental design, and has been limited to concepts of strategy that are mainly scientific in nature. Previous studies have failed to address the relationships between HABs, CFP and social ecology. Failure to acknowledge these important relationships and aspects has led to continuous unsuccessful attempts to eradicate and/or alleviate CFP within endemic regions, and on a global scale. This presentation also reviews various issues within the South Pacific regions that ultimately affect the transmission of CFP including an array of environmental considerations, political and governmental dilemmas, fishery development, foreign dependencies, local social ecology and culture. Through careful consideration and empirical evidence it is suggested and promised that the use of emerging trans-disciplinary methodologies such as Ecosystem Health Perspectives will broaden the framework of CFP research, and provide the best and most appropriate platform for further investigation on disease occurrence and sustainable restorative solutions for CFP in the South Pacific regions and worldwide.

**October 18, 11:00 (S2-8330), Invited**

## Ciguatera poisoning and climate oscillations in Rarotonga, southern Cook Islands

Teina **Rongo** and Robert van Woesik

Florida Institute of Technology, 150 W. University Blvd., Melbourne, FL, 32901, USA. E-mail: eturere@yahoo.com

Ciguatera fish poisoning is a critical public-health issue among Pacific Island nations. Accurately predicting outbreaks has become a priority, particularly in Rarotonga in the southern Cook Islands, which has reported the highest global incidence of ciguatera poisoning in the last 20 years. However, since 2006 cases of ciguatera poisoning have declined, and in 2011 ciguatera cases were the lowest in nearly 20 years. Here we examined (1) the frequency of disturbances and its influence on ciguatera-poisoning events, and (2) whether there were any links between cases of ciguatera poisoning and climate cycles, in particular the El Niño and the Pacific Decadal Oscillation. We found that ciguatera-poisoning events in the southern Cook Islands were linked to the positive phase of the Pacific Decadal Oscillation, a phase that is also accompanied by a high frequency of El Niño events and cyclones. We show that ciguatera poisoning is positively related with the overpass of cyclones. The recent decline in the incidence of ciguatera poisoning in Rarotonga, and the continued decline through 2011, coincided with the recent shift of the Pacific Decadal Oscillation into a negative phase, where El Niño events and cyclone frequency is low. We therefore predict that ciguatera poisoning will continue to decline in Rarotonga over the next decade, during this negative phase of the Pacific Decadal Oscillation.

**October 18, 11:30 (S2-8386)**

## Toxic epiphytic dinoflagellates in Peter the Great Bay, Sea of Japan, Russia

Marina S. Selina, Tatiana V. Morozova, Nellya G. Litvinova and Tatyana Yu. **Orlova**

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Studies of epiphytic dinoflagellates on macroalgae in Russian coastal waters of the Sea of Japan in 2008-2011 revealed thirteen species. Their maximum species richness and abundance were observed in late summer and early autumn. Five of the species are known as toxic: *Ostreopsis* cf. *siamensis*, *O*. cf. *ovata*, *Prorocentrum lima*, *Amphidinium operculatum*, and *A. carterae*. *Ostreopsis* spp. predominated and were most widely distributed. They were recorded from August until October, and reached their highest abundance in September (maximum density = 330,000 cells $g^{-1}$ DW). Additionally, *Ostreopsis* spp. showed some regularity in their emergence and distribution over Peter the Great Bay. The maximum warming of water in summer, followed by the emergence of *Ostreopsis* spp. cells on macrophytes, apparently becomes a stimulatory factor for cysts of these species to germinate. In Peter the Great Bay, their proliferation was reported only on macrophytes, regardless of the class of host macrophytes. Densities of the epiphytic dinoflagellates were very low in the water column and sediments. Only the type of thallus (divided/laminar) was of substantial importance. The hydrodynamic regime of the studied area played a decisive role in distribution of *Ostreopsis* spp. Thus, slightly shaken sites in Peter the Great Bay were the most favorable for proliferation. The total abundance of *P. lima*, *A. operculatum* and *A. carterae* did not exceed 3,500 cells $g^{-1}$ DW. Due to the lack of monitoring of epiphytic dinoflagellates in the area, it is still unclear if these species were invasive or whether they had inhabited this area previously.

**October 18, 11:50 (S2-8827)**

## Geographic distribution of benthic dinoflagellates along Korean coasts

Changkyu **Lee**, Taegyu Park and Youngtae Park

Southeast Sea Fisheries Research Institute/National Fisheries Research and Development Institute, Sanyangilju-ro, Tongyeong-si, Gyeongnam, 650-943, R Korea. E-mail: changkl@nfrdi.go.kr

The benthic dinoflagellate *Gambierdiscus* spp. is the primary causative agent of ciguatera fish poisoning in tropical and subtropical areas. However, the geographic distribution of benthic dinoflagellates along the Korean coastline is poorly understood. The population densities of benthic dinoflagellates were investigated along the southern coast of Korea, including Jeju Island from June to September during 2011 and 2012. *Gambierdiscu*s sp., *Ostreopsis* sp., *Coolia* sp., *Prorocentrum lima* and other unknown benthic dinoflagellates were found. *Gambierdiscus* sp. was detected from thirty-two samples (42.6%) out of seventy-five samples at densities of 0.038-2.912 cells $g^{-1}$ macroalgae along the Jeju Island coast during 2011. *Ostreopsis* sp. was the most dominant benthic dinoflagellate, and its abundance ranged from 0.07 to 6.07 cells $g^{-1}$ of macroalgae. Vertical distributions from 0 to 15 m depth were also surveyed at 3 m intervals in the coastal waters off Jeju Island. Most benthic dinoflagellates were distributed within the 6 m depth zone. This result indicates that *Gambierdiscus* sp. is widely distributed along the Jeju Island coastline, and suggests potential ciguatera fish poisoning in Korean waters. Morphological and molecular genetic characterization of these benthic dinoflagellates is currently in progress.

**October 18, 12:10 (S2-8826), Invited**

## Accidental taxonomists and the resurgence of *Gambierdiscus* research

Patricia A. **Tester** and R. Wayne Litaker

Center for Coastal Fisheries and Habitat Research, National Centers for Coastal Ocean Science, National Ocean Service, 101 Pivers Island, Beaufort, NC, 28516, USA. E-mail: pat.tester@noaa.gov

*Gambierdiscus* is the dinoflagellate genus identified most closely with the production of ciguatoxins and the symptoms of ciguatera fish poisoning (CFP). While CFP has not had the attention or visibility of other HAB related illnesses, it claims more victims than all other HAB caused illnesses combined. Unfortunately, both tools and strategies for routine monitoring for CFP or *Gambierdiscus* abundance have not been developed in endemic areas. In part, this is because both the cells and ciguatoxins are difficult to detect and quantify. Also, it is generally believed there is little or nothing that can be done to relieve the symptoms of CFP, so it is grossly underreported even in areas where there are mandatory reporting requirements. In 2001, a small proposal was submitted to the Smithsonian Institution to develop polymerase chain reaction (PCR) assays for *Gambierdiscus* species as a first step toward monitoring capabilities. Thus, started a naïve but very interesting and productive journey wherein we became "accidental taxonomists" setting the stage for the revitalization of *Gambierdiscus*. Our first detour on the way to developing monitoring tools was the revision of the genus and the description of four new species. Along the way, isolation and culture techniques were greatly improved and the characterization of species-specific physiological requirements have enabled habitat mapping. Validation of these habitat maps has been supported by the ability to detect and quantify *Gambierdiscus* by recently developed qPCR assays. Late breaking information on new species, range extensions and species-specific toxicities are posted on the website: http://gambierdiscuswiki.wikispaces.com/.

# S2 Session Poster Presentation

## S2-1

### Occurrence of epiphytic dinoflagellate *Gambierdiscus* spp. in the uninhabited Baekdo Islands and Seopsom Island in the vicinity of Seogwipo, Jeju Province, Korea

Seung Ho **Baek**

Korea Institute of Ocean Science and Technology (KIOST)/ South Sea Branch, Geoje, 656-830, R Korea. E-mail: baeksh@kordi.re.kr

*Gambierdiscus toxicus*, Adachi et. Fukuyo, is a epiphytic ciguatoxin-producing armored dinoflagellate, often attached to macroalgae. This organism is the primary causative agent of ciguatera fish poisoning which occurs in tropical and subtropical regions. However, regardless of the fact that populations of *Gambierdiscus* spp. have expanded from sub-tropic and tropic areas to temperate areas, the monitoring of *Gambierdiscus* spp. is lacking in the coastal waters of Korean temperate regions. This study was performed at the uninhabited Baekdo Islands off the southern coast of Korea, and at Seopsom Island in the vicinity of Seogwipo, Jeju Province during April and May, 2011. Cell densities of *Gambierdiscus* spp. attached to macroalgae at Baekdo and Jeju Islands ranged from zero to 56.4 cells $g^{-1}$. Maximum densities were recorded on the brown alga *Cladophora japonica* off Jeju Island. In particular, the cell densities of *Gambierdiscus* spp. were influenced by the substrate characteristics of the macroalgae. The continuous monitoring of toxic benthic dinoflagellate is necessary to predict and prevent future ciguatera poisoning in Korean coastal waters.

# S3

# POC Topic Session
# Challenges in understanding Northern Hemisphere ocean climate variability and change

**Co-Sponsored by CLIVAR and ICES**

***Co-Convenors***: *Jürgen Alheit (ICES/Germany), Emanuele Di Lorenzo (PICES/USA), Michael Foreman (PICES/Canada), Shoshiro Minobe (PICES/Japan), Hiroaki Saito (PICES/Japan) and Toshio Suga (CLIVAR/Japan)*

***Invited Speakers***:
*Kenneth Drinkwater (Institute of Marine Research, Norway)*
*Young-Oh Kwon (Woods Hole Oceanographic Institution, USA)*
*Nathan Mantua (University of Washington, USA)*
*Yoshi N. Sasaki (Hokkaido University, Japan)*
*Akinori Takasuka (National Research Institute of Fisheries Science, FRA, Japan)*

Physical climate variability and change exert substantial impacts on marine ecosystems, particularly on longer timescales because of the longer ocean memory compared with the atmosphere, and the cumulative effects on marine ecosystems. On a centennial scale, climate changes due to anthropogenic forcings may dominate over natural variability, but variations on decadal or shorter timescales may be mainly due to natural climate variability. Furthermore, natural climate variability can be modified via climate changes. Therefore, a correct understanding of the mechanisms underlying climate variability and change should be the basis for understanding and predicting future conditions of the North Pacific and North Atlantic. For the North Pacific there is no widely accepted consensus on the mechanisms governing decadal-to-multidecadal climate variability, and this mainly reflects the uncertainty of how, or even whether, the mid-latitude ocean influences the atmosphere. Some linkages between processes, such as oceanic memory due to Rossby wave propagation, are generally accepted, and predictability associated with these processes may also be important for understanding marine ecosystem impacts. It is also unclear if teleconnection dynamics between the North Pacific, North Atlantic and the Arctic exert an important control on the ocean's decadal climate state. This session brings together researchers of marine ecosystems, physical oceanography and climate to share ideas about what physical parameters and processes are important in understanding and predicting the response of specific marine ecosystems to climate forcing. Through collaboration among PICES, CLIVAR and ICES, this session invites contributions exploring important developments in the research field of the North Pacific climate variability and change, including physical environmental variations and their predictability, teleconnection dynamics between oceanic basins, such as the Pacific and Atlantic Oceans, and linkages between physical conditions and marine ecosystems.

## Thursday, October 18 (9:00-17:50)

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|---|---|
| 09:00 | ***Introduction by Convenors*** |
| 09:05 | **Kenneth F. Drinkwater**<br>Challenges in understanding ocean climate variability and change and its impacts: Temporal and spatial scales and multi-forcings (S3-8639), Invited |
| 09:30 | **Jürgen Alheit**<br>Impact of multi-decadal climate forcing on northern hemisphere small pelagic fish populations (S3-8595) |
| 09:50 | **Andrey S. Krovnin, Boris N. Kotenev and George Moury**<br>Interaction of major teleconnection patterns as a mechanism linking the North Pacific and North Atlantic climate (S3-8493) |
| 10:10 | **Nathan Mantua and Megan Stachura**<br>Empirical evidence for North Pacific ecosystem regime shifts revisited (S3-8834), Invited |

10:35 ***Coffee/Tea Break***

10:55 **William T. Peterson, Jay Peterson, Cheryl A. Morgan and Jennifer L. Fisher**
Tracking ecosystem change in the northern California Current (S3-8688)

11:15 **Akinori Takasuka, Ichiro Aoki and Yoshioki Oozeki**
Environmental windows for small pelagic fish in the western North Pacific: How do their vital parameters respond to climate variability and change? (S3-8802), Invited

11:40 **Albert J. Hermann, Nicholas A. Bond, Georgina A. Gibson, Enrique N. Curchitser, Kate Hedstrom and Phyllis J. Stabeno**
Biophysical frequency response of the Bering Sea to large-scale forcing (S3-8710)

12:00 **Hyung Jeek Kim, Kiseong Hyeong, Chan Min Yoo, Dongseon Kim and Boo-Keun Khim**
Impact of strong El Niño events on sinking particle fluxes in the 10ºN thermocline ridge area of the northeastern equatorial Pacific (S3-8584)

12:20 **Elena I. Ustinova and Yury D. Sorokin**
Regional features of the climate variability and change in the Far-Eastern Seas (S3-8753)

12:40 ***Lunch***

14:00 **Young-Oh Kwon**
Role of the Kuroshio-Oyashio Extensions and Gulf Stream in the decadal climate and ecosystem variability (S3-8636), Invited

14:25 **Bunmei Taguchi and Niklas Schneider**
Dynamics of North Pacific oceanic heat content variability on decadal time-scale (S3-8752)

14:45 **Yoshi N. Sasaki, Shoshiro Minobe and Niklas Schneider**
Interannual to decadal variability of the Gulf Stream and Kuroshio Extension jets (S3-8397), Invited

15:10 **Jennifer L. Fisher, William T. Peterson, Cheryl A. Morgan and Jay Peterson**
Basin-scale *versus* local-scale drivers of copepod community dynamics in the northeast Pacific (Newport, Oregon, USA) (S3-8718)

15:30 ***Coffee/Tea Break***

15:50 **Andrew Davis and Emanuele Di Lorenzo**
Forcing dynamics of mesoscale eddies in the California Current (S3-8332)

16:10 **Vadim Navrotsky**
Effects of solar activity on climate-ocean ecosystems interactions (S3-8532)

16:30 **Howard J. Freeland**
Temperature, salinity and density trends along Line-P and the implications for mixed layer formation (S3-8380)

16:50 **Patrick Cummins and Diane Masson**
Wind-driven variability of dissolved oxygen below the mixed layer at Station P (S3-8643)

17:10 **Haruka Nishikawa, Yoichi Ishikawa, Masafumi Kamachi, Hiromichi Igarashi, Shuhei Masuda, Toshimasa Doi, Shiro Nishikawa, Yoshihisa Hiyoshi, Yuji Sasaki, Takashi Mochizuki, Hiroshi Ishizaki, Tsuyoshi Wakamatsu and Toshiyuki Awaji**
Estimation of nutrient supply process in the spring Kuroshio-Oyashio transition region (S3-8523)

17:30 **Toshio Suga, Shigeki Hosoda, Ryuichiro Inoue, Kanako Sato, Koketsu Shinya, Taiyo Kobayashi, Fumiaki Kobashi, Katsuya Toyama, Toshiyuki Kita, Makio C. Honda, Kazuhiko Matsumoto, Kosei Sasaoka, Tetsuichi Fujiki, Hajime Kawakami, Masahide Wakita, Yoshikazu Sasai, Akihiko Murata, Kazuhiko Hayashi, Yoshimi Kawai, Vincent Faure, Akira Nagano, Takeshi Kawano and Toshiro Saino**
Western North Pacific Integrated Physical-Biogeochemical Ocean Observation Experiment (INBOX) (S3-8619)

17:50 *Session Ends*

## S3 Posters

S3-1 **Svetlana Yu. Glebova**
Winter cyclonic activities over the ocean as a factor in the subsequent changes in the atmospheric and thermal regime of the Far Eastern Seas and north-west Pacific (with a shift in one year)

S3-2 **Qinghua Qi, Rong-shuo Cai and Qilong Zhang**
The variability of sea temperature in South China Sea (SCS) and its relationship with the early or later of SCS summer monsoon outbreaks

S3-3 **Licheng Feng, Baochao Liu and Jianping Li**
A study of the effect of wind on Changjiang (Yangtze) River diluted water in summer

S3-4 **Howard J. Freeland**
The current status of the international Argo project

S3-5 **Hong-jian Tan and Rong-shuo Cai**
Possible impact of El Niño Modoki on marine environment in China offshore and its adjacent seas

S3-6 **Taewook Park, Chan Joo Jang, Minho Kwon, Hanna Na and Kwang-Yul Kim**
ENSO effect on surface salinity variability in the Yellow and East China Seas in summer

S3-7 **Dmitry V. Stepanov, Victoriia I. Stepanova and Nikolay A. Diansky**
Interannual to interdecadal variability of circulation in the Japan/East Sea based on numerical simulations

S3-8 **Jianguo Du, William W.L. Cheung, Bin Chen, Qiulin Zhou and Shengyun Yang**
Progress and prospect of impacts of climate changes on marine biodiversity

S3-9 **Larissa A. Gayko**
Air-sea interaction along the coast of north-western East/Japan Sea within 75 years

S3-10 **Yang Liu, Sei-Ichi Saitoh, I. Nyoman Radiarta, Tomonori Isada, Toru Hirawake, Hiroyuki Mizuta and Hajime Yasui**
Impact of climate variability on marine aquaculture: A case study on the Japanese kelp in southern Hokkaido, Japan, using satellite remote sensing and GIS-based models

S3-11 **Yuri Oh, Chan Joo Jang and Jihyun Lee**
Enhanced stratification in the southwestern East Sea (Japan Sea)

S3-12 **Yoshikazu Fukuda, Wataru Ito, Toshiya Nakano, Shiro Ishizaki and Tsurane Kuragano**
Decadal variability of subsurface temperature in the North Pacific and recent modulation of the leading EOF modes

S3-13 **Larisa Chernysheva and Viktoria Platonova**
Seasonal climate variability on the coastal zone of the western part of North Pacific

S3-14 **Kosei Komatsu**
3D structure and decadal change of the nutrient in the Kuroshio region detected from historical data

S3-15 **Naoki Furuichi, Toshiyuki Hibiya and Yoshihiro Niwa**
Assessment of turbulence closure models for resonant inertial response in the oceanic mixed layer using a large eddy simulation model

S3-16 **Olga Skaberda, Lubov' Vasilevskaya and Julia Stochkute**
The relationship between the air temperature of East Kamchatka and the water temperature of western part of the Bering Sea

S3-17 **Yulong Liu, Qi Wang and Jinkun Yang**
The features of bifurcate line about the North Equatorial Current in the Pacific

S3-18 **Chan Joo Jang, Jihyeon So, Taewook Park and Sinjae Yoo**
Mixed layer variability and its associated chlorophyll *a* changes in the East Sea (Japan Sea)

# S3 Session Oral Presentations

**October 18, 09:05 (S3-8639), Invited**

## Challenges in understanding ocean climate variability and change and its impacts: Temporal and spatial scales and multi-forcings

Kenneth F. **Drinkwater**

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Marine ecosystems respond both to natural climate variability and to anthropogenic-induced changes. Some of the important physical processes that affect marine ecology will be reviewed with special attention to their time and space scales. The impacts of these physical processes on the ecology will then be presented by providing examples of ecological responses to past climate forcing principally from the subarctic seas in both the Pacific and Atlantic. Emphasis will be on the mechanisms linking the climate to the ecology. However, the changes we observe in the marine ecology are not simply a response to climate but also are influenced by human-induced factors, such as fishing, pollution, ocean acidification, land development, *etc.*, as well as non-climate forced species interactions and diseases. The response of the marine environment is to the combination of all of these factors, many of which interact non-linearly. These challenges and what needs to be done to address these issues will also be discussed.

**October 18, 09:30 (S3-8595)**

## Impact of multi-decadal climate forcing on northern hemisphere small pelagic fish populations

Jürgen **Alheit**

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The Atlantic Multi-decadal Oscillation (AMO) represents a basin scale mode of variability in North Atlantic sea surface temperature (SST) on decadal and longer time scales with a periodicity of 60-70 years. It influences the dynamics of plankton, benthos and fish populations as demonstrated by a growing body of publications. Changes in abundance and shifts in distributions from plankton to fish have been shown to occur over multi-decadal periods. Particularly impressive are respective fluctuations of small pelagic fish populations such as herring, sardines, sardinellas and anchovies in the eastern North Atlantic, which have been observed since the second half of the 19th century. This contribution will summarize the results of a recent ICES workshop on the basin-wide impact of the AMO, highlight new findings and draw comparisons to multi-decadal climate variability and long-term fluctuations of small pelagic fish populations in the North Pacific.

**October 18, 09:50 (S3-8493)**

## Interaction of major teleconnection patterns as a mechanism linking the North Pacific and North Atlantic climate

Andrey S. **Krovnin**, Boris N. Kotenev and George Moury

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The major atmospheric teleconnection patterns (TP) and associated sea-surface temperature anomaly (SSTA) fields in the North Pacific and North Atlantic often defined on the basis of EOF analysis, are orthogonal by the definition. However, in some cases the correlation coefficients among their indices are non-zero and reach the statistically significant values over the periods of 2-3 decades. We have identified two modes of the atmosphere-ocean interaction during 1950-2011, when the coupling between the certain (but different for each mode) North Pacific and North Atlantic TPs was especially strong. The first mode (1950-1986) was characterized by the prominent impact of the Pacific/North American (PNA) TP on the western and central North Atlantic. It was corresponded by the well-pronounced seesaw between the Aleutian and Icelandic Lows realized through this pattern. Its role in formation of the Atlantic Multidecadal Oscillation (AMO) is also considered. The well-known Atlantic SSTA Tripole is rather a product of the AMO evolution than a result of the NAO impact. The second mode of interaction was associated with establishment of positive phase of the West Pacific (WP) TP in winter of 1987. This was accompanied by strengthening of relationships between the western North Pacific and Northeast Atlantic (Scandinavian TP) as well as between the WP TP and NPGO. The absolute values of correlation coefficients between the WP index and indices of the Scandinavian pattern and NPGO (with 5-year running means) for two periods (1950-1986 and 1987-2011) increased from 0.01 to 0.49 and from 0.13 to 0.72, respectively. A qualitative mechanism describing the evolution and switch of the modes is proposed.

**October 18, 10:10 (S3-8834), Invited**

## Empirical evidence for North Pacific ecosystem regime shifts revisited

Nathan **Mantua** and Megan Stachura

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The 1977 climate shift and related ecosystem regime shift in the North Pacific have been the subject of extensive study for several decades now, and new evidence continues to mount for other shifts and low frequency variations in climate and ecosystem states around the world. In this analysis we update and expand upon Hare and Mantua's analysis from the year 2000 of 100 environmental time series that represented multiple views of the climate and ecology of the Northeast Pacific Ocean and Bering Sea. In addition to updating the time series used in the original study, we add new time series for the annual abundance of Asian pink, chum, and sockeye salmon population groups, and additional fishery data from the northwest Pacific and its marginal seas. We use principal components analysis, non-metric multidimensional scaling analysis, and dynamic factor analysis to objectively identify and evaluate primary patterns of biological and biophysical covariation across the northwest and northeast Pacific study domain. We examine relationships between the dominant patterns of biological productivity with summertime and wintertime sea level pressure and sea surface temperature across the study domain to gain insights into possible climatic drivers of ecosystem state variations. We also critically examine the notion that monitoring North Pacific ecosystems may allow for an earlier identification of regime shifts than is possible from monitoring climate data alone.

**October 18, 10:55 (S3-8688)**

## Tracking ecosystem change in the northern California Current

William T. **Peterson**[1], Jay Peterson[2], Cheryl A. Morgan[2] and Jennifer L. Fisher[2]

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Hydrography and plankton have been sampled in shelf and slope waters off Newport OR, fortnightly, since 1996. Water column profiles of temperature, salinity, and oxygen are taken and samples collected for zooplankton with plankton nets. The value of data on copepod species composition and community structure has increased greatly due to recent finding that these variables are highly correlated with survival of Columbia River salmon (coho and Chinook). Hydrography and copepod community structure are correlated with the Pacific Decadal Oscillation: when the PDO is negative, cold salty waters from the Gulf of Alaska feed the northern California Current (NCC) and large, lipid-rich copepods are transported to the shelf waters; when positive, a greater proportion of the NCC is fed by warm fresher waters from offshore, which bring small, oceanic lipid-poor copepods to the coast. Thus the basin-scale variations in winds that drive the PDO result in changes in transport that in turn control local food chain structure and salmon survival. Curiously, local upwelling has little affect on copepod biomass, production or community structure – rather, the PDO "explains all". Scenarios of future climate-driven ecosystem change will need to consider the role played by the PDO and variations in source waters (and the copepods contained therein) which feed the northern California Current.

**October 18, 11:15 (S3-8802), Invited**

## Environmental windows for small pelagic fish in the western North Pacific: How do their vital parameters respond to climate variability and change?

Akinori **Takasuka**[1], Ichiro Aoki[2] and Yoshioki Oozeki[1]

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How do vital parameters of small pelagic fish respond to climate variability and change? This is an essential question in specifying what physical parameters and processes regulate responses of fish community to climate forcing. In this talk, we briefly review several potential mechanisms linking climate variability and changes to population dynamics of small pelagic fish, in particular, the out-of-phase population oscillations between anchovy and sardine, in the western North Pacific. Different hypotheses are based on direct and indirect effects of physical factors on fish vital parameters. Then, we show examples of dramatic differences in optimal environmental windows for spawning among multi-species small pelagic fish in the western North Pacific. The effects of temperature, salinity, and zooplankton on spawning probability were compared among Japanese anchovy, Japanese sardine, Pacific round herring, chub and spotted mackerel, and Japanese jack mackerel, based on a long-term data set of egg surveys. The species with more eurythermal/stenothermal patterns tended to exhibit more euryhaline/stenohaline patterns; however, even the species with similar temperature optima could be separated in terms of temperature–salinity space. Differential responses of spawning probability to zooplankton were interpreted in the context of energy allocation strategy for fueling spawning. Anchovy, mackerel and jack mackerel were categorized into the species close to an income breeder, whereas sardine and round herring were categorized into the species with more capital features. Such species-specific responses to environmental factors would constitute a key to understand biological processes and consequences of climate variability and change.

**October 18, 11:40 (S3-8710)**

## Biophysical frequency response of the Bering Sea to large-scale forcing

Albert J. **Hermann**[1], Nicholas A. Bond[1], Georgina A. Gibson[2], Enrique N. Curchitser[3], Kate Hedstrom[4] and Phyllis J. Stabeno[5]

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The Bering Sea is highly productive and exhibits significant interannual change in both physical and biological attributes; these include ice cover and the production of zooplankton consumed by fish. Seasonal to decadal changes in shortwave radiation, along with other factors, appear to play a major role in these dynamics. Continued change is anticipated, driven by natural variability and long-term trends in global climate. Frequency spectra can be markedly different among time series of the major factors which force the system (*e.g.* shortwave radiation *vs.* wind stress), and the impedance and resonance of the biophysical system may produce unexpected responses to these forcing terms and their phasing. Here we examine results from a regional biophysical model of the Bering Sea which downscales a 40-year global atmopsheric hindcast, as well as three different IPCC global atmospheric projections. These are used to explore: 1) which are the most significant forcing elements and their frequency spectra; 2) what is the resulting frequency response of different elements of the biophysical system; and 3) how does this multivariate frequency response affect the predictability of future states of the Bering Sea.

**October 18, 12:00 (S3-8584)**

## Impact of strong El Niño events on sinking particle fluxes in the 10ºN thermocline ridge area of the northeastern equatorial Pacific

Hyung Jeek **Kim**[1], Kiseong Hyeong[1], Chan Min Yoo[1], Dongseon Kim[2] and Boo-Keun Khim[3]

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The influence of ENSO variability on sinking particle fluxes was evaluated from time-series sediment trap experiments carried out for 8 years at a station (10°30'N, 131°20'W) located in the 10°N thermocline ridge of the northeastern equatorial Pacific. Six El Niño/La Niña events were observed over the monitoring period. During the normal periods, sinking particle fluxes had distinct seasonal fluctuations, with high fluxes in winter-spring and low values in summer-fall. This seasonal variability was caused by seasonal shifts in the location of the intertropical convergence zone. Weak (2004/05) and moderate El Niño (2006/07) events were accompanied by a significant reduction of sinking particle fluxes. In contrast, La Niña events (2007/08 and 2008/09) were associated with an increase in sinking particle fluxes to a level of three times higher than that during the normal periods. These results are consistent with the results of previous studies in the equatorial Pacific. However, the strong El Niño events (1997/98 and 2009/10) caused three-fold increase of sinking particle fluxes compared to the average particle flux during the normal period, which is completely opposite to the general trend observed in the equatorial Pacific. Our results, together with the findings of a previous study of the 1982/83 strong El Niño event, suggest that enhanced biological productivity occurs in the 10°N thermocline ridge area under strong El Niño conditions.

**October 18, 12:20 (S3-8753)**

## Regional features of the climate variability and change in the Far-Eastern Seas

Elena I. **Ustinova** and Yury D. Sorokin

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The presentation summarizes the features of climate variability and change in the Far-Eastern Seas: updated trends, regime shifts, quasi-periodical variations, extreme events and some linkages between large-scale and regional-scale climate processes. For the last 52 years, analysis of SST trends showed that minimal trends to warming have been observed in summer. Significant reduction of the ice extent occurred only in the Okhotsk Sea. As a rule, long-term fluctuations of the regional climate are irregular: their amplitude and frequency characteristics change in time. In particularly, the redistribution of ice cover variance on frequencies towards high frequencies has occurred in the Okhotsk Sea and Tatar Strait in the last 16 years: from 22-years scale to 18.6 (from “solar” cycle to “lunar”) and from quasidecadal scale to 7-8 years. The contribution of 2-4 years fluctuations has decreased, but the "noise" component has increased. Recent two decades are characterized by an increase in temporal variance of regional thermal parameters and more frequent occurrence of the extreme events. Among well-known large-scale climate regime shifts, the shift of 1977/78 is strongest for the Bering Sea, but the shift of 1988/89 for the Japan/East Sea. The Okhotsk Sea is characterized by “regional” regime shifts (*e.g.*, 1984). In the Far-Eastern Seas “North Atlantic signal” is present both in the time series of the physical environmental parameters (such as air and water temperature, the types of atmospheric circulation), and in the biological series. Probably, the influence of the “North Atlantic signal” through larger-scale (hemispheric) mode of variability (Arctic oscillation) occurs.

**October 18, 14:00 (S3-8636), Invited**

## Role of the Kuroshio-Oyashio Extensions and Gulf Stream in the decadal climate and eco-system variability

Young-Oh **Kwon**

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Role of energetic western boundary current system in the decadal climate variability is examined based on climate model simulations and observational data in the North Pacific and North Atlantic. Ocean-to-atmosphere feedback associated with the north-south shift of the Kuroshio Extension (KE) path drives anomalous wind stress curl pattern similar to that originally caused the KE change a few year before, but with opposite sign and weaker amplitude. The result consistently found in four different simulations and observation supports the existence of coupled ocean-atmosphere decadal variability in the North Pacific. On the other hand, observational analyses suggest ocean-to-atmosphere feedback associated with the Oyashio Extension acts as a positive feedback to the wind stress curl forcing.

In the North Atlantic, the leading SST EOF mode for the last 100+ years is the Atlantic Multi-decadal Oscillation (r=0.87 with the area-averaged index). The second EOF mode is highly correlated with the north-south shift of the Gulf Stream (GS) path (r=0.54). In the multi-decadal time scale, the latter is leading the former with maximum lag-correlation (r=0.40) at 6-year lead, and climate model simulations suggest both are associated with the Atlantic Meridional Overturning Circulation (AMOC). The GS variability associated with AMOC is also highly correlated with the eco-system in the western North Atlantic. For example, two populations of silver hake (*Merluccius bilnearis*) in the Northeast U.S. Shelf show significant changes in their spatial distribution that are correlated with the north-south shift in the GS (r=0.71), and that changes in the GS precede changes in hake.

**October 18, 14:25 (S3-8752)**

## Dynamics of North Pacific oceanic heat content variability on decadal time-scale

Bunmei **Taguchi**[1] and Niklas Schneider[2]

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Upper ocean heat content (OHC) is a widely monitored oceanic state variable for climate change. OHC signals are also at the heart of the decadal climate variability, carrying climate memory that may provide the source of the skill for decadal prediction. Thus, understanding of the generation and propagation of OHC is important. In the mid-latitude North Pacific Ocean, OHC signals are often found to propagate eastward as opposed to frequently-observed westward propagations of sea surface height, a similar variable to OHC representing the ocean subsurface state. We investigate this dichotomy using a 150-year CGCM integration. Simulated OHC signals are distinguished in terms of two processes that can support eastward propagation: higher baroclinic Rossby wave (RW) modes that are associated with density perturbation, and temperature and salinity anomalies that are density compensated, a.k.a. spiciness anomalies. Our analysis suggests a unique role of the Kuroshio/Oyashio Extension (KOE) region as an origin of the spiciness and higher mode RW signals as follows. First, wind-forced, westward-propagating first baroclinic RW causes circulation anomalies in the KOE region, accompanying the meridional shift of the subarctic front. Anomalous advection of mean temperature and salinity gradients then generates spiciness anomalies, which are advected eastward by mean currents. While being advected, the surface temperature anomaly associated with the spiciness signal is damped by air-sea heat exchange and thus generates density perturbation, which further propagates eastward as higher mode RWs. The result suggests that large OHC anomalies are associated with the spiciness gradients and axial variability of oceanic fronts.

**October 18, 14:45 (S3-8397), Invited**

## Interannual to decadal variability of the Gulf Stream and Kuroshio Extension jets

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The Gulf Stream and Kuroshio Extension jets not only transport nutrients and biota downstream but also act a barrier for mixing subtropical and subarctic water masses. In this presentation, we review interannual to decadal fluctuations of the latitudes of the Gulf Stream and Kuroshio Extension jets, and then we propose new theory, which extends thin-jet theory for meanders on monthly and seasonal timescales, in order to understand the dynamics of the jet variations on interannual to decadal timescales. In this theory, the low-frequent variability of the jets is attributed to westward propagation of meridional shifts of the jets from east. These westward propagating signals are induced by large-scale wind fluctuations, but are trapped around the jet axis. Using satellite altimeter data and an eddy-resolving ocean general circulation model output, we show that the dynamics in the thin-jet framework accounts for the bulk of interannual to decadal fluctuations of the Gulf Stream and Kuroshio Extension jets. Our results suggest that the Gulf Stream (Kuroshio Extension) jet brings atmospheric signals from the eastern to the western North Atlantic (North Pacific), and the resultant meridional shift of the jet induces the notable oceanic changes, such as sea surface temperature and eddy activity, around the jets.

**October 18, 15:10 (S3-8718)**

## Basin-scale *versus* local-scale drivers of copepod community dynamics in the northeast Pacific (Newport, Oregon, USA)

Jennifer L. **Fisher**[1], William T. Peterson[2], Cheryl A. Morgan[1] and Jay Peterson[1]

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We have been exploring the relative effects of basin-scale forcing versus local upwelling on copepod community structure and biomass in the northeast Pacific at stations that represent the nearshore coastal upwelling zone, shelf break, and the open ocean out to 100 km from shore. Hydrographic and zooplankton data have been collected every two weeks for the past 17 years at the nearshore station, and this effort has shown that copepod species composition exhibits a strong seasonal cycle and that inter-annual variations in specific copepod communities are driven largely by basin-scale processes opposed to processes associated with local upwelling. Initial analyses also suggest that the community dynamics nearshore are in synch with those offshore, both at the shelf break (40 km from shore) as well as in the open ocean up to 100 km from shore. This suggests that large-scale transport processes control zooplankton species composition and community structure along the northern California Current and in the coastal upwelling zone off Oregon, USA, whereas upwelling itself may control only local productivity.

**October 18, 15:50 (S3-8332)**

## Forcing dynamics of mesoscale eddies in the California Current

Andrew **Davis** and Emanuele Di Lorenzo

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Growing evidence suggest that ecosystem variability is impacted by low-frequency changes in transport dynamics. Mesoscale-eddies exert dominant control of cross-shelf exchanges yet the forcing dynamics underlying their low-frequency variability remain uncertain. Using an ensemble of high resolution ocean model hindcasts of the central and eastern North Pacific from 1950-2010 we diagnose the dynamics controlling low-frequency modulations of the eddy statistics in the California Current. After separating the intrinsic and deterministic fraction of eddy variability in the southern (28.5°N to 34.5°N) and northern (34.5°N to 50°N) California Current System, we find that the eddy counts and variance exhibit deterministically forced low-frequency fluctuations and a strong seasonal cycle. In the southern region, ~50% of the low-frequency eddy variance is modulated by coastally trapped waves of southern origin and changes in the seasonal wind stress curl gradient. In contrast in the northern region, coastally trapped waves play a minor role and ~60% of the low-frequency eddy variability is forced by changes in the wind stress curl gradient. Understanding and quantifying the external forcings of eddy variability allows us to better estimate how climate variability and change impact the mesoscale transport and ecosystem dynamics in the California Current.

**October 18, 16:10 (S3-8532)**

## Effects of solar activity on climate-ocean ecosystems interactions

Vadim **Navrotsky**

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The role of the World Ocean in Global Climate Change is considered from two points of view: a) heat energy accumulation in the Ocean and its discharge into the atmosphere as purely physical processes; b) participation of living matter in the Ocean in these processes. In the Ocean solar energy is absorbed and accumulated in rather thick layers due to water transparency and small-scale turbulence. In zones of convergence and downwelling this energy is drawn in the three-dimensional deep-ocean circulation, after some time it can return to surface layers in zones of divergence and upwelling, and participates in ocean-atmosphere interaction. The mismatch between the times and zones of energy input into the ocean and its manifestation at surface layers leads to occurrence of multi-cycle response even to mono-cycle forcing. The oceanic living matter, especially phyto- and bacterioplankton, absorbs solar energy and changes water transparency, controlling the depth and thickness of layers and total amount of the energy accumulation. Having ability to react not only to fluctuations of heat energy supply, but also to extra weak fluctuations of electromagnetic and magnetic fields of terrestrial and extraterrestrial (mainly solar) origin, phytoplankton and phytobacteria should be considered as active forcing of global climate fluctuations observed on different scales. Several mechanisms of solar activity effects on climate-ocean ecosystems interactions are analyzed.

**October 18, 16:30 (S3-8380)**

## Temperature, salinity and density trends along Line-P and the implications for mixed layer formation

Howard J. **Freeland**

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In 1997 a paper was published outlining the extent of pervasive changes in temperature, salinity and sigma-t. It was concluded that sea surface temperatures were increasing around all of the Gulf of Alaska and sea-surface salinities were decreasing. This increased the density barriers to mixing and so required a decrease in mid-winter mixed-layer depths.

Since that time much has changed. On the positive side there we have 15 years more data, but on the negative side the Line-P program continues in a more restricted form and this changes our ability to observe systematic trends. Further, on the positive side, since 2003 the Gulf of Alaska has been well-populated by Argo floats. This paper will review the impact of the systematic changes in the way Line-P and Station Papa are observed and how these changes affect our ability to observe long term changes. It will be shown that the long term trends are continuing, but that this would be difficult to determine if we did not have the Argo data base to supplement the ship-board CTD observations. The potential energy of the upper water column is showing systematic declines, which means that more kinetic energy is needed (from wind-forcing) to create the mid-winter mixed layers. In 1997 Freeland *et al*. observed a surprisingly large trend in mixed-layer depths of 63 metres/century. It will probably come as no surprise that this very large trend is not continuing.

### October 18, 16:50 (S3-8643)

## Wind-driven variability of dissolved oxygen below the mixed layer at Station P

Patrick **Cummins** and Diane Masson

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Variability of dissolved oxygen below the mixed layer is examined in data from Ocean Weather Station P (145W, 50N) in the eastern subarctic Pacific. At depths of 150 to 400 m, $O_2$ variability on isopycnals and heaving of the climatological oxycline both contribute importantly to variability on interannual to decadal time scales. $O_2$ anomalies adjusted for isopycnal variations are shown to be well correlated with results from a stochastic climate model driven by local Ekman pumping over the 54 year period, 1956 - 2010. This variability is associated with vertical heaving of isopycnals at low frequencies occurring as an integrated response to local wind forcing. Long-term oxygen declines observed below the mixed layer at Station P are due to secular trends on isopycnal surfaces. These declines have been moderated over the 200-400 m depth range by the downward vertical displacement of the oxycline associated with the long-term deepening of isopycnal surfaces.

### October 18, 17:10 (S3-8523)

## Estimation of nutrient supply process in the spring Kuroshio-Oyashio transition region

Haruka **Nishikawa**[1], Yoichi Ishikawa[1], Masafumi Kamachi[1,2], Hiromichi Igarashi[1], Shuhei Masuda[1], Toshimasa Doi[1], Shiro Nishikawa[1], Yoshihisa Hiyoshi[1], Yuji Sasaki[1], Takashi Mochizuki[1], Hiroshi Ishizaki[1], Tsuyoshi Wakamatsu[1] and Toshiyuki Awaji[1]

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Kuroshio-Oyashio transition region (KOTR) is known to be spring high productivity and distribution area or a part of migration routes of many pelagic fishes. Their stocks may be greatly affected by feeding environment of KOTR. For example, recruitment success of Pacific saury and Neon flying squid have significant positive correlations with interannual variations of spring chlorophyll *a* density in the KOTR. Since two major currents, the Kuroshio and Oyashio, inflow to the area, the KOTR has complicated environmental structure. For that reason, it is not completely understood that how the spring primary production is formed. We focused on nutrient supply that is one of the controlling factors for primary production and try to clarify when and where nutrients are supplied to surface layer. In this study, we found that spring chlorophyll *a* density averaging from 145–180ºE and 30–40ºN well corresponds to dimension of the area with chlorophyll *a* density of more than 0.5 mg/m$^3$. Then we estimated time and place of sub-surface water entrainment occurred by using satellite chlorophyll *a* data and output of high-resolution ocean data assimilation system (MOVE/MRI.COM) and compared high chlorophyll *a* (more than 0.5 mg/m$^3$) water and low chlorophyll *a* (less than 0.5 mg/m$^3$) water. As a result, high chlorophyll *a* water tends to entrain the Oyashio water in winter and to entrain the Kuroshio-Oyashio mixing water in spring. These results suggest that time and place of nutrient rich water entrainment affect the productivity in the spring KOTR.

### October 18, 17:30 (S3-8619)

## Western North Pacific Integrated Physical-Biogeochemical Ocean Observation Experiment (INBOX)

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Mesoscale and submesoscale processes must play key roles in linking physical conditions with marine ecosystems through intense convergence/divergence, upwelling/downwelling, mixing, *etc.* Given the considerable interactions between mesoscale and large-scale dynamics, even larger-scale linkages will ultimately depend on those processes. Understanding of those processes, however, is still limited mainly due to the difficulty in measuring them. To acquire physical-biogeochemical data which could resolve mesoscale/submesoscale phenomena in the western North Pacific, JAMSTEC launched an interdisciplinary project "Western North Pacific Integrated Physical-Biogeochemical Ocean Observation Experiment (INBOX)" in 2010. INBOX aims to quantify impacts of mesoscale/submesocale physical processes on biogeochemical phenomena, so that we could understand impacts of physical environmental variations on marine ecosystems. As the first phase of INBOX, 30 profiling floats equipped with oxygen sensors were deployed in the 150km-square area centered at the biogeochemical mooring station S1 maintained since spring 2010 south of the Kuroshio Extension at 30°N, 145°E. The S1 mooring has a profiling buoy (POPPS) equipped with conductivity-temperature-depth-oxygen (CTDO) sensors, a scalar irradiance sensor, and a fast repetition rate fluorometer (FRRF) measuring the top 150m every one or two days. It also has an acoustic Doppler current profiler (ADCP) measuring horizontal velocity every hour above 500m depth, and time-series sediment traps at 200m, 500m and 5000m. In this presentation, following the overall description of INBOX, highlights of early results will be introduced.

# S3 Session Poster Presentations

## S3-1

### Winter cyclonic activities over the ocean as a factor in the subsequent changes in the atmospheric and thermal regime of the Far Eastern Seas and north-west Pacific (with a shift in one year)

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This study identifies the asynchronous correlation (with a shift of up to one year) between the intensity of winter cyclonic activity over the Asia-Pacific region (30-65°N, 130°E-160°W) and a variety of atmospheric and oceanographic parameters of regional and "local" scales. To analyze of the cyclone's intensity in the January-March, 1992-2011, Kunitsyn's index cyclonicity was used. This index is calculated for each cyclone as a square of number of the closed isobars outlining them, and in fact is proportional to the kinetic energy of the cyclone. The total Kunitsyn's index cyclonicity, calculated by summing up the indices of all the cyclones, is an indicator of the energy state of the atmosphere in the Asia-Pacific region in winter. It is found a statistically significant correlation between the intensity of winter cyclones and atmospheric processes of the summer season (half-yearly-shift) and the next winter season (the shift of one year). It is shown that after frequent passage of deep cyclones (activation of the winter cyclogenesis), the summer atmosphere action centers (AAC) (Far Eastern Low and Hawaii High) are generally intensified, the activity of the southern monsoon increases, and at the same time the surface temperature of the ocean rises. The next winter, the Siberian High is shifted to the north; the northern monsoon becomes more active. At that over the all Far Eastern seas quantity of the "cold" atmospheric types increases, the temperature of water in them is reduced, ice conditions are worsening. Probably, increased winter cyclogenesis causes in the atmosphere a strong perturbation, which persists throughout the year.

## S3-2

### The variability of sea temperature in South China Sea (SCS) and its relationship with the early or later of SCS summer monsoon outbreaks

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Spatio-temporal variations of the temperature in SCS were investigated based on the reanalysis dataset of China seas from 1986 to 2003. With focus on the intraseasonal variation of SST, its relation with the occasion of SCS summer monsoon (SCSSM) onset was discussed. The results show that the temperature anomaly lower than 50m in SCS presents similar distinct variations pointing to the homologous and out-phase distribution patterns. There exists a significant evolution mode on intraseasonal scale, in which positive SST anomaly developed from the west region of Palawan in April, and extended rapidly westward and northward in May and June. The analysis indicates that, the intraseasonal evolution was associated closely with the early or later of the SCSSM outbreaks. Synthesizing with the previous studies, it is considered that the anomalous intraseasonal increment of the SST in SCS was one of important factors controlling the SCSSM onset and has a certain significance of forecast. In addition, the intraseasonal evolution of the SST can be related well with the variation of the warm pool in SCS. It is found that the intraseasonal thermal anomaly during the period before the onset of the SCSSM was striking of positive correlation with that of the Indian Ocean warm pool (IOWP), while no evident relation with that of the Western Pacific warm pool (WPWP). The SST in SCS was expected to give rise to the interannual anomaly of the SCSSM onset through the impact on the large scale of meridional and zonal atmospheric currents.

## S3-3

## A study of the effect of wind on Changjiang (Yangtze) River diluted water in summer

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A three-dimensional hydrodynamic model for Yangtze Estuary and the adjacent sea was developed within the framework of Environmental Fluid Dynamics Code (EFDC). This model was used to study the relationship between winds and Changjiang (Yangtze) River diluted water (CRDW) in summer. Simulated elevations, currents, temperatures and salinities are fairly consistent with observed data. Numerical experiments show that wind plays an important role in the expansion of CRDW. Wind induced Ekman transport would push CRDW to the right of wind direction. At a speed of 5m/s, easterly, southeasterly, southerly and southwesterly wind push CRDW seaward significantly, while westerly, northwesterly, northerly and northeasterly wind confine CRDW to the coastal area. The Ekman transport is intensified with intensified wind, resulting in that more CRDW will be transported to the right of wind direction. Due to stratified water, the turbulence is relatively weak in the axis of the low-salinity tongue. The weaker turbulence consumes less wind energy. So the water in the axis of the tongue is accelerated more than water in other areas. Then, more diluted water is transported through the axis area of the low-salinity tongue. Eventually, the width of the tongue becomes smaller with stronger winds. Statistical analysis of observed data also verifies the numerical conclusions.

## S3-4

## The current status of the international Argo project

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This poster will illustrate the current status of the international Argo project and will outline challenges and changes that will be faced in the near future. The poster is being presented on behalf of the Argo co-chairs. At the time of writing 28 nations are tracking more than 3500 floats in near real-time. These are supplying CTD profiles in near real-time at the rate of about one profile every 4 minutes, and these are all accessible in a single format. The array is global and samples are being acquired from all ocean of the world.

Some problems do remain. Coverage in the deep southern ocean remains below the target levels and strategies are being developed to address this deficit.

An increasing number of floats are now reporting through the Iridium satellite communication system and through Argos-3. Each of these allows much faster data transmission than the older Argos system and carries various other advantages. Within the last 12 months there has been a sudden upsurge in the number of manufacturers of floats suitable for use in Argo. Also, there are now several experimental models of floats in operation capable of sampling the entire water column to depths of at least 6000 decibars.

The World Ocean Data Base contains about 470,000 temperature plus salinity profiles. Argo has been gathering data only since 2001, but late in 2012 we compute that Argo will gather its millionth CTD profile. This will be cause for celebration.

### S3-5

## Possible impact of El Niño Modoki on marine environment in China offshore and its adjacent seas

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El Niño Modoki, a distinguished tropical Pacific phenomenon from canonical El Niño, has been observed since the late 1970s, followed by the unique influence on global climate. In this study, relationships between the marine environment (sea surface temperature (SST), sea surface salinity (SSS ) and Current) in China offshore and its adjacent seas and El Niño Modoki were investigated based on the Chinese Ocean Reanalysis Assimilation (CORA), Simple Ocean Data Assimilation (SODA) and Hadley Centre Sea Ice and Sea Surface Temperature (HadISST) datasets. The analysis results show that the relations present distinct differences from that of canonical El Niño: (1) the El Niño Modoki in boreal winter has a significant negative correlation with SST of China offshore in the following months with the significant regions locating in East China Seas (ECS) and Japan Sea/ East Sea (2) while in SSS, an significant negative correlation is also found in ECS, north of South China Sea (SCS) and Japan's southern seas; (3) the ocean currents in ECS and SCS are influenced remarkably by El Niño Modoki, *e.g.*, anomalous anticycloic circulation appears in SCS while cycloic circulation in ECS in winter. The study also suggests that the Kuroshio and East Asia atmospheric circulation anomalies induced by El Niño Modoki maybe the primary factors for the aforementioned relationships.

### S3-6

## ENSO effect on surface salinity variability in the Yellow and East China Seas in summer

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This study investigates interannual variability of sea surface salinity (SSS) in the Yellow and East China Seas (YECS) in relation to ENSO using a global ocean general circulation model. A cyclostationary EOF analysis finds that the interannual variability of the SSS in the YECS is mainly attributable to a Changjiang river discharge (CRD) variability. The CRD variability is linked to El Niño–Southern Oscillation (ENSO)-related precipitation over east China. That is, composite precipitation patterns for El Niño and La Niña years show that when El Niño events occur in winter, rainfall increases over central China in the rainy season of the following years. The increased rainfall in El Niño years results from enhanced southwesterly moisture flux from the South China Sea into central China. The heavy rainfall increases CRD, resulting in SSS decrease in the YECS. For example, during the summer of 1998 when an ENSO-related extreme flood occurred over the Changjiang, the surface salinity in the YECS reached a minimum value than other years. This suggests that interannual variability of summer SSS in the YECS is influenced by ENSO via the summer precipitation system over central China.

## S3-7

## Interannual to interdecadal variability of circulation in the Japan/East Sea based on numerical simulations

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Interannual to interdecadal variability of circulation in the Japan/East Sea (JES) is investigated based on numerical simulations. The large-scale circulation of the JES is reconstructed by using the INMOM. The model is a three-dimensional, $\sigma$-coordinate, nonlinear, finite difference model. The hydrostatic and Boussinesq approximations are used in the model. To reproduce large-scale circulation of the JES, 1/10° and 1/20° meshes with 15 sigma levels are used. ETOPO2 is used to represent the coastline geometry and bottom topography. The initial temperature and salinity fields are specified from Levitus data and the atmosphere forcing is specified from CORE data. The general circulation of the JES was reconstructed from 1958 to 2006. Analysis of reproduced circulation showed that the model adequately reproduces the large-scale three-dimensional circulation and its seasonal variability.

To study the variability of circulation in the JES we calculated and analyzed the relative vorticity variability both in the layer from 200 m to 800 m and the depth of 200 m, 500 m and 800 m. It was analyzed the variability of circulation in the central part of the JES and in the Japan Basin. We established that the harmonics with the periods of 4-5, 7 and 10 years dominated in the variability of circulation in the central part of the JES and with the periods of 2.3, 3.5 and 8 years dominated in the variability of circulation in the Japan Basin. It was compared the variability frequency spectra of this sea regions, atmospheric forcing and PDO index.

## S3-8

## Progress and prospect of impacts of climate changes on marine biodiversity

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Marine biodiversity is an important part of the global biodiversity, and the issue of biodiversity and climate change is becoming a focus of the Convention on Biological Diversity. Therefore, studies of impacts of climate change on marine biodiversity has important significance for the protection of global biodiversity. Analyses and discussions in this paper are aimed at the advance of research on impacts of climate changes on marine biodiversity, and at the situation and problems of the research in China. Based on the analyses, a set of research strategies on impacts of climate changes on marine biodiversity were put forward, including marine animal population history study, target species study, sensitive marine ecosystem study, marine biodiversity scenarios, ocean biogeographic information system and so on.

## S3-9

## Air-sea interaction along the coast of north-western East/Japan Sea within 75 years

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The analysis of long-term series of observations of sea surface water temperature and air temperature at six coastal stations Maritime from 1930 to 2011. At all stations a positive trend in air temperature detected. A significant trend is the water temperature was found in Vladivostok, Possyet and Sosunovo stations. For 75 years, most of the water temperature increased at the station Vladivostok (at 0.9°C), and the air temperature - the station of Nakhodka (at 2.0°C). It is established that the size of the correlation coefficient between the temperature of air and water, is an indicator of stability. There is good correlation between the temperature of air and water at the stations, except station of Nakhodka. The low correlation coefficient between water and air temperature at the station due to local peculiarities Nakhodka water circulation.

### S3-10

## Impact of climate variability on marine aquaculture: A case study on the Japanese kelp in southern Hokkaido, Japan, using satellite remote sensing and GIS-based models

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Japanese kelp (*Laminaria japonica*) is one of the most valuable cultured and harvested species in Japan. This research added new physical parameter (sea surface nitrate [SSN] from satellite remote sensing data) to develop more accurate GIS (Geographic Information Systems) -based models to identify the most suitable areas for hanging culture in southern Hokkaido, Japan. The local algorithm to estimate SSN was developed by using satellite measurements of sea surface temperature and chlorophyll *a*, the result was shown high correlation with shipboard data ($r^2$=0.87, RMSE=1.39). Multi-criteria evaluation was adapted to the GIS models in order to rank the sites on a scale of 1 (least suitable) to 8 (most suitable). The results indicated that 37% of the total potential area, especially Minamikayabe is the most suitable area. The study also combined suitability scores with climatic factors (the Oceanic Niño Index) to examine the potential impact of climate change on the development of Japanese kelp aquaculture from 2003 to 2012. The results suggest that the climate variability could influence the development of kelp aquaculture through change in suitability areas. Therefore, the climate condition needs to be considered for future development of marine aquaculture.

### S3-11

## Enhanced stratification in the southwestern East Sea (Japan Sea)

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This study investigates stratification change in the southwestern East Sea (Japan Sea) using bi-monthly profile data of temperature and salinity measured by NFRDI (National Fisheries Research and Development Institute) for 36 years from 1971 to 2006. A linear trend analysis reveals that, in winter, the upper ocean (surface to about 100 m) has been warmed, while the subsurface (especially within the thermocline) has been cooled. This opposite trend intensifies stratification in the southwestern East Sea (Japan Sea) where the temperature mainly determines the density. Interestingly, the cooling trend is stronger than the warming trend. The similar changes are observed in summer, but with warming within shallower depth. The cooling trend in the subsurface is mainly attributed to the upward movement of the thermocline. This study suggests that the stratification increase in the southwestern East Sea (Japan Sea) is mainly associated with the cooling in the subsurface, rather than the upper ocean warming.

## S3-12

## Decadal variability of subsurface temperature in the North Pacific and recent modulation of the leading EOF modes

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We diagnosed decadal variability of subsurface temperature in the North Pacific and discuss the recent status using the historical objective analysis of monthly global dataset from 1950 to 2011 produced by Japan Meteorological Agency.

We performed EOF analysis for the 0-700m vertically averaged subsurface temperature in the North Pacific like a usual way to sea surface temperature (SST). The spatial pattern of the first mode indicates Pacific Decadal Oscillation (PDO) like SST and its time coefficient varies with PDO index defined by the first EOF mode of SST. The second mode shows north-south dipole pattern like North Pacific Gyre Oscillation (NPGO) in SST although it shifts westward with more clear decadal variability in temporal coefficient than SST.

The first mode temporal coefficient of subsurface temperature peaked in the mid-1980's then decreases gradually with local minimum (maximum) around the 2002 (2007) respectively. The second mode temporal coefficient peaked around 2003 and bottomed around 2008 then it has increased again. From the late 1990's, the first mode index shows clear decadal variability superimposed to longer variation with almost simultaneously second mode index fluctuation in contrast to before when the each index changes independently.

## S3-13

## Seasonal climate variability on the coastal zone of the western part of North Pacific

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Dynamic of various characteristics of seasonal processes in cold and warm half-year was investigated. Meteorological stations are located from the north to south in the coastal zone of western part of North Pacific for the period of investigation from 1917 to 2010. The structure of cold and warm half-years was determined by the correlation of periods with different temperature. In particular, date of beginning and end, duration of periods, sum of temperatures and average estimate of temperatures of different periods were considered. It was determined that in the last decade of the 20th century in the ranks of the various characteristics of the thermal regime of the cold half-year were change of phases of warming 20-40-year cycles to phases of cooling. In the warm half-year most similar warming trend was observed in the sums of positive temperatures and temperatures above 10°C. In the warm season trend of warming has continued in recent decades in contrast to the cold half-year. Thus the structure of intra-warming since the beginning of this century has changed. If before, there was a marked increase in the prevailing winter temperatures in recent decades, the trend of warming is appear of the warm half-year.

## S3-14

# 3D structure and decadal change of the nutrient in the Kuroshio region detected from historical data

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The Kuroshio plays major roles in transporting heat and organic/inorganic materials from the subtropical region to the subarctic one. Focused on the nutrient in the Kuroshio region, historical hydrographic data were analyzed to clarify the three dimensional structure of the nutrient and its seasonal and interannual variabilities. Along the jet of the Kuroshio, the nutrient maximum was detected on the isopycnal surface of 24.5-25.5$s_q$ in the whole region of the Kuroshio. The structure was analogous to the characteristic one well-known as Nutrient Stream found in the Gulf Stream region in the North Atlantic. It should be emphasized that the nutrient concentration on the 24.5-25.5$s_q$ surface gradually decreases along the Kuroshio toward the downstream region. It implies that the high nutrient water is originated from the upstream and its adjacent coastal regions and transported downstream epipycnally along the Kuroshio as is the case with the Gulf Stream. Moreover, the along-jet maximum was detected only in spring, which is attributed to more active consumption by the phytoplankton on the inshore side of the jet under the adequate irradiance because the strong baroclinicity inclines isobathes on the isopycnal surfaces and the water depth on the inshore side is much shalower than the offshore one. The historical data revealed that the decadal change of the nutrient concentration on the subsurface isopycnal surfaces was synchronized with the cyclic climate change in the Pacific, suggesting the effect of the induction process on the nutrient supply to the euphotic layer in the Kuroshio region.

## S3-15

# Assessment of turbulence closure models for resonant inertial response in the oceanic mixed layer using a large eddy simulation model

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Turbulent processes in the oceanic mixed layer play crucial roles in regulating the temperature and velocity fields in the upper ocean, thus controlling atmosphere-ocean interactions leading to climate changes. Accurate parameterization of subgrid-scale upper ocean processes therefore must be incorporated into oceanic general circulation models and/or coupled atmosphere-ocean general circulation models.

In this study, large eddy simulation (LES) of the resonant inertial response of the upper ocean to strong wind forcing is carried out; the results are used to evaluate the performance of each of the two second-order turbulence closure models presented by Mellor and Yamada (1982) (MY) and by Nakanishi and Niino (2009) (NN). The major difference between MY and NN is in the formulations of the stability functions and the turbulent length scale both strongly linked with turbulent fluxes; in particular, the turbulent length scale in NN, unlike that in MY, is allowed to decrease with the increase of density stratification. We find that MY underestimates and NN overestimates the development of mixed layer features such as the strong entrainment at the base of the oceanic mixed layer and the accompanying decrease of sea surface temperature. Considering that the stability functions in NN show a better performance than those in MY in reproducing the vertical structure of turbulent heat flux, we slightly modify NN to find that the discrepancy between LES and NN can be reduced by more strongly restricting the turbulent length scale with the increase of density stratification.

## S3-16

## The relationship between the air temperature of East Kamchatka and the water temperature of western part of the Bering Sea

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The lag correlation analysis was carried out for every month at time lags 0-24 months. It was carried out on monthly average air temperature at 3 stations of the Eastern coast (Korf, Ossora, Petropavlovsk, lighthouse) and monthly average water temperature in the western part of the Bering Sea from 1951 to 2009.

The thermal influence of the Bering Sea begins to show since may. Moreover the water temperature anomalies in April determine the air temperature anomalies in May-June, *i.e.* with 1-2 month lags (water temperature leading). At the beginning of summer the relation is found only in the North-Eastern coast (Ossora and Korf). In the middle of summer the water temperature determines the air temperature synchronously and air-temperature in the end of summer - an early autumn. In the autumn the relations between both temperatures are synchronous. The long-term relations (from 6 to 14 months) are brightly shown only at the beginning of summer in Petropavlovsk: the water temperature in the west of the Bering Sea in April, May, August, September-December of previous year determines the air temperature in June. In Korf the June air temperature is determined by water temperature of April, November and December of previous year.

The asynchronous relation of average air and water temperature on the eastern coast of Kamchatka is a direct and significant; the water temperature anomalies in December determine the average air temperature anomalies on the coast in March, September-November of the next year.

In general, the temperature of the eastern coast of Kamchatka is characterized by close direct synchronous relations with the water temperature of the western part of the Bering Sea within May-November (in December and April they are absent, and from January to March carrying out the correlation analysis is impossible) and asynchronous relations in May-June, August-September (with shift 1-2 months).

## S3-17

## The features of bifurcate line about the North Equatorial Current in the Pacific

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This study shows that there are three branches of North Equatorial Current (NEC) in the thermocline. In addition to Kuroshio and Mindanao current, there is a third current flow directly from the inner ocean to the equator. Thus, in each layer, there are two bifurcation line of NEC, a west boundary bifurcation and an inner bifurcation respectively. A new identification method dividing the NEC in the Pacific, to track line and the bifurcation channel is employed in this study. We focus on the climatological characteristics of the western boundary of the NEC bifurcation line and the inner zone. The bifurcation line of the western boundary drift polarward with depth, and the inner zone bifurcation line show a clockwise rotation with depth around 180°E. As for seasonal variation, the average position of western boundary of the bifurcation line reaches the most south in June and the most north in December, while the inner zone bifurcation line is southward in spring and summer, northward in autumn and winter. The initial signal source of the two bifurcation lines' latitude change are different.

The position of NEC bifurcation lines determine the exchange and distribution between the subtropical and tropical circulations. The interannual and interdecadal changes of NEC bifurcation line significantly affect the heat distribution and thermal structure changes of tropical and subtropical Pacific, thus exert influence on the North Pacific and global climate.

## S3-18

# Mixed layer variability and its associated chlorophyll *a* changes in the East Sea (Japan Sea)

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We investigates year-to-year variability of springtime chlorophyll *a* (CHL-a) concentration in association with ocean mixed layer depth (MLD) in the East Sea (Japan Sea). MLD data were obtained from 1/12° Global HYbrid Coordinate Ocean Model (HYCOM) for the period (2004-2010). For CHL-a concentration, Sea-viewing Wide Field-of-view Sensor (SeaWiFS) and Moderate-Resolution Imaging Spectroradiometer (MODIS) data were used. The spring CHL-a concentration shows substantial year-to-year variability. In 2008, CHL-a concentration in the Ulleung basin in April reaches a maximum (8 times larger than the other years) for the period (2004-2010). The increase of the spring CHL-a concentration in 2008 is attributed to considerable deeper winter mixed-layer (about 2 times larger than normal years) that probably entrains more deep-ocean nutrients into upper ocean, making favourable spring bloom condition. The larger winter MLD in 2008 is caused by intensified wind and ocean surface cooling that are associated with strengthened Siberian high and Aleutian low. On the other hand, spring CHL-a in 2004 is not elevated significantly, although the winder MLD deepens considerably. Deeper mixed layer in spring seems to prohibit phytoplankton bloom in 2004 through unfavourable light condition. Difference responses of spring CHL-a to winter MLDs in two years (2004 and 2008) suggest that springtime stratification also plays a crucial role in phytoplankton bloom in the East Sea (Japan Sea).

# S4

## FIS/MONITOR/POC Topic Session
## Monitoring on a small budget: Cooperative research and the use of commercial and recreational vessels as sampling platforms for biological and oceanographic monitoring

***Co-Convenors**: Steven Barbeaux (USA), Jennifer Boldt (Canada), Martin Dorn (USA) and Jae Bong Lee (Korea)*

***Invited Speaker**:*
*Rudy Kloser (CSIRO (Commonwealth Scientific and Industrial Research Organisation), Australia)*

Long-term monitoring is a key component of an ecosystem-based approach to fisheries management. Time series data enable the examination of changes in oceanographic and community metrics. Government funding sources for long-term monitoring of biological and oceanographic processes has dwindled in recent years, while the mandate for this type of information has increased. If data driven ecosystem-based management continues to be goal then methods for reducing the costs of data collection must be found while data quality is maintained. An example of this type of innovative approach can be found in Alaska walleye pollock (*Theragra chalcogramma*) fishery where researchers have teamed with commercial fishers to deploy inexpensive temperature and depth data storage tags on trawl nets. At the same time, data on fish density and distribution are being collected using the fishing vessels' own acoustic systems. These data are being used to validate oceanographic models, to assess the effects of oceanographic conditions on bycatch in the walleye pollock fishery, and to evaluate the effects of oceanographic conditions on walleye pollock density and distribution. This session is intended to explore the ways in which cooperative research with other seagoing stakeholders and the use of commercial and recreational vessels as sampling platforms for biological and oceanographic monitoring can be integrated into ocean monitoring systems. With sufficient interest by the contributors, a special issue of *Fisheries Research* will be sought.

### Wednesday, October 17 (9:00-12:50)

| | |
|---|---|
| 09:00 | ***Introduction by Convenors*** |
| 09:05 | **Steven J. Barbeaux**<br>Cooperative monitoring in the Alaska walleye pollock (*Theragra chalcogramma*) fishery (S4-8510) |
| 09:25 | **Rudy J. Kloser, Tim E. Ryan, Ryan Downie, Mark Lewis and Gordon Keith**<br>Using commercial vessels to monitor deep-water fisheries and basin scale ecosystems (S4-8546), Invited |
| 09:50 | **Sonia Batten and Anthony Walne**<br>Ship of Opportunity sampling of lower trophic levels (S4-8392) |
| 10:10 | **Elizabeth A. Logerwell, Steven J. Barbeaux and Lowell W. Fritz**<br>Using walleye pollock acoustic survey data and Steller sea lion foraging information to manage fisheries – sea lion interactions in the Aleutian Islands (S4-8435) |
| 10:30 | ***Coffee/Tea Break*** |
| 10:50 | **Viktor N. Filatov, Yury.V. Eremin, Elena I. Ustinova and Aleksey V. Ballo**<br>Monitoring of oceanographic and biological conditions in the Pacific saury fisheries expedition (S4-8811) |
| 11:10 | **Ata Suanda and John A. Barth**<br>Long-term observations of internal waves with shore-based video cameras (S4-8361) |
| 11:30 | **Oksana G. Mikhailova**<br>Coastal monitoring the state of pink shrimp *Pandalus borealis* population on West Kamchatka (S4-8382) |

11:50 **Christopher Siddon**
Collaborating with the commercial fishing industry: An intensive, cost-effective method to improve red king crab stock assessments in southeastern Alaska, U.S.A. (S4-8689)

12:10 **Christopher N. Rooper, Michael H. Martin and Mark E. Wilkins**
Using acoustic data to map the presence or absence of deep-water sponges and corals in closed areas in the Gulf of Alaska (S4-8648)

12:30 **Kazuaki Tadokoro, Yuji Okazaki, Akinori Takasuka, Tadafumi Ichikawa and Hiroya Sugisaki**
Archiving historical meso-zooplankton samples collected around Japan (S4-8552)

12:50 *Session Ends*

## S4 Posters

S4-1 **Igor Burago, Georgy Moiseenko, Olga Vasik and Igor Shevchenko**
Sharing marine "small science" data

S4-2 **Aimee A. Keller, W. Waldo Wakefield, Victor H. Simon, John A. Barth and Stephen D. Pierce**
Environmental sampling, hypoxia and the Northwest Fisheries Science Center's Cooperative U.S. West Coast Groundfish Bottom Trawl Survey

S4-3 **Orio Yamamura, Kouji Kooka and Takeomi Isono**
Monitoring demersal fish community containing predators of walleye pollock using a small fishing boat

# S4 Session Oral Presentations

### October 17, 09:05 (S4-8510)

## Cooperative monitoring in the Alaska walleye pollock (*Theragra chalcogramma*) fishery

Steven J. **Barbeaux**

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Researchers in Alaska are implementing cooperative monitoring programs to address the issue of long-term monitoring to help achieve the objective of an ecosystem-based approach to fisheries management. Innovative approaches to implementing cooperative monitoring systems can be found in the Alaska walleye pollock (*Theragra chalcogramma*) fishery. In this fishery researchers have teamed with commercial fishers to deploy inexpensive temperature and depth data storage tags on trawl nets. At the same time data on fish density and distribution are being collected using the fishing vessels' own acoustic systems. These data are being used to validate oceanographic models, to assess the effects of oceanographic conditions on bycatch in the walleye pollock fishery, monitor the impacts of the fishery on the stock across a wide range of temporal and spatial scales, and evaluate the effects of oceanographic conditions on walleye pollock density and distribution. These projects demonstrate cooperative monitoring programs in which researchers work with other sea going stakeholders to inexpensively collect biological and oceanographic data that can be integrated into a long-term ocean observing system.

### October 17, 09:25 (S4-8546), Invited

## Using commercial vessels to monitor deep-water fisheries and basin scale ecosystems

Rudy J. **Kloser**, Tim E. Ryan, Ryan Downie, Mark Lewis and Gordon Keith

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To monitor small scale deep-water and remote fisheries it has been very cost effective to use fishing vessels. This has in the Australian experience been facilitated with the overall governance of the fisheries where there are clear incentives for engaging in monitoring. More broadly this incentive is also driven by societal drivers for sustainable fisheries. To meet these challenges new technologies and methods have been developed to ensure data quality is maintained. In particular for deep water resources there is a need to lower instruments close to the fish using net mounted multi-frequency acoustic and optical devices. Based on this technology we demonstrate how acoustic surveys can provide fundamental stock size information for recovering stocks. At the larger ocean basin scale, fishing vessels can provide valuable insights into the structure and function of pelagic ecosystems. The data is sourced from calibrated echo sounders and provides a cross sectional view of ocean basins up to 1000 m deep. This bio-acoustic sampling method has been integrated into an ocean observing system looking at decadal trends in environmental variability. On selected long term transects we integrate the bioacoustics with continuous plankton recorder measurements. Complementary depth stratified net tows and fine scale acoustic and optical sampling is helping to provide some of the necessary biological interpretations. An ongoing research question is focused on how best to use the data for ecological indicators or input into ecological models.

**October 17, 09:50 (S4-8392)**

## Ship of Opportunity sampling of lower trophic levels

Sonia **Batten**[1] and Anthony Walne[2]

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Continuous Plankton Recorders (CPRs) have been towed behind commercial ships and other vessels of opportunity on their regular routes of passage for multiple decades and in several of the world's oceans. These surveys generate spatially and temporally referenced quantitative data on the abundance and distribution of many zooplankton and larger phytoplankton taxa. Benefits, (*e.g.* highly cost-effective sampling of large remote oceanic regions) are discussed as well as limitations of this approach (*e.g*. lack of control over exactly when and where sampling occurs). The Pacific CPR survey has also, in the past, made use of marine bird and mammal observers onboard the vessel. In more recent years, the CPR has itself become a sampling platform with instrumentation added to the towed body which autonomously collects physical data (T, S, D) and chlorophyll fluorescence, or microplankton via a self-contained water sampler. There is thus the potential to develop large scale, multi-trophic level monitoring programs with some supplemental physical data. While microscopic processing of all CPR survey data can take several months to complete, more recently a near-real-time approach has been adopted along some transects with data available within 60 days. This presentation will describe the CPR sampling program, its strengths and weaknesses and highlight its contribution to oceanographic monitoring.

**October 17, 10:10 (S4-8435)**

## Using walleye pollock acoustic survey data and Steller sea lion foraging information to manage fisheries – sea lion interactions in the Aleutian Islands

Elizabeth A. **Logerwell**[1], Steven J. Barbeaux[1] and Lowell W. Fritz[2]

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[2] Alaska Ecosystems Program, Alaska Fisheries Science Center, National Marine Mammal Laboratory, National Oceanic and Atmospheric Administration, 7600 Sand Point Way NE, Seattle, WA, 98115, USA

We investigate whether cooperative surveys can be an effective way to manage fisheries at the local scales that are important to predators such as Steller sea lions *Eumetopias jubatus*. To do so we conducted a wintertime acoustic survey of sea lion prey, walleye pollock *Theragra chalcogramma*, in the central Aleutian Islands from a commercial vessel equipped with scientific quality echosounders and evaluating the quality, resolution and variability of the survey data. We also collected Steller sea lion distribution and diet information during the same winter to determine where sea lions rely on pollock for foraging. We conducted multiple calibrations of the acoustic system on the commercial vessel participating in the cooperative survey and found that the system was scientifically reliable. We also quantified the biomass of pollock potentially available for sea lions and the fishery, located areas of high pollock biomass, and identified areas where pollock are likely to be important to sea lions. We found that the diet composition of sea lions was related to pollock abundance, but that the distribution of sea lions among haul-out sites was not. Instead, the distribution of sea lions appeared to be driven by the distribution of Atka mackerel *Pleurogrammus monopterygius*, their most common prey year round. This suggests that in the Aleutian Islands, sea lion diets respond to small-scale, short-term distribution of prey (pollock) whereas their spatial distribution during the non-breeding season among haul-out sites may primarily reflect the larger annual-scale distribution of their dominant prey (Atka mackerel).

### October 17, 10:50 (S4-8811)

## Monitoring of oceanographic and biological conditions in the Pacific saury fisheries expedition

Viktor N. Filatov[1], Yury.V. Eremin[2], Elena I. **Ustinova**[3] and Aleksey V. Ballo[2]

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[2] Engineering Centre "Geotok", 42 Kalinina St., Vladivostok, 690012, Russia
[3] Pacific Fisheries Research Centre (TINRO-Centre), 4, Shevchenko Alley, Vladivostok, 690091, Russia. E-mail: eustinova@mail.ru

This paper presents the monitoring system of oceanographic and biological conditions in the period of the saury fishery (from August to the beginning of December) in the Northwestern Pacific. The effectiveness of the Pacific saury fishery depends on the ability of operational analysis and forecasting of hydrometeorological conditions, since fishing activities are related to oceanic fronts of different scales. In recent years, practical experience of creating and using new information technologies, operational scientific support, including the collection and assimilation of data, analysis and diagnosis of the situation near real-time, forecast, visualization and distribution was obtained. Monitoring of hydrometeorological characteristics was based on various sources of information in the area of Pacific saury fishing. Monitoring results were used for operational purposes in field and as a basis for further studies. Sea surface temperatures were monitored with accurate, calibrated temperature sensors on fishing vessels. Usage of SST data obtained *in situ* allowed us to improve the SST fields derived from satellite data directly in the fishing area and to reveal local ocean conditions (areas of the fronts, the individual eddies, *etc.*). The presence of a scientist on board of the commercial fishing or processing vessel provides a collection of biological data (*e.g.*, size-age structure of sampled fish). These data are added to the long time-series on the biological characteristics of saury. The “saury-related” monitoring can be integrated into a large ocean monitoring system.

### October 17, 11:10 (S4-8361)

## Long-term observations of internal waves with shore-based video cameras

Ata **Suanda**[1] and John A. Barth[2]

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Shoaling internal waves are an intermittent but important part of the circulation on open coastlines as they are implicated in the mixing and transport of pollutants and planktonic organisms including juvenile fish. Due to complicating factors such as variable bathymetry, stratification, and background currents, the arrival timing and frequency of wave occurrence is poorly understood and long-term observations are needed. Over the shallowest portions of the shelf, traditional in-situ measurement of internal waves can be costly as instruments are susceptible to strong forces from breaking surface gravity waves. In this work, a low-cost observation technique using shore-based video cameras is presented to provide long-term measurement of internal waves. In August, 2011 an experiment combined in-situ measurements from ADCP and thermistor chains with video observations of 12 internal wave events on the central Oregon inner shelf. The surface expression of internal waves, visible as streaks of increased pixel intensity in video imagery, are tracked through time and space and compared to wave propagation speed and direction from in-situ measurements. Archived video observations from this location are also analyzed to extend the time series to five months of measurement, capturing 50 events and allowing quantification of optimal atmospheric conditions for observing internal wave streaks. Lastly, consideration is given towards extending the technique to the use of non-research, freely available beach webcams; a rapidly expanding resource of ocean-viewing cameras.

**October 17, 11:30 (S4-8382)**

## Coastal monitoring the state of pink shrimp *Pandalus borealis* population on West Kamchatka

Oksana G. **Mikhailova**

Laboratory of the commercial invertebrate, Kamchatka Research Institute of Fisheries and Oceanography, Naberezhnaya, 18 Petropavlovsk-Kamchatsky, 683000, Russia. E-mail: mikhailova.o.g@kamniro.ru

In several recent decades in view of deficiency in financing target studies of pink shrimp on the coast of West Kamchatka the state of the object has been monitored by observers taken aboard commercial fishing vessels. The data they have obtained in commercial district near the south-west coast of Kamchatka for 2004-2012 became a basis for stock abundance assessment and forecast. The TAC for the district was estimated on the data for 2005-2011. For now a stable growth of pink shrimp stock abundance is evidenced in the observation. Since sampling is carried out using a specialized shrimp trawl, also utilized in commercial fishing, analysis can include a number of commercial parameters, unavailable in scientific survey sampling. A huge biostatistical data pool on distribution, size-weight characteristics and dynamics of egg development (incubation takes 9-10 months) of pink shrimp in the mentioned district has been formed for recent period thanks to the inclusion. Temperature data in the area inhabited by pink shrimp were also collected; preferred range of temperatures varied depending season of reproduction. The temperatures preferred by pink shrimp during release of larvae were 1,5-1,9°C and during spawning - 0,5-1,0°C. The commercial fleet normally operates in spring or autumn, and is helping to track population migrations. Thus, current monitoring of pink shrimp from commercial vessels plays a very important role and can be used in the case of limited finances in the future.

**October 17, 11:50 (S4-8689)**

## Collaborating with the commercial fishing industry: An intensive, cost-effective method to improve red king crab stock assessments in southeastern Alaska, U.S.A.

Christopher **Siddon**

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One of the main goals of fisheries science is to provide the best stock assessment information to managers. This is a difficult task due to the vast areas of fishing grounds and the paucity of fishery independent data. A collaborative effort between the Alaska Department of Fish and Game (ADFG) and the commercial fishing industry provides a novel, cost-effective method to improve stock assessment methods and facilitate positive working relationships. Utilizing the strengths of the fishing industry and the ADFG we designed a joint project to improve the understanding of red king crab distributions and ground-truth current stock assessment methods. Specifically, we compare a Catch Survey Analysis (CSA) model with depletion and mark-recapture estimates for six areas. CSA estimates use ADFG summer survey data, while depletion and mark-recapture estimates were done during the fall on commercial vessels. Approximately 9000 crab were caught and tagged. Of the crab recaptured 1-2 months later, 3–29% of them were tagged. The depletion model estimate of crab abundance for St. James Bay was 30% lower than the estimate from the CSA model. The mark-recapture estimates of crab abundance averaged 3.6 (±1.6 SE) times higher than the CSA model estimates. In addition, results from the mark-recapture data suggests large changes in crab behavior (movement and catchability) over relatively short time scales (months).

### October 17, 12:10 (S4-8648)

## Using acoustic data to map the presence or absence of deep-water sponges and corals in closed areas in the Gulf of Alaska

Christopher N. **Rooper**, Michael H. Martin and Mark E. Wilkins

Resource Assessment and Conservation Engineering Division, Alaska Fisheries Science Center, National Marine Fisheries Service, 7600 Sand Point Way NE, Bldg. 4., Seattle, WA, 98115, USA. E-mail: chris.rooper@noaa.gov

Corals and sponges are slow-growing and vulnerable to damage from fishing gear. As a result, many areas where corals and sponges are prevalent have been closed to fishing throughout the world. Three areas in the western Gulf of Alaska with little historical fishing effort and believed to contain significant sponge and coral habitat were closed to fishing in 2005. In August of 2010 we conducted a survey aboard a chartered fishing vessel to evaluate the prevalence of coral and sponge habitat in these areas. We conducted 73 camera drops within the three areas noting the presence of sponge and coral, while simultaneously collecting acoustic data from the vessel's echosounder. The objective of the analysis was to model the presence of coral and sponge habitat in the closed areas using the acoustic data, and to use the model to infer likely coral and sponge habitat throughout the designated closed areas. Depth, slope and seafloor hardness were estimated from the acoustic data and interpolated into raster maps. These variables were extracted at camera drop locations and used in general additive models to predict the presence or absence of coral or sponge. The analysis indicated that only a small fraction of the areas have seafloor characteristics that would likely support significant coral and sponge formation. The acoustic data used in the analysis were collected with a commercial grade echosounder that is commonly available on fishing vessels in Alaska, highlighting the possibility of further opportunistic acoustic data collection to map coral and sponge habitat in Alaska.

### October 17, 12:30 (S4-8552)

## Archiving historical meso-zooplankton samples collected around Japan

Kazuaki **Tadokoro**[1], Yuji Okazaki[1], Akinori Takasuka[2], Tadafumi Ichikawa[2] and Hiroya Sugisaki[3]

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Meso-zooplankton constitutes a key community and knowledge about this community would improve our understanding of the effects of climate change on marine ecosystems. The samples can be preserved in buffered formaldehyde for long time with low cost. Therefore, meso-zooplankton samples have been utilized in studies to understand the effects of large-scale climate change on marine ecosystems. The Fisheries Research Agency of Japan and multiple prefectural fisheries stations/institutes have systematically collected fish egg and larvae by plankton nets (Marutoku and NORPAC nets) to investigate the spawning of the commercially important pelagic fish such as Japanese sardine from 1970s around Japan. More than 6,000 samples were collected in the last fiscal year. A portion of those samples contributed to Odate Collection, which is a world-famous meso-zooplankton archive. Also, another portion of the samples have been used for studies on the long-term variation of the marine ecosystems analyzed by bench top Video Plankton Recorder (B-VPR) in the Kuroshio waters. However, the samples had not yet been systematically archived in the center institute. In the current situation, it is difficult to use the samples for the large-scale studies efficiently. Therefore, we have started to archive the historical collection of samples systematically in the Tohoku National Fisheries Institute from this year. Moreover, we are constructing the database of the archival samples to utilize them more efficiently.

# S4 Session Poster Presentations

### S4-1

## Sharing marine “small science” data

Igor Burago[1,3], Georgy Moiseenko[2], Olga Vasik[1] and Igor **Shevchenko**[1,3]

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As noted by Paul F. Uhlir and Peter Schröder, data management for big research projects and programs, and for small endeavors, performed by a single investigator or a small group, in observational sciences differ dramatically. Major science programs usually specify data formats, quality assessment procedures and even ensure open access to the collected data through established data centers. Smaller science programs, however generally do not have these components. Thus, in many cases their research data are not visible to and reusable by potential users. Since marine science is dominated by “small science” research projects, promotion of data sharing is essential for completing most PICES projects including those of FUTURE. The PICES community has been already provided with several information services available to members and expert groups at the TCODE geospatial portal (http://67.212.128.197/geonetwork). Among them is an electronic catalog for publishing metadata. Metadata are “data about data” which help to search and eventually lead to relevant data themselves. This service is an outcome of the PICES metadata federation project. It allows scientists to prepare, post, edit and make metadata spatially searchable by particular groups of end users on the Internet. However, as past experience confirms, this tool is not widely employed and the number of submissions doesn't grow much mostly due to the common behavioral attitude. Therefore, PICES urgently needs to implement a data policy and promote a data sharing etiquette. For example, all PICESians should claim their data “officially” by submitting metadata to a searchable catalog, and the metadata and data set references should be cited when a scientific report or a paper is published.

### S4-2

## Environmental sampling, hypoxia and the Northwest Fisheries Science Center’s Cooperative U.S. West Coast Groundfish Bottom Trawl Survey

Aimee A. Keller[1], W. Waldo Wakefield[2], Victor H. Simon[1], John A. **Barth**[3] and Stephen D. Pierce[3]

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The NOAA NMFS Northwest Fisheries Science Center (NWFSC) currently conducts a number of groundfish research and monitoring projects that are cooperative and collaborative with the fishing industry. These include a West Coast Groundfish Bottom Trawl Survey (WCGBTS), a hook and line survey of shelf rockfishes in the Southern California Bight, pelagic trawl surveys of juvenile groundfishes, and acoustical optical pilot surveys of pelagic rockfishes in untrawlable habitats. In the context of such cooperative research programs, advancements in sampling technologies have allowed new types of data to be collected during traditional NMFS surveys. For example, environmental sensing packages are attached to trawls and record a full array of environmental parameters (*e.g.*, depth, temperature, salinity, dissolved oxygen, chlorophyll fluorescence, turbidity, and light). These improved environmental sensing capabilities have led to collaborations with academic partners and with the developers and manufacturers of sensing packages. In 2007, the NWFSC added an environmental sampling program to the WCGBTS that included collaboration with physical oceanographers at Oregon State University. This program was initiated, in part, in response to hypoxia that was observed on the continental shelf of the Pacific Northwest, in a region not previously characterized by hypoxic conditions. Fishery and environmental sampling is conducted from chartered commercial trawlers from 55 to 1280 meters and from the U.S.-Canada border to the U.S.-Mexico border. A nested sampling design encompasses the oxygen minimum zone of the California Current as well as a known hypoxic area on the continental shelf off the Oregon coast.

## S4-3

# Monitoring demersal fish community containing predators of walleye pollock using a small fishing boat

Orio **Yamamura**, Kouji Kooka and Takeomi Isono

Hokkaido National Fisheries Research Institute, Kushiro, Hokkaido, 085-0802, Japan. E-mail: orioy@affrc.go.jp

The Doto area is a nursery ground of the Japan Pacific population (JPP) of walleye pollock, one of the most important fishing targets in the Japanese waters. Juvenile pollock settle from late summer through winter into the area, where the predation mortality by demersal fishes is significant. We have continued a monthly monitoring of the demersal fish community during the settlement season (April – December) in this area for 10 years, using a small fishing boat (7.3 ton) equipped with a Danish seine. On a typical survey day trip, this boat departs 5:00 in the morning, samples 4 stations using a Danish seine, and returns to the port by 14:00. It is chartered at <100,000 yen (ca. 1,250 USD) a day.

The fishing gear used had a limitation in catchability of large-sized and benthopelagic gadids (*i.e.* pollock and Pacific cod) due to the low height of the sampling gear. But it has been useful in monitoring non-commercial predators including Kamchatka flounder (*Atheresthes evermanni*) and plain sculpin (*Myoxocephalus jaok*). The data is used to quantify the predation impact on newly settled age-0 pollock. In this paper, the temporal and bathymetric change in demersal fish community structure will also be presented.

# S5 MEQ/FUTURE Topic Session

## Social-ecological systems on walleye pollock and other commercial gadids under changing environment: Inter-disciplinary approach

***Co-Convenors**: Keith Criddle (USA), Suam Kim (Korea), Mitsutaku Makino (Japan), Ian Perry (Canada), Yasunori Sakurai (Japan) and Anatoliy Velikanov (Russia)*

***Invited Speakers**:*
*Oleg Bulatov (Russian Federal Research Institute of Fisheries and Oceanography, Russia)*
*Alan Haynie (Alaska Fisheries Science Center)*

In order to build bridges between scientists, decision-makers, stakeholders, and across sectors, there is a need for more in-depth and concrete inter-disciplinary research framework in the context of the PICES integrative science program FUTURE. One of the typical groundfish resources in the North Pacific, pollock is highlighted to facilitate such academic discussions under the PICES framework. Research on walleye pollock from the perspectives of ecology, biology, stock dynamics, harvesting, fisheries management, history, marketing, processing, international trade, consumption, and culture will be presented. Inter-relationships among these varied perspectives, information needs, potential values for other disciplines, *etc.*, will be discussed during this session. An expected outcome of this session will be a holistic framework for the inter-disciplinary research, which could be applied to other species.

### Tuesday, October 16 (9:00-17:30)

09:00 ***Introduction by Convenors***

09:05 **Oleg A. Bulatov**
Walleye pollock: Global view (S5-8399), Invited

09:35 **Tetsuichiro Funamoto, Osamu Shida, Kazuhiko Itaya, Orio Yamamura, Ken Mori, Yoshiaki Hiyama and Yasunori Sakurai**
Comparisons of recruitment fluctuation mechanisms of walleye pollock in the Sea of Japan and the Pacific Ocean off northern Japan (S5-8526)

09:55 **Anatoliy Ya. Velikanov**
Long-term changes in abundance and annual catches of walleye pollock off Sakhalin Island in the Japan/East Sea and the Okhotsk Sea: From collapse to renewal (S5-8357)

10:15 **Benjamin C. Williams, Gordon H. Kruse and Martin W. Dorn**
Variations in walleye pollock (*Theragra chalcogramma*) maturation rates in the Gulf of Alaska (S5-8455)

10:35 ***Coffee/Tea Break***

11:00 **Anatoly V. Smirnov**
Ecosystem approaches to pollock fishery management in Russia (S5-8333)

11:20 **Hiroshi Kuroda, Daisuke Takahashi, Tomonori Azumaya and Humio Mitsudera**
Development of a high-resolution coastal model around Hokkaido for fisheries science – A study on passive transport of eggs, larvae and juveniles of walleye pollock (S5-8747)

11:40 **Igor K. Trofimov**
About distribution of under-yearling saffron cod in Karaginsky and Olutorsky Gulfs, Bering Sea (S5-8383)

12:00 **Toru Nakagawa, Masayuki Chimura, Naoto Murakami, Takashi Ichikawa, Norio Shirafuji, Jun Yamamoto, Tetsuichiro Funamoto, Ken Mori, Yoshiaki Hiyama and Toyomitsu Horii**
Establishment of a rearing system of larval and juvenile walleye pollock for elucidating their biological properties and responses to environmental changes (S5-8565)

12:20 ***Lunch***

14:00 **Alan C. Haynie**
FishSET: A new tool to better incorporate fisher behavior into fisheries management (S5-8707), Invited

14:30 **Osamu Shida, Yukio Mihara and Kazushi Miyashita**
Interannual changes in the timing of walleye pollock spawning migration and their impacts on gill-net fisheries in the southwestern Pacific coast of Hokkaido, Japan (S5-8696)

14:50 **Yohei Kawauchi, Masayuki Chimura, Takashi Muto, Masamichi Watanobe and Kazushi Miyashita**
The effect of environmental factors on the distributions of walleye pollock (*Theragra chalcogramma*) juveniles in Funka Bay and vicinity, Hokkaido, Japan (S5-8385)

15:10 **Mikhail A. Stepanenko**
Bering Sea pollock recruitment, abundance, distribution and approach to fishery management under changing environment (S5-8327)

15:30 ***Coffee/Tea Break***

15:50 **Keith R. Criddle and James Strong**
Straddling the line: Cooperative and non-cooperative strategies for management of Bering Sea pollock (S5-8379)

16:10 **Masamichi Kawano and Masahito Hirota**
Market and distribution of walleye pollock (S5-8780)

16:30 **Suam Kim, Sukyung Kang and Dohoon Kim**
The ecology of walleye pollock and its market importance in Korea (S5-8830)

16:50 *Discussion*

17:30 *Session Ends*

## S5 Posters

S5-1 **Andrei N. Stroganov and Alexei M. Orlov**
On the population structure of Pacific cod

S5-2 **Sergey S. Ponomarev**
Inter-annual variability of Pollock 0–year–class abundance in the northern sea of Okhotsk

S5-3 **Andrey Smirnov**
Correlation of pollock and herring yield broods inhabiting the northern part of the Sea of Okhotsk

S5-4 **Nadezhda L. Aseeva, Marina B. Shedko, Andrey Smirnov and Alexander S. Sergeev**
New data on ectoparasites of walleye pollock in the Okhotsk Sea

S5-5 **Tadayasu Uchiyama, Gordon H. Kruse and Franz J. Mueter**
Effects of water temperature increases on eastern Bering Sea juvenile pollock predation

# S5 Oral Presentations

### October 16, 09:05 (S5-8399), Invited

## Walleye pollock: Global view

Oleg A. **Bulatov**

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Walleye pollock (*Theragra chalcogramma*) is one of the leading fishery targets in the North Pacific. The history of large-scale fishing dates back to the early 1960s. The first large-scale fishing grounds were located in the eastern Bering Sea. Historical maximum catch of pollock was observed in the late 1980s and exceeded 7 million tons, putting this species in first place among the world's fisheries. According to FAO (Yearbook , 2011), world landings decreased substantially during 2000-2009 compared with the 1980s. The global landings in 1965-2010 averaged 4 million tons. The world's principal pollock fishing nations (Russia, USA) increased their landings during the last two years, but it remained below the long-term average value. Fishing, processing and trading of pollock production involves great financial and human resources in various countries (Russia, USA, Japan, Korea, China, and EU). Knowledge of the causes of variability, stock assessments, and thus fishery yields, are important for future planning. It is now known that temperature conditions during early life stages have a significant impact on pollock recruitment. Cold years appear to produce mostly poor recruitment, but warm years produce strong yearclasses. This is probably due to the fact that survival of eggs, larvae and yearlings increase in warm years, due to increased concentration of food, accelerating their metabolism which leads to an increase in fishable biomass. What are the prospects of fishable biomass of walleye pollock in the future? A "working hypothesis" suggests that global temperatures in the Arctic region passed a maximum in 2000, will reach average values in 2015, and minimum levels in 2030. Thus, we can expect decreasing pollock stocks in the Bering Sea from 2020 to 2030, and increases in the Sea of Japan.

### October 16, 09:35 (S5-8526)

## Comparisons of recruitment fluctuation mechanisms of walleye pollock in the Sea of Japan and the Pacific Ocean off northern Japan

Tetsuichiro **Funamoto**[1], Osamu Shida[2], Kazuhiko Itaya[3], Orio Yamamura[1], Ken Mori[1], Yoshiaki Hiyama[1] and Yasunori Sakurai[4]

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The northern Japan Sea stock (JSS) and the Japanese Pacific stock of walleye pollock (JPS) are mainly distributed in the Sea of Japan and the Pacific Ocean off northern Japan, respectively. This paper summarizes and compares the factors affecting recruitment variability of these two stocks. Drifts of early life stages are important in controlling recruitment for both stocks, and eggs and larvae of JSS are transported into the nursery ground by the Tsushima Warm Current (TWC). However, TWC carries larvae and juveniles of JSS also into the Sea of Okhotsk, resulting in poor JSS recruitment when the TWC is strong. On the other hand, the main larval nursery ground of JPS is Funka Bay, and northwesterly winds are necessary for eggs and larvae to be transported into this bay. Hence, JPS recruitments are enhanced in years when northwesterly winds are predominant during the spawning season. The relationships between recruitment and water temperature during the spawning season are significant for both stocks, but negative for JSS and positive for JPS. Although underlying mechanisms of these opposite relationships are probably complex, one possibility is that spawning grounds are formed at favorable positions to egg drifts in cold years for JSS and warm years for JPS. In contrast to JPS, of which cannibalism has a significant impact on recruitment, young pollock are rarely found in the stomach of adult JSS. Because adult pollock are distributed under colder conditions than young pollock, high thermal conditions in the Sea of Japan seem to cause a separation between young and adult pollock. In stock-recruitment relationships, density dependence is recognized for only JPS, probably due to intensive cannibalism. These comparisons indicate that surrounding environmental conditions and pollock adaptations to these environments induce the different recruitment fluctuation mechanisms of JSS and JPS.

**October 16, 09:55 (S5-8357)**

## Long-term changes in abundance and annual catches of walleye pollock off Sakhalin Island in the Japan/East Sea and the Okhotsk Sea: From collapse to renewal

Anatoliy Ya. **Velikanov**

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Southern populations of walleye pollock are very unstable and have low abundance. Nevertheless, in the 1970-1980s these populations were rather productive providing high annual catches in some years. At present, most pollock stocks in the southern part of the species area are at low levels of abundance without any signs of renewal. During the recent ten-year period, only some of these stocks showed growth in abundance. Sea waters of Sakhalin Island are a specific zone for pollock distribution from north to south within the species area. Currently, the three pollock stocks distributed near the Sakhalin coast differ by abundance and reproduction: a stock near western Sakhalin is deeply depressed whereas a stock near north-eastern Sakhalin has experienced abundant growth. Along with large changes in abundance, there have been observed significant changes in population biological structure and other ecological rebuilding related to reproduction. The renewal processes of pollock stock abundance are different for each population in the Sakhalin sea waters, although climatic trends are similar. This may be because of specific functions of the marine ecosystem related to pollock reproduction areas near Sakhalin Island. Pollock reproduction may be greatly affected by water temperature and dissolved inorganic nitrogen transport in the WTC zone near western Sakhalin. In the most productive south-western part of the Okhotsk Sea, the increase and decrease in pollock stock abundance is related to long-term changes in ice cover. These examples could serve as indicators of future shifts in southern pollock populations.

**October 16, 10:15 (S5-8455)**

## Variations in walleye pollock (*Theragra chalcogramma*) maturation rates in the Gulf of Alaska

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Knowledge about life history and reproductive biology are needed in modern stock assessments for the estimation of spawning stock biomass. Stock assessments often assume that spawning season and age of maturity are constant among years. However, environmental conditions and population abundance may influence the timing of maturation. Adult abundance and stage of reproductive maturity have been monitored annually by fishery independent surveys for walleye pollock *(Theragra chalcogramma)* in early spring in Shelikof Strait, western Gulf of Alaska, for almost three decades. Utilizing these data we developed generalized linear models to examine the oceanographic and population drivers of interannual trends in walleye pollock maturity. Variability in age and size at maturity has consequences on spawning stock biomass and biological reference points used to set harvest rates. Moreover the abundance and quality of reproductively mature fish have important consequences on the economic value of roe, which is one of the primary products produced of this fishery.

### October 16, 11:00 (S5-8333)

## Ecosystem approaches to pollock fishery management in Russia

Anatoly V. **Smirnov**

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Walleye pollock is species number 1 for Russian fisheries. Pollock fisheries are stable and it catch (1.5-2.0 million t) comprises 60-70% of the total harvest in the Russian EEZ of the Far Eastern Seas. During the fishing season in the Sea of Okhotsk the factory trawlers and catcher boats conduct about 20 thousand hauls and several thousand hauls of seine net sets in the coastal zone. Evaluating and assessing walleye pollock fishery impacts on the ecosystems of the Bering and Okhotsk Seas is therefore important. This issue has recently become critical due to ongoing Marine Stewardship Council certification of pollock fisheries in the Russian EEZ. TINRO-Center has conducted planning and field research operations using an ecosystem approach to marine biological resources for over a quarter-century. In addition, biological data are collected by observers on pollock fishing boats. As a result, complex information is available not only on quantitative assessments of fishery species but also on detailed evaluations of the structure and composition of pelagic and bottom communities and their inter-annual dynamics. It is concluded that the midwater pollock fishery has no negative influence on the marine ecosystem as a whole and its individual elements. All recommendations on minimizing negative impacts of fishing operations to the ecosystem are promptly introduced into the legislation of Russian fishery – Fisheries Act, Fishing Rules, *etc.*

### October 16, 11:20 (S5-8747)

## Development of a high-resolution coastal model around Hokkaido for fisheries science – A study on passive transport of eggs, larvae and juveniles of walleye pollock

Hiroshi **Kuroda**[1], Daisuke Takahashi[2], Tomonori Azumaya[1] and Humio Mitsudera[3]

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We develop a 1/50-degree coastal model around Hokkaido, which is connected by one-way nesting to the 1/10-degree ocean model employed as a part of an ocean forecast system of the Fisheries Research Agency (FRA-ROMS). The whole of the Hokkaido coast is included in the model domain, that is, oceanographic conditions in the North Pacific, Okhotsk Sea, and Japan Sea around Hokkaido are integrated simultaneously. The ocean models are driven by climatological forcing without coupling with a sea-ice model. We focus on the Pacific shelf-slope region around Funka Bay, off southwest Hokkaido, where the main spawning ground of walleye pollock is formed in winter. Our model simulates the typical seasonal variation of water masses around Funka Bay. In winter to spring, extremely cold fresh subarctic water, namely, the Coastal Oyashio water, is transported from the Okhotsk Sea mainly by the Coastal Oyashio trapped against the Pacific shelf-slope region. In summer to autumn, subarctic water is replaced with warm saline subtropical water, namely, the Tsugaru Warm Current water, supplied from the Japan Sea. Using simulated velocities from the 1/10- and 1/50-degrree models, we perform passive particle-tracking experiments simulating the movement of eggs, larvae and juveniles of walleye pollock. The transport pathways and dispersion processes are significantly different between the model resolutions. Drastic vertical displacement of particles can be detected in the 1/50-degree model, suggesting that buoyancy/density of eggs, larvae and juveniles is essential to control their vertical position under realistic oceanographic conditions.

**October 16, 11:40 (S5-8383)**

## About distribution of under-yearling saffron cod in Karaginsky and Olutorsky Gulfs, Bering Sea

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The distribution of under-yearling saffron cod was studied on the shelf of Karaginsky and Olutorsky Gulfs using bottom trawl survey data from 1971–2006. During the first months, the under-yearlings stay neashore (<10m deep). They can be observed in trawl catches for the first time in August. Their frequency of occurrence, catch-per-hour and area of distribution over the shelf increases from August to December, for example, the frequency increases from 1% to 35%. From summer to December, the under-yearlings inhabit locations with the highest sea temperatures. In August, at the beginning of autumn cooling of the shelf, they leave to feeding in open ocean waters. Until October, the under-yearlings stay at depths <50m. In November, the average water temperature near the bottom and at the depths around 50m get about 2ºC. The under-yearlings undertake mass migration to depths >50m. In December, the highest water temperatures can be observed at depths >50m, and the under-yearlings are spread widely over the shelf. Principle aggregations occur over the depth range of 50–100m. In January, the under-yearlings migrate to the lagoons and inlets to depths <50 m and stay until May. From January to March the temperatures on the shelf are the lowest – slightly above -2ºC.

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**October 16, 12:00 (S5-8565)**

## Establishment of a rearing system of larval and juvenile walleye pollock for elucidating their biological properties and responses to environmental changes

Toru Nakagawa[1], Masayuki **Chimura**[2], Naoto Murakami[1], Takashi Ichikawa[1], Norio Shirafuji[1], Jun Yamamoto[3], Tetsuichiro Funamoto[2], Ken Mori[2], Yoshiaki Hiyama[2] and Toyomitsu Horii[4]

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Investigating the biological properties and responses to environmental changes of larvae and juvenile walleye pollock (*Theragra chalcogramma*) using laboratory experiments is important for elucidating the factors controlling their recruitment. We conducted experiments to establish a rearing system for pollock from hatching to juveniles. Pollock were reared from hatching in small tanks ($0.5m^3$) at 5, 8 and 11°C and in large tanks ($15m^3$) at approximately 5 and 9°C. They were fed sufficient amounts of rotifers, *Artemia* nauplii, frozen copepod and artificial dry diet according to their growth. In the small tanks, the larvae exposed to higher temperatures grew faster, but their survival rates decreased sharply after they reached approximately 7mm in standard length, corresponding to the size of appearance of caudal fin rays, at all temperature conditions. It was possible that the n-3 highly-unsaturated fatty acid (n-3 HUFA) content of rotifers was inadequate for larvae to survive. Therefore, in the large tanks (5°C), which started rearing later, larvae were fed rotifers which contained more n-3 HUFA than the rotifers used in the other tanks, and larval survival was much improved. To elucidate the temperature effect on early growth and survival, we need to conduct experiments again using n-3 HUFA rich rotifers which were used in the large tank (5°C). The pollock in the large tanks (5°C) have been reared for over 3 months and their early growth was comparable to that of wild fish. We judged that the rearing system of pollock from hatching to juveniles under the temperatures that wild fish experience has been established.

### October 16, 14:00 (S5-8707), Invited

## FishSET: A new tool to better incorporate fisher behavior into fisheries management

Alan C. **Haynie**

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Since the 1980s, fisheries economists have employed models in various fisheries to explain what factors influence fishers' spatial and participation choices. A better understanding of this behavior is useful for predicting how fishermen will respond to the creation of marine reserves, to changes in market conditions, or to management actions such as the implementation of catch share programs.

While research in this area has informed our understanding of how fishers make decisions, little empirical research has actually been incorporated directly into the fisheries management process. Currently, NOAA Fisheries and partners are developing the Spatial Economics Toolbox for Fisheries (FishSET), which aims to facilitate the better integration of models of fisher behavior into management.

An initial challenge is integrating data that may be overlapping and of variable quality. Working with economists and data specialists from all US management regions as well as academic experts, we are developing best practices and tools to improve data organization and standardization. A second core component of this project is the development of estimation routines that enable comparisons of state-of-the-art fisher location choice models. As well as facilitating the application of these models, FishSET will enable new research advances to be more easily and robustly tested and applied when the advances lead to improved predictions of fisher behavior. FishSET efficiently organizes statistical code so that leading innovators can build on each others' work and methods can be transparent and more widely available. In this talk, we discuss the modeling approach utilized and details of project implementation.

### October 16, 14:30 (S5-8696)

## Interannual changes in the timing of walleye pollock spawning migration and their impacts on gill-net fisheries in the southwestern Pacific coast of Hokkaido, Japan

Osamu **Shida**[1], Yukio Mihara[1] and Kazushi Miyashita[2]

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The Japanese Pacific Stock of walleye pollock (JPS) is the largest pollock stock around Japan. It is a key component of the Oyashio ecosystem, as well as one the most important target species for commercial fisheries. The southwestern Pacific coast of Hokkaido including Hidaka Bay and Funka Bay is a main spawning ground of JPS. It has been considered that adult fish migrate from feeding grounds to this area before spawning period. Commercial gillnet fisheries targeting spawning adults of the JPS mainly operate from October to January which includes the spawning period. We examined interannual changes in spawning migration timing and their impacts on commercial gill-net fisheries based on the analyses of data obtained in acoustic surveys and the analysis of monthly commercial catch data. Results of acoustic surveys conducted from 1998 to 2005 distinctly show a change in the timing of spawning migration in 2000. Similarly, an extensive change in percent of walleye pollock catch from October to November, the first half of a main commercial gillnet fishing season, was observed in 2000. Time series of interannual variability of this value from 1980 to 2005 suggest that the timing of spawning migration shifted in 1990 and 2000. Such decadal scale shifts of the timings were probably caused by climate changes in the Oyashio waters. We will discuss the effects of changes in the timing of migration on commercial fisheries through changes in the formation of fishing grounds and differences in monthly unit prices.

**October 16, 14:50 (S5-8385)**

## The effect of environmental factors on the distributions of walleye pollock (*Theragra chalcogramma*) juveniles in Funka Bay and vicinity, Hokkaido, Japan

Yohei **Kawauchi**[1], Masayuki Chimura[2], Takashi Muto[3], Masamichi Watanobe[4] and Kazushi Miyashita[5]

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Japanese Pacific walleye pollock stock juveniles are known to shift their diet to larger prey as they grow beyond 30mm in TL. Small juveniles (<30mm) have been found to feed in warm, low-salinity water, whereas large ones (>30mm) find their prey in cold, high-salinity water. The shift is probably influenced by their spatial migration patterns. We aimed to examine the effects of physical and biological environments on the diel vertical migration and the distribution of juveniles by using quantitative echosounders (38kHz), CTDs, and net sampling. We conducted research cruises in May 2011 around Funka Bay, Hokkaido. Inside of the bay during daytime, small juveniles were mainly distributed in the shallow warm (>5°C), low-salinity (<33.0psu) water, whereas large ones were mainly distributed in the deeper cold (<5°C), high-salinity (>33.0psu) water. At night, the large juveniles migrated to shallower depths. Outside of the bay, the body sizes didn't vary among water masses during daytime, whereas during nighttime, the vertical distribution of juveniles was extended and their body size increased with depth. Analysis of stomach contents indicated that large juveniles ate larger copepods (>0.5mm in body width) than small juveniles in all locations and at all times sampled. These results indicate that large juveniles probably escaped from predation, because the escape ratio from predator (*e.g.*, flounders) was low due to tenuity of the deeper cold water mass in the bay. Outside of the bay during nighttime, the juveniles were probably distributed in suitable water for feeding, because the encounter rate with predator was low due to the thicker cold water mass.

**October 16, 15:10 (S5-8327)**

## Bering Sea pollock recruitment, abundance, distribution and approach to fishery management under changing environment

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Recent research demonstrated that the annual change in the physical oceanographic condition, productivity and species composition of the zooplankton community in the Bering Sea were associated with the great differences of the eastern Bering Sea pollock seasonal migrations and distribution, reproduction, survival of recruits at early stages of development and, finally, with the abundance of year classes and pollock total biomass in the Bering Sea. The annual eastern Bering Sea pollock recruitment varied significantly. The highly abundant year classes abundant appeared just in 1978, 1982, 1984, 1989, 1992, 1996, 2000, 2006, 2008, and 2009. Pollock biomass has declined in recent years but since 2010 it is again increasing as a result of the appearance of three relatively strong year classes - 2006, 2008 and 2009.

Recently, new data have appeared that shed light on the relationship between the overwinter survival of young-of-the-year pollock and the year classes' abundance in the Bering Sea. These data suggest that high survival of young-of-the year pollock could be associated with short-duration climate shifts. Annual variation in the spatial distribution of the eastern Bering Sea pollock in the northwestern direction in summer-autumn period appears to depend on plankton abundance and distribution, water temperature, total biomass of pollock, age composition and abundance of year classes. In general, most pollock, including post-spawning and immature fish, migrated during summer and autumn period from the southeastern Bering Sea in northwestern direction because zooplankton production of the northwestern Bering Sea was usually higher.

Relatively large abundances of pollock were noted in the northwestern Bering Sea in 1995-1997 and 2004-2011. In other years (1994, 1997, 2000-2003) a lot of fish stayed near spawning grounds in the southeastern area during all

seasons. In 2003-2006 the abundance of zooplankton in the southeastern Bering Sea was relatively low. In 2007-2009 the abundance of zooplankton in the Bering Sea was high across the entire Bering Sea shelf, but the distribution of pollock in the northern Bering Sea was limited by low temperature.

Eastern Bering Sea pollock resources are exploited in US and Russian EEZs and in the central Bering Sea (Donut Hole). Fishery management and regulation are carried out under national US and Russia Fishery Acts, Russia-US Fishery Agreement (1988) and the Convention on the Conservation and Management of Pollock Resources in the Central Bering Sea. The total catch and catches in Russian and US EEZs fluctuate significantly depending on pollock biomass and social factors. The total catch increased rapidly in middle 1980's and reached a peak in 1985-1990 when catches ranged from 2.04 to 3.59 mln. t. as a result of very intensive international fishing in the Donut Hole. The catch in US EEZ in 2000-2007 ranged from 1.13 to 1.49 mln t, decreased in 2008-2010 to 0.80-0.99 mln t, and increased rapidly in 2011 to 1.25 mln t. In Russian EEZ annual catch in 2000-2011 ranged from 0.31 to 0.51 mln t.

**October 16, 15:50 (S5-8379)**

## Straddling the line: Cooperative and non-cooperative strategies for management of Bering Sea pollock

Keith R. **Criddle** and James Strong

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The eastern Bering Sea fishery for pollock (*Theragra chalcogramma*) yields gross exvessel revenues of about $300 million and a first wholesale value over $1 billion; it is the premier U.S. fishery. While there is general agreement that this fishery is managed under principles that will ensure sustainability, the eastern Bering Sea pollock stock is not wholly contained within the U.S. EEZ and there are concerns about the role of historic and potential future catches from regions such as the Bogoslof Basin, the Donut Hole, and the Navarin Basin. The management of straddling stocks can be highly contentious and challenging, particularly when the stock is migratory or when the spatial distribution of abundance is variable. The absolute abundance of pollock and the spatial distribution of pollock abundance have varied considerably over the past three decades, with warmer conditions being associated with a shift of the center of abundance to the north and west, where a portion of the stock is subject to harvest by vessels licensed to operate in the Russian Federation EEZ. We use stochastic simulations to identify optimal cooperative and non-cooperative harvest management strategies from the perspective of U.S. and Russian pollock fisheries under climate-induced changes in abundance and the distribution of abundance. Like it or not, this stock is a shared stock. Game theory suggests that cooperative solutions offer many advantages; identifying cooperative solutions provide important leverage in negotiations. In the absence of cooperation it is even more important to identify strategic noncooperative solutions.

**October 16, 16:10 (S5-8780)**

## Market and distribution of walleye pollock

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The purpose of this presentation is to provide an overview of the products, processing technology, distribution, and the human consumption and cultural role of walleye pollock. Walleye pollock have become one of the most important species in world fish trade and markets and standardization may lead to additional product demand in many countries. The growth of international trade has resulted from an increase in the number of consuming countries and from increases in the number of countries that produce pollock products. The change has been driven by the standardization of frozen surimi grades and production techniques and by the expansion of surimi consumption from Japan and Korea to the USA, Europe and Russia. In addition, fillet and H&G (headed and gutted) production is increasing in USA and Russia and the demand for walleye pollock is still expanding. At the same time, many other low-cost fish products are also entering international markets, especially the white-fish markets where they compete with walleye pollock products. When thinking about the walleye pollock resources, it is important to understand and anticipate demand and production trends.

**October 16, 16:30 (S5-8830)**

### The ecology of walleye pollock and its market importance in Korea

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Walleye pollock is one of important commercial fishery resources that the Korean people have. It has been widely utilized in a variety of foods (soup, steamed, salted, broiled, *etc.*) and prepared using various cooking methods. The production of walleye pollock has shown a tremendous decline since the mid 1980s in Korea. For instance, it declined from 137,660 tons in 1982 to 766 tons in 2000 and it was also severely reduced to less than 1 ton in 2010. The reduction in harvests has been offset by increased imports of walleye pollock. However, the total supply is not meeting the demand for walleye pollock in the market. In this study, we analyze the current supply of and demand for walleye pollock in the Korean market and examine the change of catch by comparing changes in walleye pollock biology under changing environments. Based on the results, we predict the change of walleye pollock production and its impact on the market. In addition, we considered supply and demand management, and resource management alternatives for a stable supply of walleye pollock.

# S5 Poster Presentations

**S5-1**

### On the population structure of Pacific cod

Andrei N. Stroganov[1] and Alexei M. **Orlov**[2]

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The modern population structure of Pacific cod was formed in the Pleistocene-Holocene period, with its features of transgressions and regressions of the World ocean waters, and forming of the relief in the north Pacific region. Summarizing the results of the few population-genetic studies of Pacific cod, a generalized scheme of the organization of Pacific cod population might be presented in as the following.There exists a central grouping, which can be traced back to ancestral forms, which colonized the North Pacific from the Arctic after the Bering Strait opened 5.4-5.5 million years ago (according to updated data). This subunit combines the modern population of Pacific cod from deep-sea Okhotsk and Bering Seas, Gulf of Alaska and coastal waters of the Pacific, living at stable temperature and salinity conditions, exposed to relatively weak changes, even during periods of global glaciation maxima and accompanying oceanic regressions. Some internal differentiation can be determined by the power of gene flow between different parts of the range, which are under the effect of various factors from the water current systems to the biological characteristics of individual stocks. The next subunit is the group of the Sea of Japan, which may have acquired its individual genotype characteristics in the process of repeated isolation of the Sea of Japan from the Pacific (for example, in glacial ages). The last and most heterogeneous subunit (which could be named as “Holocene invaders”) is a kind of mixture of small “young” groups distributed now in the Yellow Sea, in shallow waters of the Okhotsk and Bering Seas, in the coastal fjord-like waters from the Georgia basin (Strait of Georgia, Canada, and Puget Sound, USA) in the south to the Gulf of Alaska in the north. They colonized these regions during the postglacial transgression, and formed their morpho-biological and genetic characteristics under a wide range of conditions under the impact of environmental factors, often located on the boundaries of tolerance for Pacific cod.

### S5-2

## Inter-annual variability of Pollock 0–year–class abundance in the northern sea of Okhotsk

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The pollock abundance in the sea of Okhotsk varies significantly among years. Large fisheries can occur on a base of several strong year-classes. The autumn 2011 trawel survey registered high abundance of Pollock 0–year–class (4-13 cm): 61.571 billion. Potentially, the main reason for high 0–year–class abundance is high abundance of its parent stock. The biomass of mature pollock was estimated as 6.341 million tons, with an abundance of spawned eggs of 37.242 x $10^{13}$ in the sea of Okhotsk in spring 2011. Favorable weather and ice conditions minimized the mechanical damage to pollock eggs during spring 2011. Optimal water temperatures allowed increased survival rates of eggs and hatched larvae. Based on the size of 0-year-class pollock in autumn 2011, we can assume there was abundant food during summer. In addition, the rate of cannibalism appears to have been low because of sufficient of food for older pollock. 0-year-class pollock were distributed widely over the shelf and to depths more than 200 meters in 2011. Therefore, the density of pollock was decreased. We suggest that all these factors are reasons for high 0-year-class abundance in 2011. At the same time, it does not guarantee high abundance of this year–class will continue, because mortality in the winter-spring period is increasing. The final estimation of abundance of the 2011 year–class will be known just after spring survey in the Sea of Okhotsk in 2012.

### S5-3

## Correlation of pollock and herring yield broods inhabiting the northern part of the Sea of Okhotsk

Andrey **Smirnov**

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The data on North-Okhotsk pollock and Okhotsk and Gizhiga-Kamchatka herring during the period 1978–2004 are analyzed based on samples obtained by scientists of the Research Institute of Fisheries and Oceanography. These species inhabit the northern part of the Sea of Okhotsk. It is known that a brood can vary in abundance and yield, respectively. The broods can be divided based on yield: high-yield, *i.e.* having high-abundance, poor-yield with low abundance, and middle-yield having intermediate values between extreme indices. The range can be graded by a three-point system: high-yield broods have three points, middle-yield has 2 points, and poor-yield has 1 point. We ascertained that the yield of North-Okhotsk pollock and Gizhiga-Kamchatka herring possess inverse correlations: during the years of high-yield pollock, herring had poor-yield, and vice versa. Despite the dynamics of North-Okhotsk pollock yield and Okhotsk herring being directly related, the broods of the same yield were formed in the same years. It is probable that pollock and Okhotsk herring populations are formed under the same conditions while conditions of Gizhiga-Kamchatka herring population formation in Shelekhov Bay, where the main spawning grounds are located, vary considerably. Moreover, the variable character of these correlations may be explained by immense pressure of commercial fishing on pollock and Okhotsk herring whereas Gizhiga-Kamchatka herring are caught in smaller numbers.

## S5-4

## New data on ectoparasites of walleye pollock in the Okhotsk Sea

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New data on walleye pollock *Theragra chalcogramma* infection by ectoparasites were obtained in the pelagic survey of PV Professor Kaganovsky conducted in the Okhotsk Sea in March-May of 2010. Among 6313 examined specimens of pollock with length 6-70cm, 20% were infected by ectoparasites: the parasitic copepods *Clavella perfida* Wilson*, Haemobaphes diceraus* Wilson, and *Lepeophtheirus cuneiter* Kabata, and the leech *Berigbdella rectangulata* (Levinsen). All these parasites are pathogenic for their hosts; moreover, they damage the outward appearance of the fish products. *C. perfida* was the most widespread: it was found in 1007 specimens of pollock from all parts of the Sea, mainly in adults from the depth 150-200m, with an intensity of 1-20 parasites per fish (the highest intensity was in the Shelikov Bay and at Kuril Islands, the lowest – in the central part of the Sea). *H. diceraus* was found in 170 specimens, mainly adults, also from almost the whole Sea, except of the waters at Sakhalin Island; on average 3% of fish were infected (up to 17% at north-west Kamchatka) with intensity of 1-2 parasites per fish. *L. cuneiter* was found only once at Sakhalin coast. *B. rectangulata* was only found in samples from west Kamchatka where it infected about 6% of fish with intensity of 1-20 parasites per fish; infections were localized on gills. Possibly, the leech distribution is limited to this region because of higher water temperatures. Generally, the infectiousness of pollock by ectoparasites increases with its age and from south to north. The data on ectoparasites could be used in studies of the pollock population structure.

## S5-5

## Effects of water temperature increases on eastern Bering Sea juvenile pollock predation

Tadayasu **Uchiyama**, Gordon H. Kruse and Franz J. Mueter

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Walleye pollock is the most abundant and commercially most important groundfish species in the Bering Sea. However, the eastern Bering Sea (EBS) pollock stock declined substantially after 2003 because of poor recruitment between 2001 and 2005. Juvenile pollock are important forage fish in the EBS ecosystem, often representing the largest fraction in the diets of major Bering Sea piscivores. Predation seems to play an important role in determining pollock recruitment strength. Some studies have suggested that a pool of cold water on the EBS shelf provides a refuge for juvenile pollock from their predators, and the warming trend of recent climate may have caused an increase in predation on juvenile pollock. We constructed a biomass dynamics models of walleye pollock, Pacific cod, arrowtooth flounder, and four other flatfish species with trophic interactions to quantify the magnitude of predation, and to test the hypothesis that reduction in the extent of the cold pool (indicated by annual mean water temperature) intensified predation on juvenile pollock, contributing to poor pollock recruitment in 2001 – 2005. Preliminary results indicate that an increase in water temperature caused more intense cannibalism on juvenile pollock, while having minor effects on predation by other fish predators. Despite the increased rate of cannibalism, concurrent declines in adult pollock biomass kept predation on juveniles at low levels between 2001 and 2005, the period of poor pollock recruitment. Climate likely affected pollock recruitment through processes other than predation/cannibalism, such as reduced forage quality for juvenile pollock under warmer climate conditions.

# S6 BIO/MEQ Topic Session
# Environmental contaminants in marine ecosystems: Seabirds and marine mammals as sentinels of ecosystem health

**Co-Sponsored by JSPS**

***Co-Convenors***: *Peter Ross (Canada), Hideshige Takada (Japan) and Yutaka Watanuki (Japan)*

***Invited Speakers***:
*John Elliott (Science & Technology Branch Environment Canada)*
*Atsuhiko Isobe (Ehime University, Japan)*
*Andy Sweetman (Centre for Chemical Management, Lancaster University, UK)*
*Hideshige Takada (Tokyo University of Agriculture and Technology, Japan)*
*Rei Yamashita (Tokyo University of Agriculture and Technology, Japan)*

Urban and industrial developments in the world's coastal regions have led to the release of a large number of pollutants (heavy metals, POPs, plastics, oils, radioactive substances) into the marine environment. In some cases, these have detrimental effects on variety of marine resources in coastal and offshore areas. It is increasingly important to identify sources, subsequent transport through marine physical systems and resulting spatial patterns of these anthropogenic stressors. Compared to river-lake systems, knowledge of anthropogenic stressors in marine systems is less understood due to difficulties with detection over wide areas and in offshore regions. As top predators, such as many marine mammals and seabirds, bio-magnify some of these pollutants, these organisms can be used as bio-indicators of coastal, marine and/or food web contamination. The utility of these 'sentinels' was discussed at the PICES-2011 MEQ Workshop. This session will: 1) identify spatial patterns and geographic areas of concern (high concentrations) of pollutants or other stressors in the PICES region using bio-indicator species, 2) examine mechanisms of transport, and ultimate disposition, of contaminants in marine ecosystems, and 3) discuss health risks for certain predators and human consumers. Review papers, case studies, and innovative methods papers on anthropogenic stressors in marine predators are invited, as well as papers that distinguish between the effects of natural and anthropogenic stressors. In particular, studies linking predator habitat use with spatial aspects of stressors in the environment and in predators are encouraged.

## Wednesday, October 17 (9:00-13:00)

| | |
|---|---|
| 09:00 | ***Introduction by Convenors*** |
| 09:05 | **Andy Sweetman, John Crosse, Richard Shore, Gloria Pereira and Kevin Jones**<br>Long term trends in PBDE concentrations in gannet (*Morus bassanus*) eggs from two UK colonies (S6-8461), Invited |
| 09:30 | **Rei Yamashita, Hideshige Takada, Mai Miyazaki, Takashi Yamamoto, Akinori Takahashi, Maki Yamamoto, Philip N. Trathan and Yutaka Watanuki**<br>Persistent organic pollutants (POPs) in preen gland oils from streaked shearwaters reflect exposure in overwintering areas (S6-8745), Invited |
| 09:50 | **Sang Hee Hong, Gi Myung Han, Won Joon Shim, Sung Yong Ha and Nak Won Heo**<br>Concentrations and profiles of persistent organic pollutants (POPs) in birds collected from an urbanized coastal region of South Korea (S6-8763) |
| 10:10 | **Annamalai Subramanian and Shinsuke Tanabe**<br>Developing Asian countries as sources of pollutants to the Asia-Pacific region (S6-8540) |
| 10:30 | ***Coffee/Tea Break*** |
| 10:50 | **John E. Elliott, Kyle H. Elliott, Melanie F. Guigueno, Laurie K. Wilson, Sandi Lee and Abde Idrissi**<br>Seabirds are indicators of persistent contaminants in the marine environment: Examples from the Pacific Coast of Canada (S6-8626), Invited |

11:15 **Peter S. Ross**
Persistent Organic Pollutants (POPs) in marine mammals: Harmless chemicals or lingering poisons? (S6-8641)

11:35 **Vasiliy Yu. Tsygankov, Margarita D. Boyarova, Anna A. Lukashkina, Peter A. Tyupeleev, Ilya A. Shcherbakov, Yuri V. Prikhodko and Olga N. Lukyanova**
Marine mammals as bioindicators of persistent toxic substance (PTS) contamination in Russian Subarctic marine ecosystems (S6-8554)

11:55 **Atsuo Ito, Rei Yamashita, Hideshige Takada, Takashi Yamamoto, Kozue Shiomi, Carlos Zavalaga, Takuya Abe, Shinichi Watanabe, Maki Yamamoto, Katsufumi Sato, Hiromi Kohno, Ken Yoda, Tomohiko Iida and Yutaka Watanuki**
POPs in the preen gland oil of Streaked Shearwaters breeding on the islands in Japan reflect marine pollution in western North Pacific (S6-8465)

12:15 **Atsuhiko Isobe, Shin'ichiro Kako and Etsuko Nakashima**
Marine/beach plastic litter as a transport vector of pollutants (S6-8533), Invited

12:35 **Kosuke Tanaka, Hideshige Takada, Rei Yamashita and Yutaka Watanuki**
Marine plastics: Monitoring matrix for persistent organic pollutants (POPs) and carrier of POPs to seabirds (S6-8731), Invited

12:55 *Discussion*

13:00 *Session Ends*

## S6 Posters

S6-1 **Andrey S. Neroda, Vasily F. Mishukov, Vladimir A. Goryachev, Denis V. Simonenkov and Anna A. Goncharova**
Radioactive isotopes in atmospheric aerosols over Russia and the Sea of Japan following the nuclear accident at Fukushima nr. 1 Daiichi nuclear power station in March 2011

S6-2 **Tatiana Chizhova, Pavel Tishchenko, Liubov Kondratieva and Takuya Kawanishi**
Polycyclic aromatic hydrocarbon (PAH) distribution in the Amur River estuary

S6-3 **Yulia Koudryashova, Natalia Prokuda, Natalia Khodorenko, Tatiana Chizhova and Pavel Tishchenko**
PAHs in sediments of rivers of the Primorsky Region, Far East of Russia

S6-4 **Mikhail V. Simokon**
Ecological risk evaluation of metals in the coastal areas of Peter the Great Bay, Japan/East Sea

# S6 Session Oral Presentations

### October 17, 09:05 (S6-8461), Invited

## Long term trends in PBDE concentrations in gannet (*Morus bassanus*) eggs from two UK colonies

Andy **Sweetman**[1], John Crosse[1,2], Richard Shore[2], Gloria Pereira[2] and Kevin Jones[1]

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Polybrominated diphenyl ethers (PBDEs) are a class of anthropogenic organic compounds widely used as flame retardants in products such as carpets, paints, mattresses, furniture and electronic devices. PBDEs are hydrophobic, resistant to degradation, bioaccumulative, toxic and prone to long range transport (LRT) with tetra- to penta- BDEs listed in Annex A of the Stockholm Convention on Persistent Organic Pollutants. The three most commonly used technical PBDE mixtures (PentaBDE, OctaBDE and DecaBDE) have been produced in large amounts with recent global production rates of more than 50 kilotons. Trends in PBDE contamination in biota have been found to vary with habitat, species and region within Europe, but long-term data for UK biota are sparse. PBDE contamination over the period 1977 – 2007 has been determined in marine ecosystems around the UK using the eggs of the gannet (*Morus bassanus*), which have been collected from two colonies, Ailsa Craig and Bass Rock. PBDE concentrations in eggs from both colonies increased from the late 1980s, peaked in 1994, and then rapidly declined so that concentrations in 2002 were similar or lower to those in eggs from the 1970/80s. PBDE congener profiles and time trend data suggest that the penta-BDE technical formula has been the main source of PBDE contamination to date in the eggs of gannets from the UK. However, the contribution of heavier congeners to ΣPBDE concentrations has increased over time in the eggs which may indicate that other sources, or possible degradation of DecaBDE, are becoming more important.

### October 17, 09:30 (S6-8745), Invited

## Persistent organic pollutants (POPs) in preen gland oils from streaked shearwaters reflect exposure in overwintering areas

Rei **Yamashita**[1], Hideshige Takada[1], Mai Miyazaki[1], Takashi Yamamoto[2], Akinori Takahashi[2], Maki Yamamoto[3], Philip N. Trathan[4] and Yutaka Watanuki[5]

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Persistent organic pollutants (POPs), such as polychlorinated biphenyls (PCBs) and p,p'-DDE (metabolites from Dichlorodiphenyltrichloroethane; DDTs), are highly accumulated in seabirds. This reflects the process of biomagnification, such that seabirds at the top of food webs can serve as a sentinels of marine pollution. For global POP monitoring, we propose a nondestructive method by utilizing preen gland oil, *i.e.*, oils secreted from the preen glands (located at the base of the tail feathers) of seabirds. We analyzed PCBs and p,p'-DDE in preen gland oils from streaked shearwaters (*Calonectris leucomelas*) at a breeding colony on Awa Island, Japan. Annual movements of these birds were tracked using geolocators which showed that the birds overwinter in one of the following three regions; Arafura Sea (AFS), South China Sea (SCS) or Northern New Guinea (NNG). PCB and DDE concentrations were higher in birds overwintering in SCS than the other locations. These results were consistent with the spatial pattern observed for the other monitoring media (*e.g.* mussels and sediments). In addition to this link to regional exposure, we examined the role of trophic level by measuring fatty acid composition in preen gland oils and stable isotope signatures (delta$^{13}$C and delta $^{15}$N) in feathers. Fatty acid composition and stable isotope signatures showed no difference among three wintering areas. Hence, higher POPs concentrations in SCS birds appear to be largely due to regional differences in pollution levels. This study demonstrates that seabirds can be useful media for identifying POPs hotspots on a global scale when their annual movement and feeding ecology are understood.

## October 17, 09:50 (S6-8763)

## Concentrations and profiles of persistent organic pollutants (POPs) in birds collected from an urbanized coastal region of South Korea

Sang Hee **Hong**, Gi Myung Han, Won Joon Shim, Sung Yong Ha and Nak Won Heo

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Birds can occupy upper trophic levels and accumulate a wide range of contaminants, and can therefore serve as bioindicators for environmental pollution, particularly by persistent organic pollutants (POPs). Although POP monitoring has been extensively carried out for a variety of abiotic and biotic samples including air, water, sediment, bivalves, fish, and human milk in various locations of South Korea over the last decade, little information is available on POP contamination in birds. In this study, legacy and emerging POPs were monitored in birds collected an urbanized coastal region of South Korea. The black-tailed gull and domestic pigeon were selected as the primary target species for the assessment of contamination by POPs and a comparison between marine and terrestrial ecosystems. The POP concentration (unit: ng/g lipid weight) in resident birds was in the range of 71-7,120 (median value: 1,600) for PBDEs, 14-131,000 (13,400) for PCBs, 40-284,000 (11,200) for DDTs, nd-2,800(273) for CHLs, 23-2,020 (406) for HCHs, 2-1,520 (261) for HCB, and nd-48 (5) for pentachlorobenzene. The overall concentration of POPs was high in seagull compared to pigeon, which islikely due to their differing diet and trophic position. The stable isotope ratio of nitrogen and carbon showed that seagull enriched the heavier isotopes relative to pigeon. However, the level of emerging POPs such as PBDEs was high in pigeon. Interestingly, BDE-209 and other higher brominated PBDEs are dominant in domestic pigeon, while BDEs 47, 99 and 153 are dominant in seagulls. This result indicates exposure to the highly brominated BDE mixtures through unintentional intake of road dust or soils, while the gulls acquired contaminants via the marine food web. Lindane (g-HCH) was also relatively abundant in pigeon, due to its current usage in the remedy of head lice. This study demonstrated that these two bird species acquire POPs from different sources, one representing a locally-contaminated terrestrial ecosystem, and the other being a marine food web-based biomagnification.

## October 17, 10:10 (S6-8540)

## Developing Asian countries as sources of pollutants to the Asia-Pacific region

Annamalai **Subramanian** and Shinsuke Tanabe

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It has long been believed that the industrialised nations represent the dominant sources of global contamination by organic pollutants. Studies in recent decades have shown that, in addition to the industrialized world, developing countries are also contributing to serving as pollution sources. This talk will be an extensive review of the studies conducted by our laboratory (CMES, Ehime University, Japan) on the sources, distribution, environmental fate, spatial and temporal trends and possible toxic implications of some persistent toxic substances in the Asia-Pacific region. Localized contaminant hotspots can be attributed to the widespread use by some countries. Our results showed two different characteristics of transport of these persistent chemicals. Chemicals like DDTs and PCDD/Fs were transported shorter distances and their levels were higher near to their sources, whereas chemicals like HCHs, PCBs and PBDEs were found even at sites far removed from their sources. It was also evident that some nationsserved as sources of certain contaminants; Japan and Hong Kong (China) may be important contributors of PCBs to the global environment, while India was a source for HCHs and Vietnam for DDTs. PBDEs were found to originate from both industrialized and developing nations in the Asia-Pacific region. The higher levels of toxic POPs (like dioxins) in some areas present health hazards to human and wildlife, which is likely to become a topic of considerable management concern in the future.

**October 17, 10:50 (S6-8626), Invited**

## Seabirds are indicators of persistent contaminants in the marine environment: Examples from the Pacific Coast of Canada

John E. **Elliott**[1], Kyle H. Elliott, Melanie F. Guigueno, Laurie K. Wilson, Sandi Lee and Abde Idrissi

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Marine birds are effective sentinels for monitoring xenobiotic contamination of the marine environment. Their eggs provide a relatively non-intrusive tool to measure substances, such as persistent organic pollutants (POPs) and mercury, which are maternally transferred to the egg via yolk lipids or proteins. Here we report and discuss data from long term monitoring of POPs and mercury in seabird eggs from the northeast Pacific over four decades (1970-2011). For this program, the marine system was divided, and representative species selected. The nearshore subsurface is monitored using two cormorant species (double-crested, *Phalacrocorax auritus*, and pelagic, *P. pelagicus*); both feed on a variety of benthic and pelagic fish. The offshore subsurface is monitored using the rhinoceros auklet, *Cerorhinca monocerata*, which feeds mainly on small pelagic fishes. The offshore surface is monitored with the Leach's storm-petrel, *Oceanodroma leucorhoa*, which feeds mainly on surface plankton and larval fishes. At three breeding colonies for each species along the Pacific coast of Canada and at four year intervals, 15 eggs are collected and analyzed as five pools of 3 eggs each. Data will be presented on long term temporal trends and spatial variation for representative organic contaminants. For example, a recent retrospective study using archived samples, showed that polybrominated diphenyl ether (PBDE) and hexabromocyclododecane (HBCD) flame retardants increased 10-fold from 1990 to 2011 in storm-petrel eggs from the Gulf of Alaska. Stable carbon, nitrogen and sulphur isotopes reveal some of the role of dietary variation in relative contaminant burdens within seabirds, possibly related to marine regime shifts.

**October 17, 11:15 (S6-8641)**

## Persistent Organic Pollutants (POPs) in marine mammals: Harmless chemicals or lingering poisons?

Peter S. **Ross**

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The Stockholm Convention (2004) provides an international framework to phase out contaminants considered to be 'persistent, bioaccumulative, and toxic', and arose from national regulations enacted in the 1970s in most industrialized nations. Our work in the Northeastern Pacific Ocean over the past 15 years has shown that harbour seals (*Phoca vitulina*) and killer whales (*Orcinus orca*) are contaminated with a variety of POPs. While we have noted improving (*i.e.* decreasing) trends for many POPs, the levels of PCBs continue to exceed established health thresholds in many marine mammals. In support of such risk-based evaluations, we developed new techniques (endocrine, immune and genomic measurements) to measure the health of wild marine mammals. Results indicate PCBs are affecting immune function, thyroid hormone and vitamin A levels, and the expression of Aryl hydrocarbon (AhR), Thyroid hormone (TRα), Estrogen (ERα), and Interleukin-10 (IL-10) receptors in healthy, free-ranging individuals. Collectively, this body of knowledge indicates that high trophic level marine mammals are at heightened risk of infectious disease outbreaks, reproductive impairment, and developmental abnormalities. Modelling suggests that the health of killer whales from the NE Pacific will not be 'protected' from PCBs until the end of the 21st Century. The lingering health risks associated with a single chemical product underscore the profound vulnerability of high trophic level marine mammals to POPs, and raise fundamental questions about the contamination of Pacific food webs, the implications for coastal (including aboriginal) peoples, and the effectiveness of chemical regulations in protecting aquatic ecosystems from injury.

**October 17, 11:35 (S6-8554)**

## Marine mammals as bioindicators of persistent toxic substance (PTS) contamination in Russian Subarctic marine ecosystems

Vasiliy Yu. **Tsygankov**[1], Margarita D. Boyarova[1], Anna A. Lukashkina[1], Peter A. Tyupeleev[2], Ilya A. Shcherbakov[1], Yuri V. Prikhodko[1] and Olga N. Lukyanova[1,2]

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Marine mammals bio-magnify various pollutants may therefore be used as bioindicators in global monitoring of environmental contamination. While several studies have reported PTS accumulation in marine mammals in Subarctic regions, data for Russian areas of the Bering Sea is very scarce. We measured persistent organochlorine (OC) pesticides (isomers and metabolites of HCH and DDT) and toxic elements (Hg, Pb, Cd, As) in the liver and muscles of grey whales (*Eschrichtius robustus;* 4 male and 3 female) of different ages, and Pacific walrus (*Odobenus rosmarus divergens;* 5 male and 3 female) caught in summer 2010-2011 from the coast (Mechigmensky Bay) of the Bering Sea. The total concentration of pollutants in the adult grey whales was higher than in young individuals. POP content in muscle and liver of the whales varied from 297 to 3581 ng/g lipids, and from 769 to 13808 ng/g lipids, respectively. The total concentrations of POPs in Pacific walrus was higher than levels in grey whales. The total concentration of PTS in muscles and liver of pacific walrus varied from 197 to 5659, and from 4856 to 90263 ng/g lipids, respectively. This fact may be caused by the differences in diets and specific positions in food web. Maximum concentrations of toxic elements were discovered in the liver of adult individuals. Mercury has only been found in organs of adult individuals. Since no major local point sources of contamination exist in this region, the origin of many of these contaminants can be attributed to long-term transport via atmospheric processes and ocean currents.

**October 17, 11:55 (S6-8465)**

## POPs in the preen gland oil of Streaked Shearwaters breeding on the islands in Japan reflect marine pollution in western North Pacific

Atsuo Ito[1], Rei Yamashita[2], Hideshige Takada[2], Takashi Yamamoto[3], Kozue Shiomi[4], Carlos Zavalaga[5], Takuya Abe[5], Shinichi Watanabe[6], Maki Yamamoto[7], Katsufumi Sato[4], Hiromi Kohno[8], Ken Yoda[5], Tomohiko Iida[9] and Yutaka **Watanuki**[1]

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Persistent Organic Pollutants (POPs) are diffused and transported in the sea. POPs are highly accumulated in the tissues of marine top predators through bio-magnification, and can disturb endocrine function and induce reproductive failure. To monitor POPs in the seas around Japan, we analyzed those in the preen gland oil collected from streaked shearwaters *Calonectris leucomelas* breeding at four islands. Foraging ranges of the sample birds were tracked using GPS tags. Total PCB was highest in birds breeding at Uwa and foraging mainly within small area (<60km) in Seto-Inland Sea. Total DDT was highest and the proportion of DDE (metabolite of DDT) was lowest in birds breeding at Nakanokami and presumably foraging in East China Sea. Total HCH was highest in birds breeding at Awa and foraging in northern Japan Sea. All POPs were lowest and the proportion of lower-chlorinated PCB congeners was highest in birds breeding at Funakoshi and foraging in Pacific Sea off northern Japan. These regional variations could be related to the trends in emissions, and subsequent transport and fate of POPs, and are consistent with previous observations of regional variation of POPs in mussels and seawater. Thus, we conclude that the POPs in the seabird preen gland oil during breeding partly reflects those in the seas around their breeding colonies.

**October 17, 12:15 (S6-8533), Invited**

## Marine/beach plastic litter as a transport vector of pollutants

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Plastic litter in the marine environment and along adjacent coastlines is a serious threat to some biota. Our research on beach/marine litter represents a collaborative project between physical oceanographers and environmental chemists. Firstly, we established a numerical model to hindcast/forecast drifting objects carried by ocean currents over the East Asian marginal seas. In addition, we attempt to establish time series for beach litter quantities on various beaches of Japan by analyzing webcam images positioned on the shoreline. Furthermore, we examined toxic metals such as lead (Pb) contained within plastic litter as additives which serve as catalysts, pigments, and plastic stabilizers. The potential risk of toxic metals leaching into a beach environment from plastic litter washed ashore was evaluated by *in-situ* beach survey and leaching experiments in conjunction with a Fickian diffusion model analysis. In particular, fishing floats made from polyvinyl chloride (PVC), which are frequently found on various beaches in Japan, showed high levels of Pb. Pb leaching experiments using collected PVC floats suggested that Pb in plastic litter can leach into water adjacent to the beach, and that plastic litter may act as a "transport vector" of toxic metals to the beach environment. The present study indicates that plastic litter carried by ocean currents can deliver contaminants to the beach environment.

**October 17, 12:35 (S6-8731), Invited**

## Marine plastics: Monitoring matrix for persistent organic pollutants (POPs) and carrier of POPs to seabirds

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Increasing amounts of plastics end up in the world's oceans, as a consequence of increased plastic production and poor management of garbage. Plastic debris is frequently observed on the sea surface. It has been revealed that marine plastics contain persistent organic pollutants (POPs), reflecting sorption from ambient seawater. The International Pellet Watch (IPW) uses marine plastics as a medium to monitor POP concentrations and patterns in marine environments. IPW showed that POPs are widely distributed in oceanic environments, though their concentrations in open oceans are trace. IPW identified POP hotspots, including coastal areas near Los Angeles, San Francisco, Tokyo, and Osaka in the North Pacific, and DDT hotspots near south China and Vietnam. In addition to sorption-derived chemicals, marine plastics contain additives. It has been reported that many species of marine organisms ingest plastics. Thus, transfer of the chemicals from ingested plastics to the tissue of marine organisms has been of concern. We measured the flame retardant polybrominated diphenyl ethers (PBDEs) in the abdominal adipose tissue of 12 individuals of short-tailed shearwaters accidentally caught during experimental fishing in the North Pacific Ocean. All the examined seabirds contained plastics in their digestive tract. In three individuals, higher brominated congeners (*e.g.*, BDE-209 and BDE-183) were detected both in the adipose tissue and ingested plastics. These congeners were not detected in pelagic fishes, which can be considered as prey of the seabirds. Thus, the detection of the higher brominated congers suggests that marine plastics can act as carrier of toxic chemicals to tissue of seabirds.

# S6 Session Poster Presentations

## S6-1

### Radioactive isotopes in atmospheric aerosols over Russia and the Sea of Japan following the nuclear accident at Fukushima nr. 1 Daiichi nuclear power station in March 2011

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On March 11, 2011, at 14:46 local time (or JST) an earthquake occurred with an epicenter near the eastern coast of Honshu Island (Japan), at a distance of approximately 70 km from the nearest point on the Japanese coast. The 'Great East Japan Earthquake' triggered extremely destructive tsunami waves which resulted in a number of nuclear accidents at Fukushima Nr. 1 Daiichi Nuclear Power Station. The Fukusima-1 nuclear accidents have resulted in a release of some radioactive elements, including radioactive iodine-131, cesium-134, and cesium 137. Artificial radionuclides, such as iodine-131 (I-131), cesium-134 (Cs-134) and cesium-137 (Cs-137), as well as natural isotopes of beryllium-7 (Be-7) and potassium-40 (K-40) were detected in atmospheric aerosols over Vladivostok between March 11 and June 17, 2011. Additionally, Cs-134 and Cs-137 were detected in atmospheric aerosols over Tomsk between March 16 and June 17, 2011. Artificial radionuclides were also detected in atmospheric wet deposition samples. Moreover, these radionuclides were detected in atmospheric aerosols over the sea surface of the Sea of Japan between May 3 and May 31, 2011 during an expedition of the sailing vessel "Nadezhda". Between March 25 and April 15, an increase in concentrations of atmospheric aerosols over Vladivostok from 121 $\mu g/m^3$ to 330 $\mu g/m^3$ was detected. This increase was accompanied by an increase in gamma-ray activity associated with Cs -134, Cs-137 and I-131. During the period March 18 to April 8, gamma-ray activity of Cs-137 and Cs-134 in atmospheric aerosols increased 100 times compared with the minimum detectable activity (MDA) level, and peaked in the weekly sample collected from April 8 to 15 (166 $\mu Bq/m^3$ and 169 $\mu Bq/m^3$ respectively). Variability of gamma activity of natural isotopes of Be-7 and K-40 was not greater than one order magnitude throughout the sampling period. Between March 25 and April 8, 2011, a 100-fold increase in gamma-ray activity of Cs-137 and Cs-134 in atmospheric aerosols compared to the minimum detectable activity (MDA) level was detected in the city of Tomsk. Maximum values of Cs-137 and Cs -134 concentrations (213.8 $\mu Bq/m^3$ and 84.5 $\mu Bq/m^3$ respectively) were observed in samples taken from April 1 to 8. Maximum gamma-ray activity of Cs-137, Cs -134 and I-131 over the Sea of Japan surface was 61 $\mu Bq/m^3$, 153.7 $\mu Bq/m^3$ and 787 $\mu Bq/m^3$ respectively.

## S6-2

### Polycyclic aromatic hydrocarbon (PAH) distribution in the Amur River estuary

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A large number of organic compounds, including anthropogenic pollutants, are transported into marine environment through riverine runoff. In order to eo evaluate the impact of pollutants, it is important to investigate the transport, fate and effects of anthropogenic compounds in the aquatic environment. The distribution and fate of pollutants in water and sediments of estuaries depends on several factors including salinity, pH and other factors. Polycyclic aromatic hydrocarbons (PAHs) are widespread pollutants in aquatic systems and can often be delivered as a result of anthropogenic inputs. Their main sources include both high and low temperature combustions of fossil fuels (*e.g.* industrial pyrolysis, urban coal and oil power stations, automobile and ship exhaust), the direct release from oil and its products, as well as natural events including volcanoes and forest fires. PAHs are considered to be hazardous to the environment, in that they possess carcinogenic and mutagenic activities.

We determined the concentrations of two- to six-ring PAHs in the dissolved phase (DP) and particulate phase (PP) in the Amur River estuary. Samples were collected in June 2006 on the vessel R/V "BGK-795". The salinity ranged from 0.035‰ to 25.17‰. Concentrations of PAHs in the samples were determined by means HPLC-fluorescence detection. The total concentration of 12 PAHs in PP ranged from 4.85 to 11.1 ng/L (or 0.18 to

1.39 mkg/g). The total concentration of 12 PAHs in DP ranged from 25 to 91.4 ng/L. Concentrations of PAHs were highest at the mouth of the Amur River and decreased with distance away into the sea. Hence we expect the main source of PAHs in the estuary to be the Amur River.

### S6-3

## PAHs in sediments of rivers of the Primorsky Region, Far East of Russia

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At present, environmental monitoring programs rely heavily on sediments for the contamination assessment of aquatic systems, reflecting the ability of sediments to accumulate pollutants. When hydrophobic contaminants are released into the aquatic environment, they typically partition to suspended matter, which can lead to sedimentation. River estuaries are especially vulnerable to contamination, with coagulation, adsorption and co-precipitation processes acting in this geochemical “river-sea” barrier. Polycyclic aromatic hydrocarbons (PAHs) are hydrophobic contaminants that are highly stable in the environment; they are able to bioaccumulate to a degree through the food chain and can present risks to human and ecological health. Sediments were collected from estuarine areas in six rivers (Artemovka, Gladkaya, Lebyazh'ya, Lebedinnaya, Partizanskaya and Razdol'naya) flowing into the Japan Sea. PAHs from the USEPA priority PAH list were quantified. Concentrations of PAHs in the samples were determined by means of HPLC-fluorescence detection. The total concentration of PAHs ranged from 70 to 405 mg/kg of dry weight. In this study we also determined concentrations of humic substances and total organic carbon (TOC). It was found strong correlation between total concentration of PAHs and TOC content in studied sediments.

### S6-4

## Ecological risk evaluation of metals in the coastal areas of Peter the Great Bay, Japan/East Sea

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Analytical information on the concentrations of environmental contaminants alone is insufficient to characterize the health of marine ecosystems. The biological consequences of exposure to such contaminants is an essential component of ecotoxicological monitoring, and represents a foundation for risk assessment. One important step in such a risk assessment is to determine which of the chemicals detected at a site are bioaccumulative. The distribution of metals in marine sediments of Peter the Great Bay demonstrates localized areas of contamination near known point sources. The highest concentrations of arsenic and heavy metals in the surficial layer of marine sediments were observed in the vicinity of waste discharges associated with different kinds of human activity. Accumulation of metals by marine organisms to a degree reflects ambient condition and therefore indicates their bioavailability of local contaminants to the food web. For example, concentrations of lead in mussels from a site adjacent to a municipal solid waste source were significantly higher than in mussel tissues from other sites ($p<0.05$). Harbor seals from Peter the Great Bay are common top predators in the local food web and accumulate mercury up to 2.12 mg/kg in the liver. This suggests that some metals may reach harmful concentrations to some biota in Peter the Great Bay. The Hakanson method represents a useful tool to evaluate the potential risk of metal pollution and provides a means to classify sites according to risk level.

# S7 BIO/FIS Topic Session

## Jellyfish in marine ecosystems and their interactions with fish and fisheries

**Co-Sponsored by ICES**

***Co-Convenors**: Richard Brodeur (PICES/USA), Cornelia Jaspers (ICES/Denmark), Christopher Lynam (ICES/UK), Song Sun (PICES/China), Shin-Ichi Uye (PICES/Japan) and Won-Duk Yoon (PICES/Korea)*

***Invited Speakers**:*
*Thomas K. Doyle (University College Cork, Ireland)*
*William M. Graham (University of Southern Mississippi, USA)*
*Reiji Masuda (Kyoto University, Japan)*

Evidence is accumulating that gelatinous zooplankton populations have increased substantially in many regions of the world, most likely through anthropogenic stresses, but we have insufficient understanding of how these blooms affect fish and, more broadly, marine ecosystems. Some benefits of jellyfish to marine fish include provisioning of food for some species and shelter for juvenile stages of several others. There is also a relatively minor human benefit in that some jellyfish are both commercially fished and cultured for human consumption in several countries. However, the negative effects of jellyfish population outbursts are thought to greatly exceed any positive ones and their effects on ecosystems and the economies that depend on them can be profound. These effects have been examined through field studies, controlled laboratory experiments, and estimated using quantitative ecosystem models. Jellyfish are generally detrimental to fish because they feed on zooplankton and ichthyoplankton, and so are both predators and potential competitors of fish. Relatively little of the energy consumed by gelatinous zooplankton ends up at higher trophic levels of interest to humans compared to krill and forage fishes. Jellyfish blooms also directly impact commercial fisheries through filling or clogging trawls and fouling fixed gear and aquaculture net pens, resulting in enormous economic losses worldwide. This session will focus on empirical field, laboratory, or modeling studies that examine the effects jellyfish have on marine ecosystems, fish species and fisheries, and relevant ecosystem-based management issues important to the needs of society over wide-ranging space and time-scales up to and including climate variations.

### Thursday, October 18 (9:00-18:00)

| | |
|---|---|
| 09:00 | ***Introduction by Convenors*** |
| 09:05 | **William M. Graham, Stefan Gelcich, Carlos M. Duarte, Shin-ichi Uye, Richard Brodeur, Robert H. Condon and NCEAS Jellyfish Working Group**<br>Jellyfish and fisheries: Risks, trade-offs and adaptations (S7-8601), Invited |
| 09:35 | **Thomas K. Doyle, Emily J. Baxter, Graeme C. Hays, Hamish D. Rodger and Neil M. Ruane**<br>Detrimental impacts of jellyfish on finfish aquaculture: insights from the North East Atlantic (S7-8603), Invited |
| 10:05 | **Reiji Masuda, Yuko Miyajima, Ryosuke Ohata and Yoh Yamashita**<br>Jellyfish as a predator and prey of fishes: Underwater observations and rearing experiments (S7-8630), Invited |
| 10:30 | ***Coffee/Tea Break*** |
| 10:50 | **Jennifer E. Purcell, Ana Sabatés, Verónica Fuentes, Francesc Pagès, Uxue Tilves, Alejandro Olariaga and Josep-María Gili**<br>Predation potential of blooming jellyfish, *Pelagia noctiluca*, on fish larvae in the NW Mediterranean Sea (S7-8367) |

11:10 **Cornelia Jaspers**
The invasive ctenophore *Mnemiopsis leidyi* in northern European waters and its potential impact on fisheries (S7-8597)

11:30 **Shin-ichi Uye, Alenka Malej and Tjasa Kogovsek**
Comparative analysis of the Inland Sea of Japan and the northern Adriatic: Can changes in anthropogenic pressures disclose jellyfish outbreaks? (S7-8623)

11:50 **Martin K.S. Lilley, Steven E. Beggs, Thomas K. Doyle, V.J. Hobson, K.H.P. Stromberg and Graeme C. Hays**
Direct and indirect evidence for massive differences in jellyfish biomass between the Pacific and Atlantic: Implications for fisheries bycatch? (S7-8590)

12:10 **Lucas Brotz, William W.L. Cheung, Reg Watson, Kristin Kleisner, Evgeny Pakhomov, Philippe Cury, Roxane Maranger, Brooke Campbell and Daniel Pauly**
Anthropogenic impacts related to observed increases of jellyfish populations (S7-8509)

12:30 ***Lunch***

14:00 **Christopher P. Lynam, Martin K.S. Lilley, Thomas Bastian, Thomas K. Doyle, Steven E. Beggs and Graeme C. Hay**
Have jellyfish in the Irish Sea benefited from climate change and overfishing? (S7-8676)

14:20 **Alexander V. Zavolokin**
Jellyfish of the Far Eastern Seas of Russia: Composition, spatio-temporal variations and significance for ecosystems (S7-8331)

14:40 **Song Sun, Chaolun Li, Guangtao Zhang, Shiwei Wang and Xiao Xia Sun**
Giant jellyfish blooms in the Yellow Sea and East China Sea (S7-8450)

15:00 **Akira Okuno, Tatsuro Watanabe, Satoshi Kitajima, Naoto Honda and Katsumi Takayama**
Numerically simulated migration/distribution of *Nemopilema nomurai* in the Japan Sea using temperature-based controls (S7-8633)

15:20 **Masaya Toyokawa, Akira Yasuda, Yusuke Murata, Kazuhiro Aoki, Manabu Shimizu and Minoru Hamada**
*Aurelia* swarms originate from polyps near the mouth of a bay: evidence from Mikawa Bay and Ise Bay (S7-8464)

15:40 ***Coffee/Tea Break***

16:00 **Mary Needler Arai**
Predation on gelatinous cnidaria and ctenophores (S7-8402)

16:20 **Brian E. Smith and Jason S. Link**
The presence of gelatinous zooplankton in the diets of fishes of the Northeast U.S. continental shelf: Trends in shelf-wide feeding and consumptive removals (S7-8667)

16:50 **James J. Ruzicka, Elizabeth A. Daly and Richard D. Brodeur**
Salmon and jellyfish: Bumping elbows in the Northern California Current (S7-8360)

17:10 **John C. Field Jarrod A. Santora Keith Sakuma Amber Payne and Baldo Marinovic**
Spatial and temporal patterns of variability in Scyphomedusae in the central California coastal marine ecosystem (S7-8798)

17:30 **Richard D. Brodeur, Mary Beth Decker, Elizabeth A. Daly, Caren Barcelo, James J. Ruzicka and Kristin Cieciel**
A tale of two *Chrysaora*: Pivotal roles in contrasting marine ecosystems (S7-8430)

17:50 *Discussion*

18:00 *Session Ends*

## S7 Posters

S7-1 **Sim Yee Kwang, Chuah Chern Chung, Anita Talib and Khairun Yahya**
Exogenous impacts on the massive occurrence of jellyfish in the northern part of Malacca Straits, Malaysia

S7-2 **Wen-Tseng Lo, Hung-Yen Hsieh and Shwu-Feng Yu**
Comparison of siphonophore assemblages during northeasterly and southwesterly monsoon seasons in the Taiwan Strait, western North Pacific Ocean

S7-3 **Ryosuke Makabe, Ryuji Furukawa, Mariko Takao and Shin-ichi Uye**
Marine construction as a factor boosting *Aurelia aurita* s.l blooms: A case study of a new floating pier deployment in Hiroshima Bay, Japan

S7-4 **Takashi Kamiyama**
Planktonic ciliates as a prey source for moon Jellyfish *Aurelia aurita*: Feeding activities and growth effects of ephyra and metephyra stages

S7-5 **Satoshi Kitajima, Akira Okuno, Naoki Iguchi, Naoto Honda, Tatsuro Watanabe and Osamu Katoh**
Low temperature excludes medusae of *Nemopilema nomurai* in the Japan Sea in winter

S7-6 **Thomas Bastian, Damien Haberlin, Mary Catherine Gallagher, Sean Rooney, Graeme C. Hays and Thomas K. Doyle**
Tracking the lion's mane jellyfish: Horizontal and vertical movements of *C. capillata* (Scyphozoa) in a shallow coastal environment

S7-7 **Steven E. Beggs, Thomas Bastian, Martin K.S. Lilley and Thomas K. Doyle**
Annual and regional variations in associations between Scyphomedusae and juvenile gadoids in the Irish Sea

S7-8 **Martin K.S. Lilley and F. Lombard**
Developing a technique for *in-situ* monitoring of fragile planktonic organisms

S7-9 **Kristin Cieciel, Jeanette Gann and Bruce Wing**
Methods for conducting individual measurements on trawled jellyfish

S7-10 **Naoki Fujii, Shinya Magome, Atsushi Kaneda and Hidetaka Takeoka**
Relationship between jellyfish abundance and environmental fluctuations in Uwa Sea

S7-11 **Jun Nishikawa, Fatimah Md. Yusoff, Nguyen Thi Thu, Khwanruan Srinui, Mulyadi and Shuhei Nishida**
Jellyfish fisheries in Southeast Asia

# S7 Session Oral Presentations

### October 18, 09:05 (S7-8601), Invited

## Jellyfish and fisheries: Risks, trade-offs and adaptations

William M. **Graham**[1], Stefan Gelcich[2], Carlos M. Duarte[3], Shin-ichi Uye[4], Richard D. Brodeur[5], Robert H. Condon[6] and NCEAS Jellyfish Working Group[7]

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Coastal marine jellyfish populations are widely known for boom-and-bust 'bloom' cycles over time-scales ranging from days to decades. And while long-term global increases remain debated, there is little doubt that human activities such as fisheries over-harvesting, cultural eutrophication, coastal hypoxia, and habitat modification exacerbate ecosystem degradation in favor of jellyfish populations. Yet, it is important to weigh the perceived 'negatives' against the 'positive' roles of jellyfish. We present a synthesis of jellyfish in the context of fisheries management issues to present a balanced view of the actual risks and trade-offs using the 'ecosystem services' framework including Regulating, Supporting, Cultural and Provisional Services. There are numerous examples of jellyfish contributing to ecosystem services, and these examples are often lost in the growing negative media attention of jellyfish harming human enterprise such as fishing, tourism and production of power or freshwater. Our analysis shows a notable scaling difference between jellyfish 'impacts' and 'services': negative 'impacts' often increase non-linearly with increasing jellyfish numbers, and positive 'services' increase, at best, linearly. In other words, jellyfish increases will likely create more harm than good. Thus, it becomes important to understand where critical cultural thresholds exist when technological counter-measures or changes in management practices are necessary to offset large variations or long-term increases of jellyfish populations. This comprehensive approach provides stakeholders and resource managers a mechanism by which human vulnerability to jellyfish populations can be assessed and, when beyond the critical thresholds, mitigated with a justification for necessary resources.

### October 18, 09:35 (S7-8603), Invited

## Detrimental impacts of jellyfish on finfish aquaculture: Insights from the North East Atlantic

Thomas K. **Doyle**[1], Emily J. Baxter[1], Graeme C. Hays[2], Hamish D. Rodger[3] and Neil M. Ruane[4]

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Local and regional increases in jellyfish biomass have been associated with overfishing, habitat modification, translocation and climate change. With this rise in jellyfish there is often an associated increase in their negative socio-economic impacts, *e.g.* closure of beaches, large fish kills. This talk will provide an overview of the detrimental impacts of jellyfish on the finfish aquaculture industry in the North East Atlantic. In essence, there are two types of jellyfish relevant to finfish aquaculture: those that are capable of causing catastrophic fish kills (in the order of hundreds of thousands), and those that are capable of causing background levels of mortalities (10-20 mortalities per day often due to gill disorders). Though catastrophic fish kills tend to make the headlines, they are infrequent and usually localized events (*i.e.* single farm). Background level events can occur over large areas (in many farms) and over protracted periods and therefore are of economic importance. Early warning systems are being developed to help detect such events including modelling, satellite imagery, physical detection devices and standard monitoring protocols (plankton hauls at farms). However, even if it is known when and where a large jellyfish bloom will occur, it is much more difficult to keep jellyfish out of the cages. Considering that the aquaculture industry generates thousands of jobs and many millions of Euros each year within the EU, with significant growth expected to meet the decline in wild fisheries catch, mitigation measures need to be urgently developed.

**October 18, 10:05 (S7-8630), Invited**

## Jellyfish as a predator and prey of fishes: Underwater observations and rearing experiments

Reiji **Masuda**, Yuko Miyajima, Ryosuke Ohata and Yoh Yamashita

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Jellyfish can be a voracious predator of fish larvae, yet it can also be an important prey item of fishes. Predator—prey interactions between them have been studied in our laboratory. Vulnerability of fish larvae to predation by moon jellyfish *Aurelia* sp. was compared among several different fish species. Japanese anchovy *Engraulis japonicus* and ayu *Plecoglossus altivelis* were most vulnerable to jellyfish predation, followed by red sea bream *Pagrus major*, jack mackerel *Trachurus japonicus* and chub mackerel *Scomber japonicus*. Two filefish species, *Stephanolepis cirrhifer* and *Thamnaconus modestus*, were most durable to jellyfish predation, probably due to skin resilience to effects of nematocysts. Several species of hatchery-reared fish juveniles were confirmed to prey on moon jellyfish. Red sea bream and tiger puffer *Takifugu rubripes* fed on jellyfish but without having a positive effect on growth. Two filefish species, in contrast, can grow by feeding only on jellyfish. Jack mackerel did not feed on jellyfish. Underwater observations of giant jellyfish *Nemopilema nomurai* revealed that jack mackerel is the most common fish to associate with the jellyfish, followed by filefishes. Fish that associated with giant jellyfish can be categorized into two facultative groups: 1) feeding on jellyfish such as filefishes and 2) fish using jellyfish for predator avoidance or as an aid for migration such as jack mackerel. Many reef fishes also fed opportunistically on giant jellyfish. We conclude that conservation of the ecosystem can be a solution for both the prevention of jellyfish blooms and for the sustainable management of fishery resources.

**October 18, 10:50 (S7-8367)**

## Predation potential of blooming jellyfish, *Pelagia noctiluca*, on fish larvae in the NW Mediterranean Sea

Jennifer E. **Purcell**[1], Ana Sabatés[2], Verónica Fuentes[2], Francesc Pagès[2], Uxue Tilves[2], Alejandro Olariaga[2] and Josep-María Gili[2]

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Blooms of *Pelagia noctiluca* jellyfish appear to be increasing in the Mediterranean Sea and cause economic damage to aquaculture and tourism industries. This species also is known as a predator of fish larvae. We combined data from experimentally measured digestion rates, *in situ* jellyfish gut contents, jellyfish and fish larva abundances, and temperature to calculate the potential predation effects on fish larvae. Although fish larvae averaged < 1% of the available mesozooplankton at shelf, front, and oceanic stations, they ranged from 5 to 32% of the prey in *P. noctiluca*. Between 0.3 and 5.5% of the *P. noctiluca* contained fish larvae. Larvae of myctophids and anchovy (*Engraulis encrasicolus*) were the most frequently consumed. Digestion times (20 to 500 min) were significantly related to temperature (21-24ºC), but not to larval size (1.5 to 30 mm in length). Jellyfish size (4 to 60 mm in bell diameter) was not tested because small larvae were fed to ephyrae and large larvae to medusae. Digestion times averaged 2.5 h, with a mean possible measurement error of 0.5 h. *P. noctiluca* densities ranged from 0.5 to 5.0 medusae $m^{-3}$, with highest densities at the front stations. Fish larva densities ranged from 0.1 to 1.0 larvae $m^{-3}$, with highest densities at the shelf stations. We estimated that between 18 and 32% of the available fish larvae were consumed daily by *P. noctiluca*. Thus, *P. noctiluca* poses an important threat to fish populations and fisheries in the Mediterranean Sea.

**October 18, 11:10 (S7-8597)**

## The invasive ctenophore *Mnemiopsis leidyi* in northern European waters and its potential impact on fisheries

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The recent invasion by *Mnemiopsis* in northern European waters has lead to concerns for fishery interests especially in the central Baltic Sea, where it overlaps with commercially important cod recruits on their spawning grounds. We present laboratory feeding rate experiments along with video recordings, *in situ* reproduction rates and distribution data to investigate the direct and indirect effect on the Baltic cod population. Feeding rates on cod larvae were low and negligible for eggs under the hydrographic conditions characteristic for the spawning grounds. Further, *Mnemiopsis* passively selected against cod eggs. Application of our clearance rates to *in situ* abundances confirmed that *Mnemiopsis* has a negligible direct predation impact on cod offspring. Further, due to drastically reduced reproduction rates at low salinities, occurrence of *Mnemiopsis* in the central Baltic appears to be dependent on advection, and is unlikely to reach large population sizes. Hence, *Mnemiopsis* constitutes neither a direct nor a potential indirect threat to the cod population in the central Baltic. However, its large reproduction potential in high saline areas with 11,500 eggs ind$^{-1}$ d$^{-1}$ and observed high abundances in parts of northern Europe make *Mnemiopsis* a severe potential food competitor with fish in these higher saline systems.

**October 18, 11:30 (S7-8623)**

## Comparative analysis of the Inland Sea of Japan and the northern Adriatic: Can changes in anthropogenic pressures disclose jellyfish outbreaks?

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Jellyfish blooms appear to be increasing in intensity and frequency in many coastal waters worldwide. We have observed a long-term increase of jellyfish outbreaks, particularly of the moon jellyfish *Aurelia aurita s.l.,* in the Inland Sea of Japan and the northern Adriatic, both semi-enclosed temperate seas in the northern hemisphere, having almost similar surfaces, average depths (ca. 35m), volumes, river inflows, annual seawater temperature ranges (ca. 10~28°C) and human populations in the coastal zone (ca. $3 \times 10^6$). Both are productive ecosystems and important fishing grounds. In these two systems, the outbreaks of the *A. aurita* medusa population became more prominent after the 1980s-90s, when various anthropogenic impacts (*e.g.* warming, eutrophication, hypoxia, loss of biodiversity) also became conspicuous. Our experiments demonstrated that these are important factors responsible for the survival and asexual reproduction of polyps to boost. Marine construction projects (*e.g.* docks, ports, marinas, aquaculture facilities), which provide overhanging surface areas for polyps to selectively settle and form colonies, have been added in both systems. Recently, recurrent *A. aurita* blooms may be attributable to the above-mentioned environmental deterioration that has prevailed in these two systems. Formerly productive fishery grounds have turned to a state that may be described as 'jellyfish-permeated', as manifested by the recent annual fish catch which is less than half of the peak observed in the 1980s.

**October 18, 11:50 (S7-8590)**

## Direct and indirect evidence for massive differences in jellyfish biomass between the Pacific and Atlantic: Implications for fisheries bycatch?

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Jellyfish have wide-spread distributions and high abundance in many ocean basins; yet, data is sparse in many locations where it would be useful to predict typical abundance for application to fisheries management. Using a global database of over 60 published gelatinous zooplankton biomass estimates (Lilley *et al.* 2011), we highlight broad-scale physical and productivity variables that are important for dictating the occurrence of jellyfish. Available data indicates considerable differences in biomass between the Atlantic and Pacific Oceans, with profound consequences for species foraging on gelatinous zooplankton. One such species is the endangered leatherback turtle *Dermochelys coriacea* which inhabits both oceans; however, there is little direct evidence currently describing the prey field available to these migrating turtles. Here we use the database to assess direct and indirect evidence of differences in gelatinous biomass between Atlantic and Pacific Oceans, with reference to both fisheries bycatch and turtle foraging behaviour.

Lilley, M.K.S., Beggs, S.E., Doyle, T.K., Hobson V.J., Stromberg, K.H.P., Hays, G.C. (2011) Global patterns of epipelagic gelatinous zooplankton biomass, *Marine Biology*, 158: 2429-2436. doi: 10.1007/s00227-011-1744-1.

**October 18, 12:10 (S7-8509)**

## Anthropogenic impacts related to observed increases of jellyfish populations

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Jellyfish populations are increasing in numerous coastal ecosystems around the world, yet the cause(s) of these increases remains unknown. While direct evidence of causal linkages is scant, several theoretical and correlative studies have associated increasing jellyfish blooms with anthropogenic impacts on marine ecosystems, including overfishing, eutrophication, ocean warming, and coastal development. Here, we present an analysis using a generalized additive model to explore increasing jellyfish populations in relation with indicators of anthropogenic impacts on Large Marine Ecosystems. Our study provides further evidence that jellyfish blooms may be linked to human activities and their associated effects on ecosystem health.

**October 18, 14:00 (S7-8676)**

## Have jellyfish in the Irish Sea benefited from climate change and overfishing?

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Climate change and overfishing may lead to ecosystem instability and may benefit non-exploited organisms such as jellyfish. In the Irish Sea, an increase in jellyfish abundance was evident between 1994 and 2009. Jellyfish abundance correlated positively with sea surface temperature (SST) and copepod biomass and negatively with spring precipitation. Principal components regression indicated that climatic indices explained 68% of the interannual variability in jellyfish abundance, where the components were based on the North Atlantic Oscillation Index, SST and precipitation. The frequency of cnidarian material present in Continuous Plankton Recorder (CPR) samples has also increased since 1970, with a period of frequent outbreaks between 1982 and 1991. Before this period, the herring stock in the northern Irish Sea declined rapidly to a low level, potentially stimulating structural change in the ecosystem. In 1985, there was a step decrease in CPR copepod biomass and in 1989, a step increase in the phytoplankton colour index, suggesting a cascading regime shift during the 1980s. Subsequent overexploitation of gadids, coupled with warm temperatures and the poor recruitment of cod, led to the rapid decline in cod biomass from 1990. While the biomass of sprat has decreased in the last decade, the herring stock has recovered partially. Reductions in demersal fishing pressure since 2000 appear to have facilitated further rises in haddock biomass. Since the 1980s regime shift, SST has increased, the fish community has altered and jellyfish abundance has risen such that jellyfish and haddock may now play an increasingly important role in the ecosystem.

**October 18, 14:20 (S7-8331)**

## Jellyfish of the Far Eastern Seas of Russia: Composition, spatio-temporal variations and significance for ecosystems

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I examined the species composition, horizontal and vertical distribution, vertical migrations, biomass, abundance and diets of jellyfish based on archival data of the TINRO-Center from trawl catches and plankton hauls in the western Bering Sea, Okhotsk Sea, western Japan Sea, and northwestern Pacific Ocean from 1990-2012. Ten species of Scyphozoa and seven species of Hydrozoa occurred in the catches. Jellyfish were widespread and have the highest concentrations in the northwestern Bering Sea, eastern Okhotsk Sea and Pacific Ocean south of Commander Islands and eastern Kamchatka. The Scyphomedusae *Chrysaora* spp., *Cyanea capillata* and the Hydromedusa *Aequorea* spp. dominated the jellyfish biomass in the trawl catches. The Hydromedusa *Aglantha digitale* was the most abundant species in the plankton net samples. During warm seasons, highest biomass of jellyfish occurred in surface waters (about 50 % in the upper 50-m layer). However, the vertical structure of jellyfish abundance typically displayed two peaks: in the surface layer and in the deep water (700-800 m or deeper). Seasonally, the biomass and abundance of jellyfish increased from spring to fall. During cold seasons, the number of jellyfish in the epipelagic layer decreased sharply due to their death following spawning and probably from migration of some individuals from surface to deep waters for overwintering. Biomass and abundance of jellyfish varied greatly from year to year and may change tenfold. Potential impacts of jellyfish on marine communities were also examined. Jellyfish biomass and abundance in the Far Eastern Seas and adjacent waters are relatively low and their blooms do not have large-scale, negative ecological consequence.

## October 18, 14:40 (S7-8450)

# Giant jellyfish blooms in the Yellow Sea and East China Sea

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Giant jellyfish, mainly *Nemopilema nomurai* Kishinouye 1922, is one of the largest jellyfish species in the world. Giant jellyfish blooms in the East Asia area are a very serious problem for the fishery and the marine ecosystem. What causes giant jellyfish blooms and how to prevent them from occurring in the future are the key questions. There are many data analysis, laboratory experiments, modeling and field investigations to test the various hypotheses on the causes of giant jellyfish blooms. The jellyfish project "The key processes, mechanisms and ecological consequences of jellyfish blooms in the China coastal waters" has been conducted for two years, analyzing the life cycle strategy, where it comes originates from and the resulting spatial distribution patterns, have been summarized . The role of the human activities, including the fishery, and correlations between the jellyfish bloom and temperature and eutrophication have been investigated. We show that the Yangtze River estuary and adjacent areas are the most important areas for giant jellyfish blooms, and the distribution patterns of the blooms depend on physical oceanographic conditions. Human activities play a vital role in the occurrence of giant jellyfish blooms.

## October 18, 15:00 (S7-8633)

# Numerically simulated migration/distribution of *Nemopilema nomurai* in the Japan Sea using temperature-based controls

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In the last decade, massive blooms of *Nemopilema nomurai* have frequently occurred, and fisheries in the Japan Sea have suffered severe damages from the blooms. Hence, in 2009, we developed a particle-tracking simulator that predicts/analyzes the appearance of the jellyfish in the Japan Sea, in order to warn fishers of the jellyfish appearance. As demanded, the simulator showed notable skill to forecast *N. nomurai* appearance. However, the simulator didn't consider survival conditions of *N. nomurai*, so that it could not reproduce the winter shrinkage of *N. nomurai* distribution (*i.e.*, they quickly disappear from the Japan Sea in winter). Recently, it was suggested that the habitat of *N. nomurai* in the Japan Sea is regulated by temperature around 14°C. Thus, we appended two temperature-based controls to our simulator. First, the swimming depth of *N. nomurai*, which was modeled by diel vertical migration, was modified so that the range of the migration was determined in relation with the depth of 15°C isothermal surface. Second, a survival condition was modeled so that the jellyfish can't survive in waters cooler than 14°C. A set of hindcasts revealed that the modified simulator represented spatiotemporal variation in the swimming depth of *N. nomurai* more realistically, with little impact on its skill in the appearance forecast. Furthermore, the modified simulator successfully depicted the winter shrinkage of *N. nomurai* distribution in the Japan Sea. Thus, our simulator is now able to predict the end of the range of *N. nomurai* bloom in a year.

**October 18, 15:20 (S7-8464)**

## *Aurelia* swarms originate from polyps near the mouth of a bay: Evidence from Mikawa Bay and Ise Bay

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Dense swarms of *Aurelia* jellyfish are often observed in innerbay areas of Japan, but we do not know where they originate from. The distribution of polyps was investigated in Mikawa Bay and polyps were shown to be concentrated near the baymouth. Results of numerical simulation showed that *Aurelia* ephyrae around the baymouth in winter-spring were transported to the innerbay in summer. This strongly suggests that the polyp colonies near the baymouth are the source of the jellyfish swarms in the bay. Three years of observation at an island near the baymouth showed that there was small interannual variation in the number of ephyrae produced yearly. The distribution of floating docks in the bay showed that floating docks are concentrated in the innermost bay and in the baymouth, but those in the innermost bay do not contribute to the jellyfish population. Combining the distribution of polyps in Mikawa Bay and Ise Bay indicates a circum-baymouth network of polyp colonies. This suggests that adding floating docks without fouling-control measures will increase jellyfish population in innerbay areas. The most effective way to prevent the large outbreaks of *Aurelia* jellyfish blooms, at least in these bays, is to remove the polyp colonies from the floats near the baymouth.

**October 18, 16:00 (S7-8402)**

## Predation on gelatinous cnidaria and ctenophores

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Over the last decade it has become recognized that pelagic coelenterates are utilized as prey particularly by other coelenterates and fish. Although the organic content may be lower than other prey, the high rates of digestion allow rates of assimilation comparable to prey such as arthropods. Fish have been raised on coelenterate diets.

**October 18, 16:20 (S7-8667)**

## The presence of gelatinous zooplankton in the diets of fishes of the Northeast U.S. continental shelf: Trends in shelf-wide feeding and consumptive removals

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An increase in gelatinous zooplankton (GZ) of the world's oceans has been documented and attributed to various drivers (*e.g.* water mass warming and overfishing). Specifically for the Northeast U.S. continental shelf, an increase of ctenophores in fish stomachs has been reported for spiny dogfish (*Squalus acanthias*). Here we address the relationship between trends of GZ in the environment and the consumption of these prey by fishes of the Northeast U.S. continental shelf from 1977-2010. We define GZ as scyphozoans, siphonophores, ctenophores, and salps. The predators examined were spiny dogfish, pollock (*Pollachius virens*), and butterfish (*Peprilus triacanthus*). The abundance of GZ on the shelf has cycled over time with 10-12 year periods and notable increases in the early 1980s and late 1990s to early 2000s. Two diet indices, percent frequency of occurrence and percent diet by mass of GZ for these fishes have varied over time with resultant pulses of predation. Annual consumptive removals of GZ by these fishes combined range from approximately 20,000 MT to 120,000 MT, with spiny dogfish being the primary GZ feeder examined. Interestingly, the relationship between GZ abundance in the environment and fish consumption was positive, suggesting that the increased GZ in fish diets corresponded to increases in GZ abundance. These increases in abundance appear to provide surges of food for commercially-important fishes on the shelf. However, the bioenergetic tradeoffs of consuming greater amounts of GZ with lower energy density compared to other prey (*e.g.* fishes and crustaceans) for these predators remains unknown.

### October 18, 16:50 (S7-8360)

## Salmon and jellyfish: Bumping elbows in the Northern California Current

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Inter-annual variability of salmon production in the northeast Pacific is understood to be driven by oceanographic variability and bottom-up processes affecting prey availability. Scyphozoan jellyfish may play an important role shaping bottom-up energy flow through pelagic food webs in diverting plankton production away from higher trophic levels. Although jellyfish and juvenile salmon feed at different trophic levels, they may be indirect competitors for plankton production. A systematic sensitivity analysis of an end-to-end ecosystem model suggests that juvenile salmon are particularly sensitive to jellyfish abundance. Pelagic surveys off Oregon and Washington (1999-2011) were used to examine the relationship between the dominant jellyfish (*Chrysaora fuscescens*) and salmon production. There was a significant, negative correlation between *C. fuscescens* and the strength of coho and Chinook returns to the Columbia River. Examination of spatial distributions across years showed a generally positive association between *C. fuscescens* and salmon. However, significant differences occurred between the distribution of jellyfish and yearling coho and Chinook during individual years, generally cooler ocean years, perhaps due to an expansion of optimal salmon habitat. Whether the association is behavioral or driven by oceanographic processes, it enhances the opportunity for indirect competition. Examination of feeding intensity in September showed that coho and Chinook stomachs were less full at stations with higher jellyfish biomass, and this relationship was not observed in June when jellyfish biomass is relatively lower. To isolate and quantify the potential effect of *C. fuscescens* variability on salmon production, end-to-end model scenarios were conducted under alternate spatial overlap configurations.

### October 18, 17:10 (S7-8798)

## Spatial and temporal patterns of variability in Scyphomedusae in the central California coastal marine ecosystem

John C. **Field**[1], Jarrod A. Santora[2], Keith Sakuma[1], Amber Payne[1] and Baldo Marinovic[3]

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Elements of the pelagic community, including Scyphomedusae, have been quantitatively surveyed along the Central California coast during late spring (May, June) since 1983. Although the survey has traditionally focused on pelagic stages of juvenile rockfish, in order to develop indices of year class strength for stock assessments, recent efforts have included efforts to characterize the broader micronektonic community both spatially and temporally, and to improve our understanding of inter-annual variability and population dynamics, among-species associations, and relationships between the spatial structure of communities and physical oceanographic variables. Data on the abundance of Scyphomedusa (primarily *Chrysaora fuscescens* and *Aurelia* sp.) have been quantified for most of the time period between 1990 and 2012, and these show large annual fluctuations that track each other in some years, but are mismatched in others. These two species have generally different habitats, and preliminary investigations into the distribution of these species over time suggest interesting spatial relationships between large jellies and other important elements of the ecosystem (such as krill and juvenile salmon). We present these results, and discuss the dynamics of jellyfish relative to physical factors as well as the trends in abundance and productivity of other pelagic micronekton in the central California pelagic ecosystem.

## October 18, 17:30 (S7-8430)

# A tale of two *Chrysaora*: Pivotal roles in contrasting marine ecosystems

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As in many regions of the world, the shelf waters of the western United States have experienced large increases and high interannual variability in jellyfish populations. The northern California Current (NCC) is a productive upwelling zone that is home to large populations of medusae particularly during late summer. Similarly, the productive eastern Bering Sea (EBS) shelf exhibits seasonal blooms of jellyfish that can vary by orders of magnitude. NOAA has conducted seasonal trawl surveys in the NCC since 1999 and documented a substantial biomass of jellyfish consisting primarily of one species, *Chrysaora fuscescens* with abundances generally peaking in late summer. Likewise, NOAA pelagic and demersal surveys in the EBS also show substantial jellyfish biomass dominated by a congener, *C. melanaster*. Spatial overlap of these jellyfish with pelagic fishes can be substantial and there appear to be regions of intense spatial overlap where trophic interactions may be occurring. Diets of these jellyfish species in both areas suggest they are primarily planktivorous, although they have the potential to feed on early stages of marine fishes. Trophic overlap can be high in the NCC with planktivorous species such as Pacific sardines and herring that consume copepods and euphausiid eggs. In this study, we examine the spatial overlap and co-occurrence of jellyfish and pelagic fish in both the NCC and EBS to determine the species that have the potential to be most affected by high jellyfish biomass and the geographic areas in which these interactions are likely to occur.

# S7 Session Poster Presentations

## S7-1

### Exogenous impacts on the massive occurrence of jellyfish in the northern part of Malacca Straits, Malaysia

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A study of exogenous impacts on the massive occurrence of jellyfish population in the northern part of Straits of Malacca was conducted for 12-months period from September 2009 to August 2010 around the coastal waters of Penang National Park, Penang Island. Over the last several decades, the number of jellyfish is claimed to be increasing in most part of the world's ocean but yet, the lack of interest in the study of jellyfishes due to its low economic value in South East Asia resulted in the scarcity of reliable base line data. Although there is no formal report or scientific research describing the impact of jellyfish bloom on the livelihood of the local population, jellyfish have had severe impacts on the Malaysian tourism industry. With the understanding of potential impact of jellyfish towards the ecosystem, this study deals largely with frequent sampling by towing methodology to provide complete data on distribution and relative abundance of each jellyfish species with the aims to uncover the seasonal population patterns of jellyfish species in northern Malacca Straits. Water quality parameters were also analyzed from the study locations to determine and understand the associated exogenous factors leading to jellyfish blooms. The results suggest that terrestrial input of sewage, land based pollutants and other human activities might cause nutrient loading into coastal waters and result in frequent massive jellyfish occurrence. Other physical water parameters didn't show significant correlation with jellyfish abundances but the impact of climate change is not to be underestimated. We are expecting jellyfish blooms to expand at more locations in the Malacca Straits in the future.

## S7-2

### Comparison of siphonophore assemblages during northeasterly and southwesterly monsoon seasons in the Taiwan Strait, western North Pacific Ocean

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The spatial patterns of siphonophores were analyzed in relation to local hydrographic features during two different monsoon seasons (the northeasterly monsoon in winter *vs.* the southwesterly monsoon in summer) in the Taiwan Strait. Forty-eight species were identified, with five types of calycophoran siphonophores (*Lensia subtiloides*, *Chelophyes appendiculata*, *Chelophyes contorta*, *Bassia bassensis*, and *Diphyes chamissonis*) being most common in both seasons. Significantly higher abundances of 4 of the 5 common species were recorded in summer than in winter. Differences in the siphonophore species compositions were also observed between the northern and southern part of Taiwan Strait, with significantly higher diversity in the southern waters. The distribution patterns of siphonophore assemblages were closely linked to the hydrographic features influenced by the dynamic nature of the currents in the study area, with temperature, salinity, and zooplankton biomass being the three most important factors.

## S7-3

## Marine construction as a factor boosting *Aurelia aurita* s.l blooms: A case study of a new floating pier deployment in Hiroshima Bay, Japan

Ryosuke **Makabe**, Ryuji Furukawa, Mariko Takao and Shin-ichi Uye

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Increase of marine construction is thought to be one of the causes of frequent jellyfish outbreaks in recent years, although no direct evidence has been reported. In April 2010, a new floating pier of 48-m length and 6-m width was installed in the Kuba fishing port, Hiroshima Bay. We examined the abundance of planktonic *Aurelia aurita* in Kuba before (January-May 2010) and after (December 2010-May 2011) the installation, together with monitoring of the polyp population dynamics on the under side of the pier. Planktonic *A. aurita* during the study period were primarily confined to newly liberated ephyrae, probably due to rapid exchange of water in the port (ca. 50% of water day$^{-1}$) by tide. Before the pier was deployed, ephyrae occurred at average and maximum densities of 1.1 and 5.9 ephyrae m$^{-3}$, respectively. Polyp colonies were not founded under the pier until August 2010; thereafter they maintained the population by asexual reproduction and 61% of them strobilated during December 2010-May 2011 and released a total of $1.8 \times 10^7$ ephyrae. Average and maximum densities of ephyrae during this period were 4.1 and 18.8 ephyrae m$^{-3}$, respectively, nearly triple of those before the deployment. These facts demonstrate that marine construction like floating piers add new substrates for polyps, which would give rise to more ephyrae thereby potentially boosting jellyfish blooms.

## S7-4

## Planktonic ciliates as a prey source for moon Jellyfish *Aurelia aurita*: Feeding activities and growth effects of ephyra and metephyra stages

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Blooms of the moon jellyfish *Aurelia aurita* often occur in eutrophic embayment where microzooplankton occur abundantly. Hence, microzooplankton may play a role as prey source for *A. aurita*. I measured feeding and growth rates of the larval stages (ephyra and metephyra) fed a diet of planktonic ciliates, the main components of microzooplankton. Also, growth rates of ephyra on a diet of ciliates were compared with the value on a diet of *Artemia* spp. Results of laboratory experiments indicated that ephyra actively fed on ciliates and the disc diameter of ephyra feeding on ciliates increased during the incubation period of 5 days. Growth rates expressed as relative daily increases of disc diameter linearly increased with carbon specific feeding rates until about 4 µgC ind d$^{-1}$ and stable to be about 15% above the levels. The increase of growth rates responding to feeding rates on ciliate prey was not significantly different from the value on *Artemia* prey. On the other hands, significant feeding rates of metephyra were not observed on ciliate prey in a feeding experiment. Also, the disc diameter of metephyra did not increase on a diet of ciliates during 5 days of incubation, even if the consumption of ciliate prey was observed. These results suggest that planktonic ciliates are available food source for growth of the ephyra stage of *A. autrita* as well as metazoan but the value for growth as prey source of microzooplankton probably decreases with the development of the stage on and after metephyra.

## S7-5

## Low temperature excludes medusae of *Nemopilema nomurai* in the Japan Sea in winter

Satoshi **Kitajima**, Akira Okuno, Naoki Iguchi, Naoto Honda, Tatsuro Watanabe and Osamu Katoh

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The abundance of *Nemopilema nomurai* often becomes high in the Japan Sea in summer and autumn, but they always disappear in winter. To examine whether this disappearance is related to hydrographic conditions, we investigated the distribution of *N. nomurai* and hydrographic parameters in the Japan Sea between 2006 and 2011. *N. nomurai* was collected by a trawl net with a mouth opening of 76.5 $m^2$ from 60 m depth to the surface. Jellyfish were observed in 2006, 2007, 2009 and 2010 with a mean abundance of 21.6, 16.0, 47.3, and 0.1 individuals per $10^6$ $m^3$. The distribution of *N. nomurai* was quite heterogeneous and related to intense flow of the Tsushima Current determined directly by Acoustic Doppler Current Profiler and estimated by a numerical model; however, this species was not observed at some stations north of 38.5°N even with the intense flow of the Tsushima Current. These stations with no *N. nomurai* were characterized by surface temperatures below 13.0°C, 13.4°C and 10.8°C in 2006, 2007, and 2009, respectively, whereas surface salinity varied as well as stratification intensity. Reports of *N. nomurai* sightings from fishermen, oceanographers, and fisheries scientists also drastically decreased at temperatures below 14°C as determined by satellite images. These facts indicate that medusa of *N. nomurai* could not survive due to low winter temperatures in the Japan Sea.

## S7-6

## Tracking the lion's mane jellyfish: Horizontal and vertical movements of *C. capillata* (Scyphozoa) in a shallow coastal environment

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Jellyfish outbreaks can adversely impact human health and economic activities. In the North Atlantic and Pacific Oceans, the highly venomous lion's mane jellyfish, *Cyanea capillata*, is a hazard for open-water swimmers and fishermen. Furthermore, in several coastal seas, *C. capillata* is suspected to impact on fish larvae survival and recruitment, and is thought to be involved in part of the chronic plankton-related mortality of fish farmed in northern Europe. Understanding the factors driving the distribution of this species is therefore critical in order to develop strategies to limit its detrimental impacts. Using acoustic tracking technique (Vemco V9 continuous transmitters) and drogue deployments, we investigated the horizontal and vertical movements of individual *C. capillata* ($n$=5) in a coastal area off Dublin, Ireland. The distance travelled by individual jellyfish over the duration of the tracking (2.7-7.7 h) ranged from 1.6 to 5.9 km. The horizontal movements of these individuals broadly followed the local currents, which were driven by the tidal cycle. This resulted in a back and forth movement of the jellyfish in the area. However, at times, the velocity of tracked individuals differed from the velocity of surface drogues. Vertical movements were marked by periods of intense activity, but were diverse and changing. A mean vertical speed of 1.2 m $min^{-1}$ (s.d.=0.86) was calculated from >2-min long continuous upward or downward movements ($n$=33). Our results confirmed what previous studies already suggested: scyphomedusae are not quite the passive drifters they were once thought to be.

## S7-7

## Annual and regional variations in associations between Scyphomedusae and juvenile gadoids in the Irish Sea

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Identifying interactions between scyphomedusae and other components of the ecosystem requires information on their distribution and abundance. Six years of data (2007-2012) on jellyfish bycatch collected during a juvenile gadoid fish survey from the Irish Sea were analysed. This dataset enables a fine scale examination of the distribution of juvenile gadoid fish (whiting, haddock) and scyphomedusae (*Aurelia aurita and Cyanea* spp.) in the Irish Sea. While scyphomedusae are known predators of fish eggs and larvae, juvenile fish may benefit via enhanced survival through their presence, actively seeking shelter and food from them. A unique dataset from the Irish Sea is examined to see if an overlap between jellyfish and juvenile gadoids is observed, similar to observations in the North Sea. Associations between scyphomedusae and juvenile fish are examined at an annual and regional level.

## S7-8

## Developing a technique for *in-situ* monitoring of fragile planktonic organisms

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While Scyphozoan jellyfish are widely reported, many fragile and transparent members of the gelatinous zooplankton escape notice and are thought to play a considerable role in nutrient cycling. To study these organisms, minimal handling and *in-situ* measurements are required to further understand their effect on the ecosystem. We have developed respiration chambers of 5 and 30 litres allowing both laboratory and *in-situ* monitoring of respiration and excretory products throughout incubation. Here we present a diverse selection of data to show the broad-scale applicability of this method to this understudied group of organisms.

## S7-9

## Methods for conducting individual measurements on trawled jellyfish

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Bering Aleutian Salmon International surveys (BASIS) are conducted yearly during late summer/early autumn in the eastern Bering Sea. These surveys coordinate fisheries and oceanographic sampling by using a series of surface and mid-water trawls, deployments for physical and biological oceanographic measurements, and zooplankton net tows to investigate ecological conditions and juvenile forage fish in the eastern Bering Sea. During 2003, jellyfish were noted as comprising a large portion of the trawl catch and in 2004 were added to the sample collection, identification, and measurement efforts. Methods detailing condition of jellyfish and impact on measurements from a trawl net had yet to be addressed. Many jellyfish ending up on the sorting table from a trawl net are broken and torn (some species more so than others), therefore we investigated methods for accurate determination of weights and size ranges. Experiments were conducted to examine water loss over time and its effect on individual weight measurements, diameter measurement variability due to specimen orientation, the relationship between bell diameter and weight verses bell height and weight, and non-trawled jellyfish weight verses trawled jellyfish weight. Preliminary results show no significant difference was observed in bell measurements based on body orientation and the diameter weight relationship is the more appropriate measurement for capturing condition based on R values. Increased variability from individual measurement methods and a lack of known measurement error are potential issues which have a direct effect on biomass and abundance estimates for macro-jellyfish.

### S7-10

## Relationship between jellyfish abundance and environmental fluctuations in Uwa Sea

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In the Seto Inland Sea of Japan, increasing moon jellyfish (*Aurelia* sp.) populations have damaged fisheries and have caused some large social and economic problems. To fully understand the population dynamics of moon jellyfish in this region, analysis of patterns in temporal jellyfish abundance in relation to environmental factors are essential. In the Uwa Sea, located in western Seto Inland Sea, moon-jellyfish aggregations are distributed in surface waters near coastal lines during summer months. By monitoring the appearance of moon jellyfish aggregations, results will indicate jellyfish abundances. In using the JAMSUS (Jellyfish Aggregation Monitoring System in Uwa Sea) method, we set up a video monitoring system on a hill with a full view of Hokezu Bay (part of the Bungo Channel) during summer and autumn from 2003 to 2011. From this we observed temporal shifts in dense aggregations of moon jellyfish. The aggregation frequency of occurrence (Index of jellyfish abundance) varied widely in Hokezu Bay. In 2009, moon jellyfish aggregations appeared most frequently during the monitoring period. The index of jellyfish abundance is possibly correlated with number of days in which the water temperature was over 15$^{o}$ Celsius from February until April. In another analysis, the index of jellyfish abundance was negative correlated with the catch of zooplankton-feeding fish.

### S7-11

## Jellyfish fisheries in Southeast Asia

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While jellyfish swarms sometimes can have negative impacts on human activities, such as damage to fishing gear and/or fishery products, the clogging of water intake systems of electric power plants, and stinging swimmers at the beach, some species have been beneficial to humans because they have been utilized as food, especially in Chinese cuisine. Southeast Asia is the center of the jellyfish fisheries (JF) in terms of the amount of catch, and at least 8 species of jellyfishes that belong to the order Rhizostomeae, class Scyphozoa, are harvested. However, little detailed information is known on the target species, collection and processing methods, and the ecological impacts and economic aspects of the fishery in each country. We have been investigating JF at several sites in Vietnam, Indonesia, Thailand, and Malaysia. This paper presents detailed information on the JF in those fishing grounds in these countries. In Quang Vinh village, Thanh Hoa province, northern part of Vietnam, for example, two species, *Rhopilema hispidum* and *R. esculentum* are commercially exploited. The number of *Rhopilema* jellyfish collected by fishermen is estimated to be 800,000-1,200,000 inds. per fishery season, suggesting that the fishery may have an impact on jellyfish populations in the area. Fishery aspects, including target species, processing methods, market prices and other factors at various jellyfish fishing grounds in Southeast Asia will be presented.

# S8 POC/FIS Topic Session
# Linking migratory fish behavior to End-to-End models II

***Co-Convenors**: Enrique Curchitser (USA), Shin-ichi Ito (Japan) and Michio Kishi (Japan)*

***Invited Speaker**:*
*Robert Humston (Washington and Lee University, USA)*

In order to understand ecosystem response to climate impacts, End-to-End modeling (E2E) approaches are essential. One of the most difficult parts for E2E is the modeling of fish migration. Fish behavior can be very complex; it is a consequence of genetics, physical, chemical and biological environments and their interaction. Learned behavior may also be a factor. To model fish behavior, integrated studies are needed including laboratory experiments, tagging and acoustic observations, and modeling. The purpose of this session is to review the current state of development in laboratory experiments, field observations and modeling to understand fish behavior and to discuss future potential collaborations to improve fish migration models. Presentations related to laboratory experiments, field observations and modeling works related to fish behavior are welcome.

## Wednesday, October 17 (9:00-12:40)

09:00 ***Introduction by Convenors***

09:05 **Robert Humston**
Selecting appropriate models of fish movement for End-to-End models of marine ecosystems (S8-8831), Invited

09:30 **Ivonne Ortiz, Kerim Aydin and Albert J. Hermann**
20 species, 15 lengths: How fish move driven by happiness as defined by growth and predation (S8-8706)

09:50 **Seokjin Yoon, Terui Takeshi, Michio J. Kishi and Shin-ichi Ito**
An individual-based modeling approach for Pacific saury migrations (S8-8570)

10:10 **Yoshioki Oozeki, Takeshi Okunishi, Akinori Takasuka and Daisuke Ambe**
Annual change in migration pattern of Pacific saury larvae from spawning to nursery grounds (S8-8681)

10:30 ***Coffee/Tea Break***

11:00 **Masanori Takahashi, Atsushi Kawabata, Chikako Watanabe, Michio Yoneda, Daisuke Ambe and Takeshi Okunishi**
Migratory behavior and recruitment process of the Pacific stock of chub mackerel *Scomber japonicus* (S8-8766)

11:20 **Tohya Yasuda, Ryuji Yukami and Seiji Ohshimo**
Changes in spatial distribution of chub mackerel under climate change: The case study using Japanese purse seine fisheries data in the East China Sea (S8-8560)

11:40 **Jung Jin Kim, William T. Stockhousen, Yang-Ki Cho, Gwang Ho Seo and Suam Kim**
Transport processes of eggs and paralarvae of Japanese common squid, *Todarodes pacificus* in the Northwest Pacific (S8-8765)

12:00 **Akira Okuno, Tatsuro Watanabe, Naoto Honda, Katsumi Takayama, Naoki Iguchi and Satoshi Kitajima**
Importance of swimming-depth model of jellyfishes *Nemopilema nomurai* in simulation of their migration in the Japan Sea (S8-8634)

12:20 **Satoshi Nakada, Takashi Uenaka, Ken-ichi Kitao, Kenta Matsui, Yoichi Ishikawa, Naohisa Sakamoto, Koji Koyamada, Toshiyuki Awaji and Sei-Ichi Saitoh**
Estimated migration of scallop larvae in Funka Bay by using streamline visualization (S8-8677)

12:40 *Session Ends*

## S8 Poster

S8-1 **Michio J. Kishi**
Discussions on random walk and behavioral movement models coupled with NEMURO. FISH: Case study on chum salmon and saury

# S8 Session Oral Presentations

## October 17, 09:05 (S8-8831), Invited

### Selecting appropriate models of fish movement for End-to-End models of marine ecosystems

Robert **Humston**

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The performance of fish movement models is often evaluated by how well they approximate the spatial distribution of individuals within a population – *e.g.*, patterns of density across an area of interest and correlations with habitat features. With these static criteria, many different approaches to modeling fish movement may seem effective or equivalent. However, such 'snapshots' of fish distribution only tell a moment of the full story. When movement models are incorporated into spatially and temporally articulated simulations of population, community, or ecosystem dynamics, the pathways that fish travel to seek preferred habitats as environments or biological needs change are just as important as their 'success rate' in locating them. This dynamic interaction with the environment determines individual experience and subsequently scales to influence biological dynamics at the population through ecosystem levels. Therefore, selecting an appropriate method for simulating fish movement in End-to-End models of marine ecosystems must consider the model assumptions and behavioral mechanisms that determine these pathways. Appropriate models will meet the specific needs and constraints of the simulation while also maintaining a reasonable degree of biological realism. The greatest advances in this area may then come from defining the boundaries of 'acceptable realism' from empirical data. To do so will require new approaches to connecting modeling and field efforts.

## October 17, 09:30 (S8-8706)

### 20 species, 15 lengths: How fish move driven by happiness as defined by growth and predation

Ivonne **Ortiz**[1], Kerim Aydin[2] and Albert J. Hermann[3]

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With high resolution end to end models incorporating fish, movement is increasingly important. These exercises, usually restricted to a few species have variable number of length classes and no fisheries removals. Here, we present the fish portion of a vertically integrated model that links processes from climate to fisheries in the Eastern Bering Sea at a resolution of ~10km. FEAST (Forage-Euphausiid Abundance in Space and Time) models 15 fish species linked to 5 zooplankton groups and 20 fisheries specified by sector, gear and target species. Species include walleye pollock, Pacific cod, arrowtooth flounder, salmon, capelin, herring, eulachon, sandlance and myctophids, squids, shrimp and epifauna; these have a two-way interaction with six groups from the NPZ module: three copepods, two euphausiids, and benthos.

Fish follow gradients based on potential growth (in weight) and least predation mortality (numbers of fish). Ten fish groups have 15 length categories, with growth based on bioenergetics and prey consumption as a function of length and preference. Temperature limitations are intrinsic to bioenergetic models, but while most models assume a fixed cost of swimming, we model such cost as a function of speed (measured as body length per second) and temperature. Thus the model works because of the dynamic prey fields. We showcase the movement of pollock, a commercial species with annual catches of over a million tons in the US. Diets are compared to food habits databases, and biomass distribution to summer surveys as well as catches to evaluate model performance in cold and warm years.

## October 17, 09:50 (S8-8570)

## An individual-based modeling approach for Pacific saury migrations

Seokjin **Yoon**[1], Terui Takeshi[2,3], Michio J. Kishi[1,3] and Shin-ichi Ito[4]

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A two-dimensional Individual-Based Model (IBM) coupled with fish bioenergetics model (NEMURO.FISH) has been developed to simulate the migration and growth of Pacific saury. In the model, fish movement was controlled by feeding and spawning migrations with passive transport by ocean current. Feeding migration was assumed to be governed by search for local optimal habitats, which was estimated by spatial and temporal data on water temperature and prey density. First priority of migration direction is optimum temperature and second one is best growth. For instance, fishes out of optimal temperature range move towards a place with optimal temperature condition until reaching the optimal, while fishes in the optimal temperature move towards a place with maximum growth condition. Spawning migration was modeled based on "larvae fitness algorithm", *i.e.*, spawning fishes search for a place where their larvae can grow up best. In the model, the spawning period depends on the body length, and the spawning migration starts one month advanced to the spawning period and continues two months. For environmental forcing, the model was integrated with satellite data of SST and surface chlorophyll *a* concentration and simulated surface current velocity. The model was run for two years from February 2002 to January 2004. Spawning grounds were located from latitude 30°N to 40°N but biased to the eastward. We conclude the condition of an artificial westward migration was needed during spawning season.

## October 17, 10:10 (S8-8681)

## Annual change in migration pattern of Pacific saury larvae from spawning to nursery grounds

Yoshioki **Oozeki**[1], Takeshi Okunishi[2], Akinori Takasuka[1] and Daisuke Ambe[1]

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Migration patterns of Pacific saury *Cololabis saira* larvae from spawning to nursery grounds were examined based on the dataset from larval distribution surveys during the winter season since 1990. In the surveys, a neuston net was towed for 10 minutes broadly off the Pacific coast of Japan (29–34°N, 131–141°E). Distribution and experienced temperature of saury larvae from 1993 to 2009 were analyzed by the numerical particle tracking model using the satellite-based sea surface current and temperature data. Ages of saury larvae were estimated based on the growth equation obtained from the larval samples collected from 1990 to 1998 through otolith microstructure analyses, since size-at-age is relatively stable during winter. Numerical particle tracking was conducted through the end of April. Larval growth during the transport was estimated by the relationship of larval growth to environmental factors which was obtained in a previous study. Winter spawning grounds were consistently located on- and off-shore the Kuroshio Axis from southern Kyusyu Island to east area of Boso Peninsula. The outputs of the simulation model indicated that larvae and juveniles were transported by the Kuroshio Current to the northern area of the Kuroshio Extension or by the Kuroshio Countercurrent to the coastal area of southern Japan. Allocation rate from the spawning ground to these two nursery areas changed annually, which could be discussed in relation to the annual changes of environmental factors.

## October 17, 11:00 (S8-8766)

## Migratory behavior and recruitment process of the Pacific stock of chub mackerel *Scomber japonicus*

Masanori **Takahashi**[1], Atsushi Kawabata[1], Chikako Watanabe[1], Michio Yoneda[2], Daisuke Ambe[1] and Takeshi Okunishi[3]

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This study shows the general migration patterns of the Pacific stock of chub mackerel *Scomber japonicus* and possible causes of recruitment variability based on field surveys and laboratory experiments. Spawning occurs from March to June in the waters off central Japan. Eggs and larvae are transported northeastward by the Kuroshio current, and juveniles arrived in the Kuroshio Oyashio transition area as a nursery ground. In autumn and winter adult fishes start a spawning migration from the Oyashio area but larger and older fish tend to reach the spawning ground and start spawning earlier than smaller and younger fishes. Field surveys showed that the number of occurrences of juveniles and their body sizes are positively correlated with the abundance of recruit fishes. The results of otolith analyses indicated that variations in the timing of hatch date and growth rate of larvae appeared to reflect the body size of juveniles. Larvae in high-abundance cohort showed higher growth rates compared to those in low-abundance cohort. Particle tracking experiment using the observed ocean-environmental data indicated that higher growth rates found in high-abundance cohort could be attributed to higher temperature experienced. This assumption was supported by the evidence of the relationship between growth rate and temperature conducted under similar conditions. Our findings also indicated that females in early spawning season tended to produce larger eggs and larvae with higher survival rates. These findings suggest that temperature should be one of the key factors for recruitment success of chub mackerel in terms of its spawning and early life traits.

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## October 17, 11:20 (S8-8560)

## Changes in spatial distribution of chub mackerel under climate change: The case study using Japanese purse seine fisheries data in the East China Sea

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Early experimental studies have shown ectothermic fish select temperatures that deliver physiologically optimal interactions. However, we still lack the information necessary to model the nature of movements over their expansive habitat range. Japanese purse seine fisheries in the East China Sea are useful research platforms to associate habitat selection with oceanographic conditions in small pelagic fishes because they operate throughout the expansive continental shelf where boundaries of water-masses exist. Here, we present changes in spatial distribution of both adult chub mackerel *Scomber japonicus* and sea surface temperatures (SSTs). Spatial distributions of the mackerel from 1973 to 1999 were established month by month by generating kernel density maps using catch-per-unit-effort data at each location. This method could show spatio-temporal changes in "hotspot" (*i.e.*, 50% kernel density) of the mackerel using a similar scale. To represent geographical variations in SSTs, we calculated positional deviance of the 15°C contours in a north-south direction using satellite-derived SST data from 1981 to 1999. Our results showed that the geographical SST condition varied from year to year. However, interannual variation was not shown in mean SSTs within the mackerel hotspots. Therefore, we found a relationship between mean positional index of SSTs and mean location of hotspots. Periodic analyses indicated that the monthly location of hotspot fluctuated not only in a seasonal cycle but also in multi-year and decadal cycles. These results demonstrate that the mackerel shift their habitat in response to given thermal conditions associated with regional climate change.

**October 17, 11:40 (S8-8765)**

## Transport processes of eggs and paralarvae of Japanese common squid, *Todarodes pacificus* in the Northwest Pacific

Jung Jin **Kim**[1], William T. Stockhousen[2], Yang-Ki Cho[3], Gwang Ho Seo[3] and Suam Kim[1]

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Transport pathways of eggs and larvae are influenced by oceanic currents. The Tsushima Warm Current and Kuroshio Current are considered to be the most important for determining larval transport and distribution of Japanese common squid in the northwestern Pacific. To estimate accurate larval transports, we developed an individual-based model (IBM) that incorporates the ability of squid larvae to migrate vertically to a preferred depth range. It was applied to particle tracking module of Regional Ocean Modeling System (ROMS) incorporating vertical movement based on their ontogenetic changes at preferred depth ranges. Particle tracking experiments were conducted to infer the spawning ground of *Todarodes pacificus* paralarvae, and to reconstruct trajectories from the East China Sea (ECS) and southwestern East/Japan Sea (EJS) to nursery grounds off the Korean Peninsula and Japanese Island, and to delineate distribution patterns of paralarvae during peak spawning season. The results of backward in time experiments indicated that spawning grounds were located from central ECS near the 29°N for summer stock, and that from southern ECS along the continental shelf to south of Jeju Island for winter stock. Also, results from simulating paralarval distribution for autumn and winter spawning populations indicated that aggregation of paralarvae in autumn and winter occurred off central Honshu East/Japan Sea in October to November and off southwest Kuyshu Isalnd in February to March, respectively. Most (86%) paralarvae were transported to the EJS from spawning ground for autumn population, while transport to the Pacific Ocean (PO) was 13% at 60 days after release. The transport to PO was dominant (40%) for winter population, followed by EJS (33%) and ECS (27%).

**October 17, 12:00 (S8-8634)**

## Importance of swimming-depth model of jellyfishes *Nemopilema nomurai* in simulation of their migration in the Japan Sea

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In the last decade, massive blooms of a jellyfish species *Nemopilema nomurai* have frequently occurred and fisheries in the Japan Sea have suffered severe damages. Hence, we developed a particle-tracking simulator based on the hydrodynamic data produced by JADE (JApan sea Data assimilation Experiment), an operational ocean forecast system, to analyze/forecast the jellyfish migration in the Japan Sea. While horizontal movement of the jellyfishes is passive to oceanic velocity, they show vigorous, complicated autonomous action in the vertical direction. Since oceanic velocity in the Japan Sea shows significant vertical shear, swimming depth of the jellyfishes must be adequately modeled for the simulation. Thus, we conducted hindcasts of the jellyfish migration for the massive blooms in 2006, 2007 and 2009 to examine three swimming-depth models, namely, two fixed swimming depths at surface (8.75m) and subsurface (42.5m) and diel vertical migration that is regulated by temperature. The simulated migration of the jellyfishes was quite sensitive to the selection of swimming-depth model, and difference between the results was more obvious when meteorological events (*e.g.* typhoon passing) enhanced the vertical shear in oceanic velocity. We compared simulation results with the observed appearance of the jellyfishes in each year and concluded that the diel-migration model is the most valid among the three. It has been suggested that the massive migration of the jellyfishes may affect ecosystem in the Japan Sea. Our simulation will be a helpful tool for investigation of material transport by the jellyfishes.

**October 17, 12:20 (S8-8677)**

## Estimated migration of scallop larvae in Funka Bay by using streamline visualization

Satoshi **Nakada**[1], Takashi Uenaka[1], Ken-ichi Kitao[2], Kenta Matsui[2], Yoichi Ishikawa[3], Naohisa Sakamoto[1], Koji Koyamada[1], Toshiyuki Awaji[4] and Sei-Ichi Saitoh[5]

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Migration of scallop larvae released from aquafarms should contribute to the yearly fishery production, and be informed to fishermen in order to improve the harvesting efficiency. We propose a new method for the daily migration of the scallop larvae by utilization of streamline visualization based on the vast, spatiotemporally high-resolution datasets of the state-of-the-art ocean simulation in Funka Bay located in Northern Japan as a pilot study from a viewpoint of aquaculture. The streamlines extended from the aquafarm emulate the migration of scallop larvae and have opacity that depends on the elapsed time from daily release. The superposed opacity of the streamlines indicates probabilistic density function of the scallop larvae in the bay, which represent the uncertainty caused by the early decrease of scallop larvae and the estimated errors of the flow field. The results of the superposed streamlines suggest that the larvae were accumulated around the circumference of the summertime clockwise eddy formed in the northern part of the bay in end of June 2008. On the other hand, the larvae in the southern part of the bay scattered to outside of the bay or joined to the northern part of the bay. Our results were corresponding to the observed distribution of the larvae, suggesting the potential use for prediction of the migration of the scallop larvae.

# S8 Session Poster Presentation

### S8-1

## Discussions on random walk and behavioral movement models coupled with NEMURO.FISH: Case study on chum salmon and saury

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Humston *et al.* (2004, Trans. Am. Fish. Soc., 133) reviewed the random walk and behavioral movement modelsthat were applied to Biscayne Bay, Fl. USA. They concluded that a random walk model cannot explain the observed regional distribution of fish. However, their model did not include “two-way” coupling between the fish bio-energetic and the lower ecosystem models. In this presentation, I will discuss the kind of behavioral movement models that should be used for chum salmon and saury.In NEMURO.FISH, the uncoupled mode, the growth and weight of an individual fish are computed using plankton densities simulated by NEMURO but with no feedback between fish consumption and plankton mortality. In the coupledmode, the feeding, growth and weight of a representative fish are computed and prey removals due to feeding by fish appear as mortality terms on the prey. On the other hand, migration route of chum salmon must be determined based on magnetic field of the earth and/or temperature and/or prey density. Here, I will discuss which migration models show good performances.

# S9 FIS/MEQ Topic Session
# Ecological functions and services associated with marine macrophyte communities as indicators of natural and anthropogenic stressors in nearshore zones of the North Pacific

***Co-Convenors**: Ik-Kyo Chung (Korea) and Jun Shoji (Japan)*

***Invited Speakers**:*
*Masakazu Hori (National Research Institute of Fisheries and Environment of Inland Sea, Japan)*
*Katsumasa Yamada (National Institute for Environmental Studies, Japan)*

Diverse communities of marine and estuarine macrophyte vegetation including kelp beds, seaweeds, macrobenthic algae, seagrasses, and salt marshes occur along the coastlines of the PICES member countries. In addition to the direct primary production of organic material into marine ecosystems, these macrophytic communities are also considered as ecological engineers that can have important indirect supporting roles in the lives of heterotrophic organisms such as fishes, shellfish, seabirds, and other marine organisms. Seasonal growth and breakdown of macrophytic vegetation has important implications for the biochemistry of essential nutrients in the nearshore zones, and for the interactions among vertebrate and invertebrate members of marine and estuarine communities. Fluctuations in physical and chemical parameters such as sea water temperature, salinity, nutrient availability, incident light levels, water flow, and sediment conditions contribute as complex regulating factors toward the establishment and persistence of macrophyte communities. In contrast, the physical structure of the macrophytes themselves can modify the local environment, affect the composition and abundance of their associated organisms, and provide essential ecological roles as recruitment sites, nursery areas, foraging habitats, and sinks for marine carbon. These interactions among ambient environmental parameters, macrophytes, and their associated organisms are collectively known as ecosystem functions and services, which are influenced not only by natural forces but also by anthropogenic stressors. The topic session will focus on the ecological functions and services provided by diverse communities of macrophytes throughout the North Pacific coastal zone. In particular, presentations are encouraged that explore the diversity and dynamics of ecosystem functions and services provided by macrophytes that may be regarded as biotic indicators of natural shifts and human-induced stressors in nearshore ecosystems.

## Friday, October 19 (9:00-12:35)

09:00 ***Introduction by Convenors***

09:05 **Masakazu Hori**
Effect of coastal seascape diversity on associated fish production (S9-8495), Invited

09:30 **Nam-Il Won, Hideki Takami, Yutaka Kurita, Daisuke Muraoka and Tomohiko Kawamura**
Trophic structure of the rocky shore ecosystem in Otsuchi Bay, Japan: Implications for benthic–pelagic coupling (S9-8529)

09:50 **Tsutomu Noda, Yoshitomo Nagakura, Daisuke Shimizu, Hideaki Aono, Hiroyuki Okouchi, Masami Hamaguchi, Atsushi Fukuta, Yasuhiro Kamimura and Jun Shoji**
Impact of the tsunami from the Great East Japan Earthquake on seagrass beds and fish assemblages in Miyako Bay (S9-8632)

10:10 **Shiori Sonoki, Yuka Morita, Jun Syoji and Kazushi Miyashita**
Monitoring seasonal variations in a seagrass bed by an acoustics method (S9-8416)

10:30 ***Coffee/Tea Break***

10:50 **Katsumasa Yamada**
Functional diversity and functional redundancy of a faunal community in a seagrass ecosystem of northern Japan (S9-8587), Invited

11:15 **Sang Rul Park, Joseph Stachelek and Kenneth H. Dunton**
The role of salt marsh plants as a net sink or source for carbon dioxide in the southwestern Gulf of Mexico (S9-8506)

11:35 **Ekaterina V. Golovashchenko**
The economic value of ecosystem services in Kievka Bay (Japan Sea) (S9-8675)

11:55 **Seokjin Yoon, Michio J. Kishi, Satoshi Nakada, Yoichi Ishikawa, Tomonori Isada and Sei-Ichi Saitoh**
Ecological functions of a kelp community as an indicator of anthropogenic nutrient stressors (S9-8772)

12:15 **Chang Geun Choi and Seok Jin Oh**
Development of artificial seaweed bed for ecological restoration (S9-8558)

12:35 *Session Ends*

## S9 Posters

S9-1 **Chunjiang Guan, Jie Na, Meng Xu and Xiutang Yuan**
Studies on carbon, nitrogen, and phosphorus uptake fluxes by *Suaeda salsa* around the Bohai Sea District

S9-2 **Ivan I. Cherbadgy and Ludmila I. Sabitova**
Influence of environmental factors on ammonium and phosphate uptake rates by a red alga (*Ahnfeltia tobuchiensis*) population in Izmena Bay (Kunashir Island)

S9-3 **Yun Hee Kang, Chang Jae Choi and Sang Rul Park**
Effects of intensity and season of disturbance on the marine benthic community of a rocky intertidal shore with a periodic green tide occurrence in Korea

# S9 Session Oral Presentations

### October 19, 09:05 (S9-8495), Invited

## Effect of coastal seascape diversity on associated fish production

Masakazu **Hori**

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Coastal ecosystems are characterized by the prominence of foundation species, such as those in seagrass beds, coral reefs, and kelp/sargassum beds. These habitats help maintain the high productivity and species diversity of marine invertebrate and fish species, which normally have wide spatial distribution and use multiple habitats throughout their life cycles. Therefore, seascape diversity and spatial extent are important factors when determining the productivity and diversity of their associated organisms. Global environmental change, which is now obvious in coastal ecosystems, directly influences seascape diversity by prompting the reduction, extinction, and replacement of those foundation species. Our study demonstrated how changes in this diversity affect the functioning of an ecosystem, particularly the secondary production of associated fish species. We performed a field census and mesocosm experiment that duplicated a typical near-shore seascape within the temperate western-Pacific region. Our objective was to manipulate its structure with beds of seagrass, sargassum, and ephemeral algae, as well as a tidal flat. Here, the growth rate of fish species was significantly decreased in parallel with a loss of seascape diversity. Furthermore, the impact of the dominant type of seascape on production varied by season. Results of our stable isotopic analyses showed that POM, derived from seagrass and sargassum beds, contributed not only to in-situ fish production but also to the survival of bivalve species that inhabited the adjacent tidal flat. These findings provide knowledge that is necessary for adaptive management of coastal ecosystems, such as when decision-makers must select sites for MPA from among many candidates.

### October 19, 09:30 (S9-8529)

## Trophic structure of the rocky shore ecosystem in Otsuchi Bay, Japan: Implications for benthic–pelagic coupling

Nam-Il **Won**[1], Hideki Takami[2], Yutaka Kurita[2], Daisuke Muraoka[2] and Tomohiko Kawamura[3]

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Coastal regions are among the most productive ecosystems in the world. Environmental factors such as more frequent natural disasters and greater climate change are important parameters that shape coastal ecosystem structures and functioning. Benthic–pelagic coupling, which refers to the linkages between those two environments, plays a major role in determining the production and biological structure of these aquatic systems. Here, we report trophic linkages between the benthic community and coastal fish assemblages in a macroalgal forest on the rocky shore at Otsuchi Bay, Japan. This area was hit by the Japan Tsunami in 2011, after this research had been conducted in 2007 and 2008. Benthic organisms were collected by SCUBA and fish were sampled by net. Stable isotope ratios were analyzed in benthic invertebrates, fish, benthic diatoms, and POM. Gut contents in fish and caprellid amphipods were also examined. Benthic diatoms were exclusively abundant in the gut contents of caprellid amphipods that consumed the seaweed *Sargassum yezoense*. Most fish species appeared to feed on caprellid amphipods, based on an examination of their gut contents in July. Stable isotope analysis also suggested a trophic linkage from benthic diatoms via caprellid amphipods to coastal resident fish, with different trophic contributions made toward each fish species. These results highlight the fact that benthic primary production could be an important energy source for pelagic biological components within a coastal ecosystem, following benthic–pelagic trophic pathways. Our investigation demonstrates that further study is needed about the environmental effects on coastal benthic–pelagic coupling so that researchers can better understand the coastal ecosystem as it continues to experience recently increasing natural and anthropogenic environmental stressors.

### October 19, 09:50 (S9-8632)

## Impact of the tsunami from the Great East Japan Earthquake on seagrass beds and fish assemblages in Miyako Bay

Tsutomu **Noda**[1], Yoshitomo Nagakura[2], Daisuke Shimizu[2], Hideaki Aono[2], Hiroyuki Okouchi[1], Masami Hamaguchi[3], Atsushi Fukuta[4], Yasuhiro Kamimura[4] and Jun Shoji[4]

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Broad seagrass beds serve as nurseries for larvae and juvenile fish in Miyako Bay, along the Pacific Coast in northern Japan. However, that area was attacked by a tsunami that resulted from the Great East Japan Earthquake on 11 March 2011. Because of this disaster, the local environment was thought to have been severely damaged.

Since 2010, our research group had been researching seasonal changes in seagrass beds and juvenile fish assemblages at two sites in the Bay (Hanoki, a pocket beach on the east side, and Akamae, a shallow coastal area on the inner most side). This project was re-started in June 2011, after the tsunami struck. The density of seagrass was measured by the quadrat method, and fish were collected by a seine net, identified by species, and measured for lengths and weights.

Between June 2010 and June 2011, the density of seagrass per square meter decreased from 34 shoots to 0 to 3 shoots at Akamae. Likewise, at Hanoki, that density dropped from 32 shoots to 12 shoots over the same time period. However, the latter location showed an increase in density, from 16 to 22 shoots $m^{-2}$, between July and November of 2011.

The fish assemblage at Hanoki did not different much between June 2010 and June 2011. There, the dominant species was *Gymnogobius heptacanthus* (68.9% in 2010 and 60.4% in 2011). By contrast, the most common species at Akamae in 2011 were *Engraulis japonica* and *Hypomesus japonicus*. These results indicate that the tsunami profoundly affected life in the inner-bay area. However, recovery is proceeding at Hanoki and the habitat for juvenile fish seems to have been sustained and is gradually recovering there, despite the impact of the tsunami.

### October 19, 10:10 (S9-8416)

## Monitoring seasonal variations in a seagrass bed by an acoustics method

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Seagrass beds perform various functions in coastal ecosystems, such as for fish production, water purification, and the maintenance of species biodiversity. However, their decrease has been reported. To investigate appropriate measures for their conservation, we used a small quantitative echosounder (KCE-300; Kaijo Sonic Corporation) to assess their standing stocks and distribution in the area surrounding Takehara-shi, Hiroshima. Tests were conducted in November of 2011 (during their normal period of decline) and in May 2012 (during their period of growth). The dominant species was eelgrass (*Zostera marina*). Acoustics data were analyzed with Echoview (Version 4.9; Myriax Software Pty Ltd.). Spatial statistics were used to estimate bed thickness, reflected intensity, standing stock, and distribution area. Those data were interpolated with Arc GIS (Version 10; ESRI Corporation). The average thickness was 60 cm in May and 30 cm in November, with both density and volume being higher earlier in the year. Although distribution was almost the same at both sampling times, the longer eelgrass was differently located. The method used here enables researchers to evaluate seasonal changes in biomass production from seagrass beds, and to establish the validity of sampling data.

**October 19, 10:50 (S9-8587), Invited**

## Functional diversity and functional redundancy of a faunal community in a seagrass ecosystem of northern Japan

Katsumasa **Yamada**

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High ecosystem functions (also ecosystem service) are not always offered from a natural community, even if diversity in that community is high. This is because the quality and quantity of functioning differs among species in the community. Furthermore, species composition (relative abundance), which is determined by environmental changes on multiple scales and/or because of biological interactions, may lead to idiosyncratic fluctuations in the ecosystem functions of a community. Such contradictory processes can be resolved by measuring the "*functional diversity* (including *functional-group diversity*)". This concept is defined as the value and range of functional traits and ecosystem function of organisms present in a community.

Patterns and variations among faunal (mainly macrofauna) functional (group) diversities were evaluated in the estuarine and marine seagrass meadows along the North Pacific coast of Japan. The main focus was on how disturbances and environmental changes can affect the structure of functional diversity in the food web. The importance of "*functional redundancy*", *i.e.*, the overlap in functional roles by several species in a community, was also investigated in macrofaunal communities of seagrass meadows. This existence of *functional redundancy* may lead to complementary maintenance of ecosystem functions. Furthermore, from the landscape perspective, seagrass ecosystems (*i.e.*, seagrass patches) with high faunal diversity may act as sources of high biodiversity as well as ecosystem functions.

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**October 19, 11:15 (S9-8506)**

## The role of salt marsh plants as a net sink or source for carbon dioxide in the southwestern Gulf of Mexico

Sang Rul **Park**[1], Joseph Stachelek[2] and Kenneth H. Dunton[2]

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Estuaries are known as blue carbon sinks because of their high productivity of salt marsh plants. Nevertheless, few studies have examined carbon uptake rates in the field. Despite the difficulties associated with conducting such experiments, our goal was to evaluate the role these plants have as a net sink or source for carbon dioxide in the southwestern Gulf of Mexico. We used a LI-6400 portable photosynthesis system (LI-COR, Lincoln, NE, USA), with a conifer chamber, to measure seasonal leaf gas exchange for the main emergent salt marsh plant species in the Nueces River Delta. Soil respiration was also measured seasonally with a LI-6400 and a soil $CO_2$ flux chamber. Gas exchange measurements from all species exhibited distinct seasonal variations. Stomatal conductance and transpiration were at maximum levels during the summer, indicating that plants were exposed to high apparent heat and water stresses. Intrinsic water-use efficiency in all species was greatest in the Fall, as evidenced by low stomatal conductance and high net photosynthesis. The highest ratios of net photosynthesis to respiration were recorded in the Fall, when dark respiration was reduced. This demonstrated that the Fall season plays a critical role in determining annual productivity in this region. Soil respiration also showed distinct seasonal variations, increasing during Spring and Summer, and decreasing in Fall and Winter. These results provide invaluable information about how emergent marsh vegetation functions as a sink or source of carbon under the varying temperature and moisture conditions that are linked to changes in the regional climate.

### October 19, 11:35 (S9-8675)

## The economic value of ecosystem services in Kievka Bay (Japan Sea)

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Evaluation of ecosystem services is necessary for capital investment, industrial planning, and assessment of losses due to anthropogenic activity and pollution. We estimated the value of such services in Kievka Bay (northwestern Japan Sea), based on their classification and methods for determining total economic value. Earlier assessments had been made in Peter the Great Bay (Lukyanova, Nigmatulina, Golovashchenko, 2010), and in the eastern and western Sakhalin zones (Golovashchenko, 2011). Kievka Bay was selected for this study for the following reasons: 1) its rich marine biodiversity; 2) presence of scientific and manufacturing research, especially on sea cucumber mariculture; 3) recreational activity; and 4) upcoming deployment of a biotechnology park. Food production and other services were evaluated separately. Although Kievka Bay is quite small (13,600 ha), its potential gross value is apparently significant for the production of fish, algae, and invertebrates. In 2011, its estimated value was $469 \times 10^4$ USD, or 345 USD per ha. When the income approach was used, which did not account for expenses associated with fish catches and production, that estimate was 250 USD per ha. The total gross value of ecosystem services, including regulating disturbances, biogeneous cycling, biological control, and recreation, was $585 \times 10^5$ USD, or 4304 USD per ha. Biogeneous cycles had the highest value while that for producing raw materials was the lowest.

### October 19, 11:55 (S9-8772)

## Ecological functions of a kelp community as an indicator of anthropogenic nutrient stressors

Seokjin **Yoon**[1], Michio J. Kishi[1], Satoshi Nakada[2], Yoichi Ishikawa[3], Tomonori Isada[4] and Sei-Ichi Saitoh[4]

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Nutrient availability frequently controls the rates of primary production in estuarine and coastal waters. There, concentrations and loading rates directly reflect human populations and activities. Nutrient-loading, or eutrophication, is a key causative agent for accelerating primary production. Because primary producers directly respond to greater loads by increasing production, it is obvious that marine plant communities play important roles as indicators of anthropogenic nutrient stressors in coastal waters. Kelp communities have a capacity for primary production that is equal to that of terrestrial plants and land forests. Thus, they absorb large quantities of nutrients. More than 50 species of kelp have been reported worldwide, of which ~20 occur in the Asia-Pacific region. To evaluate quantitatively the ecological functions of a kelp community as an indicator of anthropogenic stressors associated with riverine nutrient-loading, we developed an ecosystem model by coupling a kelp bioenergetics model with a lower trophics-level model for the North Pacific marine ecosystem (NEMURO). This was integrated with a three-dimensional coupled ocean (Kyoto OGCM) and river runoff model. The new model was applied to Funka Bay, Northern Japan, and was run for two years (February 2008 to January 2010). We simulated three scenarios: (1) current conditions, (2) a kelp-controlled environment, and (3) a scenario controlled by riverine nutrient-loads. We concluded that kelp aquaculture has the potential to remove nutrient loads that result from river runoff and activities associated with commercial shellfish aquaculture.

**October 19, 12:15 (S9-8558)**

## Development of artificial seaweed bed for ecological restoration

Chang Geun **Choi**[1] and Seok Jin Oh[2]

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The brown macroalgae, *Sargassum* and Laminariales, form dominant and important seaweed beds around Korea and Japan. However, these beds have recently begun to disappear because of various anthropogenically induced factors. In an effort to recover those lost seaweed beds, many fishery scientists and phycologists have tried to create new ones from artificial reefs. To observe the colonization and succession of seaweed species, we first used a rope seeding technique, spore bag technique, and adult plant transplantation methods to restore beds on artificial reefs in Korea. The surface of each artificial reef turned brown within one month of its placement. Within three months of placement, *Enteromorpha intestinalis* and *Colpomenia sinuosa* appeared in remarkably high numbers on those reefs. The thalli of these early-stage species were decayed in the month after five months in the Spring. Within six months of placement, coralline algae had covered the reefs. During the winter season, brown algae, such as *Sargassum* spp. and *Ecklonia kurome*, appeared, and by 24 months after placement, coverage by the latter was approximately 50 to 80% on almost all reefs. Therefore, our results demonstrate that former seaweed beds can be re-established within two years of being seeded on artificial reefs.

# S9 Session Poster Presentations

## S9-1

### Studies on carbon, nitrogen, and phosphorus uptake fluxes by *Suaeda salsa* around the Bohai Sea District

Chunjiang **Guan**[1], Jie Na[2], Meng Xu[2] and Xiutang Yuan[1]

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As one of the most salt-resistant plants in a shoals environment, *Suaeda salsa* is widely distributed in the Bohai Sea District. We studied fluxes in its uptake of carbon, nitrogen, and phosphorus in the wetlands of that district. At each survey station, we harvested all of the plants from randomly selected 1-$m^2$ quadrats and recorded their wet weights. After the plants were dried, we then determined the ratio of dry to wet weight and calculated the per unit area of biomass, based on dry weight. These tissues were then ground into powder and samples were measured for total carbon content (TC) and total nitrogen content (TN) with an ElementarVario Macro CHN Elemental Analyzer. The total phosphorus content (TP) was obtained after burning the samples. Plants of *S. salsa* covered an area of 7397 ha. Total biomass production in 2009 was 21,041 t in July, 26,147 t in October, and 15,234 t in November. Carbon uptake flux by this species was 6577 t in July, 8539 t in October, and 5712 t in November. Nitrogen uptake flux was 201 t in July, 279 t in October, and 178 t in November while that of phosphorus was 17 t in July, 32 t in October, and 17 t in November. These data showed that the maximum uptake flux by all three occurred in October.

## S9-2

### Influence of environmental factors on ammonium and phosphate uptake rates by a red alga (*Ahnfeltia tobuchiensis*) population in Izmena Bay (Kunashir Island)

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We studied how temperature (T°C); photosynthetically active radiation (PAR); levels of oxygen ($O_2$), ammonium ($NH_4$) and phosphate ($PO_4$) in the seawater; and C, N, P, and Chl-*a* contents in algal tissues influenced the uptake rates of ammonium ($M_{NH4}$) and phosphate ($M_{PO4}$) by *Ahnfeltia tobuchiensis* (Ahnfeltiales, Rhodophyta). Measurements were made *in situ* at Izmena Bay during the Summer. This population of unattached agar-containing red alga formed a stratum up to 50 cm thick that occupied an area of 23.3 km² and had a fresh weight of 125,000 tons. The rate of ammonium uptake during daylight hours ($M_{NH4}^d$) varied from 0.00 to 0.78 µmol $NH_4$ g $DW^{-1}$ $h^{-1}$. It depended mainly on the concentrations of the substrate ($r^2 = 0.72$, $p < 0.001$) and $O_2$ ($r^2 = 0.44$, $p < 0.001$) in the water and on the P content in algal tissues ($r^2 = 0.64$, $p < 0.001$). The average daily $PO_4$ uptake rate in the population was 0.01 µmol $PO_4$ g $DW^{-1}$ $h^{-1}$, with that level being twice as high as at night. The tissue-P content ($r^2 = 0.79$; $p < 0.001$), concentration of $NH_4$ in the water ($r^2 = 0.58$; $p < 0.001$), and $O_2$ level ($r^2 = 0.26$; $p < 0.001$) were the dominant factors regulating $M_{PO4}^d$ during the day, whereas N and C contents in algal tissues determined $M_{PO4}^n$ during the night. Values for $M_{NH4}$ and $M_{PO4}$ in *A. tobuchiensis*, calculated in terms of algal weight, were relatively low (0.21 µmol $NH_4$ g $DW^{-1}$ $h^{-1}$ and 0.01 µmol $PO_4$ g $DW^{-1}$ $h^{-1}$), for a mean population biomass of 5.4 kg FW $m^{-2}$, or 1.8 kg DW $m^{-2}$. Despite this, the average daily uptake rates were 9.1 mmol $NH_4$ $m^{-2}$ and 0.43 mmol $PO_4$ $m^{-2}$. The mean net primary production ($P_n$) by the population during this study period was 22.5 g $O_2$ $m^{-2}$ and 8.4 g C $m^{-2}$ for the daylight hours. Thus, the population can be regarded as one of the most highly productive ocean ecosystems. This population performs important functions, such as supplying oxygen to the seawater and effectively absorbing nutrient elements (an excess of which can result in eutrophication). These roles substantially improve the ecological conditions of a water body. Partial removal of the alga (10-20% of the population biomass) for industrial purposes would also promote the elimination of excess nutrient elements from the ecosystem and enhance the biological purification of coastal waters.

## S9-3

# Effects of intensity and season of disturbance on the marine benthic community of a rocky intertidal shore with a periodic green tide occurrence in Korea

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The effects of intensity and time of disturbance on the recovery of marine benthic organisms were investigated at a rocky intertidal shore in Gwangyang Bay, Korea. We hypothesized that both factors would influence how a benthic community structure recovered after a disturbance. In all, 28 35- × 35-cm plots were established. The experimental design comprised disturbance intensity [two levels: cleared plot (w/ biofilm) and sterile plot (little biofilm)] and seasonal disturbance (two levels: Fall 1999 and Spring 2000). Population development and benthic community structure during the recovery process were dependent on disturbance intensity. Green and turf-forming algae dominated on cleared substrates whereas the sterile substrate had the largest coverage of sessile organisms. These results suggested that the presence of biofilm facilitated the settlement and recruitment of macroalgae by providing various habitat structures. However, it also indirectly inhibited the establishment of sessile organisms because of high competition for space due to the dominance by macroalgae. In addition, the sterile plots had greater species richness because of relatively low macroalgal coverage. The timing of disturbance had considerable effects on the recovery patterns from benthic organisms on sterile plots. Coverage by green algae was higher on Spring-sterile plots than on Fall-sterile plots due to low space competition because the disturbance had occurred just before the green algal blooms. However, barnacles and bivalves showed the lowest densities on Spring-sterile plots because they were suppressed by this bloom. All of our findings indicate that the season of disturbance affects the recovery pattern of a benthic community.

# S10 BIO/MEQ/FUTURE Topic Session
# Ecosystem responses to multiple stressors in the North Pacific

**Co-Sponsored by SOLAS**

***Co-Convenors**: Vladimir Kulik (Russia), Ian Perry (Canada) and Motomitsu Takahashi (Japan)*

***Invited Speaker**:*
*Natalie Ban (James Cook University, Australia)*

Marine ecosystems of the North Pacific, both coastal and offshore, are influenced by multiple stressors, such as increased temperature, change in iron supply, harmful algal blooms, invasive species, hypoxia/eutrophication, ocean acidification, and intensive fishing. These multiple stressors can (but do not always) act synergistically to change ecosystem structure, function, and dynamics in unexpected ways that can differ from responses to single stressors. Further, these stressors can be expected to vary by region and over time. This session seeks to understand the responses of various marine ecosystems to multiple stressors and to identify appropriate indicators of these effects. Contributions are invited which review and define categories of indicators to document the status and trends of ecosystem change at a variety of spatial scales (*e.g.*, coastal, regional, basin) in response to multiple stressors. Emphasis will be placed on empirical and theoretical approaches that forge links between ecosystem change and the intensities of multiple stressors. This session will form a contribution to the work of PICES WG 28 on *Development of Ecosystem Indicators to Characterize Ecosystem Responses to Multiple Stressors* (http://www.pices.int/members/working_groups/wg28.aspx). .

**Friday, October 19 (9:00-12:15)**

09:00 ***Introduction by Convenors***

09:05 **Natalie C. Ban, Stephen S. Ban and Hussein M. Alidina**
Mapping cumulative impact: Advances, relevance and limitations to marine management and conservation in Pacific Canada, and emerging Bayesian approaches (S10-8514), Invited

09:25 **R. Ian Perry and Jennifer Boldt**
Identifying multiple stressors and potential habitat responses in marine ecosystems of Pacific Canada (S10-8612)

09:45 **Vladimir V. Kulik**
Mapping cumulative human and natural impacts in the Sea of Okhotsk (S10-8559)

10:05 **Motomitsu Takahashi, Sachihiko Itoh, Naoki Yoshie, Kazuhiko Mochida, Masakazu Hori and Shigeru Itakura**
Comparative study on ecosystem responses to anthropogenic activities and natural stressors among inland, shelf and oceanic waters around Japan (S10-8568)

10:25 ***Coffee/Tea Break***

10:45 **Mingyuan Zhu, Ruixiang Li and Zongling Wang**
Ecosystem Changes under multi-stressors in the Yellow Sea (S10-8573)

11:05 **Kyung-Su Kim, JeongHee Shim and Suam Kim**
The combined effects of elevated carbon dioxide concentration and temperature on the early development stage of olive flounder *Paralichthys olivaceus* (S10-8429)

11:25 **Anna V. Skriptsova, Ludmila I. Sabitova and Ivan I. Cherbadgy**
Long-term changes in the subtidal macrophyte community in Peter the Great Bay (Sea of Japan): A response to climate change? (S10-8428)

11:45 *Discussion*

12:15 *Session Ends*

## S10 Posters

S10-1 **Evgeniya Tikhomirova**
Typical distributions of primary production at the surfaces of Peter the Great Bay (Japan Sea)

S10-2 **Kanako Naito, Setsuko Sakamoto, Mineo Yamaguchi, Ichiro Imai and Ken-ichi Nakamura**
Iron as a triggering factor for harmful dinoflagellate blooms

S10-3 **Aya Morinaga and Kazumi Matsuoka**
Eutrophication suggested by the heterotrophic signal of dinoflagellate cyst assemblages; Case of Omura Bay, West Japan

S10-4 **Yuta Inagaki, Tetsuya Takatsu, Masafumi Kimura, Yota Kano, Toyomi Takahashi, Yoshihiko Kamei, Naoto Kobayashi and Tatsuaki Maeda**
Effects of hypoxia on annual changes in growth and somatic condition of flathead flounder *Hippoglossoides dubius* in Funka Bay, Japan

S10-5 **Tetsuya Takatsu, Koji Shinoda, Shoichi Inoue, Tomofumi Seta and Yuta Inagaki**
Drastic reduction of demersal fish abundance by hypoxia in Mutsu Bay Japan in the fall of 2011

S10-6 **Stephani Zador and Kirstin Holsman**
Identifying and comparing ecosystem stressors in the eastern Bering Sea and Gulf of Alaska

S10-7 **Yumiko Yara, Meike Vogt, Masahiko Fujii, Hiroya Yamano, Claudine Hauri, Marco Steinacher, Nicolas Gruber and Yasuhiro Yamanaka**
Ocean acidification limits temperature-induced poleward expansion of coral habitats

S10-8 **Anastasiia Strobykina**
Spatial and temporal variability of nutrients in the Okhotsk Sea shelf zone

# S10 Session Oral Presentations

### October 19, 09:05 (S10-8514), Invited

## Mapping cumulative impact: Advances, relevance and limitations to marine management and conservation in Pacific Canada, and emerging Bayesian approaches

Natalie C. **Ban**[1], Stephen S. Ban[1] and Hussein M. Alidina[2]

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Analysis of cumulative human impacts in the marine environment is still quite new but developing rapidly. First, we present a study from Pacific Canada that aimed for a realistic consideration of cumulative impacts at a regional scale. Thirty-eight human activities were considered, with each broken down according to stressor types and a range of spatial influences. To add to the policy relevance, existing stressors within and outside of conservation areas were compared. Results indicate the entire continental shelf of Canada's Pacific marine waters is affected by multiple human activities at some level. Commercial fishing, land-based activities and marine transportation accounted for 57.0%, 19.1%, and 17.7% of total cumulative impacts, respectively. Surprisingly, most areas with conservation designations contained higher impact scores than the mean values of their corresponding ecoregions. The study in Canada provides an option for mapping cumulative impacts using available data and many assumptions. We will briefly mention another approach, which is being taken in a study in Australia's Great Barrier Reef region. It focuses on a more specific ecosystem component – coral mortality – and assesses the contribution of stressors towards that component. Using a Bayesian belief network approach, expert elicitation is used to inform stressor relationships when empirical data are absent. Despite recent advances in mapping cumulative impacts, many limitations remain, and the Bayesian approach provides one framework for overcoming some of these. Thus, despite limited data availability, preliminary analyses such as these can provide information relevant to precautionary management and conservation efforts.

### October 19, 09:25 (S10-8612)

## Identifying multiple stressors and potential habitat responses in marine ecosystems of Pacific Canada

R. Ian **Perry** and Jennifer Boldt

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All marine ecosystems are exposed to multiple anthropogenic activities and natural stressors. These include changing environmental conditions, disruption of habitats, fishing, marine shipping, invasive species, and other stressors. The impacts of single activities/stressors to particular habitats and ecosystem components are often known, at least in part. What is usually poorly known, however, are the cumulative impacts of multiple stressors. This presentation identifies the significant human activities and natural stressors acting on specific habitat types in the Strait of Georgia, British Columbia, Canada (and possibly one other Canadian Pacific marine ecosystem, if time permits). Using an expert-based screening method, the study ranks which habitats are most affected by specific activities and stressors, identifies which activities/stressors affect the larger variety of habitats, and estimates which habitats may have greater vulnerability to which activities and stressors. The presentation is a contribution to the work of PICES Working Group 28 on the development of ecosystem indicators to characterise ecosystem responses to multiple stressors.

### October 19, 09:45 (S10-8559)

## Mapping cumulative human and natural impacts in the Sea of Okhotsk

Vladimir V. **Kulik**

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The Sea of Okhotsk is the most productive zone of Russian fisheries. It produces up to 2/3 of the total national catch or about 1 million tons. Consequently it has high fishering fleet activity. The grid of frequencies of human fishing activity was obtained by classifying every ship-track by their operations for the last decade and then normalizing, merging and appropriately scaling these data. The Sea of Okhotsk represents an ecosystem adapted to severe winter weather, when it is mostly covered with ice, and intrusions of warm Pacific waters in summer. Variation in environmental parameters is very high; therefore multivariate anomaly detection methods were used to find extreme events in environmental conditions (monthly SST, Chl-*a* and sea ice areas). Frequencies of extreme events for the last decade were scaled and merged. Finally, the cumulative impact score was calculated and mapped based on Halpern *et al.* (2007-2009)

### October 19, 10:05 (S10-8568)

## Comparative study on ecosystem responses to anthropogenic activities and natural stressors among inland, shelf and oceanic waters around Japan

Motomitsu **Takahashi**[1], Sachihiko Itoh[2], Naoki Yoshie[3], Kazuhiko Mochida[4], Masakazu Hori[4] and Shigeru Itakura[4]

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We assessed ecosystem responses to anthropogenic activities and natural stressors in the Seto Inland Sea (inland water), the East China Sea (shelf water) and the Kuroshio/Oyashio waters off northern Japan (oceanic water) using an expert-based screening method. Based on published scientific reports, we scored vulnerabilities representing as spatial scale, frequency, functional impact, resistance, recovery time and certainty and identified most influential activities/stressors in the ecosystems. Increase in dissolved inorganic nitrogen by water discharge from rivers have resulted in eutrophication, harmful algal bloom, hypoxia and acidification in the Seto Inland Sea, and currently the problem is highlighted in the Chiangjiang Estuary and the adjacent waters in the East China Sea. For the intertidal and costal habitats, reclamation has lead to reduced areas of tidal flat and sea glass bed. Heavy industrial fishing was influential to the rocky shelf in the Seto Inland Sea, the continental soft shelf in the East China Sea and the slope in the Kuroshio/Oyashio waters. Increases in sea temperature cause changes in species compositions in multiple trophic levels in the three ecosystems. Increase in lowest temperature allows warm water species to overwinter in the Seto Inland Sea. Increasing temperature causes population alteration in small pelagic fishes such as sardine an anchovy in the East China Sea and the Kuroshio/Oyashio waters. Our results demonstrate that anthropogenic activities are influential synergistically in the inland and coastal shelf waters, but increasing temperature and industrial fishing affect the entire ecosystems around Japan.

### October 19, 10:45 (S10-8573)

## Ecosystem Changes under multi-stressors in the Yellow Sea

Mingyuan **Zhu**, Ruixiang Li and Zongling Wang

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The Yellow Sea is a marginal productive sea in North West Pacific Ocean. Recently, it is under high pressure from human activities and climate changes, such as increase of pollutants discharge from land sources, marine sources and atmospheric depositions, (especially excess nitrogen loading), over fishing and habitat modification, as well as temperature increases, reduction of fresh water loading, dust storms, *etc.* Consequently, a number of ecosystem changes have occurred. Nutrient concentration and ratio estimates have varied. Nitrogen increased, phosphate remained relatively constant or decreased, and silicate decreased significantly. The ratio of nitrogen to phosphate increased as did that the ratio of nitrogen to silicate. Variation of community structure at lower trophic levels was also observed. The abundance of phytoplankton decreased in the 2nd half of the last century and has increased during the present century. Zooplankton decreased in the western part of the Yellow Sea, but increased in the eastern part. Among benthic organisms, polychaetes showed increasing trends recently. Some disruptive responses of the ecosystem appearred, such as increases in harmful algal blooms (HAB) of micro algae and macro algae, jellyfish blooms and hypoxia. Further studies and management actions to reduce environment stresses are urgently needed.

### October 19, 11:05 (S10-8429)

## The combined effects of elevated carbon dioxide concentration and temperature on the early development stage of olive flounder *Paralichthys olivaceus*

Kyung-Su **Kim**[1], JeongHee Shim[2] and Suam Kim[1]

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Due to a high warming rate and possible local acidification in Korean waters, fishermen and aquaculturists require scientific knowledge on the biological reactions to environmental change for proper management of fisheries. To examine the effects of ocean warming and acidification on the early growth of olive flounder (the most popular fish species in the aquaculture industry), we conducted experiments with larvae reared under different conditions: combination of 400 and 1500 ppm atmospheric $CO_2$ and 18°C and 22°C of seawater temperature. Fertilized eggs of flounder were hatched in the system and larvae were reared for 4 weeks. After 4 weeks, the body weight and length were measured to differentiate the Specific Growth Rate at different rearing conditions. Bone structure and some sensor systems such as the lateral-line and surface porse were examined to compare normal and acidity-affected fish using a scanning electron microscope.

**October 19, 11:25 (S10-8428)**

## Long-term changes in the subtidal macrophyte community in Peter the Great Bay (Sea of Japan): A response to climate change?

Anna V. **Skriptsova**, Ludmila I. Sabitova and Ivan I. Cherbadgy

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The recent state of the *Ahnfeltia* communities in the Amursky Bay (Peter the Great Bay, Sea of Japan) was studied. Comparison of modern data with data obtained in 1992 showed reductions of *Ahnfeltia tobuchiensis* and *Chondrus armatus* stocks by 1.5 and 17 times, respectively. The resources of *Ahnfeltiopsis flabelliformis* increased by 5 times. The algal biomass per square meter also was also changed and led to community alteration. In the northern bed the association co-dominated by *A. tobuchiensis* and *C. armatus* was present in 1992, but by 2005 this association was succeeded by an *A. tobuchiensis* and *Ah. flabelliformis* co-dominated association. It is suggested that seaweed stock alteration and changes of structure of the algal associations could be driven by variations of environmental conditions in strata locations, mainly due to increasing water temperature. This supposition is supported by our observations of increased surface water temperatures in the *Ahnfeltia* stratum from 1986 to 2005. A similar temperature trend was generally found by Russian climatologists along the Russian coast of the Sea of Japan. To test the hypothesis of climate related changes of Ahnfeltia beds we studied the effect of temperature in a range of 5-15°C on the photosynthetic rate and growth rate of *A. tobuchiensis, C. armatus* and *A. flabelliformis* in laboratory experiments. The key finding of these experiments was the decrease of growth and photosynthetic rates of *C. armatus* and increase of the same parameters of *A. tobuchiensis* and *Ah. flabelliformis* at temperatures above 10°C.

# S10 Session Poster Presentations

## S10-1

## Typical distributions of primary production at the surfaces of Peter the Great Bay (Japan Sea)

Evgeniya **Tikhomirova**

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This study is based on available oceanographic data (seawater temperature, nitrates, phosphates and silicates) collected from 1952 to 2009. Criterion for reference years and anomalous years are the results of the author's work (Luchin and Tikhomirova, 2010), in which classification of years was based on thermal conditions (for warm, normal and cold years) and done separately for surface and subsurface layers. The surface data collected in Peter the Great Bay for July to September (12 468 stations) describe the surface water conditions during their maximum warming-up. Considering the thermal state of surface waters, 1952, 1958, 1960, 1967, 1968, 1973, 1975, 1978, 1984, 1988, 1991, 2000, 2006-2008 were classified as warm years; 1953, 1969, 1970-1972, 1976, 1977, 1981, 1982, 1985-1987, 1989, 1990, 1992, 1994, 1997, 1999, 2001, 2003-2005 as normal years; 1954, 1957, 1962, 1974, 1979, 1980, 1983, 1993, 1995, 1996, 1998, 2002, 2009 as cold years. The estimation of primary production in Peter the Great Bay based on the average long-term monthly data was made using the advanced model of V.V. Menshutkin (1993). In the present model, primary production is estimated from the water temperature, concentration of biogenic substances and irradiance. The model is based on principles of imitating modeling with new additions. Specifics of spatial variability of primary production in the investigated area and for warm, normal and cold years are shown. The spatial distribution of primary production was well corelated with the distribution of biogenic substances, meteorological conditions, river discharge variability and the current systems in the Bay.

## S10-2

## Iron as a triggering factor for harmful dinoflagellate blooms

Kanako **Naito**[1], Setsuko Sakamoto[2], Mineo Yamaguchi[2], Ichiro Imai[3] and Ken-ichi Nakamura[1]

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Iron is an essential element for the biochemical and physiological functioning of microalgae. However, the mechanism of iron uptake by eukaryotic microalgae is not yet fully understood because of the intricate iron chemistry of natural seawater and the difficulty in cultivation of axenic microalgae in uncontaminated conditions. Dissolved iron fractions consist largely of colloidal hydrolysis species and most of those are bound by organic ligands in natural waters. As a result of the above mentioned iron speciation, the concentrations of directly bioavailable iron species are extremely low in natural waters. To clarify utilization of the iron for the harmful algal species, we examined the growth experiments using a newly developed artificial synthetic medium in the presence of different iron species. The present study demonstrated that particulate $FePO_4$ and FeS were bioavailable for the growth of the dinoflagellates *Cochlodinium polykrichoides, Heterocapsa circularisquama* and *Karenia mikimotoi*. The differences in concentration of organic ligands in each medium caused the changes of the growth (maximal growth yield and specific growth rate) of harmful algae examined. These results suggest that the iron speciation has significant effects on controlling the harmful algal bloom formation in coastal areas. We point out the possibility that iron is a triggering factor for harmful dinoflagellate blooms showing the expansion in the North Pacific Ocean.

## S10-3

# Eutrophication suggested by the heterotrophic signal of dinoflagellate cyst assemblages; Case of Omura Bay, West Japan

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Omura Bay is a typical enclosed sea located in West Japan. Two short cores collected from the center (St-1 core) and southern parts (St-3 core) of the bay were palynologically analyzed in order to produce a trophic history of the bay. The ages of the St-1 and St-3 cores based on $^{210}$Pb and $^{137}$Cs were back to ca. 1925 and ca. 1970 respectively. Dinoflagellate cyst assemblages of both cores were divided into three phases; from the bottom to ca. 1970 (first phase), from 1970 to ca. 2000 (second phase) and from, ca. 2000 to the present (third phase). In the first stage, the dinoflagellate cyst assemblage was characterized by a gradual increase in cell density and dominance of photosynthetic species consisting of *Spiniferites* spp. and *Tuberculodinium vancampoae*. During the second phase, the total cyst density and that of heterotrophic *Polykrikos kofoidii* and *P. schwartzii* rapidly increased. The third stage cyst assemblage was characterized by a decrease of total cyst density and dominance of heterotrophic species. The Chemical Oxygen Demand (COD ) of the center of the bay gradually increased since the 1970s, reached a maximum of 2.5mg/L around 2000 and thereafter decreased. The rapid increase of heterotrophic species is the heterotrophic signal of the dinoflagellate cyst responding to the eutrophication of Omura Bay.

## S10-4

# Effects of hypoxia on annual changes in growth and somatic condition of flathead flounder *Hippoglossoides dubius* in Funka Bay, Japan

Yuta **Inagaki**[1], Tetsuya Takatsu[2], Masafumi Kimura[1], Yota Kano[2], Toyomi Takahashi[2], Yoshihiko Kamei[3], Naoto Kobayashi[3] and Tatsuaki Maeda[2]

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Hypoxia (dissolved oxygen<2.0ml/l) occurred near the seafloor annually in August from 2007 to 2011. Annual variation in bottom water temperature did not significantly differ between 1989 and 2011. Density of small *Ophiura* spp. (<9mm in disc diameter (DD)), a prey of *Hippoglossoides dubius*, were higher in 2007 and 2011 than in 2002 and 2003, and mean DDs were smaller in 2007 and 2011 than in 2002 and 2003. *Ophiura* spp. might tolerate hypoxia better than other benthic organisms, and the hypoxia between 2007 and 2011 did not cause increased mortality in *Ophiura* spp., but caused growth stagnation. The relative condition factor *K'* (= body weight·$10^5$/total length$^b$; male: b=3.258, female: b=3.217) of *H. dubius* was lower in the 1995 year-class than in the 1989, 1991, 2003, 2004, 2006, 2007, and 2008 year-classes. The growth rate was lowest in the 1995 year-class (male: 18.4mm·year$^{-1}$; female: 26.7mm·year$^{-1}$) and high in the 2006 and 2007 year-classes (male: 34.6mm·year$^{-1}$, 78.7 mm·year$^{-1}$; female: 44.5mm·year$^{-1}$, 80.9mm·year$^{-1}$; F-test: both $p$<0.001). The 1995 year-class fed on mysidaceans in 2000 and 2001, and other year-classes fed on small *Ophiura* spp. in 2009 and 2011. The dominant prey shift from mysidaceans to small *Ophiura* spp. -due to the increase of small *Ophiura* spp. which was caused by moderate hypoxia - might have improved somatic condition and increased the growth rate of the 2003, 2004, 2006, 2007, and 2008 year-classes.

## S10-5

## Drastic reduction of demersal fish abundance by hypoxia in Mutsu Bay Japan in the fall of 2011

Tetsuya **Takatsu**[1], Koji Shinoda[2], Shoichi Inoue[2], Tomofumi Seta[2] and Yuta Inagaki[2]

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Hypoxia (<2ml of $O_2$/liter) near the seafloor in Mutsu Bay was observed in September 2011. We examined annual variation in abundances, compositions and diversities of demersal fishes. Sampling was carried out by T/S *Ushio-maru* of Hokkaido University. Demersal fishes were collected by 5-11 tows of a small otter trawl net (4.4m height and 5.9m width) from May to November in 1989–2012 exclusive of 1992 and 1998, and the catch efficiency was assumed to be 1. Mean dissolved oxygen concentrations above 30cm of seafloor measured by Winkler's method were 4.1ml/L (range: 3.83–4.47ml/L), 1.6ml/L (0.74–2.54ml/L) and 3.3ml/L (2.56–4.17ml/L) in June 2011 as the pre-hypoxia period, September 2011 as hypoxia and June 2012 as post-hypoxia, respectively. Mean demersal fish biomass in June in 1990-2011 was 8.18±1.20kg/10,000m$^2$ (±SE), and the biomass decreased to 2.99kg/10,000m$^2$ in hypoxia and 0.59kg/10,000m$^2$ in post-hypoxia. Shannon-Wiener's *H'* and *J'* decreased from pre-hypoxia to hypoxia, and slightly recovered in post-hypoxia (1.04, 0.29 and 0.63dit, and 0.71, 0.28 and 0.57 in June 2011, September 2011 and June 2012, respectively). The biomass composition of a gurnard *Lepidotrigla* sp. was 36% in pre-hypoxia and high in hypoxia (95%) and post-hypoxia (77%), so this species might tolerate hypoxia better than other demersal fishes. However, also the biomass of *Lepidotrigla* sp. decrease from 1.45±0.35kg/10,000m$^2$ (mean±SE) in June in 1990-2011 as pre-hypoxia to 0.42kg/10,000m$^2$ in June 2012 as post-hypoxia (29% of mean in 1990-2011). Hypoxia might lead to mass mortality and major changes in demersal fish community structure.

## S10-6

## Identifying and comparing ecosystem stressors in the eastern Bering Sea and Gulf of Alaska

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The eastern Bering Sea (EBS) and Gulf of Alaska (GOA) are large marine ecosystems located at similar latitudes and separated by the Alaska Peninsula. The EBS habitat is dominated by a broad, soft-bottom continental shelf, whereas the GOA habitat is a diverse mix of rocky shelf, canyon and deep water. Each is host to a similar suite of species, but has fundamentally different oceanography and food web structures. Both ecosystems are exposed to multiple natural stressors and anthropogenic activities that include direct and indirect effects of fishing and climate change. In this study we identify the major human activities and natural stressors acting on specific habitat types in each ecosystem, rank the vulnerability of each activity-habitat combination, and use this information to identify the most vulnerable habitats based on cumulative impacts of influential stressors. We compare findings between these two ecosystems and discuss potential effects of management actions. The presentation is a contribution to the work of PICES Working Group 28 on the development of ecosystem indicators to characterize ecosystem responses to multiple stressors.

## S10-7

## Ocean acidification limits temperature-induced poleward expansion of coral habitats

Yumiko Yara[1], Meike Vogt[2], Masahiko **Fujii**[3], Hiroya Yamano[1], Claudine Hauri[2], Marco Steinacher[4,5], Nicolas Gruber[2] and Yasuhiro Yamanaka[3]

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Using results from four coupled global carbon cycle-climate models combined with *in situ* observations, we estimate the combined effects of future global warming and ocean acidification on potential habitats for tropical/subtropical and temperate coral communities in the seas around Japan. The suitability of the coral habitats are identified primarily on the basis of the currently observed ranges for temperature and saturation states ($\Omega$) with regard to aragonite ($\Omega_{arag}$). We find that under the "business as usual" SRES A2 scenario, coral habitats will expand northward by several hundred kilometers by the end of this century. At the same time, coral habitats are projected to become sandwiched between the tropical regions, where the frequency of coral bleaching will increase, and the temperate-to-subpolar latitudes, where $\Omega_{arag}$ will become too low to support sufficiently high calcification rates. As a result, the area of coral habitats around Japan that is suitable to tropical-subtropical communities will be reduced by half by the 2020s to 2030s, and is projected to disappear by the 2030s to 2040s. The suitable habitats for the temperate coral communities are also becoming smaller, although at a less pronounced rate due to their higher tolerance for low $\Omega_{arag}$.

## S10-8

## Spatial and temporal variability of nutrients in the Okhotsk Sea shelf zone

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Coastal ecosystems are objects of continuous scientific research since their vulnerability to external impacts is quite strong. Water areas situated at regions of mixing of river and sea waters are especially affected by external impacts. As a rule, fresh water contains high concentrations of biogenic substances that considerably determines high biological diversity in these regions. The purpose of this work is to investigate the structure and variability of hydrochemical parameters at the coastal area of the Sea of Okhotsk influenced by the Amur River discharge. During the warm period of the year the discharge from the Amur River is one of the basic sources of fresh water, nutrients and polluting substances for the Okhotsk Sea. Analysis of the vertical structure, seasonal variability and distribution of biogenic substances is presented by multiyear monthly averaged data. Nutrient concentration distributions are analyzed on the basis of all available data series for the period of 1950-2000. The total number of analyzed oceanographic stations is about 1500. The available data array allowed us to essentially improve our understanding of the spatial distribution of phosphates, nitrates and silicates at the extensive water area affected by the Amur River discharge.

# S11 MONITOR/POC Topic Session
# Effects of natural and artificial calamities on marine ecosystems and the scheme for their mitigation

**Co-Sponsored by JSFO and FRA**

***Co-Convenors**: Michael Foreman (Canada), Toyomitsu Horii (Japan), Vladimir Kulik (Russia), Phillip Mundy (USA), Sei-ichi Saitoh (Japan), Hiroya Sugisaki (Japan) and Tokio Wada (Japan)*

***Invited Speakers**:*
*Josef Cherniawsky (Institute of Ocean Sciences, Canada)*
*Shin-ichi Ito (Tohoku National Fisheries Research Institute, Japan)*
*Nikolai Maximenko (International Pacific Research Center, USA)*
*Stanley Rice (University of Tampa, USA)*
*Masahiro Yamao (Hiroshima University, Japan)*

From ancient times, we have been discussing and taking countermeasures on revival of fisheries and social infrastructures of waterside from natural disasters such as tsunamis and floods. The earthquake (Magnitude 9.0) that occurred in northeastern Japan on the 11th of March, 2011, was beyond our imagination. The earthquake and the subsequent gigantic tsunami destroyed the regional fisheries and surrounding society, and impacted marine ecosystems in eastern Japan. The tsunami also damaged the nuclear power plant of Fukushima, posing a serious threat to the North Pacific ecosystems due to the radioactive contamination of the ocean. Other recent examples of disasters which caused serious problems of environmental pollution for the marine ecosystems are hurricane Katrina in 2005, and the oil spill of the Gulf of Mexico in 2010. The magnitude of climatic disasters such as storms and floods may have been enhanced due to global warming. Since oil refineries, factories, power plants and other industrial infrastructures are often built in the coastal areas of the world, coastal ecosystems are vulnerable to natural and artificial disasters. For the wise use of ecosystem services, it is urgent and important to reveal the effects of natural and artificial disasters on marine ecosystems, to document their restoration processes, and to promote effective measures for restoration and mitigation of disaster impacts. The purposes of this session are to discuss: (1) the effect on the marine ecosystem by disasters, (2) the effect on the marine industries and societies by disasters, (3) schemes for the mitigations and recoveries from the disasters, (4) field monitoring on the effect and the process of recoveries, (5) domestic and international cooperation, and (6) policy and its effect.

## Tuesday, October 16 (9:30-17:30)

09:30 *Introduction by Convenors*

09:40 **Stanley D. Rice**
Exxon Valdez: Long Term environmental consequences of oil persistence and toxicity (S11-8835), Invited

10:10 **Hiroya Sugisaki**
**On behalf of *Japanese Society of Fisheries Oceanography***
General report on the projects aided by the PICES/ICES/JSFO fund for fisheries and oceanographic research on the recovery from the Great East Japan Earthquake (S11-8539)

10:30 *Coffee/Tea Break*

10:50 **Shin-ichi Ito, Shigeho Kakehi, Taku Wagawa, Yoji Narimatsu, Yutaka Kurita, Tomoko Sakami, Hideki Takami, Hideki Kaeriyama, Ken Fujimoto, Tsuneo Ono, Hiroyuki Tanaka, Takashi Kamiyama, Shigeru Itakura, Yuji Okazaki, Kazuaki Tadokoro, Akira Kuwata, Hiroaki Saito, Masaki Ito and Tsutomu Hattori**
The application of marine research to the study the marine ecosystem on the Pacific coast of northeastern Japan after the Great East Japan Earthquake disaster (S11-8403), Invited

11:20 **Daisuke Muraoka, Tomoko Sakami, Goro Yoshida, Masakazu Hori, Hiromori Shimabukuro, Takehisa Yamakita and Hitoshi Tamaki**
Impact of the Great East Japan Earthquake on *Zostera* meadows in the coastal area close to the epicenter (S11-8441)

11:40 **Hideki Takami, Tomohiko Kawamura, Daisuke Muraoka, Nam-Il Won and Hiroshi Nakaie**
Effects of the mega-earthquake and tsunami on rocky shore ecosystems on Sanriku Coast, Japan (S11-8345)

12:00 **Hiroshi Isami and Atsushi Tsuda**
Effects of the tsunami on zooplankton communities in Otsuchi Bay, northern Japan (S11-8650)

12:20 ***Lunch***

13:50 **Masahiro Yamao Zulhamsyah Imran, Achmad Zamroni, Kazuko Tatsumi and Michiko Amamo**
Strengthening social resilience in earthquake and tsunami affected coastal Asia through improvement of livelihood and social capital (S11-8820), Invited

14:20 **Natsuki Hasegawa and Toshihiro Onitsuka**
Damage from the tsunami on the Asari clam fishery in east Hokkaido, Japan and the problems in its recovery (S11-8352)

14:40 **Delvan Neville, Richard D. Brodeur, A. Jason Phillips and Kathryn Higley**
Assessment and characterization of radionuclide concentrations from the Fukushima Reactor release in the plankton and nekton communities of the Northern California Current (S11-8703)

15:00 **Toshihiro Wada, Yoshiharu Nemoto, Shinya Shimamura and Satoshi Igarashi**
Tsunami disaster and nuclear power plant accident effects on fishery facilities and marine products in Fukushima Prefecture: Present conditions and prospects (S11-8594)

15:20 ***Coffee/Tea Break***

15:40 **Nikolai Maximenko and Jan Hafner**
Tracking marine debris generated by the March 11, 2011 tsunami using numerical models and observational reports (S11-8530), Invited

16:10 **John A. Barth, Jonathan Allan, Craig Risien, Jan A. Newton and NANOOS Colleagues**
The Northwest Association of Networked Ocean Observing Systems (NANOOS) interactive tsunami evacuation maps (S11-8821)

16:30 **Josef Cherniawsky and Roy Walters**
Predicting future tsunami waves and currents on the West Coast of Canada (S11-8800), Invited

17:00 **Xiaorong Li, Huaming Yu and Songyang Song**
A new method based on FVCOM to simulate the impacts of a tidal power station on the surrounding marine environment (S11-8810)

17:20 *Discussion*

17:30 *Session Ends*

## S11 Posters

S11-1 **Yuichiro Yamada, Shinnosuke Kaga and Takehiko Ogata**
Influence of a huge tsunami on the coastal plankton community structure, especially on the abundance of the toxic dinoflagellate (*Alexandrium tamarense*) in Ofunato Bay, Sanriku, Japan

S11-2 **Yuji Okazaki, Yutaka Kurita and Shinji Uehara**
Changes in the demersal fish communities of the sandy beach in Sendai Bay after the disturbance by the tsunami

S11-3 **Hiroyuki Tanaka, Shigeho Kakehi and Shin-ichi Ito**
Temporal variation of polycyclic aromatic hydrocarbons in surface seawater from Sendai Bay, Japan, between June 2011 and March 2012

S11-4 **Daisuke Ambe, Hideki Kaeriyama, Yuya Shigenobu, Ken Fujimoto, Hajime Saito, Hideki Sawada, Tsuneo Ono, Takashi Setou and Tomowo Watanabe**
Distribution of radioactive cesium in sea sediment and bottom boundary layer after the Fukushima Daiichi Nuclear Power Plant accident

S11-5 **Galina S. Borisenko, Yuriy G. Blinov and Igor I. Glebov**
Investigation of radioactive pollution of biological resources in the northwest part of the Pacific Ocean after leakage at the nuclear power station “Fukushima-1” in Japan

S11-6 **Hideki Kaeriyama, Daisuke Ambe, Masachika Masujima, Kou Nishiuchi, Ken Fujimoto, Tsuneo Ono and Tomowo Watanabe**
Oceanic dispersion of radioactive cesium around Japan and western North Pacific after the Fukushima Dai-ichi Nuclear Power Plant accident

S11-7 **Hiroya Sugisaki**
**On behalf of *Japanese Society of Fisheries Oceanography***
General report on the projects aided by the PICES/ICES/JSFO fund for fisheries and oceanographic research on the recovery from the Great East Japan Earthquake (S11-8539)

# S11 Session Oral Presentations

**October 16, 09:40 (S11-8835), Invited**

### Exxon Valdez:  Long Term environmental consequences of oil persistence and toxicity

Stanley D. **Rice**

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Long term oil persistence and consequences from the 1989 Exxon Valdez oil spill are the unpredicted legacy of this spill.  The initial impacts were predicted — hard to deal with oil in the intertidal, and thousands of birds and marine mammals killed.  Long term consequences were not predictable, but the post spill consequences were well studied spill, and the spill was not complicated with a compromised environment from earlier spills or industrial development.  Now, after 20 plus years, researchers have been able to document long term consequences and oil persistence.  Although the beaches were cleaned in the first two summers by thousands of workers, oil still persists in some intertidal subsurface sediments, and continues to be a factor in the survival of some species.  Pink salmon embryos were affected for four years following the spill; laboratory studies confirmed their extreme sensitivity. Sea otters, who forage in the lower intertidal where oil contamination continues, exhibited symptoms of exposure and poor population recovery well into the second decade.  Two pods of killer whales, with low reproductive capacity, continue to have population effects from the initial acutely toxic exposures.   Prince William Sound today is productive, and largely recovered from the spill, yet it is not the same as it was prior to the spill.

**October 16, 10:10 (S11-8539)**

### General report on the projects aided by the PICES/ICES/JSFO fund for fisheries and oceanographic research on the recovery from the Great East Japan Earthquake

Hiroya **Sugisaki**
On behalf of *Japanese Society of Fisheries Oceanography*

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Just after the Great East Japan Earthquake occurred on the 11th of March, 2011, PICES (North Pacific Marine Science Organization) and ICES (International Council for the Exploration of the Sea) offered a donation of CDN$55000 to a research fund for Japanese scientists.  The Japanese Society of Fisheries Science (JSFO), as the secretariat of this fund, accepted applications for research projects and selected 11 projects, mainly from the local institutes and universities of Northeastern Japan (Tohoku area; Iwate, Miyagi and Fukushima prefectures). Fisheries are a typical and very important industry in the Tohoku area. The tsunami caused by the earthquake washed away peoples' lives, society, and many industries. The objectives of the research programs are various, including monitoring water quality or debris, ecosystem research, assessment of fisheries grounds, research on the effects of the tsunami on aquaculture, food safety, *etc*.  Every research program has been successfully executed. All research directly or indirectly has contributed to the reconstruction the fisheries and livelihoods all over the Tohoku area. This paper is a general introduction of the project. The details of some of the programs are individually reported at this annual meeting.

### October 16, 10:50 (S11-8403), Invited

## The application of marine research to the study the marine ecosystem on the Pacific coast of northeastern Japan after the Great East Japan Earthquake disaster

Shin-ichi **Ito**[1], Shigeho Kakehi[1], Taku Wagawa[1], Yoji Narimatsu[1], Yutaka Kurita[1], Tomoko Sakami[1], Hideki Takami[1], Hideki Kaeriyama[2], Ken Fujimoto[2], Tsuneo Ono[2], Hiroyuki Tanaka[3], Takashi Kamiyama[1], Shigeru Itakura[3], Yuji Okazaki[1], Kazuaki Tadokoro[1], Akira Kuwata[1], Hiroaki Saito[1], Masaki Ito[1] and Tsutomu Hattori[1]

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The tsunami caused by the Great East Japan Earthquake on 11 March 2011 seriously damaged the Pacific coast of eastern Japan. Fisheries in the area were damaged, with the total amount of damage exceeding 1,200 billion yen, including fishing vessels, fishery harbors, aquaculture facilities and products, and facilities for common use. Institutions were not exempt. Several of them suffered damage and several research vessels were destroyed. However, the institutions have applied their marine research to investigate the influence of the tsunami and subsequent nuclear power plant accident on the marine ecosystem. Debris surveys were conducted immediately and debris was removed based on the information. Although there was fear that nutrient input from the land caused by the tsunami might lead to outbreaks of red tide, there were none because rapid water exchange between open ocean and bays reduced the residence time in the bays. The influence of oil and polycyclic aromatic hydrocarbons on the marine environment was also limited. However, an increase in the abundance of harmful algal cysts was recognized in the surface layer of the bottom sediments. In the rocky shore area, sea urchins and juvenile abalone were seriously affected by the tsunami in addition to the damage sustained by algae communities. The influence of the tsunami on fish distribution was limited to the larvae/juveniles of cod in the shallow region, and the abundance of the important fish species was not changed significantly. Unclear is the lasting influence of radioactive contamination to the marine ecosystem. Long-term observation is needed.

### October 16, 11:20 (S11-8441)

## Impact of the Great East Japan Earthquake on *Zostera* meadows in the coastal area close to the epicenter

Daisuke **Muraoka**[1], Tomoko Sakami[1], Goro Yoshida[2], Masakazu Hori[2], Hiromori Shimabukuro[2], Takehisa Yamakita[3] and Hitoshi Tamaki[4]

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The Great East Japan Earthquake has caused extensive damage to the Pacific coast of northeastern Japan. We report on the condition of *Zostera* meadows in the coastal area close to the epicenter as revealed by research conducted before and after the earthquake. Matsushima Bay, located in the middle of the greater Sendai Bay, is an archipelago surrounded by a shallow sea. Before the earthquake, a climax community of *Zostera* had been observed for over 10 years. Submersible research conducted after the earthquake revealed that most of the community of *Zostera* in the inner part of the bay had disappeared. However, surviving *Zostera* meadows and seedlings were found in very limited zones such as shaded areas of islands. Samenoura Bay is located on the east coast of the Oshika Peninsula, facing the Pacific Ocean. Prior to the earthquake, there was a high density of vegetation of *Zostera* species on the sandy sediment at the inner part of the bay. After the earthquake, however, nearly all of the *Zostera* vegetation disappeared. Mangokuura is an inland sea-lake located at the northern end of the greater Sendai Bay. *Zostera* vegetation was found in a wide section of this lake. After the earthquake, a vast area of *Zostera* vegetation survived. The damage caused by the tsunami might have been minimized by a specific geographical feature of the inland sea-lake. Based on these results, we conclude that it is necessary to understand the details of the damage, focusing especially on the location of each bay, and to monitor the recovery process in the long-term.

**October 16, 11:40 (S11-8345)**

## Effects of the mega-earthquake and tsunami on rocky shore ecosystems on Sanriku Coast, Japan

Hideki **Takami**[1], Tomohiko Kawamura[2], Daisuke Muraoka[1], Nam-Il Won[3] and Hiroshi Nakaie[4]

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On March 11, 2011, a massive tsunami generated by a mega-earthquake hit the Pacific coast of northeastern Japan. We analyzed the effects of the tsunami on rocky shore ecosystems at three sites on Sanriku Coast: Tomarihama, Iwaisaki in Miyagi, and Otsuchi in Iwate, where we have carried out regular surveys since 2008. All three sites included two distinct algae communities: algal forests (AF) dominated by *Eisenia bicyclice* or *Laminaria religiosa* that were formed at depths shallower than 4-10 m and crustose coralline algae areas (CCA) dominated by *Lithophylum yessoenses* that extended deeper than algal forests. The impact of the tsunami was more profound in the CCA, where juvenile abalone *Haliotis discus hannai* <20 mm in shell length (SL) and juvenile to adult sea urchin *Strongylocentrotus nudus* inhabited, than in the AF. The density of these animals largely decreased after the tsunami at all three sites. Previously unrecorded recruitments of juvenile macroalgae, which appear to have settled after the event, were observed in the CCA, probably because of the large-scale removal of herbivores, including urchins. The biomass or coverage of brown macroalgae in the AF did not differ significantly after the tsunami at all three sites. However, the site-specific effect by the tsunami was observed on the benthic invertebrates which inhabited the AF. For instance, the density of adult abalone >50 mm SL in the AF was reduced by more than half at Tomarihama, which was hit by the tsunami waves more directly, but did not decrease significantly at Iwaisaki and Otsuchi.

**October 16, 12:00 (S11-8650)**

## Effects of the tsunami on zooplankton communities in Otsuchi Bay, northern Japan

Hiroshi **Isami** and Atsushi Tsuda

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A great tsunami caused serious damage to the Pacific coast of northeastern Japan on March 11, 2011. Otsuchi Bay is a typical ria-coast bay opening to the Pacific Ocean. The tsunami caused the loss of benthic organisms and bottom substrates, and the re-deposition of debris and mud in the bay. It is therefore, supposed that the tsunami caused serious damage to benthic organisms as well as to pelagic organisms having connection with the sea bottom, such as the copepod *Acartia*. However, it is not certain whether zooplankton communities, both holo- and mero-plankton, were affected by those disturbances. The aim of our study is to clarify how tsunami-derived disturbances affected zooplankton communities in Otsuchi Bay. We carried out the sampling of zooplankton bimonthly in the bay in May 2011. Zooplankton were collected with a NORPAC net (0.1 mm mesh opening). The zooplankton samples were preserved with 5% buffered formalin seawater for abundance estimations, and preserved with 99% ethanol to identify planktonic larvae of benthos using molecular techniques. Seasonal occurrence patterns of the higher taxa did not show clear differences with those reported in pre-tsunami periods. In *Acartia* copepods, *Acartia hudsonica,* a near-shore species, was abundant at the innermost station, while *A. omorii*, a more offshore species, appeared at the outer stations even in May 2011, two months after the tsunami. The abundant occurrence and the normal zonation of *Acartia* suggest that those zooplankton recovered quickly after the disturbance. Results of the composition of planktonic larvae of the benthos will also be presented.

**October 16, 13:50 (S11-8820), Invited**

## Strengthening social resilience in earthquake and tsunami affected coastal Asia through improvement of livelihood and social capital

Masahiro **Yamao**[1], Zulhamsyah Imran[1], Achmad Zamroni[1], Kazuko Tatsumi[2] and Michiko Amamo[3]

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The purpose of this presentation is to focus on the way to strengthen social resilience in earthquake and tsunami affected coastal societies in Asia. The Great East Japan Disaster, on March 11, 2011, heavily hit a huge number of coastal societies, especially fishing communities. Northeastern Japan coastal areas are the important pillars of food security, providing the nation with agricultural and fisheries products. Several clusters of fisheries and their related industries were located in the Disaster area. The features of the Great Eastern Japan Disaster and radiation leakage from the first nuclear power plant in Fukushima are huge-scale, complex, and far reaching. Any activities designed for restoration and reconstruction should be implemented step-by-step, comprehensively and systematically. Restoration and reconstruction projects have been already implemented in the affected areas as a whole, although various arguments and proposals have been put forward on how to “build back better.” According to the experiences learned from the Sumatra earthquake and great Indian Ocean tsunami in 2004, we have come to realize that rebuilding society is an indispensable factor in securing a re-growth of fisheries and attaining a better life for those affected people. How to ensure sustainable livelihood recovery of re-settlers and enhance capacity building of coastal societies is a key issue. While reducing dependence on any relief and donor agencies, those affected people and society strengthen social resilience through the development of social capital. Community-based and community-driven approaches may be a very effective way to achieve this.

**October 16, 14:20 (S11-8352)**

## Damage from the tsunami on the Asari clam fishery in east Hokkaido, Japan and the problems in its recovery

Natsuki **Hasegawa** and Toshihiro Onitsuka

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A catastrophic tsunami on March 11, 2011 damaged the Asari clam fishery in Akkeshi-ko estuary, located on the Pacific coast of Hokkaido, Japan (N43º02', E144º52'). Sediments with clams from the fishing grounds were either washed out or locally re-arranged by the tsunami. We monitored the clams and their environmental conditions before and after the tsunami to find out the type and degree of the damage to Asari clam fishery and the problems encountered in the recovery process. The condition of the clams deteriorated after the tsunami and their numbers reached a minimum one month after the tsunami when a massive clam die-off occurred. Immediately after the tsunami, it was thought that any remaining clams could not dig themselves into the fishing grounds without enough sediment, and so might be subject to various stresses. Moreover, active individuals may have been harmed unintentionally through the aggravation of the benthic environment when fishermen buried the dying clams. The condition of the clams recovered after a few months but some individuals showed abnormal tissue in their gonads during the summer spawning season. Environmental monitoring showed that high turbidity with sand capping caused by reconstruction of the fishing grounds, which might affect the estuary ecosystem, was more frequent after the tsunami than before the tsunami. Although there was catastrophic damage to Asari clam population and fishery, a dense population of juvenile clams was observed in spring 2012, which is important for the reconstruction of fishery in the long term. This will avoid the need to transplant clams from other areas, which could possibly lead to an invasion of alien organisms and diseases. Speed is required for recovery, but care must be taken to sustain the fishery.

### October 16, 14:40 (S11-8703)

## Assessment and characterization of radionuclide concentrations from the Fukushima Reactor release in the plankton and nekton communities of the Northern California Current

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The incident at the Fukushima Daiichi nuclear plant released a substantial radioactive contamination into the environment. With the predominant wind and current flow in this part of the North Pacific, these radionuclides will gradually spread to the U.S. West Coast waters after a suitable period of time, with the possibility of affecting food quality throughout the food web (including humans). In addition to the passive transport by currents and winds, the migratory pathways of large pelagic fish extend from Japan to the Northern California Current. These organisms can serve as transport vectors for these nuclides, especially given their capacity to concentrate radionuclides from surrounding waters and prey. We examine the amount and distribution of important radionuclides in the Northern California Current ecosystem from the plankton to larger fish, seabirds and marine mammals based on archived and post-exposure organisms. In particular, we focus on albacore tuna as a target species that migrates across the North Pacific Ocean feeding throughout its range and is commercially important along the U.S. West Coast. By predicting the radio-biologic stress (if any) for a managed species as more Fukushima-related radionuclides are taken up, appropriate action may be taken before significant population effects have occurred. Determination of natural background concentrations and high quality transport models produced from these data also aid in management in the event of a future accidental release, and in regulating safe activity releases.

### October 16, 15:00 (S11-8594)

## Tsunami disaster and nuclear power plant accident effects on fishery facilities and marine products in Fukushima Prefecture: Present conditions and prospects

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The Tohoku earthquake tsunami disaster of 11 March 2011 severely damaged Fukushima's coastal areas. Parts of all 10 fishing ports were destroyed, and 873 fishing vessels (74% of all registered vessels) were damaged. Regarding prefectural facilities, the Soma branch office of the Fukushima Prefectural Fisheries Experimental Station (FPFES) was destroyed, and its research vessel, the *Iwaki-maru* (150 tons) sank in Onahama Port. The Fukushima Prefecture Fish Farming Station, located 3 km south of Fukushima No. 1 Nuclear Power Plant, was destroyed. Moreover, contamination of marine products by radioactive substances has prevented fishermen from commencing commercial fishing. As of June 2012, the Fukushima prefectural government has inspected the concentrations of radioactive substances (cesium-134/137 and iodine-131) from 4,450 specimens within 165 marine species. From April 2011 – March 2012, 24 species exceeded the tentative regulation limit of cesium (500 Bq/kg). From January – June 2012, 36 species exceeded the new legal limit of cesium (100 Bq/kg) enforced in April 2012. The specimens exceeding the legal limit were mostly found in shallower waters south of the nuclear power plant. Concentrations decreased gradually in some pelagic fishes, seaweed, abalone, and surf clams. However, most fish, especially demersal fish species, have not shown a clear declining tendency, suggesting that radioactive cesium is continuing to pass through the food web. FPFES and other cooperative organizations continue to monitor marine products, seeking to clarify the intake/discharge mechanisms for radioactive substances between the environment and marine products, to restore fishery operations quickly, and to safeguard the safety of fishery product consumers.

**October 16, 15:40 (S11-8530), Invited**

## Tracking marine debris generated by the March 11, 2011 tsunami using numerical models and observational reports

Nikolai **Maximenko** and Jan Hafner

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Statistical and diagnostic models of the trajectories of objects, floating at the sea surface, have been developed using historical data of freely-drifting, satellite-tracked Lagrangian buoys of the Surface Velocity Program and Global Drifter Program combined with real time satellite products of sea level anomaly and surface wind. The models were tested in the study on the general marine debris dynamics where they adequately reproduced the areas of the ultimate debris (mainly plastic) accumulation in the five subtropical gyres, now all documented with direct measurements. From the first days after the strike of the March 11, 2011 tsunami, the models are used to provide the conceptual framework and to trace the floating debris generated by the tsunami and moving and dispersing under effects of ocean currents, waves, and wind. In collaboration with volunteers and agencies, the models were successfully validated and help coordinate mitigation efforts and forecast future scenarios. Model experiments revealed significant differences between debris motions in different years. In the mid-latitude North Pacific these differences seem to be correlated with the North Pacific Gyre Oscillation (NPGO) ocean mode, controlling the intensity of the North Pacific Current. Problems of modeling tsunami debris trajectories include: unknown distribution, volume, and composition of the initial debris sources, complex dynamical response of debris to oceanic and atmospheric factors, unknown rate of degradation, and absence of the observational system. In this paper, we will share our experience of interaction between scientists and operational activities and discuss the fate of different types of the tsunami debris.

**October 16, 16:10 (S11-8821)**

## The Northwest Association of Networked Ocean Observing Systems (NANOOS) interactive tsunami evacuation maps

John A. **Barth**[1], Jonathan Allan[2], Craig Risien[1], Jan A. Newton[3] and NANOOS Colleagues

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NANOOS, the Northwest Association of Networked Ocean Observing Systems, serves the Washington, Oregon, and northern California region and is the Pacific Northwest Regional Association of the U.S. Integrated Ocean Observing System (IOOS), a national effort designed to enable the broadest access to coastal and ocean data, tools, products, and knowledge. The region includes the eastern Pacific Ocean and California Current, the Strait of Juan de Fuca, Puget Sound, the Columbia River, and several smaller estuaries in each of the states. Membership includes academic and research institutions, tribal, state, and local governments, and industry. The coasts of Oregon, Washington, and Northern California are exposed to tsunamis from either distant earthquakes (such as the March 11, 2011, Tōhoku, Japan tsunami) or local earthquake events. Without doubt, the greatest risk facing Northwest coastal communities is from very large locally generated tsunamis produced by an earthquake (magnitude 8-9+) occurring immediately offshore of the Pacific Northwest coast on the Cascadia Subduction Zone. The Oregon Department of Geology and Mineral Industries (DOGAMI) and the Washington State Department of Natural Resources (DNR) have mapped the zones that would be inundated by a tsunami. NANOOS, in collaboration with DOGAMI and DNR, created a Pacific Northwest Tsunami Evacuation Zones online portal (http://nvs.nanoos.org/tsunami) and smartphone app (*TsunamiEvac-NW,* iTunes or Android) to provide an at-a-glance view of tsunami hazard zones along the coasts of Oregon and Washington. The interactive maps allow users to see whether they are in a tsunami evacuation zone, and plan their own evacuation routes.

**October 16, 16:30 (S11-8800), Invited**

## Predicting future tsunami waves and currents on the West Coast of Canada

Josef **Cherniawsky** and Roy Walters

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A future megathrust earthquake and tsunami generated along the Cascadia subduction zone (CSZ) pose a real and menacing threat to the West Coast of the United States and British Columbia, in particular to towns, villages and aquaculture installations along the south and west coasts of Vancouver Island. As there are not enough paleo-tsunami observations from the past tsunamis in the area and no real measurements during the last CSZ event in 1700 CE, we will evaluate the tsunami threat with a numerical simulation. Numerical models are used to predict tsunami wave amplitudes and water speeds at a number of locations along the coast, with a focus on Ucluelet Inlet and surrounding area. Basic features of these models will be discussed to outline more robust results, while studying the differences in terms of the specifics of their numerical schemes.

**October 16, 17:00 (S11-8810)**

## A new method based on FVCOM to simulate the impacts of a tidal power station on the surrounding marine environment

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A three-dimensional, unstructured grid, finite-volume coastal ocean model (FVCOM) was employed to simulate the hydrodynamic environment of Shacheng Bay based on field observations. Three cases: case one, simulating the current state of Shacheng Bay; case two, simulating the state after the construction of a dam (however, only the effects of the dam were taken into consideration); and case three, the tidal turbines inside the dam were considered, (which is an innovative method), were calculated. The simulated results of case one agreed well with field observations, where the averaged deviation of amplitude and phase lag of four main tidal constituents—$M_2$, $S_2$, $K_1$, and $O_1$ were 3.10, 0.94, 0.5 and 0.25cm and 1.23, 3.20, 2.20 and 3.19°, respectively. Based on the well validated model, cases two and three were calculated. The water level, current field, residual current field, tidal capacity and water exchange ratio were compared and analyzed in all three cases. The results demonstrated that the velocity near the Bachimen rose by 20cm/s along with the tidal prism increasing fivefold in case two. In contrast, the speed and the theoretical tidal energy reserves were reduced by 60% and 90%, respectively, which reflect the energy consumption of the turbines in case three. These two results combined indicated that the newly proposed method used in case three can be used comparatively to correctly and thoroughly reflect the effects that a tidal power station adds to the surrounding hydrodynamic environment, while only considering the construction of the dam, which was reflected in case two, cannot.

# S11 Session Poster Presentations

## S11-1

### Influence of a huge tsunami on the coastal plankton community structure, especially on the abundance of the toxic dinoflagellate (*Alexandrium tamarense*) in Ofunato Bay, Sanriku, Japan

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After the incursion of a huge tsunami in March 2011, the greatest increase of toxic dinoflagellate *Alexandrium tamarense* ($10^5$ cells $L^{-1}$) on record was observed in Ofunato Bay in May 2011. This massive bloom might have been caused by the disturbance of the coastal environment by the tsunami followed by sequential changes of plankton community structure. We investigated the seasonal changes of environmental factors and abundances of meso- to pico-plankton. In 2011, *A. tamarense* peaked in May at water temperature 9.6 to 11.4 °C, and disappeared in the middle of June while in 2012, abundance of *A. tamarense* peaked at the end of April (14,000 cells $L^{-1}$ at 5.0 °C), and decreased in May (50 to 80 cells $L^{-1}$ at 10.0 to 11.2 °C). The negative correlation between the abundance of *A. tamarense* and the concentration of dissolved inorganic nitrate and silicate was recognized. Chlorophyll *a* concentration decreased from September (2.9 µg $L^{-1}$) to December (0.7 µg $L^{-1}$), and increased in April (23.2 µg $L^{-1}$). Cell densities of autotrophic nano-algae, heterotrophic nano-flagellates and cyanobacteria peaked in September to October, then decreased in winter to early spring. Eucaryotic nano-algae abundances were low between fall to winter, then increased in spring. Heterotrophic bacteria were abundant in fall and spring, and low in winter. As a main component of meso-plankton, the abundance of the copepod *Acartia* peaked in March (> 20,000 individuals $m^{-3}$) and September (7,200 individuals $m^{-3}$), then decreased in winter (120 individuals $m^{-3}$). These plankton community structure features in Ofunato Bay were not clearly different from those found before the incursion of the tsunami.

## S11-2

### Changes in the demersal fish communities of the sandy beach in Sendai Bay after the disturbance by the tsunami

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The tsunami caused by the Great East Japan Earthquake damaged marine environments along the coastal area in northeast Japan. Recently, it has been reported that coastal habitats such as eelgrass beds and rocky shores have been damaged after the tsunami disaster. Sendai Bay has a long sandy beach, which provides a favorable nursery ground for fish such as flatfish. Since the tsunami reached up to 6m in height in Sendai Bay, it was supposed that the shore habitat in Sendai Bay was also damaged. Thus, to describe the effects of the tsunami on the fish community and its sandy beach environment, we compared demersal fish in Sendai Bay before and after the tsunami. We sampled fish from summer to autumn in Sendai Bay from 2004 to 2010 (before the tsunami) and 2011 (after the tsunami) using a sledge net (net width:2m, net height:0.2m, mesh size:6mm). From 2004 to 2010, the ten most dominant species were four flatfishes (*Cynoglossus joyneri*, *Paralichthys olivaceus*, *Kareius bicoloratus*, *Paraplagusia japonica*), two dragonets (*Eleutherochir mirabilis*, *Repomucenus ornatipinnis*), croakers (*Nibea mitsukurii*), poachers (*Occella iburia*), flatheads (*Platycephalus* sp.) and snailfishes (*Liparis tanakai*). Although there was little difference on demersal fish abundance before and after the tsunami disaster, the abundance of *Kareius bicoloratus* and *Eleutherochir mirabilis* was lower in 2011 than that of during the period 2004 to 2010. Since the abundance of demersal fish changed annually in Sendai Bay before the tsunami, we should be careful in interpretating changes in the fish community and their abundance.

## S11-3

## Temporal variation of polycyclic aromatic hydrocarbons in surface seawater from Sendai Bay, Japan, between June 2011 and March 2012

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Polycyclic aromatic hydrocarbons (PAHs) concentrations in surface seawater from Sendai Bay, Japan, were measured to elucidate the influence of oil spills on the marine environment caused by the Great East Japan Earthquake. Seawater samples were collected at fourteen to eighteen stations in Sendai Bay during research cruises. Ten cruises were conducted between June 2011 and March 2012. Eighteen kinds of PAHs having two to six rings were analyzed in 162 samples by gas chromatography mass spectrometry. The range and average ± SD of total PAHs concentrations were 0.83-13 ng/L and 4.1±1.8 ng/L, respectively. Naphthalene, phenanthrene, and methylphenanthrene were predominant among the PAHs, and the total concentration of these three compounds accounted for more than 70% of total PAHs concentration. The highest concentration was observed at the end of August. The PAHs compositions in seawater collected during this sampling time were different from those at other sampling times. This result indicated that the origin of PAHs contamination was different among the sampling times. In summer, total PAHs concentrations in seawater collected from the coastal side of Sendai Bay were statistically higher than those from the open side. There was also a similar tendency in winter, though there was no statistical significance. Total PAHs concentrations in winter were statistically higher than those in summer. These results correspond with a general tendency in the urban atmosphere. The influence of oil spills on the marine environment seemed to be limited.

## S11-4

## Distribution of radioactive cesium in sea sediment and bottom boundary layer after the Fukushima Daiichi Nuclear Power Plant accident

Daisuke **Ambe**[1], Hideki Kaeriyama[1], Yuya Shigenobu[1], Ken Fujimoto[1], Hajime Saito[2], Hideki Sawada[2], Tsuneo Ono[1], Takashi Setou[1] and Tomowo Watanabe[1]

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A large amount of radioactive materials was discharged into the western North Pacific Ocean by the Fukushima Daiichi Nuclear Power Plant (FDNPP) disaster following the Great East Japan Earthquake and tsunami on 11 March 2011. The area off Fukushima, where demersal fishes were an important fishery resource, was directly influenced by the discharged radioactive materials. Thus, one of the emerging fisheries issues is to comprehend the effects of the radioactive materials on the sea-bottom.. For this purpose, we conducted a basic study on radioactive cesium concentrations in sea sediment off Fukushima in February of 2012, with high spatial resolution. Higher concentrations of radioactive cesium were observed south of the FDNPP and high values tended to be along the 100 m isobath. Although the radioactive cesium concentration of suspended particles in the bottom boundary layer seemed to have a similar level and horizontal distribution pattern with that of sediments in a wider range, the correlation between the two concentrations was not significant. This result suggested that the distribution of radioactive cesium was still in the transitional state and was formed by complicated multi-scale motions in the bottom layer. Meanwhile, north of the FDNPP, a lower concentration was found in the coastal region. The composition of the sediment there was dominated by larger particles compared with the sediment particles south of FDNPP. These results suggested that sediment composition was one of the major factors in forming the distribution of radioactive cesium at the sea bottom.

### S11-5

## Investigation of radioactive pollution of biological resources in the northwest part of the Pacific Ocean after leakage at the nuclear power station “Fukushima-1” in Japan

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Radiation leakage of the radionuclides tellurium, cesium, and iodine at the nuclear power plant "Fukushima-1" on March 11, 2011 was man-made environmental pollution. . Coming into the aquatic environment from the atmosphere or with radioactive water, artificial radionuclides come from biogeochemical processes occurring in holding ponds. In fish, intake of radionuclides occurs through their covering tissue with water and food. We determined the dose-forming radionuclides of cesium in fish muscle. Measurement of the activity of artificial radionuclides of cesium in muscle tissue was performed on the gamma-spectrometer. At low activity (<3 Bq/kg), radioisotope Cs-137 was isolated from the muscle tissue by the radiochemical method, with a subsequent change in the activity as measured on the beta-spectrometer. The highest concentrations of Cs-137 were registered in samples of juvenile salmon on March 23 (8.1 Bq/kg of wet weight). The same sample was recorded by Cs-134 with specific activity of 6.9 Bq/kg, which confirms Fukushima’s source of contamination. In early April the high concentration of Cs-137 and Cs-134 availability persisted. A subsequent biological survey took place in June. The concentration of Cs-137 registered at a background level (1,8 ± 0.2 Bq/kg), and the radionuclide Cs-134 was absent. In samples of Pacific saury, which came into Kuril waters, the content of Cs-137 did not exceed the background level. Studies have shown that contamination of fishery resources by artificial radionuclides Cs-137/134 after the radiation leakage at the nuclear power plant "Fukushima-1" did not exceed permissible levels in the use of fish meal (130/500 Bq/kg, accordingly).

### S11-6

## Oceanic dispersion of radioactive cesium around Japan and western North Pacific after the Fukushima Dai-ichi Nuclear Power Plant accident

Hideki **Kaeriyama**[1], Daisuke Ambe[1], Masachika Masujima[1], Kou Nishiuchi[2], Ken Fujimoto[1], Tsuneo Ono[1] and Tomowo Watanabe[1]

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The Fukushima Dai-ichi Nuclear Power Plant (FDNPP) accident after the Great East Japan Earthquake and tsunami on 11 March 2011 resulted in the elevation of the level of anthropogenic radioactivity in the marine environment in the western North Pacific from atmospheric fallout and direct discharges of highly radioactive waters. Intensive monitoring of iodine-131, cesium-134 (Cs-134) and cesium-137 (Cs-137) in seawater near offshore FDNPP, and in marine organisms in the broader area around Japan, was conducted during the time when information of radioactive contamination in the seawater around western part of Japan and western North Pacific was quite limited. In this study, we report the concentrations of Cs-134 and Cs-137 in seawater collected from the western North Pacific, Japan Sea and East China Sea during 2011. Although high concentrations of Cs-134 and Cs-137 were detected off the coast of eastern Japan, an almost background level of Cs-137 was detected from the samples collected off the coast of western Japan, Japan Sea and East China Sea. In the western North Pacific, both Cs-134 and Cs-137 were detected from the sample collected along 155˚E, but Cs-134 was not detected at almost all stations along 175˚E in June and July 2011. The Kuroshio extension seemed to prevent the southward dispersion of radioactive cesium. The vertical distributions of radioactive cesium off the coast of northern Japan around FDNPP revealed complex patterns mainly due to the water mass interaction between Oyashio water and Kuroshio water.

### S11-7

# General report on the projects aided by the PICES/ICES/JSFO fund for fisheries and oceanographic research on the recovery from the Great East Japan Earthquake

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Just after the Great East Japan Earthquake occurred on the 11th of March, 2011, PICES (North Pacific Marine Science Organization) and ICES (International Council for the Exploration of the Sea) offered a donation of CDN$55000 to a research fund for Japanese scientists. The Japanese Society of Fisheries Science (JSFO), as the secretariat of this fund, accepted applications for research projects and selected 11 projects, mainly from the local institutes and universities of Northeastern Japan (Tohoku area; Iwate, Miyagi and Fukushima prefectures). Fisheries are a typical and very important industry in the Tohoku area. The tsunami caused by the earthquake washed away peoples' lives, society, and many industries. The objectives of the research programs are various, including monitoring water quality or debris, ecosystem research, assessment of fisheries grounds, research on the effects of the tsunami on aquaculture, food safety, *etc*. Every research program has been successfully executed. All research directly or indirectly has contributed to the reconstruction the fisheries and livelihoods all over the Tohoku area. This paper is a general introduction of the project. The details of some of the programs are individually reported at this annual meeting.

# S12 BIO/FIS/POC Topic Session
# Advances in understanding the North Pacific Subtropical Frontal Zone Ecosystem

***Co-Convenors**: Taro Ichii (Japan), Skip McKinnell (PICES) and Michael Seki (USA)*

***Invited Speakers**:*
*Hiromichi Igarashi (Data Research Center for Marine-Earth Science, JAMSTEC, Japan)*

The goal of this session is to compile a comprehensive collection of papers for the first time in two decades that can serve to synthesize knowledge of the roles of climate, physics, chemistry, biology, and humans in the Subtropical Frontal Zone (STFZ). The STFZ is a large, seasonally variable, dynamic, and complex oceanic region spanning the breadth of the North Pacific Ocean from Asia to North America. Its large-scale fronts and mesoscale processes give rise to localized "hot spots" of enhanced biological aggregation. The productivity of the region provides the ecological underpinnings for multi-national commercial fisheries. The STFZ provides important habitat for many species of fish and squid, seabirds, and marine mammals that undergo extensive seasonal migrations between the STZF and summer feeding grounds in the Subarctic. Concern for interactions between protected species, such as loggerhead turtles, and fisheries are focus areas of interest today, as is the health and productivity of the fisheries resources. Finally, interest in the effect of marine debris that is accumulating in oceanic "garbage patches" is increasing, perhaps exacerbated by growing interest in the fate of the debris field in the aftermath of the 2011 tsunami near Japan. This session would provide valuable information on potential impacts of climate and humans on marine ecosystem in the STFZ. The compilation of papers submitted to this session will be published in a special issue of *Progress in Oceanography*.

## Friday, October 19 (9:00-12:30)

09:00 ***Introduction by Convenors***

09:05 **Hiromichi Igarashi, Toshiyuki Awaji, Taro Ichii, Mitsuo Sakai, Yoichi Ishikawa, Shuhei Masuda, Haruka Nishikawa, Yoshihisa Hiyoshi, Yuji Sasaki and Sei-Ichi Saitoh**
Diagnosis of the possible link between interannual variation of neon flying squid abundance in the North Pacific and the recent climate regime shift in 1998/99 by using 4DVAR ocean data assimilation product (S12-8662), Invited

09:30 **Evan A. Howell, Aimee L. Hoover, Jeffrey J. Polovina and Michael P. Seki**
Spatial and temporal variability in the biophysical properties of the North Pacific Subtropical Frontal Zone during 1997-2011 (S12-8615)

09:50 **Carey Morishige and Evan A. Howell**
Marine debris movement and concentration within the North Pacific Ocean (S12-8708)

10:10 **Kedarnath Mahapatra and Yoshihiro Okada**
Influence of climate variability on pelagic ocean condition in the Kuroshio-Oyashio Transition Area using time series remote sensing data (S12-8803)

10:30 ***Coffee/Tea Break***

10:50 **Hiroaki Saito, Kazutaka Takahashi, Yuichiro Nishibe, Ken Furuya, Koji Hamasaki, Kiyotaka Hidaka, Tadafumi Ichikawa, Mutsuo Ichinomiya, Shigeho Kakehi, Miwa Nakamachi, Yuta Nishibe, Yuji Okazaki and Yuya Tada**
Food-web structure and dynamics in the frontal zone of Kuroshio Extension (S12-8622)

11:10 **Mitsuo Sakai, Toshie Wakabayashi, Haruka Urabe, Makoto Okazaki, Yoshiki Kato, Masachika Masujima, Denzo Inagake and Yasuhiro Senga**
Distribution and growth of young neon flying squid, *Ommastrephes bartramii*, in the central North Pacific Subtropical and Transition Zones during winter (S12-8564)

11:30 **Taro Ichii, Haruka Nishikawa, Hiromichi Igarashi, Hiroshi Okamura, Kedarnath Mahapatra, Mitsuo Sakai, Toshie Wakabayashi, Denzo Inagake and Yoshihiro Okada**
Impacts of extensive squid driftnet fishery and climate variability on epipelagic nekton in the Transition Region of the central North Pacific (S12-8563)

11:50 **David G. Foley, Elliott L. Hazen, Steven J. Bograd, Scott A. Shaffer, Scott Benson, Barbara A. Block and Daniel P. Costa**
Convergence from bottom to top: An oceanographic perspective on the movements of apex predators near the North Pacific transition zone chlorophyll front (S12-8799)

12:10 **Lesley H. Thorne, Scott A. Shaffer, Elliott L. Hazen, Steven J. Bograd, David G. Foley, Melinda G. Connors, Michelle A. Kappes and Daniel P. Costa**
Effects of inter-annual variability of the transition zone chlorophyll front on the habitat use and reproductive success of Laysan and Black-footed albatrosses (S12-8618)

12:30 *Session Ends*

## S12 Posters

S12-1 **Atsushi Yamaguchi, Kohei Matsuno, Yoshiyuki Abe and Ichiro Imai**
Interannual/latitudinal variations in abundance, biomass, community structure and estimated production of epipelagaic mesozooplankton along 155˚E longitude in the western North Pacific during spring

S12-2 **Dharmamony Vijai, John R. Bower, Yoshihiko Kamei and Yasunori Sakurai**
Distribution and characteristics of neon flying squid (*Ommastrephes bartramii*) near a spawning area off Hawaii

# S12 Session Oral Presentations

### October 19, 09:05 (S12-8662), Invited

## Diagnosis of the possible link between interannual variation of neon flying squid abundance in the North Pacific and the recent climate regime shift in 1998/99 by using 4DVAR ocean data assimilation product

Hiromichi **Igarashi**[1], Toshiyuki Awaji[1,2], Taro Ichii[3], Mitsuo Sakai[3], Yoichi Ishikawa[1], Shuhei Masuda[1], Haruka Nishikawa[1], Yoshihisa Hiyoshi[1], Yuji Sasaki[1] and Sei-Ichi Saitoh[4]

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The neon flying squid (*Ommastrephes bartramii*) has a wide-spread distribution in subtropical and temperate waters in the world ocean. In the North Pacific, it plays an important role in the pelagic ecosystem and is one of the major targets in Japanese squid fisheries. The population is comprised both the winter-spring spawning cohort and the autumn spawning cohort. Here, we focus on the abundance of the autumn cohort around the dateline during 1994-2006 summer, and investigate the possible link with the ocean state variation in the central North Pacific, especially apparent climate shift in 1998/99, using 4-dimensional ocean reanalysis dataset produced by our 4DVAR data assimilation system, which can provide the best possible time-trajectory fit to the observations and create a dynamically self-consistent dataset capable of offering more information on the dynamical state than can be derived from models or data alone (Masuda *et al.*, 2010). The close relationship is found between the interannual variation in the catch per unit effort (CPUE) of the autumn cohort and that in temperature, mixed-layer depth, vertical velocity and surface wind stress fields around the area 30-40N, 180-160W in winter. These results suggest that the survival of young squids could be strongly affected by the variation of the time-varying subtropical upper ocean structure. In addition, a statistical prediction of the autumn cohort abundance is performed by applying a Linear Inverse model to the 3-D ocean temperature fields.

### October 19, 09:30 (S12-8615)

## Spatial and temporal variability in the biophysical properties of the North Pacific Subtropical Frontal Zone during 1997-2011

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The North Pacific Subtropical Frontal Zone (NPSTFZ) is a basin-wide frontal region that separates the warm, nutrient-poor subtropical waters to the south from the cool, nutrient-rich waters of the subarctic to the north. The NPSTFZ is an important forage region and migration pathway for large pelagics including swordfish (*Xiphius gladius*), a target species for many international longline fisheries in this region. Seven springtime meridional oceanographic surveys were done in the NPSTFZ north of Hawaii within the 1997-2011 period in order to characterize inter-annual and long-term biophysical changes in this dynamic system. Overall, observed North-South changes in the physical properties of the NPSTFZ compared well to historic descriptions of this region, yet variability was observed in these properties from meso-scale features including eddies and jets, as well as large-scale forcing from ENSO events. This observed variability in the physical properties was tightly coupled to changes in the stratification and the amount of nutrients available in the 0-200m layer, which was tied to observed chlorophyll concentration. HPLC-derived pigment concentrations indicated high variability in the balance of prokaryotic and eukaryotic phytoplankton, with higher concentrations of prokaryotic cyanobacteria tied to increased stratification during La Niña events. The overall magnitude of the variability in the physical features of this system, the main causes for this variability, and how this variability propagates though the biological system to higher trophic levels will be discussed.

### October 19, 09:50 (S12-8708)

## Marine debris movement and concentration within the North Pacific Ocean

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Marine debris is a global ecological concern with numerous negative impacts ranging from navigation safety to entanglement and habitat degradation. Recent attention to the so-called, "garbage patches," as well as to marine debris generated by the March 11, 2011 tsunami in Japan has elevated the need for a better understanding of marine debris movement and concentration, particularly in the North Pacific Ocean. Previous observations and modeling results suggest that marine debris occurs in greater concentrations within specific regions in the North Pacific, such as the Subtropical Convergence Zone and eastern and western garbage patches. This presentation will discuss mechanisms for regional marine debris concentration, transport, and retention within the North Pacific with a focus on mesoscale features, including the North Pacific Subtropical Frontal Zone and its relation to marine debris concentration. Other mesoscale features include eddy fields in the Subtropical Frontal Zone and the Kuroshio Extension Recirculation Gyre. Current information on the movement of marine debris resulting from the 2011 tsunami, including recent modeling results, will also be shared within this presentation.

### October 19, 10:10 (S12-8803)

## Influence of climate variability on pelagic ocean condition in the Kuroshio-Oyashio Transition Area using time series remote sensing data

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The Kuroshio-Oyashio Transition Area east of Japan is an important area for understanding of climate and ecosystem interaction in the northwestern Pacific Ocean. Ship-based observation studies undertaken in this area by Japanese scientists indicated a strong relationship between large-scale climate events and regional lower trophic levels. The purpose of present investigation is to illustrate how the time series of remotely-sensed oceanographic data such as SST and chlorophyll *a* could be used to assess the impact of climate variability on the pelagic ecosystem of this area focusing on the spatiotemporal variability of upper ocean features. A warming phase and a cooling phase were detected during 1997-99 and 2000-2003 respectively, from the SST anomaly time series. This can be attributed to the regime shift of 1998 as detected in the previous studies. The upper ocean stratification strength anomaly indicated intense stratification and mixing during the warming phase and the cooling phase respectively. During the warming event, the onset of spring phytoplankton bloom was delayed by more than one month compared to a normal year, however the cooling event was marked by early onset of the bloom. Anomalously higher chlorophyll concentration was noticed during the cooling phase (2001-2002), which can be attributed to increased mixing during this period as well as the early onset of spring phytoplankton bloom. We explored ramification of this variability in ocean condition on the pelagic ecosystem and its plausible influence on decreased Pacific saury catch during 1998-99 in this area.

### October 19, 10:50 (S12-8622)

## Food-web structure and dynamics in the frontal zone of Kuroshio Extension

Hiroaki **Saito**[1], Kazutaka Takahashi[2], Yuichiro Nishibe[1], Ken Furuya[2], Koji Hamasaki[3], Kiyotaka Hidaka[4], Tadafumi Ichikawa[4], Mutsuo Ichinomiya[5], Shigeho Kakehi[1], Miwa Nakamachi[1], Yuta Nishibe[2], Yuji Okazaki[1] and Yuya Tada[3]

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The Kuroshio Extension (KEX) forms an intensive frontal zone off Japan. It is an important nursery ground for pelagic fishes such as Japanese sardine, Japanese anchovy and chub mackerel. Recent studies have revealed that SST and winter-time mixed layer depth north of the KEX were correlated with the recruitment success of Japanese sardine. It was suggested that ecosystem responses to changes in the physical properties caused past fish-species alternation off Japan. In spite of the ecological importance of the region, the overall components of the food-web were unknown. During a 5-year interdisciplinary project SUPRFISH (Studies on prediction and application of fish species alternation, 2007-2012), we carried out several cruises to examine the food-web components from bacteria to fish as well as environmental parameters at the arrival time of larval and juvenile pelagic fish. The dominant primary producer in the KEX in spring was nano-phytoplankton. Bacterial production increased with the season and was comparable to that of phytoplankton in May when nutrients were depleted. Nitrogen that was not utilized by phytoplankton was rapidly transferred to heterotrophic organisms, and a significant fraction was transformed to detritus. Gelatinous zooplankton (appendicularian, salp, doliolid) were dominant components in mesozooplankton assemblage and important consumers of nano- and picophytoplankton. Among the copepods, detritivores such as *Oncaea* which feed on discarded house of appendicularians were dominant. Gelatinous and detritivorous zooplankton, which have been overlooked in the previous studies, play an important role of the food-web dynamics in the KEX ecosystem.

### October 19, 11:10 (S12-8564)

## Distribution and growth of young neon flying squid, *Ommastrephes bartramii,* in the central North Pacific Subtropical and Transition Zones during winter

Mitsuo **Sakai**[1], Toshie Wakabayashi[1], Haruka Urabe[2], Makoto Okazaki[3], Yoshiki Kato[1], Masachika Masujima[3], Denzo Inagake[3] and Yasuhiro Senga[2]

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Neon flying squid (*Ommastrephes bartramii*) in the North Pacific undertake a seasonal north–south migration between spawning grounds in subtropical waters and feeding grounds in subarctic waters. In this study, we describe the biology of young squid of the autumn-spawning cohort in the central North Pacific during winter (January to late February) 2010. Young, immature squid less than 30 cm in dorsal mantle length were caught using a surface-mid water trawl from the Subtropical Frontal Zone (STFZ) and the North Pacific Transition Zone (NPTZ); sea surface temperatures ranged from 12 to 22°C. Most squid were distributed where chlorophyll *a* surface concentrations were greater than 0.2 mg $m^{-3}$, indicating that they occurred north of the Transition Zone Chlorophyll Front. Males and females showed no differences in growth or abundance. We suggest that young females begin rapid growth in spring as they migrate northward through the NPTZ, while the males remain near the STFZ. This rapid growth is presumably fueled by the rich food environment in the NPTZ during March to May.

### October 19, 11:30 (S12-8563)

## Impacts of extensive squid driftnet fishery and climate variability on epipelagic nekton in the Transition Region of the central North Pacific

Taro **Ichii**[1], Haruka Nishikawa[2], Hiromichi Igarashi[2], Hiroshi Okamura[3], Kedarnath Mahapatra[4], Mitsuo Sakai[1], Toshie Wakabayashi[1], Denzo Inagake[3] and Yoshihiro Okada[4]

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We assessed impact of extensive anthropogenic (high-seas squid driftnet fishery) and natural (climate variability) events on common epipelagic fish, squid and shark in central North Pacific Transition Region during 1979-2006 based on the research survey data and the published works. Regarding the driftnet fishery, fishing was conducted in this region by Japan, Korea and Taiwan to catch neon flying squid during 1979-1992, resulting in decline in stocks of target species and non-target species (Pacific pomfret and blue shark), which were by-caught by this fishery. However, the effects of the catches were not so significant to cause apparent damage of these stocks. The driftnet fishery was conducted during the high primary production regime (1979-1998). Regarding the climate variability, the most significant event was occurrence of the low primary production regime during 1999-2002 characterized by northward shift of Transition Zone chlorophyll front in winter. Adverse effects of this regime were observed throughout the food web. However, this regime lasted for only 4 years causing reduction in the stock levels of only short-lived species such as neon flying squid. Reduction of Pacific saury stock was also observed during 1998-2002, approximately around the same regime, but it was plausibly caused by a different oceanographic phenomenon. In conclusion, the low production regime fortuitously did not occur during the driftnet fishery period, otherwise overfishing could have caused extensive damage to stocks especially of the target species. Thus, it is important to know whether the regime is productive enough or not for sustainable management of fishery stocks.

### October 19, 11:50 (S12-8799)

## Convergence from bottom to top: An oceanographic perspective on the movements of apex predators near the North Pacific transition zone chlorophyll front

David G. **Foley**[1,2], Elliott L. Hazen[1,2], Steven J. Bograd[2], Scott A. Shaffer[3], Scott Benson[4], Barbara A. Block[5] and Daniel P. Costa[6]

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The North Pacific Transition Zone Chlorophyll Front (TZCF) is an extensive region of ocean convergence driven by basin-scale atmospheric and oceanic forcing. The TZCF exhibits strong variability at scales ranging from mesoscale to seasonal and inter-annual. The TZCF also serves as an area of high usage for a number of planktonic and free-swimming marine life. The Tagging of Pacific Predators (TOPP) program has provided an unprecedented set of data concerning the movements of apex predators including a variety birds, reptiles, mammals and fishes. Oceanographic data from satellites, numerical simulations and electronic tags placed on the animals are used to link physical dynamics of the region to the recorded movements of the animals over the period 2002–2010. Global circulation forecasts based on climate forecasts are used to speculate on how future changes in the position and intensity of the convergence zone may influence future usage as foraging area or migration corridor.

**October 19, 12:10 (S12-8618)**

## Effects of inter-annual variability of the transition zone chlorophyll front on the habitat use and reproductive success of Laysan and Black-footed albatrosses

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The Transition Zone Chlorophyll Front (TZCF) provides important foraging and migratory habitat for many species of marine predator in the North Pacific Ocean. Foraging habitats of Laysan (*Phoebastria immutabilis*) and Black-footed (*Phoebastria nigripes*) albatrosses breeding in the Northwest Hawaiian Islands show marked differences in habitat use in relation to the TZCF during the breeding season, with Laysan albatrosses foraging in more northwesterly waters. Trends in the reproductive success of these two species were assessed in relation to inter-annual variability in the location of the TZCF. We evaluated the foraging movements of Laysan and Black-footed Albatrosses breeding on Tern Island, French Frigate Shoals, during the brooding period (January-February), the most constraining time during the breeding season, to determine the effect of TZCF location on albatross habitat use. Satellite tags deployed during the brooding period from 2003-2012 were used to evaluate at-sea habitat use, while data provided by the United States Fish and Wildlife Service (USFWS) were used to assess reproductive success from 1983-2012. We used daily satellite fields of sea surface temperature from 1983-2012 to examine changes in the location of the TZCF, using the 18°C surface isotherm to represent the front. We discuss our findings in relation to long-term trends in the TZCF.

# S12 Session Poster Presentations

### S12-1

## Interannual/latitudinal variations in abundance, biomass, community structure and estimated production of epipelagaic mesozooplankton along 155˚E longitude in the western North Pacific during spring

Atsushi **Yamaguchi**, Kohei Matsuno, Yoshiyuki Abe and Ichiro Imai

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A total of 105 mesozooplankton samples collected with Norpac nets from 0-150 m depth at latitudinal stations (35°-44°N) along 155°E in May, 2002 through 2011 were analyzed. Year-to-year changes in temperature anomalies showed that the subtropical domain (<39°N) was warm in 2002, 2003 and 2011, while cold in 2004-2007 although the trend was obscure in the other two domains. Mesozooplankton abundance at each station varied from 40 to 1000 inds. m$^{-3}$. Mesozooplankton biomass was consistently higher (80-100 mg DM m$^{-3}$) in the transitional domain (40-42°N) than those of the other domains. Cluster analyses identified five groups (A-E) with distinct community features; *e.g.* subtropical communities occurred in 2002-2003 (warm year) (Group A), gelatinous zooplankton (Appendicularia and Doliolida) predominated communities in 2004-2007 (cold year) (Group B), small Copepoda predominated communities in transitional domain (Group C), communities in the subarctic domain (43°N<) (Group D), and Salpida-dominated communities in the transitional domain in 2003 (Group E). Empirical metabolic rate-based carbon budget model yielded that food requirement of mesozooplankton herbivores was the greatest (500-650 mg C m$^{-2}$ day$^{-1}$) in the transitional domain. Comparison between production of mesozooplankton herbivores and food requirement by mesozooplankton carnivores showed that the latter was fulfilled by the former in the subarctic and transitional domains, but the latter was near equal to or exceeded the former in the subtropical domain. As an annual event, the feeding migration of epipelagic fish to the transitional and subarctic domains in summer may be interpreted by their utilization of the excess secondary production (=production of mesozooplankton herbivores).

### S12-2

## Distribution and characteristics of neon flying squid (*Ommastrephes bartramii*) near a spawning area off Hawaii

Dharmamony **Vijai**[1], John R. Bower[2], Yoshihiko Kamei[2] and Yasunori Sakurai[2]

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In the North Pacific, the neon flying squid (*Ommastrephes bartramii*) makes an annual round-trip migration between its subtropical spawning grounds and its northern feeding grounds near the Subarctic Boundary. In this study, we examined the distribution and characteristics of members of the winter-spring cohort near a spawning ground off Hawaii during 1990 to 2000. Significantly more males were sampled than females, suggesting they were either more numerous or more susceptible to collection with the sampling gear (jigs). Females actively fed and were significantly larger than males. Somatic indices showed females between 400 and 600 mm mantle length were either maturing or mature and suggested some females larger than 550 mm were multiple spawners. We suggest multiple spawning might be a risk-spreading strategy in the unproductive waters near Hawaii.

# S13 MEQ/FUTURE Topic Session

## Risk management in coastal zone ecosystems around the North Pacific

***Co-Convenors**: Masahide Kaeriyama (Japan) and Thomas Therriault (Canada)*

***Invited Speaker**:*
*Erlend Moksness (Institute of Marine Research, Norway)*

Currently, approximately 60% of the world's population lives within 60 km of the coast, and this number is expected to reach 75% within the next two decades due to increased population growth. The coastal zone is an extremely complex environment that includes both coastal, nearshore marine and estuarine ecosystems, and the adjacent terrestrial area. Human populations around the North Pacific rely heavily on this zone for their livelihood, but growing pressures from increasingly diverse human activities coupled with climate change and natural catastrophes (*e.g.*, earthquake and tsunami) threaten the sustainability and productivity of coastal ecosystems. Risk management based on adaptive management and precautionary principles, is one way to prioritize, identify, and potentially mitigate impacts resulting from diverse human activities in coastal zones. This session will focus on: (1) preparation and countermeasures to respond to natural catastrophes; (2) protection of coastal zone ecosystems from human-mediated impacts (*e.g.*, habitat loss, pollution, harmful algal events, invasive species), and (3) the institution and protection of marine protected areas (MPAs).

### Wednesday, October 17 (9:00-12:30)

| | |
|---|---|
| 09:00 | ***Introduction by Convenors*** |
| 09:05 | **Erlend Moksness**<br>Coastal marine ecosystems and Integrated Coastal Zone Management (ICZM): A way forward (S13-8376), Invited |
| 09:35 | **Ichiro Imai, Asami Kuroda, Yuka Onishi, Atsushi Yamaguchi and Mineo Yamaguchi**<br>History of eutrophication and harmful algal bloom (HAB) events in the Seto Inland Sea of Japan and a proposal for prevention strategies for HABs using seaweed- and seagrass-beds (S13-8649) |
| 09:55 | **Ellik Adler, Lawrence Hildebrand and Reynaldo Molina**<br>Coastal Spatial Planning in the East Asian Seas Region – Climate Change and Disaster Risk Reduction (S13-8825) |
| 10:15 | **Ji-Yeon Shin**<br>Analysis of urban high school students' and scuba divers' awareness on the ocean environment and plans to enhance public awareness (S13-8628) |
| 10:35 | ***Coffee/Tea Break*** |
| 10:50 | **Tomohiko Kawamura**<br>Secondary succession in coastal ecosystems after the enormous disturbance by the Great East Japan Earthquake on the Sanriku Coast: Importance of scientific guidelines for future sustainable fisheries and ecosystem management (S13-8389) |
| 11:10 | **Zheng Wei, Zhan Lian, Fengye Zhang and Honghua Shi**<br>Assessment of ecological loss of the oil spill based on hydrodynamic numerical model – A case study in Jiaozhou Bay (S13-8714) |
| 11:30 | **Sei-Ichi Saitoh, Katsuyoshi Tanaka and Fumihiro Takahashi**<br>Development and application of Tohoku Coastal Web-GIS for supporting recoveries of the Tohoku Earthquake (S13-8786) |

11:50 **Jianguo Du, Qiulin Zhou, Shengyuan Yang, Quan Wen and Bin Chen**
The demonstration of estuarine biodiversity conservation, restoration and PA networking in China (S13-8412)

12:10 **Blake E. Feist, Marlene Bellman, Michael J. Ford and Phillip S. Levin**
Potential vulnerability of cetaceans to groundfish fishing fleets in the California Current (S13-8795)

12:30 *Session Ends*

## S13 Posters

S13-1 **Masahide Kaeriyama, Yu-xue Qin, Yosuke Koshino, Daisuke Uryu and Hideaki Kudo**
Sustainability and risk management of Pacific salmon under changing climate and catastrophic earthquake and tsunami in coastal ecosystems around Japan

S13-2 **Tomoya Kataoka, Hirofumi Hinata and Shin'ichiro Kako**
Simultaneous monitoring at multiple sites of beached plastic litter quantity using webcam

S13-3 **Galina S. Gavrilova**
Some risks of on-bottom shellfish aquaculture in Peter the Great Bay (Japan Sea)

# S13 Session Oral Presentations

### October 17, 09:05 (S13-8376), Invited

## Coastal marine ecosystems and Integrated Coastal Zone Management (ICZM): A way forward

Erlend **Moksness**

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The coastal zone includes both coastal waters and a narrow strip of land separating the marine and terrestrial environment, and is the key area for most marine species. On a national level the area normally contains many different and highly productive ecosystems which sustain high biodiversity and offers a myriad of goods and services. The concept ICZM (Integrated Coastal Zone Management) was born in 1992 during the United Nations Conference on Environment and Development (UNCED). ICZM is defined as a decision making process focused on sustainable use, development, and protection of seaside terrestrial and coastal marine areas and their resources, in continuous realization. ICZM depends on an understanding of the coastal zone ecosystems to be managed. Thus, a basic understanding of these systems in terms of ecological, economic and social structures and processes is needed.

There is general agreement that a multi-disciplinary approach towards understanding drivers, pressures and impacts in the coastal zone is needed and requires effective integration of data and information in policy and management. Part of this is to have basic information of the different coastal ecosystems in terms of ecological structures and processes. In addition, impacts on these ecosystems from increasingly diverse human activities such as aquaculture, energy and tourism coupled with climate change, calls for adding new tools to the toolbox for management of these systems. This presentation gives an insight to the Norwegian approach to address these issues. In addition, some of the conclusions from the multi-disciplinary conference on Integrated Coastal Zone Management in 2011, which addressed issues on advice and management related to the coastal zone, will be presented.

### October 17, 09:35 (S13-8649)

## History of eutrophication and harmful algal bloom (HAB) events in the Seto Inland Sea of Japan and a proposal for prevention strategies for HABs using seaweed- and seagrass-beds

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The Seto Inland Sea is an enclosed sea and major fishing ground including aquaculture facilities. Along with serious eutrophication in 1960s and 1970s, harmful algal blooms (HABs) had markedly increased in frequency and magnitude. A maximum of 299 events per year was recorded in 1976 and incidents decreased to about 100 events per year in late 1980s due to regulations that have kept events at this level. "Law Concerning Special Measures for Conservation of the Environment of the Seto Inland Sea" was legislated in 1973 and loadings of organic matter and nutrients to the sea decreased to half of the level of 1972. New research has revealed large numbers of algicidal bacteria attached to the surface of seaweeds (maximum, million of killers per gram wet weight) such as *Ulva* sp. (Chlorophyta) and *Gelidium* sp. (Rhodophyta) without any phytoplankton blooms occurring. Further, we discovered abundant algicidal bacteria, targeting fish-killing *Chattonella antiqua* and toxic *Alexandrium tamarense*, on the surface of seagrass (*Zostera marina*) and in seawater in *Zostera* beds. The presence of large numbers of algicidal bacteria indicates the potential for preventing red tide occurrences. We here propose new prevention strategies for red tide events by cultivation of seaweeds in aquaculture areas. When we develop and restore the natural seaweed- and seagrass-beds as a part of Sato-Umi concept, these presumably function to prevent the occurrences of HABs. Further, restored seaweed and seagrass beds also serve as nursery grounds for important fisheries resources.

**October 17, 09:55 (S13-8825)**

## Coastal Spatial Planning in the East Asian Seas Region – Climate Change and Disaster Risk Reduction

Ellik **Adler**[1], Lawrence Hildebrand[2] and Reynaldo Molina[1]

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Our project 'Spatial Planning in the Coastal Zone – Climate Change and Disaster Risk Reduction in the East Asian Seas Region' focuses on spatial planning in the coastal areas of COBSEA member countries China, Cambodia, Indonesia, Philippines, Thailand and Viet Nam. The overall goal of the project is to prevent and reduce the impacts of natural disasters such as climate change and sea-level rise, and to promote sustainable development of coastal areas through the application of spatial planning. It also aims to increase countries' capacity to respond to emerging issues in their coastal zones.

The project has three phases. Phase One produced a Regional Resource Document that provides guidance to responsible authorities on how to incorporate modern and emerging concepts such as climate-change adaptation, disaster-risk reduction, and ecosystem-based management into existing coastal spatial policies and procedures. In Phase Two, national consultation meetings were held to identify country-specific capacity-building and adaptation activities. Phase Three involves the implementation of identified activities beginning with a Train-the-Trainer course on coastal and marine spatial planning.

The next step is for national trainers to develop curriculum in local languages and deliver national training courses, with the objective of strengthening capacity to plan and manage coastal zones at national, sub-national, and local scales.

The project will strengthen human resource capacities of coastal spatial planners and decision makers to make a substantial contribution toward achieving sustainable use of coastal and marine natural resources; protection of ecosystems and coastal populations; sustaining the benefits provided by marine ecosystems; and reducing risks and impacts of natural and man-made catastrophes.

**October 17, 10:15 (S13-8628)**

## Analysis of urban high school students' and scuba divers' awareness on the ocean environment and plans to enhance public awareness

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Climate change has been an issue for more than a decade. The population of high school students who participate in environmental activities in response to global warming continues to increase, however, few students pay attention to what is happening in the oceans as a result of climate change. In this study, I conducted a survey to investigate awareness on ocean environment issues of high school students and to analyze their behavior using various social network services. A similar survey was conducted for scuba divers to see how a specific marine sport affects awareness as well as future willingness to participate in ocean environmental activities. Results show awareness of global warming (mean=4.48) was the highest and of barren ground (mean=1.92) and existence of Marine Arbor Day (mean=1.81) were the two lowest. For the divers' group, results were similar, however, they showed more willingness to get education and to participate in ocean environment activities. Over 50% of respondents in both groups use at least one social network service. In the high school group, it was Kakaotalk (61.2%), Facebook (48.5%), blog (28.6%) and twitter (14.3%). Based upon this survey, I suggest an online collaborative project using several social media platforms and some feasible actions that high school students can do to enhance public awareness of the ocean environment.

**October 17, 10:50 (S13-8389)**

## Secondary succession in coastal ecosystems after the enormous disturbance by the Great East Japan Earthquake on the Sanriku Coast: Importance of scientific guidelines for future sustainable fisheries and ecosystem management

Tomohiko **Kawamura**

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Coastal ecosystems along the Sanriku Coast, northeast Japan, were heavily damaged by the mega-earthquake and subsequent massive tsunami that occurred on March 11, 2011. Effects of the tsunami are likely to vary largely by location due to differences in the profile of the seafloor and the shape of coastlines and bays. Different ecosystems and different organisms appear to have different effects. For example, in rocky shore benthic ecosystems, organisms with weaker adhesive strength had more serious impacts than strongly attached sessile organisms. Organisms inhabiting exposed areas were impacted more than those inhabiting algal forests. Changes in community structure and balance of organisms resulting from the tsunami may affect ecosystems and populations of many resource organisms for a long time. The continuous sedimentation likely caused by land subsidence triggered by the mega-earthquake may have negative effects on larval/zoospore settlement and juvenile survival of benthic animals and macroalgae. Continuous long term monitoring is important to understand such indirect and gradual effects on coastal ecosystems. Fisheries activities have already been restarted in some areas but scientific guidelines are needed for future sustainable fisheries and ecosystem management. International Coastal Research Center located in Otsuchi, Iwate was directly impacted and heavily damaged by the tsunami, but has been monitoring and examining secondary succession of coastal ecosystems immediately following these events. A related large research project "Tohoku Ecosystem-Associated Marine Sciences (TEAMS)" started this year and details will be introduced in this presentation.

**October 17, 11:10 (S13-8714)**

## Assessment of ecological loss of the oil spill based on hydrodynamic numerical model – A case study in Jiaozhou Bay

Zheng **Wei**, Zhan Lian, Fengye Zhang and Honghua Shi

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Marine oil spills cause not only enormous economic losses, but also serious damage to the marine ecological environment. Scientific assessment of ecological damage caused by marine oil spills is of great significance for promoting the sustainable development of marine ecosystems. In this paper, based on analyzing assessment techniques for ecological damage caused by marine oil spills and applying these methods to physical oceanography and ecological economic analysis, we analyzed the temporal and spatial diffusion law of marine spilled oil. Further, we developed an assessment model for ecosystem services value damage caused by oil spills according to the spatial distribution of ecosystem services coupled to the spilled oil diffusion model and ecosystem services damage assessment model and developed a rapid assessment technique for ecological losses caused by marine oil spills. Finally, we carried out an applied application in Jiaozhou Bay.

**October 17, 11:30 (S13-8786)**

## Development and application of Tohoku Coastal Web-GIS for supporting recoveries of the Tohoku Earthquake

Sei-Ichi **Saitoh**[1,2], Katsuyoshi Tanaka[3] and Fumihiro Takahashi[2]

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We started “Hakodate Marine Bio-Cluster Project” as part of the Regional Innovation Cluster Program (Global Type) in 2009 supported by the Grant-in-Aid for University and Society Collaboration from the Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan. Through this project, we developed a web-GIS integrated coastal fisheries information system by applying satellite remote sensing, buoy observation networking, 4-D VAR data assimilation system, ecosystem modeling, and marine-GIS spatial modeling data to detect potential fishing zones for coastal squid fisheries and to predict suitable sites for scallop and kelp aquaculture in southern Hokkaido coastal region, Japan. We expanded this Web-GIS tool to the Tohoku coastal region in support of recoveries from the Tohoku Earthquake. This Web-GIS, called Tohoku Coastal Web-GIS, is applied for services and contributions to support activities of recoveries from the Tohoku Earthquake. The Web-GIS contains satellite information including high resolution GeoEye images, aircraft images, fundamental bathymetry, safety information, survey results, *etc.* Twitter function is applied for input from fisherman and local government. We will present the usefulness of these on-going Web-GIS for risk management and recoveries.

**October 17, 11:50 (S13-8412)**

## The demonstration of estuarine biodiversity conservation, restoration and PA networking in China

Jianguo **Du**[1], Qiulin Zhou[1], Shengyuan Yang[2], Quan Wen[3] and Bin Chen[1]

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The threats to biodiversity for two representative estuaries of China including the Yellow River and Pear River are discussed in this paper. The goal of this project is to develop a series of best practices based on experiences derived from project supported field activities focusing on the creation of protected area networks and wetland conservation and restoration areas in the Yellow and Pearl River Estuaries. These include: (1) addressing policy gaps and institutional failures to reinforce government efforts to create and conserve estuarine ecosystems; (2) creation of new MPAs where gap analysis indicate that examples of critical habitats and species remain outside of conservation protection; (3) restoration of degraded wetland habitats; and (4) promotion of increased public awareness of the long-term significance of biodiversity resources in these two deltaic ecosystems and the role MPAs and networks play in their conservation and management.

### October 17, 12:10 (S13-8795)

## Potential vulnerability of cetaceans to groundfish fishing fleets in the California Current

Blake E. **Feist**, Marlene Bellman, Michael J. Ford and Phillip S. Levin

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Cetacean populations worldwide are confronted by a multitude of anthropogenic threats. Whaling, vessel and fishing gear interactions, resource competition, and habitat disturbance are just a few examples. While commercial fishing activity is directly associated with many of these threats, few studies have addressed the potential vulnerability of cetacean species to multiple fishing fleets operating over a large geographic area. We overlaid an existing spatially explicit model of predicted mean annual density of 12 cetacean species within the California Current Large Marine Ecosystem (CCLME) with *in situ* West Coast Groundfish Fishery (WCGF) commercial fishing effort data for fixed-gear, at-sea hake mid-water trawl, and bottom trawl fleets. We quantified the overlap or vulnerability of each species to each fleet type by multiplying the predicted mean annual cetacean density by the observed fishing fleet effort (in hours) from 2002-2009. We found that there was large inter-specific and inter-fleet variability in the overlap between cetaceans and fishing fleets and this variability was not consistent over space or time. While many of the species had relatively low vulnerability rates, others had significantly more overlap with some fleets. While there is limited evidence of direct mortality from the activities of these fleets, our results suggest there is an opportunity for sublethal affects on some cetacean species. Our analyses are an important first step in generating formal risk assessments for quantifying the population level consequences of various fishing fleets on cetaceans living in the CCLME.

# S13 Session Poster Presentations

## S13-1

### Sustainability and risk management of Pacific salmon under changing climate and catastrophic earthquake and tsunami in coastal ecosystems around Japan

Masahide **Kaeriyama**[1], Yu-xue Qin[2], Yosuke Koshino[2], Daisuke Uryu[2] and Hideaki Kudo[1]

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At present, global warming has increased various risks for Japanese chum salmon (*Oncorhynchus keta*). In the Japan Sea, the Tsushima Warm Current has been influenced by a warming climate. Abundance of early-run chum salmon returning to Hokkaido's Japan Sea coast was lower in warm years of this current than in cool years. In the future, this global warming likely will decrease carrying capacity and distributional area of chum salmon in the North Pacific Ocean. On March 11, 2012, huge earthquake and tsunami completely destroyed coastal zones in the Tohoku Region. Stable isotope analysis revealed that juvenile chum salmon had a lower trophic level after the tsunami in the coast zone. Risk management based on adaptive management and precautionary principles is one way to recover and potentially mitigate impacts on coastal zones and desired for establishing sustainable chum salmon stocks.

## S13-2

### Simultaneous monitoring at multiple sites of beached plastic litter quantity using webcam

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We computed a quantity of beached plastic litter (PL quantity) at four sites (Wakkanai, Tobishima, Wajima, Tsushima) in Japan by applying a technique for detecting pixels of plastic litter and a projective transformation to photographs taken by webcams installed at each site. The technique involves generating color references in a uniform color space to detect plastic litter pixels and removing misdetected pixels using a composite image method. The PL quantity is computed by counting pixels in an image after applying the projective transformation to a photograph where plastic litter pixels have been detected. We successfully obtained a 14-month time series of PL quantity at four sites from November 2010 to December 2011. While the PL quantities greatly varied at Tsushima and Wajima over the analyzed period, they were unchanged at Tobishima and Wakkanai during the same period. It is a great advantage of webcam monitoring that PL quantity at multiple sites sequentially can be computed. We consider that the use of webcam monitoring of PL quantity enables beach cleanups to be performed effectively, to clarify the mechanism by which plastic litter is beached, and to grasp the transportation process of plastic litter. In the future, we will grasp the transportation process of plastic litter in the East Asian seas by combining an ocean circulation model and the webcam monitoring of PL quantity at multiple sites.

## S13-3

### Some risks of on-bottom shellfish aquaculture in Peter the Great Bay (Japan Sea)

Galina S. **Gavrilova**

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Given the intensity of geomorphic processes, the coast of Peter the Great Bay (Japan Sea) can be considered dynamically active with unstable landscapes. With the passage of typhoons and the occurrence of catastrophic river floods, content of suspended matter increased to 55 ml $l^{-1}$, and sedimentation rate was 0.7 mm $day^{-1}$. Since these processes may continue for several weeks, there is increased silting and changes in the structure of benthic sediments. Natural catastrophes have an effect on development of bottom cultivation and limit the physical carrying capacity of inlets of the bay for mariculture. The expansion of bottom shellfish cultivation should be associated with zoning of water areas, in view these risks.

# S14 POC/TCODE Topic Session Changing ocean biogeochemistry and its ecosystem impacts

**Co-Sponsored by ICES, IMBER and SOLAS**

***Co-Convenors**: Silvana Birchenough (ICES/UK), Steven Bograd (PICES/USA), Arthur Chen (IGBP), Masao Ishii (PICES/Japan) and Tony Koslow (PICES/USA)*

***Invited Speakers**:*
*Curtis Deutsch (University California Los Angeles, USA)*
*Akihiko Murata (JAMSTEC, Japan)*
*Brad Seibel (University of Rhode Island, USA)*

Ocean biogeochemistry is undergoing rapid and growing anthropogenic change. A significant fraction of anthropogenic $CO_2$ is taken up by the ocean, which drives down pH and reduces the saturation state of carbonate minerals like calcite and aragonite, a process known as "ocean acidification". Global climate models also predict that dissolved oxygen concentrations in the deep ocean will decline by 20-40% over the coming century or so as global warming enhances stratification of the upper mixed layer and reduces ventilation of the deep ocean. Declining oxygen levels have now been reported from mid-ocean depths in the tropical oceans and across the North Pacific. Both processes are of particular concern in the North Pacific, where the water is naturally "old" and has shallow carbonate saturation horizons, relatively low buffering capacity, and extensive oxygen minimum zones. It is anticipated that these anthropogenic influences on the global ocean will increase in coming decades as atmospheric $CO_2$ levels and global temperatures continue to rise. We invite papers on the changing biogeochemistry of the global ocean, its impacts on organisms and ecosystem function, and emergent impacts on biogochemical cycles related to the interaction of ocean acidification and declining oxygen with climate change and other anthropogenic impacts.

## Tuesday, October 16 (9:00-17:30)

09:00 ***Introduction by Convenors***

09:05 **Akihiko Murata, Shinya Kouketsu, Toshimasa Doi, Kazuhiko Hayashi and Yuichiro Kumamoto**
Decadal changes of dissolved inorganic carbon in the Pacific (S14-8699), Invited

09:35 **Liqi Chen, Zhongyong Gao, Wweijun Cai, Heng Sun and Suqing Xu**
Surface Carbon Changes in the western Arctic Ocean under seaice rapid shrinking and its implication of Arctic Ocean Acidification (S14-8394)

09:55 **Takamitsu Ito and Curtis Deutsch**
Understanding low-frequency variability of subsurface oxygen using a hierarchy of models (S14-8705)

10:15 **Shuchai Gan and Ying Wu**
Quantification of BDOC (bio-available dissolved organic carbon) of different water masses in East China Sea (S14-8651)

10:35 ***Coffee/Tea Break***

10:55 **Kosei Komatsu, Ichiro Yasuda, Sachihiko Itoh, Toru Ikeya, Hitoshi Kaneko, Kiyotaka Hidaka and Satoshi Osafune**
Impacts of epipycnal and diapycnal nutrient-transport by the Kuroshio on the productivity in the adjacent epipelagic waters (S14-8691)

11:15 **James Christian, Laurent Bopp, John Dunne, Michael Eby, Paul Halloran, Tatiana Ilyina, Ian Totterdell and Akitomo Yamamoto**
Trends in ocean $CaCO_3$ undersaturation in the CMIP5 suite of Earth System Models (S14-8721)

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| 11:35 | **Silvana N.R. Birchenough, Nigel Lyman, David A. Roberts, Juan Moreno-Navas and J. Murray Roberts**<br>*In-situ* characterisation of habitats adjoining cold-water coral reefs using a Sediment Profile Imagery (SPI) camera (S14-8789) |
| 11:55 | **John A. Barth, Francis Chan and Stephen D. Pierce**<br>Understanding and predicting hypoxia over the Pacific Northwest continental shelf (S14-8814) |
| 12:15 | **Yvette H. Spitz and Harold P. Batchelder**<br>Oregon shelf oxygen dynamics and exchange with the deep ocean: A modeling approach (S14-8788) |
| 12:35 | ***Lunch*** |
| 14:05 | **Curtis Deutsch and Aaron Ferrel**<br>Metabolic constraints on marine habitat and its climatic change (S14-8732), Invited |
| 14:35 | **Brad A. Seibel**<br>Climate change impacts on animal function and biogeochemical cycles (S14-8700), Invited |
| 15:05 | **Angelica Peña and William Crawford**<br>Trends in oxygen concentrations in the Gulf of Alaska and British Columbia waters (S14-8518) |
| 15:25 | ***Coffee/Tea Break*** |
| 15:50 | **Yukihiro Nojiri, Sayaka Yasunaka, Shinichiro Nakaoka, Tsuneo Ono, Hitoshi Mukai and Norihisa Usui**<br>Variability of carbon cycle and biological production in the North Pacific estimated from mapping of $p\mathrm{CO}_2$, alkalinity, and dissolved inorganic carbon (S14-8625) |
| 16:10 | **Keith B. Rodgers, Masao Ishii, Daniele Iudicone, and Olivier Aumont, Matthew C. Long and Joan A. Kleypas**<br>Re-emergence of anthropogenic carbon and pacific warm pool acidification (S14-8757) |
| 16:30 | **Finlay Scott, Ruth Parker and Silvana N.R. Birchenough**<br>Predicting the regional impacts of ocean acidification: Integrating sediment biodiversity and ecosystem function (S14-8782) |
| 16:50 | **J. Anthony Koslow, Peter Davison and Ana Lara-Lopez**<br>The influence of declining oxygen concentrations and mesopelagic fish biomass on ecosystem structure in the California Current (S14-8658) |
| 17:10 | **Julie E. Keister, Anna McLaskey, Lisa Raatikainen, Shallin Busch, Amanda Winans and Paul McElhany**<br>Oxygen and pH conditions experienced by zooplankton in a North Pacific fjord: Impacts on taxonomic composition, distributions, and growth (S14-8750) |
| 17:30 | *Session Ends* |

## S14 Posters

S14-1 **Baodong Wang**
Shift in salinity regions of maximum phytoplankton biomass in the Changjiang River plume: Impacts of the Three Gorges Dam?

S14-2 **Toshiya Nakano, Takashi Midorikawa, Tomoyuki Kitamura, Yusuke Takatani, Kazutaka Enyo, Masao Ishii and Hisayuki Y. Inoue**
Recent slowdown of wintertime oceanic $pCO_2$ increase in the western North Pacific: Relationship to variation in the subtropical gyre

S14-3 **Yusuke Takatani, Daisuke Sasano, Toshiya Nakano, Takashi Midorikawa and Masao Ishii**
Decrease of dissolved oxygen due to warming and other factors in the western North Pacific subtropical gyre

S14-4 **Naohiro Kosugi, Daisuke Sasano, Masao Ishii, Kazutaka Enyo, Toshiya Nakano and Takashi Midorikawa**
Acidification in the North Pacific subtropical mode water and its relation with climate variability

S14-5 **Sébastien Putzeys, Carlos Almeida, Pierrick Bécognée, Lidia Yebra, Ángeles Marrero Diaz and Santiago Hernández-León**
Active carbon flux by diel migrant zooplankton in the eutrophic and oligotrophic waters of the Canary Current

S14-6 **Toru Suzuki, Masao Ishii, Tsuneo Ono, Takeshi Kawano, Masahide Wakita, Lisa A. Miller, Akihiko Murata, Ken-ichi Sasaki, James Christian and Robert M. Key**
PACIFICA: Pacific Ocean Interior Carbon Data Synthesis

# S14 Session Oral Presentations

### October 16, 09:05 (S14-8699), Invited

## Decadal changes of dissolved inorganic carbon in the Pacific

Akihiko **Murata**, Shinya Kouketsu, Toshimasa Doi, Kazuhiko Hayashi and Yuichiro Kumamoto

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Repeat Hydrography cruises have produced high-quality data on physical and biogeochemical properties. With these data, we can now detect decadal-scale changes of oceanic biogeochemical conditions. Among the data, dissolved inorganic carbon ($C_T$) is the most important, because it reflects changes of an anthropogenic origin, *i.e.*, uptake and accumulation of anthropogenic $CO_2$ by the ocean. We examined changes of $C_T$ in the Pacific Ocean, separating anthropogenic and natural $CO_2$. As a result, the decadal-scale storage of anthropogenic $CO_2$ in the North Pacific was close to ± 0 mol $m^{-2}$ $yr^{-1}$, except in the western subarctic Pacific. In contrast, in the subtropical regions of both hemispheres, we found an increasing trend of > 10 μmol $kg^{-1}$ for oceanic uptake of anthropogenic $CO_2$, reflecting accumulation in mode waters. The annual water column inventories of anthropogenic $CO_2$ changes calculated for 20°-longitudinal or 10°-latitudinal bands throughout the Pacific Ocean revealed relatively high values (0.7 mol $m^{-2}$ $yr^{-1}$) in the subtropical regions of both hemispheres and low values in the tropical Pacific. This distribution pattern is similar to previous estimates for the Anthropocene, implying that the distribution processes of anthropogenic $CO_2$ has not changed on a basin scale over the last decade. The total anthropogenic and natural $CO_2$ storage in the Pacific Ocean was estimated as 8.4 ± 0.5 and 0.6 ± 0.4 P gram carbon (PgC) $decade^{-1}$, respectively. In response to the storage of anthropogenic $CO_2$, ocean acidification advanced especially in mode waters, which appeared as a decrease of aragonite saturation state by -0.034 $yr^{-1}$.

### October 16, 09:35 (S14-8394)

## Surface Carbon Changes in the western Arctic Ocean under seaice rapid shrinking and its implication of Arctic Ocean Acidification

Liqi **Chen**[1], Zhongyong Gao[1], Weijun Cai[2], Heng Sun[1] and Suqing Xu[1]

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The Arctic Ocean is rapidly changing with thinning and retreating of the sea ice due to its sensitivity to global warming. The Chinese National Arctic Research Expedition (CHINARE) has observed this seaice retreating in the western Arctic Ocean (wAO). The MV Xuelong, is an icebreaker built for the Chinese polar expeditions. The MV Xuelong conducted 4 expeditions, these were: i) during the first CHINARE in 1999 (at 75°N in the marginal seaice), ii) the second CHIANRE in 2003 (at 80°N in the marginal seaice), iii) third CHINARE in 2008 (covering the Canada Basin) and iv) fourth CHINARE to close multi-year seaice area in 2010 (at 88°N a northernmost area). This work analyzed the 4 surveys of CHINARE in the wAO. We tested the hypostesis of "low-low-high" distributions of $pCO_2$ in surface water under ice melting scenario in the Canada Basin. The treatment ¨L" represents the low $pCO_2$ of surface water under the ice cover in winter and the low $pCO_2$ in the melt-ice mixed water in early summer with a biological uptake. The treatment ¨H" is used to represent a high $pCO_2$ in the open water melted ice for a period of 1-2 months duration. High $pCO_2$ of surface water in prolong open water could be explained as increased temperature due to solar radiation and enhanced rate of air-sea $CO_2$ gas exchange and nutrients depletion. This was considered the major process of carbon chemical pump where temperature was the main controlled factor. The increased in the surface water $pCO_2$ was due to this $CO_2$ uptake, which could accelerate the negative impact of ocean acidification on pelagic and benthic ecosystems. Based on the ¨L-L-H" hypothesis, it is postulated that the surface water $pCO_2$ will reach the atmospheric level and will tend to saturation. However, based on the survey conducted in the western Arctic Ocean under the CHINARE cruises, we estimated an extra $CO_2$ invasion flux of only 4.6x$10^{12}$ gC $yr^{-1}$ with ice-free basins in the Arctic Ocean. This estimation was much lower than the early predictions for this area. However, in the continental shelf such as the Chukchi shelf, which is and area characterised by a high productivity area, it is believed that the biological pump will act as the main driving force, continually pumping atmospheric carbon dioxide through surface into deep and even the burial of the sea with a strong uptake $CO_2$ in surface water. A potential trend can be observed in the Arctic Ocean acidification in the center surface Arctic Ocean and subsurface marginal regions from variability of W. The center Arctic Ocean surface acidification could be attributed to atmospheric $CO_2$ invasion and ice rapid melting, although in the Arctic marginal area the subsurface acidification could be influenced by biological recycling.

### October 16, 09:55 (S14-8705)

## Understanding low-frequency variability of subsurface oxygen using a hierarchy of models

Takamitsu **Ito**[1] and Curtis Deutsch[2]

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Time series observation of dissolved oxygen reveals significant natural variability from interannual to multi-decadal timescales. Little is known about its spatial and temporal structure and the mechanistic link to climate variability. We developed a hierarchy of models to better understand the mechanisms behind the low-frequency variability of thermocline oxygen. A simple box model suggests that decadal ventilation of thermocline waters integrates out short-lived perturbations, leaving behind decadal and longer-term variability, and observed oxygen variability is generally consistent with this concept. We performed multi-decadal hindcast simulations to characterize statistical modes of subsurface oxygen variability. An ocean biogeochemistry model was numerically integrated using data-constrained global circulation fields from the Estimating the Circulation and Climate of the Oceans. The hindcast reproduces the observed multi-decadal contraction and expansion of the suboxic waters and the observed pattern of subpolar oxygen variability. Statistical modes of subsurface oxygen were extracted using empirical orthogonal functional analysis.The leading oxygen modes are clearly related to physical climate variability on interannual and decadal time scales. Our results indicate that the depth of thermocline is a key diagnostic that controls the respiration and transport-driven oxygen anomalies that provide the link to physical climate modes of the North Pacific.

### October 16, 10:15 (S14-8651)

## Quantification of BDOC (bio-available dissolved organic carbon) of different water masses in East China Sea

Shuchai **Gan** and Ying Wu

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Bioavailability of dissolved organic carbon (DOC) has garnered recent attention for its potential impacts on carbon sink and source capacity. As a major 'food' and excrement of micro-organisms, BDOC is important for the microbial food web. In order to verify the importance of BDOC in regional carbon cycle modeling of the East China Sea, a 10-day cultivation experiment was carried out focusing on the major water masses in the East China Sea—Yangtze river plume, bloom, Taiwan Warm Current and Kuroshio Current. Excitation emission matrix fluorescence spectroscopy (EEMs), which we applied in our study, has recently been used to characterize the sources, transformation and behavior of CDOM (the light absorbing fraction of DOM) in aquatic environments. Combined with parallel factor analysis (PARAFAC), 5 individual fluorescent components have been identified: 3 humic-like and 2 protein-like components ($P_1$, $P_2$), which suggest different sources and bioavailability. We have found that $P_1$ and $P_2$ are responsible for the BDOC. The percentage of bio-available DOC ranges from 0 to 31.1% with different $P_1$ and $P_2$ fluorescence, highest in the bloom event in coastal water, lowest in the Yangtze Estuary with lowest $P_1$ and $P_2$. Estimated from the degradation process, the inorganic carbon output of different water masses was calculated. It is important to elucidate that the biological processes (both DOC degradation and production) are 'visible' by 3-D fluorescence (EEMs), which verifies that the microbial food web plays an important role in the carbon cycle of aquatic ecosystems.

### October 16, 10:55 (S14-8691)

## Impacts of epipycnal and diapycnal nutrient-transport by the Kuroshio on the productivity in the adjacent epipelagic waters

Kosei **Komatsu**[1,2], Ichiro Yasuda[2], Sachihiko Itoh[2], Toru Ikeya[2], Hitoshi Kaneko[2], Kiyotaka Hidaka[3] and Satoshi Osafune[4]

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The transport of nutrients by the Kuroshio current and its further impacts on the ecosystem in the adjacent regions have been still unknown for quite sometime. This issue is mainly due to the lack of simultaneous measurement of both horizontal and vertical fluxes of nutrients around the jet. We conducted an intensive series of observations on board of the R/V Tansei-maru at intervals of 10 miles along the 5 lines crossing the Kuroshio current, south of Japan in April 2009. The Biogeochemical multi profilings revealed that the nutrient maximum was distributed on the isopycnal surface of 24.5-26.0$s_q$ rather than in the coastal area. The structure was analogous to the characteristics of the Nutrients found in the Gulf Stream region. We estimated the maximum of the epipycnal nitrate flux at 10mmolNm$^{-2}$s$^{-1}$ around the 26.0$s_q$ just below the current measurements. There were distinctive trends of fluxes in the northern and southern sides of the jet, mainly due to eddy diffusivity. At the northern side, the nutrient transport was facilitated by the induction process, which was considered to be important for the new production with sufficient irradiance. The direct measurement of microstructure clarified an intensive upward-supply of nutrient around the area due to higher diapycnal mixing. Furthermore, the diapycnal flux of nitrate was estimated at 3.0x10$^{-6}$ mmolNm$^{-2}$s$^{-1}$ at the 25.0-25.5$s_q$ just above the core of the epipycnal flux. The high nutrient transported epipycnally along the jet could be supplied efficiently upward by the strong diapycnal mixing to contribute significantly to the spring new production around the adjacent regions.

### October 16, 11:15 (S14-8721)

## Trends in ocean $CaCO_3$ undersaturation in the CMIP5 suite of Earth System Models

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Patterns and trends in the saturation state of the oceans with respect to the biogenic carbonate minerals calcite and aragonite were examined in the Earth System Models submitted to the 5th Coupled Model Intercomparison Project. Spatial distribution of saturation state at depths of 200 m (aragonite) and 500 m (calcite) and of the depth of the saturation horizon compared favourably with observations, with pattern correlations above 0.75 in most cases; skill was generally lowest for the calcite saturation depth, with correlation coefficients below 0.5 in some cases. The models simulate the total volume of undersaturated deep water to within about 20% for aragonite but less well for calcite, with overestimates up to a factor of three; the models show consistent trends for future growth of undersaturation volume under Representative Concentration Pathways 4.5 and 8.5. The total area with undersaturation above 200 m (aragonite) and 500 m (calcite) is mostly overestimated, but for aragonite most of the models cluster around values close to that estimated from observations, and again show similar trends for future growth across models. The consensus is that this area is projected to grow by an order of magnitude by 2100 under the "no mitigation" scenario (RCP8.5). Growth of the area of shallow undersaturation under RCP 4.5 slows in the late 21st century and thus shows potential for mitigation of ocean acidification impacts if emissions growth is arrested and reversed. However, all models show substantial increases in shallow aragonite undersaturation in the Southern Ocean even under RCP4.5.

**October 16, 11:35 (S14-8789)**

## *In-situ* characterisation of habitats adjoining cold-water coral reefs using a Sediment Profile Imagery (SPI) camera

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Benthic communities and their sedimentary characteristics were studied in areas of the Outer Hebrides (Mingulay and Banana reef complex (~120-190m) and further offshore the Logachev Mounds (~500-1000 m) at Rockall Bank in 2012. This work aimed to assess the biodiversity and function of benthic habitats adjacent to the *Lophelia pertusa* reefs with *in-situ* observations collected with a Sediment Profile Imagery (SPI) and a traditional video camera. Results showed that the apparent redox discontinuity layer (aRPD) collected at Mingulay reef varied between 2 -4 cm and had distinctive Crinoids (*Leptometra* sp.) and sponges (*Mycale macilenta)*. In contrast, at the Banana reef the aRPD measures were in the order of 4-6 cm and with surface and deep burrowing fauna (tube builders). The Logachev Mounds area was characterised by presence of coral fragments, layers of coral rubble and attached fauna, hence a very limited penetration and shallow a-RPD. There was a distinctive presence of the blue sponge *(Hymedesmia paupertas)* and squat lobsters *(Munida* sp.*)* mixed in coral fragments. Cold water corals reefs are considered to be hotspots for biodiversity. The structural complexity of cold-water coral banks provides habitat for many other species within the coral fragment and rubble. The use of the SPI allowed real time observations of these habitats (*e.g.* voids and burrows), sediment type and aRPD. This information has the potential to expand our current ecological understanding of the function performed by cold-water coral habitats and to elucidate the effects of ocean acidification on these seafloor ecosystems.

**October 16, 11:55 (S14-8814)**

## Understanding and predicting hypoxia over the Pacific Northwest continental shelf

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Near-bottom waters over the inner shelf (< 50 m water depth) off central Oregon have been increasingly hypoxic (dissolved oxygen < 1.4 ml/l) over the last decade, including the appearance of anoxia in summer 2006. Near-bottom, inner-shelf hypoxia is driven by upwelling of low-oxygen, nutrient-rich sourcewater onto the continental shelf, followed by the decay of organic matter raining down from surface phytoplankton blooms. We are using a combination of moored, ship-based and autonomous underwater gliders to measure dissolved oxygen over the continental shelf and slope off Oregon in space and time. The inshore side of Heceta Bank, a submarine bank that deflects the coastal upwelling jet seaward creating a region of weaker velocities inshore, is particularly vulnerable to hypoxia. Dissolved oxygen variability near the bottom in the inner shelf is driven by changes in both offshore upwelling source water dissolved oxygen concentrations and local wind forcing. For present day source water dissolved oxygen concentrations (~2.3 ml/l), hypoxia over the inner shelf on the inshore side of Heceta Bank during the summer upwelling season is observed about 50% of the time. Given the recent declining trend in source water dissolved oxygen concentration (0.016 +- 0.005 ml/l/yr), in 50 years the frequency of the hypoxia over the inner shelf on the inshore side of Heceta Bank is predicted to be about 90%. This represents a substantial impact to the inner-shelf coastal ocean ecosystem, some dramatic examples of which, including absence of fish and invertebrate die-offs, have been observed in the recent decade.

**October 16, 12:15 (S14-8788)**

## Oregon shelf oxygen dynamics and exchange with the deep ocean: A modeling approach

Yvette H. **Spitz** and Harold P. Batchelder

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One societal issue of concern on the Oregon Coast shelf is the frequent summertime episodes of hypoxic (< 1.43 ml DO/L; DO=Dissolved Oxygen) bottom waters observed during the last decade. The development of these low oxygen conditions on the shelf are the cumulative results of both physical and biological processes; among the most important are (1) the amount of total primary production, (2) the residence time in a specific shelf region, and (3) the initial DO and nitrate concentration of the source waters upwelled onto the shelf. In order to examine the importance of these physical and biological processes as well as their interaction, a 6-component (nitrate, ammonium, phytoplankton, zooplankton, detritus, oxygen) ecosystem model has been coupled to a ROMS (Regional Oceanic Modeling System) circulation model. We analyzed the model hindcast for three years (2002, 2006, 2008) that display different hypoxia severities and spatial and temporal extends. We found that the offshore conditions in the spring as well as the northern conditions during the upwelling season have a large impact on the shelf oxygen concentration in summer and early fall. The offshore conditions are directly related to the North Pacific basin deep minimum zone that has been impacted by climate changes.

**October 16, 14:05 (S14-8732), Invited**

## Metabolic constraints on marine habitat and its climatic change

Curtis **Deutsch** and Aaron Ferrel

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The warming of the world's oceans and the consequent loss of dissolved oxygen are expected to have profound impacts on marine ecosystems, but a general framework for predicting their combined effects on species fitness and habitat is lacking. Here we define a metabolic index - the ratio of oxygen supply to demand – that measures the simultaneous effects of temperature, mass, and oxygen on the respiratory balance of marine animals. The index is calibrated with a compilation of laboratory data for diverse species of fish and crustaceans spanning tropical to polar oceans. Despite a wide range of thermal and hypoxic tolerances, the contemporary habitat of all investigated species is bounded by a similar metabolic index. The critical values imply field metabolic rates 1.4-1.8 times resting rates, a ratio that is similar to many terrestrial organisms. This suggests that climate imposes a fundamental metabolic constraint on the habitat of diverse marine animals. In contrast to terrestrial species however, climatic limits are exerted on the equatorial rather than poleward edge of species geographic ranges. Based on climate model scenarios, temperature and oxygen contribute equally to a reduction in metabolic index, doubling the rate of poleward migration of habitable area relative to a single stressor alone.

**October 16, 14:35 (S14-8700), Invited**

## Climate change impacts on animal function and biogeochemical cycles

Brad A. **Seibel**

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A large fraction of planktonic and nektonic organisms migrate from surface waters at night to depths below the photic zone during the daytime. This mass migration, in conjunction with the respiratory production of carbon dioxide by animals, is thought to play an important role in the flux of carbon from the atmosphere to the sea floor. Estimates for the contribution of this process to carbon flux depend on the metabolic rates of migrant biota, which vary by more than 1000-fold between the fastest squids and slowest ctenophores and are dependent on temperature and the concentrations of oxygen and carbon dioxide.

$CO_2$ excretion is further dependent on the amount, timing and type of fuel consumed. Intermediate depths in some regions are characterized by extreme hypoxia and hypercapnia (Oxygen minimum Zones) that have a strong influence on the states of metabolism and the metabolic pathways utilized. Importantly, these environmental parameters are changing with anthropogenic $CO_2$ production leading to potentially dramatic ecosystem changes. This talk explores these interacting variables and the consequences of changing climate on biogeochemical cycles.

**October 16, 15:05 (S14-8518)**

## Trends in oxygen concentrations in the Gulf of Alaska and British Columbia waters

Angelica **Peña** and William Crawford

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An examination of oxygen and nutrient concentrations in the Gulf of Alaska and Canadian waters of the Pacific Ocean reveals several spatial and temporal patterns and a trend of declining oxygen concentration in shelf waters. Sub-surface oxygen concentrations tend to be lower in British Columbia shelf waters than in deep-sea waters on the same isopycnal, and lowest in mid-shelf waters of the Juan de Fuca Eddy region than farther north on the continental shelf. Lowest near-bottom concentrations of 0.7 ml $L^{-1}$ in southern waters are likely due to upwelling of deep, nutrient-rich and oxygen-poor water, onto the continental shelf and to organic matter oxidation. A 32-year time-series of near-bottom oxygen in this region shows declining concentrations in late summer at a rate of 0.019 ml $L^{-1}$ $yr^{-1}$ from 1979 to 2011. This decline is attributed mainly to changes in oxygen on the same density surfaces rather than to changes in depth of constant-density surfaces. Upwelled water onto the continental shelf bottom has water properties associated with the California Undercurrent on the 26.6 sigma-t surface at 200 m depth, where oxygen is typically 2.0 ml $L^{-1}$, and declined at a rate of 0.025 ml $L^{-1}$ $yr^{-1}$ from 1981 to 2011. Subarctic waters flowing toward British Columbia, as represented by the time series at Ocean Station P, have decrease in $O_2$ since the late 1950s. These results suggest that declines in $O_2$ in southern British Columbia since the 1980s are due to declines in the two source waters flowing to the region: California Undercurrent and Subarctic waters

**October 16, 15:50 (S14-8625)**

## Variability of carbon cycle and biological production in the North Pacific estimated from mapping of $p\mathrm{CO}_2$, alkalinity, and dissolved inorganic carbon

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Observations of ocean surface $p\mathrm{CO}_2$ were collected on board cargo ships operated under the NIES monitoring project. This project contributed to expand the current available $p\mathrm{CO}_2$ data set for the areas of the North and West Pacific. The newly acquired data set is now publicly available from the programme SOCAT (Surface Ocean Carbon Atlas Project) by IOCCP and by Joint SOLAS/IMBER Carbon Working Group. The outputs of the combined data sets with neural network techniques gave reasonable mapping results, including temporal and spatial variability for 2002 to 2008. The values for alkalinity and dissolved inorganic carbon (DIC) were also calculated from the reanalysis and the modeled results used in the neural network analysis from relationships with SST and SSS for alkalinity and also from values resulted from equilibrium in carbon chemistry for DIC. The estimated DIC values agreed well with the observational DIC collected at the research vessel based time-series stations within an uncertainty of about 10 micro mol $kg^{-1}$. The maps produced of DIC values demonstrated a well established north-south gradient and a clear relationship with ocean current system. The DIC values decreased during the summer season, which mainly related to the net community productivity in the ocean surface. The DIC changes were mapped after salinity normalization and subtraction of the effect of air-sea gas exchange. The inferred amplitude of DIC was used to resolve the north-south difference of biological productivity and also the east-west difference in the high latitude. These maps were compared with the oceanic variability like ENSO or PDO to estimate the influence of these oceanic regimes on the biological production, which helped to reveal the impact of PDO and the change of DIC distributions.

**October 16, 16:10 (S14-8757)**

## Re-emergence of anthropogenic carbon and pacific warm pool acidification

Keith B. **Rodgers**[1], Masao Ishii[2], Daniele Iudicone[3], and Olivier Aumont[4], Matthew C. Long[5] and Joan A. Kleypas[5]

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We consider the hypothesis that the meridional overturning of the Pacific subtropical cells controls the supply of anthropogenic DIC to the Pacific warm pool. Waters rich in anthropogenic carbon are subducted in the subtropics of both hemispheres of the Pacific, and a significant fraction of these waters travel to the cold tongue upwelling region via inter-gyre exchange. The timescale for this process is 10-20 years. Subsequent to upwelling in the cold tongue region, these thermocline waters are modified through buoyancy exchange, and some are eventually transformed into very light warm pool water, retaining much of the anthropogenic carbon they carried to the ocean interior within the subtropical subduction regions. We refer to the upwelling of thermocline waters rich in anthropogenic carbon in the cold tongue regions as "re-emergence" of anthropogenic carbon. Data-based scaling arguments for the WOCE-era (mid-1990s) indicate a re-emergence rate of anthropogenic carbon in the cold tongue region of approximately 0.35 petagrams of carbon per year. This suggests that re-emergence is a first-order, if not dominant, driver of the acidification of equatorial Pacific warm pool waters.

**October 16, 16:30 (S14-8782)**

## Predicting the regional impacts of ocean acidification: Integrating sediment biodiversity and ecosystem function

Finlay **Scott**, Ruth Parker and Silvana N.R. Birchenough

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Ocean acidification is expected to affect the life history traits of individuals in benthic ecosystems, *e.g.* through changes in growth rate, reproductive success and mortality rates. How do these impacts affect ecosystem function and how do these effects vary spatially across large heterogeneous ecosystems? We present a model, conditioned on observational data and experimental results, that captures the sediment biodiversity – ecosystem function relationship. The model predicts sediment storage of refractory organic carbon and incorporation of phytodetrital chlorophyll in sites across the North Sea. This is used to explore the impairment of the seabed function to process and recycle production and carbon in shelf seas under a range of ocean acidification scenarios. The rates and way in which these functions are altered varies in different regions of the North Sea as a result of the assemblages present at each site and degree of functional redundancy. The impact on species which have a disproportionate contribution to maintaining function regionally and on a site by site basis is shown to be of particular importance. Our findings have consequences for the conservation of ecosystem function by focusing on key bioturbator species and spatial distribution of comparative assemblage redundancy.

**October 16, 16:50 (S14-8658)**

## The influence of declining oxygen concentrations and mesopelagic fish biomass on ecosystem structure in the California Current

J. Anthony **Koslow**, Peter Davison and Ana Lara-Lopez

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Surveys carried out by the California Cooperative Oceanic Fisheries Investigations (CalCOFI) since 1951 indicate that midwater oxygen concentrations and populations of major mesopelagic fishes in the California Current have fluctuated coherently over this period. Over the past decade, midwater dissolved oxygen concentrations have declined approximately 20% and midwater fish populations by about 39%. CalCOFI acoustic/trawl surveys indicate that midwater fishes are key plankton consumers in the California Current. However, their ecological role in this ecosystem is poorly studied. We show that the time series of diel migratory and non-migratory midwater planktivorous fishes are highly correlated with each other and with midwater fish piscivores. These groups are also correlated with the abundance of several dominant epipelagic plankton feeding and piscivorous fishes in the region and with major indices of climate variability in the North Pacific: the multivariate ENSO index and the Pacific Decadal and North Pacific Gyre Oscillations. What are the implications of declining trends in midwater oxygen concentration and the mesopelagic micronekton for trophic structure? We present evidence that grazing by midwater planktivores has a significant impact on zooplankton abundance in the California Current.

**October 16, 17:10 (S14-8750)**

## Oxygen and pH conditions experienced by zooplankton in a North Pacific fjord: Impacts on taxonomic composition, distributions, and growth

Julie E. **Keister**[1], Anna McLaskey[1], Lisa Raatikainen[1], Shallin Busch[2], Amanda Winans[1] and Paul McElhany[2]

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We are studying relationships between ocean chemistry and zooplankton distributions in Puget Sound, Washington as a model of future coastal ocean ecosystems. Puget Sound is a deep fjord that connects to the North Pacific between the U.S. and Canada through the Strait of Juan de Fuca. Hypoxia ($<2$ mg DO $l^{-1}$) and extremely low pH ($<7.5$) occur naturally in Puget Sound as a result of inputs of upwelled ocean water, high surface production, and restricted circulation; anthropogenic eutrophication and global climate change are increasing the severity of conditions. In Summer and late Autumn, when the seasonally lowest oxygen and pH occur, conditions are particularly stressful for many organisms, yet abundant zooplankton and fish inhabit the region. How these organisms tolerate the conditions and whether their behavior, growth, taxonomic composition, and energy flow through trophic webs are altered is a focus of our research. Here we will examine shifts in zooplankton community structure and vertical distributions in relation to oxygen and pH in the field as well as results from laboratory experiments on changes in growth and survival to begin to understand how the interacting stressors affect marine ecosystems through direct and indirect effects. Because oxygen and pH are predicted to decline throughout the North Pacific, understanding controls on zooplankton will be necessary to predict future fisheries and ecosystem status.

# S14 Session Poster Presentations

## S14-1

### Shift in salinity regions of maximum phytoplankton biomass in the Changjiang River plume: Impacts of the Three Gorges Dam?

Baodong **Wang**

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Spatial patterns of phytoplankton production in a down-plume direction generally show a maximum at intermediate salinities, which is attributable to declining turbidity in the presence of high nutrient levels and has been reported for various large rivers including the Changjiang. The location of this maximum along the salinity gradient differs between rivers and within rivers for different discharge conditions. A comparison of the Changjiang River before and after the closure of the Three Gorges Dam (TGD) revealed that the biomass maximum occurred at a much lower salinity after the closure of TGD than that before the closure of TGD. This shift to lower salinity region of maximum phytoplankton biomass was attributed to the drastic reduction of riverine sediment load due to trapping behind the TGD and thus improved light environment of the Changjiang River plume. Accompanimently, the nutient front, which was caused by the enhanced uptake of phytoplankton, shift to the lower salinity region.

## S14-2

### Recent slowdown of wintertime oceanic $p\mathrm{CO}_2$ increase in the western North Pacific: Relationship to variation in the subtropical gyre

Toshiya **Nakano**[1,3], Takashi Midorikawa[2], Tomoyuki Kitamura[1], Yusuke Takatani[1,3], Kazutaka Enyo[1,3], Masao Ishii[1,3] and Hisayuki Y. Inoue[4]

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We investigated decadal changes in the growth rates of oceanic $\mathrm{CO}_2$ partial pressure ($p\mathrm{CO}_2$sea) in the western North Pacific using the data of repeat hydrographic section along the 137°E meridian by the Japan Meteorological Agency for the period from 1984 to 2009 in winter. The growth rates of $p\mathrm{CO}_2$ sea between 3°N and 33°N showed significant changes after the 1997/1998 El Niño; the growth rates of $p\mathrm{CO}_2$sea for 1999–2009 (–0.3±0.9 to 1.7±0.5 µatm/yr) were lower than those for 1984–1997 (0.7±0.3 to 2.2±0.6 µatm/yr) at most latitudes. It is indicative of the notable slowdown of $p\mathrm{CO}_2$sea increase in the 2000s. The slowdown was particularly significant in the southern part of the subtropical gyre between 10°N and 20°N. It is explained by the reduction of vertical dissolved inorganic carbon (DIC) supply that is associated with the southward expansion of the western subtropical gyre.

## S14-3

# Decrease of dissolved oxygen due to warming and other factors in the western North Pacific subtropical gyre

Yusuke **Takatani**[1,2], Daisuke Sasano[1,2], Toshiya Nakano[1,3], Takashi Midorikawa[4] and Masao Ishii[1,2]

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The Japan Meteorological Agency has acquired dissolved oxygen (DO) concentration data each year since 1967 along the 137ºE repeat section in the western North Pacific. In this dataset we found significant DO decrease on various isopycnal surfaces after the mid-1980s at 20º-25ºN in the mid-subtropics. DO decreased significantly in a vertical band over most density ranges from $25.3s_f$ in the North Pacific Subtropical Mode Water (NPSTMW) though $27.3\sigma_f$ in the $O_2$ minimum Layer (OML). The major controlling factors for the DO decrease differed among isopycnal surfaces. On density surfaces shallower than $26.0\sigma_\Theta$ (less than about 400m), ocean warming had the greatest influence. Ocean warming causes deepening of isopcynal surfaces as well as a decline in oxygen solubility. It was estimated that their combined contributions accounted for >50% of the DO decrease between $25.2\sigma_\Theta$ and $25.8\sigma_\Theta$ around the NPSTMW. The DO decrease in the North Pacific Intermediate Water (NPIW) at roughly $26.8\sigma_\Theta$ (~700 m) is presumably linked to the DO decrease in the NPIW formation region and also in Oyashio water, one of the main sources of NPIW. In the OML between $27.0\sigma_\Theta$ and $27.3\sigma_\Theta$ (~1000 m), the DO decrease is attributable to the increased westward transport of lower DO water due to strengthening of the subtropical gyre.

## S14-4

# Acidification in the North Pacific subtropical mode water and its relation with climate variability

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Japan Meteorological Agency has been conducting hydrography/hydrochemistry observations for the past 40 years on the principal repeat line along 137ºE. Since 2003, we have been measuring pH precisely with a spectrophotometric method. Calculations of pH can also be made from the concentration of dissolved inorganic carbon (DIC) and the total alkalinity which was estimated from multilinear regression. Since 1994, the largest decrease in pH was detected in the North Pacific subtropical mode water (NPSTMW) and the rate of decrease was not attributable to the absorption of anthropogenic $CO_2$ from the atmosphere alone. In the ocean interior, changes in the biochemical production of DIC is a major contributing factor of pH decrease. We calculated the changes in biochemical production of DIC from the changes in apparent oxygen utilization (AOU) and stoichiometric Redfield ratio of 117/170. In the NPSTMW, nearly half of the pH decrease was attributable to this biochemical process and there was a significant negative correlation between AOU and potential temperature. Winter SST in the Kuroshio Extension, which is the formation region of NPSTMW, is lower toward the east. This indicates that NPSTMW in low potential temperature regions takes a long time to reach 137ºE. The consumption of dissolved oxygen and concomitant production of DIC on the way to 137ºE are important factors of acidification. The acidification in the interior ocean is affected by not only anthropogenic $CO_2$ but also other factors such as heat flux between the ocean surface and lower atmosphere.

## S14-5

## Active carbon flux by diel migrant zooplankton in the eutrophic and oligotrophic waters of the Canary Current

Sébastien Putzeys[1,3], Carlos Almeida[2], Pierrick Bécognée[1], Lidia **Yebra**[3], Ángeles Marrero Diaz[4] and Santiago Hernández-León[1]

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The Canary Current is characterized by a strong disruption of its flow by the Canary archipelago, forming a downstream region of high mesoscale activity. This Canaries-African coastal transition zone connects the NW African upwelling system with the oligotrophic open ocean waters of the Eastern North Atlantic subtropical gyre. Further south, the Cape Vert Frontal zone is a highly productive area influenced by a quasi-permanent upwelling and a thermohaline front. To assess the role of zooplankton in the vertical export of carbon in those areas, we studied zooplankton biomass distribution and metabolism from the coast to the open ocean in an oligotrophic zone (26ºN) and in a meso- or eutrophic one (21ºN). Zooplankton biomass followed the same pattern in both transects, presenting two dense layers of organisms. The upper layer was located above 200 m and the second one below 400 m depth coincident with the deep scattering layer. However, the average migrant biomass (0-200 m) was 2.6-fold higher at 21ºN (71.4±51.4 mmolC·m$^{-2}$) than at 26ºN (27.1±12.4 mmolC·m$^{-2}$). This was reflected in the downward export of respiratory carbon (0-900 m depth) which was 10-fold higher in the southern than in the northern transect (0.54±0.42 and 0.05±0.05 mmolC·m$^{-2}$·d$^{-1}$, respectively). Moreover, the estimated pigmented gut flux was 20-fold higher in the south than in the north (0.85±0.98 and 0.04±0.26 mmolC·m$^{-2}$·d$^{-1}$). The total contribution of zooplankton metabolism to the particulate organic carbon flux was 4% in the oligotrophic transect, contrasting with the 92% observed in the eutrophic transect.

## S14-6

## PACIFICA: Pacific Ocean Interior Carbon Data Synthesis

Toru **Suzuki**[1], Masao Ishii[2], Tsuneo Ono[3], Takeshi Kawano[4], Masahide Wakita[5], Lisa A. Miller[6], Akihiko Murata[4], Ken-ichi Sasaki[5], James Christian[7] and Robert M. Key[8]

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PACIFICA (PACIFic ocean Interior CArbon) is a data synthesis project of ocean interior carbon and its related parameters in the Pacific Ocean supported by the Section on Carbon and Climate of PICES. We collected hydrographic/hydrochemical data from 262 cruises, including non-public data that have been collected after the late 1980s and data from the CLIVAR/CO$_2$ Repeat Hydrography program in the 2000s after GLODAP (GLobal Ocean Data Analysis Project) was released. The recommended adjustment values were estimated for dissolved inorganic carbon, total alkalinity, salinity, oxygen and nutrients for all cruises using secondary quality control procedures consisting of crossover analysis and inversions (Tanhua *et al.*, 2010). We also merged 28 cruises of GLODAP in the Pacific Ocean and 59 cruises of Line P with recommended adjustment values, and finally archived data from 306 cruises in the PACIFICA source dataset with a table of recommended adjustment values as of May 2012. PACIFICA will be provided for the study of ocean carbon cycle changes and climate variability in the Pacific Ocean, and in comparison with other basins and global ocean analysis.

# BIO Paper Session

***Co-Convenors**: Michael Dagg (USA), Hiroaki Saito (Japan) and Atsushi Tsuda (Japan)*

The Biological Oceanography Committee (BIO) has a wide range of interests spanning from molecular to global scales. BIO targets all organisms living in the marine environment including bacteria, phytoplankton, zooplankton, micronekton, benthos and marine birds and mammals. In this session, we welcome all papers on biological aspects of marine science in the PICES region. Contributions from the early career scientists are especially encouraged.

## Day 1, Thursday, October 18 (14:00-17:30)

| | |
|---|---|
| 14:00 | ***Introduction by Convenors*** |
| 14:05 | **John R. Bower, Katsunori Seki, Tsunemi Kubodera, Jun Yamamoto and Takahiro Nobetsu**<br>Egg brooding in a gonatid squid off the Shiretoko Peninsula, Hokkaido, Japan (BIO-P-8672) |
| 14:25 | **Oh Youn Kwon, Jung-Hoon Kang, Kyun-Woo Lee, Woong-Seo Kim and Jin Hwan Lee**<br>Size-fractionated phytoplankton biomass and species composition in the Yellow Sea: A comparison of different latitudes in spring and summer (BIO-P-8631) |
| 14:45 | **Hidefumi Fujioka, Atsushi Tsuda and Ryuji J. Machida**<br>Early life cycle of *Neocalanus plumchrus* and *Neocalanus flemingeri* in the Oyashio region, western north Pacific (BIO-P-8586) |
| 15:05 | **Yuichiro Nishibe, Kazutaka Takahashi, Tadafumi Ichikawa, Kiyotaka Hidaka, Hiroaki Kurogi, Kyohei Segawa and Hiroaki Saito**<br>Feeding of oncaeid copepods on discarded appendicularian houses (BIO-P-8553) |
| 15:25 | ***Coffee/Tea Break*** |
| 15:50 | **Minkyung Shin, Wongyu Park and Jungwha Choi**<br>Population dynamics of *Oithona similis* off Busan, South Korea (BIO-P-8724) |
| 16:10 | **C. Tracy Shaw, Leah R. Feinberg and William T. Peterson**<br>Effects of environmental changes on the euphausiids *Euphausia pacifica* and *Thysanoessa spinifera* in the coastal upwelling zone off the Oregon Coast, USA (BIO-P-8507) |
| 16:30 | **Rui Saito, Atsushi Yamaguchi, Hiromichi Ueno, Hiroji Onishi and Ichiro Imai**<br>Interannual variations in the zooplankton community in the Alaskan Stream region during the summer of 2004-2010 (BIO-P-8497) |
| 16:50 | **Akash R. Sastri, John Nelson and Beatrix E. Beisner**<br>Spatial patterns of zooplankton community productivity and functional trait diversity in the Bering and Chukchi Seas (BIO-P-8665) |
| 17:10 | **Jarrod A. Santora, John C. Field, Isaac D. Schroeder, Keith Sakuma, Brian K. Wells and William J. Sydeman**<br>Spatial ecology of krill, micronekton and top predators in the central California Current: implications for defining ecologically important areas (BIO-P-8417) |
| 17:30 | *Session Ends* |

### Day 2, Friday, October 19 (9:00-12:30)

09:00 ***Introduction by Convenors***

09:05 **Vjacheslav S. Labay**
Long-term variability of sublittoral macrobenthos of the Sakhalin's shelf of Tatar Strait (Sea of Japan) (BIO-P-8349)

09:25 **Harold P. Batchelder**
Spatial-temporal patterns of residence-time, transport and connectivity among near-shore marine reserves on the Oregon shelf from particle-tracking using inputs from multiple physical models (BIO-P-8796)

09:45 **Yongjiu Xu, Joji Ishizaka and Hisashi Yamaguchi**
Interannual variation of jellyfish (*Nemopilema nomurai*) abundance and magnitude, and timing of phytoplankton bloom in the Yellow and East China Seas (BIO-P-8580)

10:05 **Koji Hamasaki, Akiko Tomaru, Akito Taniguchi, Yuya Tada, Yasuyuki Nogata and Haruto Ishii**
Microbial control of jellyfish larval settlement (BIO-P-8709)

10:25 ***Coffee/Tea Break***

10:50 **Tabitha C.Y. Hui, Yumi Kobayashi, Yoko Mitani, Kei Fujii, Kei Hayashi and Kazushi Miyashita**
Spatial, temporal and dietary overlap between harbour seals and fisheries in Erimo, Japan: Conflict at sea? (BIO-P-8652)

11:10 **George L. Hunt, Jr., Martin Renner and Kathy Kuletz**
The composition and distribution of seabird communities across the southeastern Bering Sea shelf (BIO-P-8816)

11:30 **Robert M. Suryan and Amanda J. Gladics**
Effects of environmental variation on diets and stable isotope signatures of a piscivorous seabird in a coastal upwelling system (BIO-P-8808)

11:50 **Andrew W. Trites, Elizabeth Atwood, Christopher Barger, Brian Battaile, Kelly J. Benoit-Bird, Ine Dorresteijn, Scott Heppell, Brian Hoover, David Irons, Nathan Jones, Alexander Kitaysky, Kathy Kuletz, Chad Nordstrom, Rosana Paredes, Heather Renner, Daniel Roby and Rebecca Young**
Is it food? A comparative analysis of increasing and decreasing populations of thick-billed murres, black-legged kittiwakes and northern fur seals in the eastern Bering Sea (BIO-P-8719)

12:10 **Peter A. Thompson, Anya Waite and Lynnath Beckley**
Investigating the recruitment failure of Australia's western rock lobster (*Panulirus cygnus)* (BIO-P-8444)

12:30 *Session Ends*

## BIO-P Session Posters

BIO-P-1 **Yuji Tomaru and Yoshitake Takao**
Diversities of diatom viruses isolated from Japanese coastal waters

BIO-P-2 **Anastasia S. Dolganova**
Far eastern seas benthos and its investigation in TINRO-Centre (2002-2012)

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|---|---|
| BIO-P-3 | **Toru Kobari, Minoru Kitamura and Makio C. Honda**<br>Seasonal changes in abundance, stage composition and depth distribution of *Neocalanus* copepods in the Western Subarctic Gyre |
| BIO-P-4 | **Chiyuki Sassa and Yuichi Hirota**<br>Seasonal occurrence of mesopelagic fish larvae in the onshore side of the Kuroshio off southern Japan |
| BIO-P-5 | **Young-Ok Kim, Seung Won Jung and Eun-Sun Lee**<br>Effects of oil pollution on attached microbial communities in short-term indoor microcosms |
| BIO-P-6 | **Seung Won Jung, Young-Ok Kim, Jung-Hoon Kang, Moonkoo Kim and Won Joon Shim**<br>Impact of dispersant plus crude oil on natural plankton assemblages in short-term marine mesocosms |
| BIO-P-7 | **Kyun-Woo Lee, Chang Kyu Joo, Jung-Hoon Kang, Oh-Yoon Kown and Won Joon Shim**<br>Acute and chronic toxicity of the water accommodated fraction (WAF) and chemically enhanced WAF (CEWAF) of crude oil in the rock pool copepod *Tigriopus japonicus* |
| BIO-P-8 | **Elena Dulepova and Vladimir Dulepov**<br>Carrying capacity of the Okhotsk Sea pelagic ecosystem |
| BIO-P-9 | **Ludmila S. Belan, Tatyana Belan, Boris Borisov, Alexander Moshchenko and Tatyana Konovalova**<br>Distribution of macrozoobenthos along the pipeline route at the Lunskoye field (NE Sakhalin Island Shelf) |
| BIO-P-10 | **Seung Ho Baek, Moon Ho Shon and Won Joon Shim**<br>Effects of the chemically-enhanced water-accommodated fraction of Iranian Heavy Crude oil on the periphytic microbial communities in microcosm experiments |
| BIO-P-11 | **Vladimir P. Korchagin, Olga Grunina, Alexander Dubov and Olga N. Vakulenko**<br>Bioconversion of algae biomass into bioethanol using homogenate from marine invertebrate digestive organs |
| BIO-P-12 | **Rie Nakamura, Toru Kobari, Kazuyuki Tanabe, Minoru Kitamura and Makio C. Honda**<br>Comparison of seasonal changes in the mesozooplankton community between the subtropical and subarctic North Pacific Ocean |
| BIO-P-13 | **Liudmila Dolmatova and Olga Zaika**<br>Temporal variations in activities of antioxidant enzymes in coelomic fluid of the holothurian *Eupentacta fraudatrix* in Alexeev Bay (Peter the Great Bay), Sea of Japan |
| BIO-P-14 | **Kiyotaka Hidaka, Takumi Nonomura, Kosei Komatsu, Sachihiko Itoh, Ichiro Yasuda, Toru Ikeya and Shingo Kimura**<br>Distribution of calanoid copepods of the genus *Paracalanus* around the Izu Ridge, south of Japan, and extent of the 'island mass effect' in the region |
| BIO-P-15 | **Hirotada Moki, Akira Okuno and Tatsuro Watanabe**<br>Development of a new ocean carbon cycle model for the Japan Sea |
| BIO-P-16 | **Corinne Pomerleau, Francis Juanes, Rodney Rountree and Kate Moran**<br>A comparative study of sound production in two marine environments monitored by the NEPTUNE Canada undersea observatory network |
| BIO-P-17 | **Kate Moran, S. Kim Juniper and Corinne Pomerleau**<br>The Two Ocean Networks Canada (ONC) undersea observatory networks: NEPTUNE Canada and VENUS |

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| BIO-P-18 | **William J. Sydeman, Jarrod A. Santora, Jason Hassrick, Marcel Losekoot, Sean Hayes and William T. Peterson**<br>Canyonlands: Krill "hotspots" of the northern California Current |
| BIO-P-19 | **Naoya Kanna, Koji Suzuki, Aiko Murayama and Jun Nishioka**<br>Bioavailability of sea ice-derived iron for phytoplankton growth |
| BIO-P-20 | **Natsuko Nakayama, Shinichi Kondo, Reiko Nakao, Yasuhiro Shima, Naotsugu Hata, Yuji Tomaru, Masami Hamaguchi, Keizo Nagasaki and Shigeru Itakura**<br>Contribution of HcRNAV viruses against *Heterocapsa circularisquama* bloom by inoculating frozen sediment |
| BIO-P-21 | **Sayaka Sogawa (nee Matsumura), Hiroya Sugisaki and Tomohiko Kikuchi**<br>Carbon and nitrogen isotope ratios of euphausiids in the northwestern Pacific |
| BIO-P-22 | **Yoshiyuki Abe, Masafumi Natsuike, Kohei Matsuno, Atsushi Yamaguchi and Ichiro Imai**<br>Variability in assimilation efficiency of the copepod *Neocalanus cristatus*: Effect of food |
| BIO-P-23 | **John R. Bower, Yusuke Okude, Tetsuya Nishikawa and Kazutaka Miyahara**<br>Movement of diamond squid in the Sea of Japan revealed using pop-up satellite tags |
| BIO-P-24 | **Shinji Shimode Kazutaka Takahashi and Atsushi Tsuda**<br>Ontogenetic vertical migration of two tropical-subtropical copepods, *Rhincalanus nasutus* and *Rhincalanus rostrifrons***,** in the northwestern Pacific Ocean: Implication for a variety of life history strategies of *Rhincalanus* |
| BIO-P-25 | **Toru Kobari, Keisuke Unno, Haruka Nagafuku, Hajime Kawakami, Minoru Kitamura and Makio C. Honda**<br>Comparisons of fecal pellet characteristics in the surface layers between the subarctic and subtropical North Pacific Ocean |
| BIO-P-26 | **Hironori Higashi, Hiroshi Koshikawa, Wang Qinxue, Motoyuki Mizuochi, Toru Hasegawa, Yoko Kiyomoto, Kou Nishiuchi, Kazumaro Okamura, Hiroaki Sasaki, Yasushi Gomi, Hideki Akiyama, Kunio Kohata and Shogo Murakami**<br>A numerical study on predominance of dinoflagellates on the central continental shelf of the East China Sea |
| BIO-P-27 | **Jingfeng Fan, Xiaohui Wang and Hongxia Ming**<br>Bacterial communities of the sea surface microlayer in the Northern Yellow Sea in China |
| BIO-P-28 | **Yuri V. Prikhodko, Vasiliy Yu. Tsygankov and Margarita D. Boyarova**<br>Pesticides and seafood safety in the Russian fish market |
| BIO-P-29 | **Wang Lijun**<br>Introduced marine species and their impacts in China seas |
| BIO-P-30 | **Konstantin A. Karyakin, Alexander A. Nikitin and Oleg N. Katugin**<br>Distribution Patterns of the Common Squid (*Todarodes pacificus*) in the Russian EEZ in 2009-2011 |
| BIO-P-31 | **Shinichi Watanabe, Satoshi Morinobu and Norimichi Souji**<br>Daily and seasonal activity patterns of horseshoe crabs in the Kasaoka Bay estuary, Seto-Inland Sea, Japan |

# BIO-Paper Session Oral Presentations

## Day 1

### October 18, 14:05 (BIO-P-8672)

### Egg brooding in a gonatid squid off the Shiretoko Peninsula, Hokkaido, Japan

John R. **Bower**, Katsunori Seki, Tsunemi Kubodera, Jun Yamamoto and Takahiro Nobetsu

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Spawning squids usually either attach their egg masses to the seafloor (in nearshore species) or release pelagic egg masses (in oceanic species). Divers off the Shiretoko Peninsula have observed another behavior that is rarely seen in squids - brooding of egg masses by swimming females. This study was conducted to document this post-spawning, egg-care behavior and identify the squid species. The study was conducted during May 2010 in nearshore waters off Rausu, Hokkaido. Egg-mass brooding females were photographed and collected by a diver. Flesh samples were collected, DNA was extracted, and a partial segment of the mitochondrial COI was amplified, cloned and sequenced. Eggs and hatchlings were also collected. The brooding females were in shallow water holding egg masses with their arms while slowly swimming. The egg masses were tube-shaped and attached to the hooks on arms I-III. Eggs formed a honeycomb pattern within a brownish mucous membrane. Genetic analyses identified the squid as *Gonatus makodai* ("Sasaki-tekagi-ika", family Gonatidae), now the third squid known to brood.

### October 18, 14:25 (BIO-P-8631)

### Size-fractionated phytoplankton biomass and species composition in the Yellow Sea: A comparison of different latitudes in spring and summer

Oh Youn **Kwon**[1,2], Jung-Hoon Kang[2], Kyun-Woo Lee[2], Woong-Seo Kim[3] and Jin Hwan Lee[1]

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We investigated the size-fractionated biomass and species composition of phytoplankton to understand latitudinal differences of phytoplankton structure in the eastern part of Yellow Sea in April 2011, 2012 and August 2010, 2011. Surveyed stations were selected along lines from coastal to off-shore waters located at two latitudes (34.5 and 36°N). In the surface waters (0-20m), total chlorophyll *a* (Chl-*a*) concentration was higher in spring (avg. 2.88 $\mu gL^{-1}$) than in summer (avg. 1.89 $\mu gL^{-1}$) at both latitudes. Micro-sized Chl-*a* occupied over 51.4% of total biomass at both latitudes in spring, while nano-sized Chl-*a* occupied over 58.4% at both latitudes in summer. In bottom waters (20m-bottom), total Chl-*a* concentration was higher in summer (avg. 1.14 $\mu gL^{-1}$) than in spring (avg. 0.76 $\mu gL^{-1}$) at both latitudes. Phytoplankton standing crops in surface waters were higher in spring (avg. 2.17 cells $L^{-1}$) than in summer (avg. 1.08 cells $L^{-1}$) at both latitudes. In bottom waters, standing crops of phytoplankton were higher in summer (avg. 0.81 cells $L^{-1}$) than in spring (avg. 0.65 cells $L^{-1}$) at both latitudes. In surface waters, micro-sized (>20 µm) diatoms dominated at both latitudes in spring. In summer, nano-sized diatoms (<20 µm) were abundant at the north latitude, while nanoflagellates predominated at the south latitude. In bottom waters, nanoflagellates dominated at both latitudes in summer, whereas *Paralia sulcata* and *Skeletonema costatum* dominated at both latitudes in spring. Consequently, biomass and standing crops of phytoplankton showed similar variability between north and south latitudes during the study, while dominant species differed in surface waters at both latitudes in summer.

**October 18, 14:45 (BIO-P-8586)**

## Early life cycle of *Neocalanus plumchrus* and *Neocalanus flemingeri* in the Oyashio region, western north Pacific

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*Neocalanus plumchrus* and *N. flemingeri* are abundantly and widely distributed copepods in the subarctic Pacific and are key species in the ecosystem. *Neocalanus* species have six nauplius stages (N1 - N6) and six copepodite stages during a year - long life cycle. Although their life histories have been reported, early life histories during nauplius stages have not been studied yet, because of identification difficulty with morphological characteristic. We used a real - time PCR method to identify them genetically to reveal the growth and vertical distribution of nauplius. The seasonal samplings were performed in the Oyashio region during the October 2009 to July 2010. Preliminary result from October to March showed that two relative species have distinct different early life cycle. All six nauplius stages of *N. flemingeri* appeared from October to March, and late nauplius stage (N4 - N6) were distributed shallower depth than early stage (N1 - N3). Compare with *N. flemingeri*, late stage of *N. plumchrus* nauplius didn't appear until March. The most of *N. plumchrus* nauplii were N3, and their abundance of N3 were greatly increase during October to March. The duration of N3 was longer than 5 months, which suggested the dormancy in this stage. Moreover, distribution depth of early nauplius stage as well as actively spawning females became shallow gradually during October to March. These results indicate that *N. plumchrus* females changed spawning depth toward surface layer during the spawning period.

**October 18, 15:05 (BIO-P-8553)**

## Feeding of oncaeid copepods on discarded appendicularian houses

Yuichiro **Nishibe**[1], Kazutaka Takahashi[2], Tadafumi Ichikawa[3], Kiyotaka Hidaka[3], Hiroaki Kurogi[4], Kyohei Segawa[3] and Hiroaki Saito[1]

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Feeding rates of three oncaeid copepods (*Oncaea venusta* small and medium forms and *O. media*) on discarded appendicularian houses were determined from laboratory measurements of fecal pellet production and assimilation efficiency. In addition, vertical distribution of oncaeid copepods, appendicularians and their discarded houses were investigated by combining net tow and optical observations from a Video Plankton Recorder (VPR) in the Kuroshio region. The oncaeid copepods produced fecal pellets at high rates of up to 0.37 µg C ind.$^{-1}$ d$^{-1}$, indicating active feeding on the discarded houses. Observations of feeding behavior revealed that the copepods ingested the particles attached on or remaining in the house as well as the house mucus itself. Assimilation efficiencies of oncaeids feeding on the houses ranged from 57% to 88%. The ingestion rates varied from 0.13 to 1.3 µg C ind.$^{-1}$ d$^{-1}$ (10–37% body C d$^{-1}$), which meets or exceeds the carbon requirements for respiration and reproduction of the copepods. The attachment of oncaeid copepods to the discarded houses was confirmed by means of the *in situ* VPR observations. We applied the laboratory measured feeding rates to the field data on abundance and estimated that the oncaeid copepod community consumed up to 21% of the house carbon while sinking through the upper 100 m of the water column. These results indicate that discarded appendicularian houses are an important food resource available to oncaeid copepods and that the copepods contribute significantly to the house degradation in the surface layer of the water column.

### October 18, 15:50 (BIO-P-8724)

## Population dynamics of *Oithona similis* off Busan, South Korea

Minkyung **Shin**[1], Wongyu Park[1] and Jungwha Choi[2]

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Copepods belonging to the genus *Oithona* are ubiquitous and abundant, and play an important role in foodwebs in the world's oceans. Despite of their ecological importance along their distribution ranges, their function and abundance in the marine ecosystem have been underestimated, as they characterize small body sizes, passing through medium zooplankton nets (200-330µm). *Oithona similis* is one of the most numerous planktonic copepods in the Korean waters. Population dynamics of *O. similis* were investigated off Busan, South Korea. Zooplankton was collected at four stations off Busan, using a conical net (45 cm diameter with 200µm mesh) from bottom to surface monthly from May 2011 to April 2012 during daylight hours. *O. similis* occurred throughout the year, ranging from 193.5 to 1557.8 ind.m$^{-3}$. The proportion of *O. similis* was from 5.1% to 35.4% in the total zooplankton number. Stages later than copepodite III occurred during the entire sampling months while copepodite II was collected only in September 2011 and February 2012. Density of adults was significantly higher than other stages and peaked in November. In adults, female proportion was significantly higher than male with the annual mean of 89.2%, particularly in October (98.9%). Density of copepodite V was higher in October, November and February while that of copepodite IV was highest in February. Copepodite III occurred from September to March in the following year. Our results implied that there were three generations of *O. similis* in the study area in a year.

### October 18, 16:10 (BIO-P-8507)

## Effects of environmental changes on the euphausiids *Euphausia pacifica* and *Thysanoessa spinifera* in the coastal upwelling zone off the Oregon Coast, USA

C. Tracy **Shaw**[1], Leah R. Feinberg[1] and William T. Peterson[2]

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Euphausiids are an important component of the food web in the northeast Pacific Ocean, serving as prey for fish (including salmon and hake), seabirds, and marine mammals. Changes in euphausiid distribution and abundance in response to environmental stressors will thus impact higher trophic levels. The dominant euphausiid species are *Euphausia pacifica* and *Thysanoessa spinifera*. Our ongoing study off Newport, Oregon, USA, has collected data twice per month since 2001, a period encompassing warm and cold years (positive *vs.* negative PDO) and different upwelling conditions (strong, weak, late, *etc.*). Our 11-year time series of environmental and biological data suggests that these two species will respond differently to environmental stressors. The timing of the spring transition is closely associated with *E. pacifica* spawning, while *T. spinifera* spawn mainly prior to the spring transition. *E. pacifica* were present year-round regardless of water temperature, while *T. spinifera* were more abundant during cold years and rare during warmer years. For *E. pacifica,* a delayed spring transition will delay spawning until later in the season, meaning larvae may not have time to mature in order to survive through the winter. Since *E. pacifica* probably live a maximum of two years, several consecutive years of delayed spring transitions has the potential to reduce *E. pacifica* recruitment and spawning stock. Warmer water temperatures are likely to decrease *T. spinifera* abundance, making them effectively unavailable to predators. Species-specific differences should be incorporated into models to better understand how changes at lower trophic levels will propagate through the food web.

### October 18, 16:30 (BIO-P-8497)

## Interannual variations in the zooplankton community in the Alaskan Stream region during the summer of 2004-2010

Rui **Saito**[1], Atsushi Yamaguchi[1], Hiromichi Ueno[2], Hiroji Onishi[3] and Ichiro Imai[1]

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The Alaskan Stream is a boundary current flowing westward along the south of the Aleutian Islands. It connects the Alaskan Gyre and the Western Subarctic Gyre. Recent physical oceanographic studies showed that there were large year-to-year variations in its transport volume. This interannual variation in physical oceanographic conditions is expected to affect the zooplankton community, an important secondary producer in marine ecosystems. The purpose of this study is to clarify the year-to-year variations in zooplankton community during seven consecutive summers from 2004-2010. Zooplankton was sampled by vertical hauls of a 100 mm mesh-sized NORPAC net from 150 m to the surface at stations along the 180° meridian and 170°30′W line (from 49°00′N to 53°00′N) during 12 June-14 August, 2004-2010. Temperature and fluorescence were also monitored by CTD at each station. In a land laboratory, zooplankton was counted by taxonomic group, and calanoid copepods were identified to copepodid stage under a dissecting microscope. The 0-150 m integrated mean temperature was lower during 2006, 2008 and 2009, and fluorescence standing stock was greater during 2004-2006, 2008 and 2009 along both sampling transects. The total zooplankton abundance was higher in 2006 and 2009. In 2008, abundances of the large calanoid copepods *Eucalanus bungii* and *Neocalanus cristatus* were greater, with dominant early copepodid stages. Low temperature and an abundant food source in these years may have resulted in high abundance of total zooplankton and early copepodid stages. The year-to-year changes in physical oceanographic environments in the Alaskan Stream may influence the variations in zooplankton abundance and population structure of calanoid copepods.

### October 18, 16:50 (BIO-P-8665)

## Spatial patterns of zooplankton community productivity and functional trait diversity in the Bering and Chukchi Seas

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The structure and function of marine food webs is critically dependent on the efficiency with which crustacean zooplankton communities take advantage of primary production. Understanding how rates of crustacean zooplankton secondary production vary is therefore necessary for our understanding of food web processes. Here we present results of a broad-scale survey of chitobiase-based secondary production estimates carried out in the summer and fall of 2008 and 2009. Our study area extended from Victoria, British Columbia through the Bering and Chukchi Seas and finally to the western Beaufort Sea. Overall we found that we could describe 67% of the variation in secondary production rates with variation in phytoplankton concentration and temperature. In order to assess how change in zooplankton community composition may be reflected in changes in function we took a trait-based approach to assess how changes in zooplankton functional diversity vary with expectations of community production rates. Functional traits for all members of the crustacean zooplankton community were assembled from a literature survey and applied to a 5 year time series of zooplankton samples collected in northern Bering Sea and southern Chukchi shelf.

**October 18, 17:10 (BIO-P-8417)**

## Spatial ecology of krill, micronekton and top predators in the central California Current: implications for defining ecologically important areas

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Marine spatial planning and ecosystem models that aim to predict and protect fisheries and wildlife benefit greatly from syntheses of empirical information on physical and biological partitioning of marine ecosystems. Here, we develop spatially-explicit oceanographic and ecological descriptions of the central California Current region. To partition this region, we integrate data from 20 years of shipboard surveys with satellite remote-sensing to characterize local seascapes of ecological significance, focusing on krill, other micronekton taxa, and top predators (seabirds and marine mammals). Specifically, we investigate if micronekton and predator assemblages co-vary spatially with mesoscale oceanographic conditions. The first principal component of environmental and micronekton seascapes indicates significant coupling between physics, primary productivity, secondary and tertiary marine consumers. Subsequent principal components indicate latitudinal variability in niche-community space due to varying habitat characteristics between Monterey Bay (deep submarine canyon system) and the Gulf of the Farallones (extensive continental shelf), even though both of these sub-regions are located downstream from upwelling centers. Overall, we identified 5 ecologically important areas based on spatial integration of environmental and biotic features. These areas, characterized by proximity to upwelling centers, shallow pycnoclines, and high chlorophyll *a* and krill concentrations are potential areas of elevated trophic focusing for specific epipelagic and mesopelagic communities. This synthesis will benefit ecosystem-based management approaches for the central California Current, a region long-impacted by anthropogenic factors.

# Day 2

**October 19, 09:05 (BIO-P-8349)**

## Long-term variability of sublittoral macrobenthos of the Sakhalin's shelf of Tatar Strait (Sea of Japan)

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Results from monitoring the macrobenthos of the Sakhalin shelf of Tatar Strait for 60 years are described. In the northern area macrobenthos biomass decreased but the trend was not statistically significant. In a southern area, there was a statistically significant decrease in biomass from the end of the fortieth year of the last century. The greatest decrease in biomass was observed in the upper sublittoral (almost 7 times greater). In the lower sublittoral the biomass dropped by a factor of 2.4. The basic changes in the macrobenthic communities over the past for 30 years were: the disappearance of some communities and occurrence of new, the changes in dominating species, and the general decrease in indicators of abundance. The observed decrease in abundance of macrobenthos in the southern area coincides with the decrease in stocks of bottom commercial fishes and crabs. The given phenomenon probably is one of the reasons for the decrease in stock, along with overfishing.

## October 19, 09:25 (BIO-P-8796)

## Spatial-temporal patterns of residence-time, transport and connectivity among near-shore marine reserves on the Oregon shelf from particle-tracking using inputs from multiple physical models

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We use velocity fields from physical circulation models to examine local residence time, transport and connectivity among recently established Oregon nearshore marine reserves using Lagrangian particle-tracking methods. By using several underlying physical models we are able to assess the influence of horizontal model resolution (ranging from 1 km to 10 km) on estimates of retention time, and seasonal and spatial patterns of connectivity among marine reserves for species having pelagic larval durations (PLD) spanning from 10-40 days. Simulations are done for 2002 (a year with many models) and other years to illustrate the between model variability within a single year, and the among year variability within a single model, and for simulations with simple-to-complex parameterizations. Simple scenarios have the larvae at constant fixed depth and pre-determined PLD. Complex scenarios have either temperature-dependent PLD, or age-dependent depths, or both. Comparison of these scenario simulations will quantify the sensitivity of connectivity and local residence time to seasonal variation in temperature and circulation, PLD, and depth preferences.

## October 19, 09:45 (BIO-P-8580)

## Interannual variation of jellyfish (*Nemopilema nomurai*) abundance and magnitude, and timing of phytoplankton bloom in the Yellow and East China Seas

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Massive appearances of *Nemopilema nomurai* have been reported in the Yellow and East China Seas (YECS) and the Sea of Japan in recent years. New satellite datasets (SeaWiFS and MODIS/Aqua, 1998-2010), corrected for turbidity in the YECS, were developed to study outbreaks of jellyfish. The satellite derived time series of sea surface chlorophyll *a* concentration (SSC) can be used as a proxy for phytoplankton biomass. Phytoplankton blooms should stimulate the production of zooplankton and provide forage for larval jellyfish. A sea surface temperature (SST) of 15°C was assumed to be the best temperature to trigger the strobilation of polyps, and match/mismatch of the temperature and phytoplankton blooms will be discussed. The seasonal variation of SSC was fitted by Gaussian functions. The parameters showed inter-annual variability as well as increasing trends of phytoplankton bloom magnitude in most parts of the YECS. Peak SSC during blooms (>5 mg $m^{-3}$) was high in the Changjiang River estuary and its adjacent waters, coastal areas of the Yellow Sea and most parts of the Bohai Sea. Durations of the blooms in these waters were usually long and the peaks were in summer, and these conditions may be favorable for jellyfish. Although years when temperature reached 15°C earlier corresponded to jellyfish outbreak years, the SST inter-annual variation was not as large as timing variation (start, end and peak) of phytoplankton blooms which did not corresponded with the jellyfish outbreak. The results indicate that a phytoplankton bloom may be one of the requirements for a jellyfish outbreak but the timing may not be the controlling factor of the outbreak.

## October 19, 10:05 (BIO-P-8709)

## Microbial control of jellyfish larval settlement

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In the jellyfish larval stage, chemical cues are reportedly required for their settlement and metamorphosis. These include small peptides, carbohydrates, glycoproteins and uncharacterized low molecular weight water-soluble compounds. There is some evidence that bacterial metabolites can be specific stimuli that induce settlement and metamorphosis in planula larvae of jellyfish. Here we report the isolation and characterization of marine bacterial isolates which facilitate the settlement of planula larvae of the jellyfish, *Aurelia aurita*. Marine bacteria were isolated from various sources such as algae, barnacles, rocks and sands collected at a rocky shore in Sagami Bay. About 400 isolates were screened by a multiwall-plate planula assay and selected into 12 inducing-isolates and 8 inhibiting-isolates for settlement. The most effective bacterial isolates were from *Pseudoalteromonas* sp., *Alteromonas* sp. and *Vibrio* sp., based on 16S rRNA gene sequences. The number of planula larvae settling on either polycarbonate or glass surfaces increased greatly in the presence of these bacterial biofilms. In large-scale trials for collecting planula larvae, polycarbonate plates with the effective bacteria collected much larger numbers of planula than those without bacteria. Interestingly, the inducing effect was inhibited by some commercially available lectins, suggesting specific chemical interaction between bacterial surface glycans and planula proteins. The results of this study provide a possible control of jellyfish outbursts. Further study is required to reveal the mechanism of jellyfish larval settlement in relation to chemical and biological interactions.

## October 19, 10:50 (BIO-P-8652)

## Spatial, temporal and dietary overlap between harbour seals and fisheries in Erimo, Japan: Conflict at sea?

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The harbour seal is an endangered species in Japan. Since protection began in the mid-1980s, the total number of harbour seals in Japan has been rebounding. With the increase in seal numbers, increased conflict with fisheries (especially salmon fixed-net fisheries) has occurred through depredation and the belief that seals compete with fisheries for prey. However, competition is unlikely if seals and fisheries take mostly different prey species, obtain prey from different areas or at different times. We studied the foraging ecology of harbour seals in Erimo, site of the largest population of harbour seals in Japan, from 2011-2012. We deployed satellite tags in July 2011 (n=1) and June 2012 (n=4). The foraging ranges (average size of 90% ranges was 30 km$^2$) of all tagged seals overlapped at least one salmon fixed-net (5 total in Erimo). We collected seal scats in summer, fall and spring, identified prey items from hard parts retrieved and compared the results with local fisheries data. Of the 39 scats with identifiable prey remains analysed, none contained salmon remains. The seals' diet differed greatly from fisheries catches. Gadoids (FO=55%), snailfish (FO=35%) and sculpins (FO=30%) were the main prey items found in seal scats. In contrast, salmonids were the main species caught by fisheries, accounting for >50% of catches by mass, followed by gadoids (15%). Resource overlap between seals and fisheries was <0.01 (Pianka index) in summer, fall and spring. As such, we conclude that competition is highly unlikely between harbour seals and fisheries in Erimo.

**October 19, 11:10 (BIO-P-8816)**

## The composition and distribution of seabird communities across the southeastern Bering Sea shelf

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Here, we test the hypothesis that the distribution of seabird communities across the southeastern Bering Sea shelf reflects the underlying hydrography and marine ecosystem structure. Over the shelf, in summer, there are four hydrographic domains: the well-mixed Inner or Coastal Domain ($z < 50$ m) the well-stratified Middle Domain ($50< z <100$ m), the three layer Outer Domain ($100< z <200$), and the Shelf Slope Domain ($200< z< 1000$ m). To examine seabird communities with respect to these domains, we quantified the cross-shelf distribution of species with respect to water depth, and clustered species with similar depth-use distributions using a 35-year database. We then mapped these clusters against the domains. There were considerable differences among seabird species in the water depths over which they were observed. Cluster analysis revealed four main species-depth clusters: Cluster 1 was primarily an inshore, shallow water group, and conformed roughly to the Inner Domain; Cluster 2 occupied the Middle Domain, though only out to about the 80 m isobath; Cluster 3 extended from the 70 m isobath to about the 180 m isobath; and Cluster 4 was found over the shelf slope and deeper waters. We also examined whether the clusters of seabird species would break down in either spring or fall, when the entire shelf is well mixed, and the hydrographic domains obscured. We found little change in the distribution or strength of the clusters, leading us to conclude that the distribution of seabird species clusters was a reflection of the underlying biology across the shelf.

**October 19, 11:30 (BIO-P-8808)**

## Effects of environmental variation on diets and stable isotope signatures of a piscivorous seabird in a coastal upwelling system

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During the past decade the Oregon Coast has experienced highly variable ocean conditions with apparent, but arrested, regime shifts, delayed upwelling, and anomalously strong hypoxia events. While physical, chemical, and some lower trophic level impacts have been relatively well documented, the effects on many middle and upper trophic level species (*i.e.*, ecosystem-scale effects) have been neglected. Common murres (*Uriaaalge*) are the most abundant breeding seabird in Oregon (ca. 600,000 individuals), with one of the largest breeding colonies (over 60,000 individuals) located at Yaquina Head on the central coast. During 2004-2011, we studied the diets of breeding common murres at Yaquina Head using both stable isotope analysis (all years) and conventional prey identification (5 years) to determine their response to annual variation in ocean conditions. Primary prey items included Pacific herring (*Clupeapallasii*), smelts (Osmeridae), North Pacific anchovy (*Engraulismordax*), Pacific sand lance (*Ammodyteshexapterus*), juvenile rockfishes (*Sebastes* spp.), and juvenile flatfishes (Bothidae, Pleuronectidae), with percent occurrence varying annually. Likewise, stable isotopes of $\delta^{13}C$ and $\delta^{15}N$ varied annually, with the most divergent values corresponding to the most anomalous years in ocean conditions. Our results suggest that signals reflecting physical forcing and biological production regimes that propagate through the food web are measurable within a major, upper trophic level consumer on the Oregon Coast.

### October 19, 11:50 (BIO-P-8719)

## Is it food? A comparative analysis of increasing and decreasing populations of thick-billed murres, black-legged kittiwakes and northern fur seals in the eastern Bering Sea

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We undertook a comparative analysis to determine why northern fur seals, thick-billed murres and black-legged kittiwakes are thriving on Bogoslof Island (southern Bering Sea) and declining on St. Paul Island (Pribilof Islands – central Bering Sea). We assessed the abundance and distribution of prey around each breeding colony (Jul–Aug 2009), and concurrently determined diets, stress levels, and foraging locations of these three top predators. Seals and some birds from the Pribilof Islands were found to travel further and for longer times to feed—and experienced higher stress levels compared to those from Bogoslof Island. Diets of fur seals and murres on St. Paul Island were dominated by juvenile pollock (low energy content), whereas diets on Bogoslof were dominated by high energy mesopelagic species (squids for murres; myctophids for kittiwakes; squids and northern smoothtongue for seals). At-sea distributions of birds and mammals were relatively uniform across the Bering Sea, but distinct between breeding islands. Seal and seabird distributions corresponded with the broad scale distribution of widely dispersed shallow patches of prey—and not with the total biomass or numerical abundance of their dominant prey species. Energy availability appears to drive reproductive success of birds and seals in the Bering Sea. Recovery of northern fur seals, thick-billed murres, and black-legged kittiwakes on the Pribilof Islands to numbers present prior to the 1975/76 regime shift will likely require dietary increases in energy-rich cephalopods and mesopelagic fishes.

### October 19, 12:10 (BIO-P-8444)

## Investigating the recruitment failure of Australia's western rock lobster (*Panulirus cygnus)*

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Australia's western rock lobster is the most valuable single-species fishery in Australia representing about 20% or $400 million in annual export earnings. Eight species of rock lobster have been found off the WA coast, however, virtually the entire recreational and commercial catch consists of the western rock lobster *Panulirus cygnus.* Exploitation of this long lived species is highly regulated and it was one of the first fisheries in the world to be endorsed by the international body, the Marine Stewardship Council, as sustainably managed. Strict controls have been in place since 1963 and the average annual catch has been ~ 11,500 tonnes per year for ~45y. Over this period the recruitment and catch of adults 4 years later has always increased during La Niña years with high coastal boundary current (Leeuwin Current) flow. Commencing in 2008 recruitment of the juveniles plummeted and has remained at historic lows. In 2010 and 2011 we undertook two research voyages to investigate the biological oceanography of *P. cygnus* near the end of its 11 month larval phase. The peak abundances of *P. cynus* were found seaward of the Leeuwin Current and associated with warm core eddies. Our results demonstrate that *P. cygnus* is highly selective in its feeding with a strong preference for chaetognaths over other potential prey items (*e.g.* salps, copepods, krill). The sterol and fatty acid composition of both *P. cygnus* and its potential prey also indicates the likely diet includes more chaetognaths than other taxa.

# BIO-Paper Session Poster Presentations

## BIO-P-1

## Diversities of diatom viruses isolated from Japanese coastal waters

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Currently, viruses are regarded as one of the major biological factors that regulate carbon cycling, microbial biomass and the genetic diversity of protists and algae. Although the significance of diatoms as key players in the oceanic carbon cycle has been recognized, the existence of diatom viruses has scarcely been appreciated, until recently. The first diatom virus was reported in 2004, a virus infecting *Rhizosolenia*. Since the initial discovery, several *Chaetoceros* viruses have been isolated and characterized. Furthermore, just recently, pennate diatom viruses have been successfully isolated. These viruses are grouped into two categories based on genomic features, single-stranded (ss) RNA and ssDNA. The ssRNA diatom viruses RsetRNAV, CtenRNAV, CsfrRNAV, Csp03RNAV and AglaRNAV infect *R. setigera*, *C. tenuissimus*, *C. socialis* f. *radians*, *Chaetoceros* sp. and *Asterionellopsis glacialis*, respectively. They harbor ca. 9kb of ssRNA genome with two open reading frames encoding putative replication-related proteins and capsid proteins. The ssDNA diatom virus group includes CsalDNAV, CtenDNAV, Csp05DNAV, ClorDNAV, CsetDNAV and TnitDNAV, infecting *C. salsugineum*, *C. tenuissimus*, *Chaetoceros* sp., *C. lorenzianus*, *C. setoensis* and *Thalassionema nitzschioides*, respectively. Their genomes are composed of covalently-closed circular ssDNA (ca. 6kb). CdebDNAV is also an ssDNA virus infecting *C. debilis* but its genome structure is unknown. These diatom viruses are all lytic to their respective host diatoms, and their infection is strain-specific rather than species-specific. These discoveries are important for understanding diatom ecology and the carbon cycle related to diatom production.

## BIO-P-2

## Far eastern seas benthos and its investigation in TINRO-Centre (2002-2012)

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The Far Eastern Seas Shelf is rich in benthic resources, which are utilized by other marine inhabitants for breeding energy and fattening. Benthos supplies food for many benthic and demersal fishes and invertebrates.

Systematic comprehensive studies of the Far Eastern Seas initially began in 1960-1970 but because the last large-scale studies of benthos were more than 25 years ago, the Laboratory of Hydrobiology a special department for benthic investigation, was created in spring 2002 and it continues working to this day. Since 2002, members of this department have participated in several marine expeditions. The benthic surveys repeated sampling the grid stations of the 1970s in the Japan, Okhotsk and Bering seas. Our benthic sampling was carried out in the depth range of 2-280 m. The samples were collected using an "Ocean-50" sampler with an area of 0.25 $m^2$. Soil was washed through sieves with meshes of < 1 mm.

Over all surveyed areas we encountered from 20 to 37 different groups of macrobenthos. It was found that 50-80% of the total biomass was accounted for by Echinodermata (sea urchins - Echinoidea, sea cucumber - Hilothuroidea, and basket stars - Ophiuroidea), bivalves (Bivalvia) and bristle worms (Polychaeta).

When comparing the results of 2002-2012 with data from 30 years ago, we found no significant changes in the qualitative or quantitative condition of benthic communities.

## BIO-P-3

# Seasonal changes in abundance, stage composition and depth distribution of *Neocalanus* copepods in the Western Subarctic Gyre

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Seasonal changes in abundance, stage composition and depth distribution of three *Neocalanus* species were investigated in the Western Subarctic Gyre of the North Pacific Ocean from depth-stratified samples collected during 4 seasons. While the young copepodites of *N. cristatus* appeared above 200 m throughout all seasons, they were most abundant in February. The copepodite stage 5 (C5) was the most abundant stage during April to October and descended to mesopelagic depths after July. The adults occurred abundantly below 500 m in July and October. The copepodites younger than C4 of *N. flemingeri* appeared above 200 m and developed into C5 during February to July. Only the adults (mostly females) were found throughout the water column in October. While *N. plumchrus* resided below 300 m in February and April, the predominant stage changed from C5 in February to adult in April. Copepodites younger than C4 were found above 150 m in July and October and comprised more than 90% of the population. These results suggest that the seasonal changes in population structure and depth distribution of *N. cristatus* and *N. flemingeri* in the Western Subarctic Gyre follow the life cycle traits of these copepods observed in the Gulf of Alaska. However, the delayed development of young copepodites during July to October is considered to be specific for *N. plumchrus* in the Western Subarctic Gyre compared with the populations in the Gulf of Alaska, Oyashio region and Strait of Georgia.

## BIO-P-4

# Seasonal occurrence of mesopelagic fish larvae in the onshore side of the Kuroshio off southern Japan

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Information on the annual reproductive cycle of mesopelagic fishes has been limited in the western North Pacific, despite their ecological importance.. The Kuroshio region is an important spawning ground for various species of mesopelagic fishes. To describe the reproductive seasonality, we examined the seasonal occurrence patterns of the mesopelagic fish larvae on the continental slope in Tosa Bay which is strongly influenced by the Kuroshio, based on monthly samples collected from January 2001 to December 2004. In total, 2,558 mesopelagic fish larvae occurred, with peak abundance during May to June. Larvae of the dominant families Myctophidae, Sternoptychidae, Gonostomatidae, Bathylagidae, and Phosichthyidae were represented by 26 species (or types) belonging to 18 genera. The twelve most abundant species accounted for 96.9% of the total catch. The seasonal occurrence patterns of these larvae were categorized into five groups in accordance with physical properties of the water column: Winter (*Notoscopelus japonicus* and *Lipolagus ochotensis*); Spring (*Symbolophorus evermanni* and *Maurolicus japonicus*); Early summer (*Myctophum asperum* and *Diaphus* stubby type); Autumn (*Lampanyctus* sp. A, *Cyclothone* spp., and *Sigmops gracile*); and Year-round (*Vinciguerria nimbaria*, *Diaphus* slender type, and *Diogenichthys atlanticus*) groups. No significant difference was observed in the months of peak abundances of these larvae during the four years, suggesting that each species has a fixed seasonal pattern of reproduction. The various patterns of seasonal occurrence would result in seasonal habitat segregation of the larvae among species, possibly reducing intraspecific competition for food resources in the oligotrophic waters of the Kuroshio.

## BIO-P-5

## Effects of oil pollution on attached microbial communities in short-term indoor microcosms

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An indoor microcosm experiment was carried out in order to investigate the effect of oil pollution on attached marine microbial communities. Microbial assemblages, including ciliates, on acrylic plates dipped in 10 L-liter cubic containers filled with WAF (Water Accommodated Fractions of crude oil) were monitored for 10 days and compared with the communities in the control. Total ciliate abundances typically decreased in the WAF. The dominant species at the initial time, before the oil exposure, *Eufolliculina* sp. and *Aspidisca* spp., were greatly diminished. However, peritrich ciliates increased and sustained their populations during the experimental period. In the microalgal community, *Thalassionema frauenfeldii* was a dominant diatom at the initial time but was considerably diminished in the WAF, while *Nitzschia directa* appeared unaffected in WAF under available silicates. Rapid growth of heterotrophic bacteria was observed and was followed by an increase in heterotrophic nanoflagellates, which can provide good feeding conditions for the peritrich ciliates.

## BIO-P-6

## Impact of dispersant plus crude oil on natural plankton assemblages in short-term marine mesocosms

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To assess the effects of crude oil and dispersant on marine planktonic ecosystems, analyses were performed in 1,000-L mesocosms over a period of nine days. Triplicate experiments were conducted for two different treatments, namely, addition of crude oil alone and oil plus dispersant. In the mesocosm with oil plus dispersant, high concentrations of total petroleum hydrocarbon (TPH) were soon found in the bottom layer. In addition, most planktonic communities responded drastically to the presence of dispersant acting to disperse TPH: total bacterial abundances increased for the first two days and then decreased rapidly for the remainder of the experiment; the abundance of heterotrophic flagellates increased rapidly in association with the increase in bacterial cells; and the abundance of phytoplankton and zooplankton communities decreased clearly within two days. A time-delayed relationship also revealed that the TPH concentration had a significant negative relationship with the phyto- and zooplankton communities within two days. However, most planktonic communities were affected less adversely in the mesocosms treated with crude oil alone than in those treated with both crude oil and dispersant. The present results demonstrate that the planktonic ecosystem was damaged more severely by the introduction of dispersant than by the harmful effects of crude oil itself. Therefore, caution should be taken when considering the direct application of dispersant in natural environments, even though it has the advantage of rapidly removing crude oil.

## BIO-P-7

## Acute and chronic toxicity of the water accommodated fraction (WAF) and chemically enhanced WAF (CEWAF) of crude oil in the rock pool copepod *Tigriopus japonicus*

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We determined the toxicity of the water accommodated hydrocarbon fraction (WAF), two chemically enhanced WAFs (CEWAFs; CEWAF-C, Crude oil + Corexit 9500 and CEWAF-H, Crude oil + Hiclean) of crude oil and two dispersants (Corexit 9500 and Hiclean) to the rock pool copepod *Tigriopus japonicus*. In the acute toxicity test, Corexit 9500 was the most toxic of all the chemicals studied. The nauplius stages of *T. japonicus* were more susceptible to the toxic chemicals studied than the adult female. The toxicity data using the nauplius stages were then considered as a baseline to determine the spiking concentration of chemicals for chronic toxicity tests on the copepod. In an experiment over two generations ($F_0$ and $F_1$), results of the chronic toxicity test, survival, sex ratio, developmental time and fecundity of the copepod exposed to several toxic chemicals showed various responses with different concentrations of chemicals. All chemicals used in this study resulted in an accumulation of toxicity. The lowest-observed-adverse-effect (LOAE) concentrations of WAF, CEWAF-H, CEWAF-C, Hiclean and Corexit 9500 were observed to be 50%, 10%, 0.1%, 1% and 1%, respectively. As a result, the two-generation toxicity tests were the most sensitive in this study and biochemical or molecular biological traits would be required for a more sensitive and precise assessment to further study.

## BIO-P-8

## Carrying capacity of the Okhotsk Sea pelagic ecosystem

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Assessment of the ecological carrying capacity of ecosystems is one of the most important problems in applied fisheries science. However, sometimes it is a concept not clearly substantiated and it is developed without quantitative parameters. Usually this term is used in the analysis populations dynamics and growth.. The ecological carrying capacity of the pelagic zone of the Okhotsk Sea to the 1980s and 2000s was calculated on the basis of data on the qualitative composition and quantitative distribution of zooplankton and nekton, as well as their ecological and energy characteristics. This characterization of the ecosystem has been calculated taking into account the natural fluctuations of its main components (zooplankton and nekton). In the 1980s the potential capacity of the Okhotsk Sea pelagic zone nekton (when converted to units of wet weight) was estimated at 50 million tonnes of fish and squid as a whole without division into species. In recent years the carrying capacity of the pelagic subsystem of the Okhotsk Sea has decreased by 1.3 times. However, currently the ecosystem, due to energy production of zooplankton communities, can support an amount of nektonic resources almost 2 times higher. It is therefore possible that changes in the productivity of nektonic communities in relation to changing climatic periods (within the 60-year cycles) will not be caused by a lack of food resources (so called bottom up control ).

## BIO-P-9

## Distribution of macrozoobenthos along the pipeline route at the Lunskoye field (NE Sakhalin Island Shelf)

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The results of macrozoobenthos investigations along the marine pipeline route at the Lunskoe field are presented. A total of 16 phyla and 126 species of macrozoobenthos were identified in the research area during July of 2006. Amphipods (63 species) and polychaetes (30 species) dominated in terms of number of species. Total benthic biomass averaged 128.3 g/m$^2$, average density was 22,456.3 ind/m$^2$. Cumaceans *Diastylis bidentata* and amphipod crustaceans (*Eogammarus hirsutimanus, Eogammarus schmidti, Eohaustorius eous eous*) were dominant numerically. The biomass was dominated by bivalve molluscs *Siliqua alta, Megangulus luteus* and cumaceans. The highest species richness and diversity were observed at a depth of 10 m, maximum species abundance was observed in the depth range of 15-25 m. Cluster analysis revealed 5 benthic communities. At present, the type of bottom sediments and depth are considered to be the main factors determining characteristics and distribution patterns of benthic assemblages.

## BIO-P-10

## Effects of the chemically-enhanced water-accommodated fraction of Iranian Heavy Crude oil on the periphytic microbial communities in microcosm experiments

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On December 7th 2007, an estimated 12,547kL of crude oil were released after a collision between the oil tanker M/V *Hebei Spirit* and a crane barge 6.5 nautical miles off the coast of Taean, South Korea. To determine the effects of an oil spill on a periphytic microbial community, we conducted exposure experiments with chemically-enhanced, water-accommodated fractions (CEWAF; control, 10, 20, 50 and 100%) of Iranian Heavy Crude oil in culture systems of artificial benthic substrates. In the adhesive algal bio-assay, bacteria and heterotrophic nano-falgellates (HNF) grew well in all treatments except the 100% CEWAF treatment. However, periphyton did not adapt to the > 20% CEWAF. Among periphyton, the diatom *Cylindrotheca* spp. dominated in the treatment and the response of *Cylindrotheca* spp. to CEWAF (*i.e.*, particularly 10%) was quite similar to changes in Chl-*a* concentration. Therefore, the total petroleum hydrocarbons caused by the CEWAF had a negative effect on periphyton and a growth-promoting effect on bacteria and HNF, respectively.

## BIO-P-11

## Bioconversion of algae biomass into bioethanol using homogenate from marine invertebrate digestive organs

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Storm cast algae biomass can be transformed into bioethanol via biochemical conversion using homogenate from marine invertebrate digestive organs (HMIDO) not used as sea food. The process involves degradation of the recalcitrant cell wall structure of fresh cast algae into a gel or soluble polysaccharide material (physical and thermo-chemical pretreatment). Polysaccharides are hydrolysed into sugars by HMIDO that are subsequently converted into bioethanol and followed by a purification process. Enzyme preparations from sea urchin and periwinkle HMIDO gave the best yield of reducing sugars. Pretreatment is used to overcome recalcitrant material and increase surface area to optimize polysaccharide accessibility to hydrolyses. The upstream operation is followed by enzymatic hydrolysis of polysaccharide material and conversion into monomeric free sugars subsequent to biological fermentation where sugars are easily fermented into ethanol and then purified via distillation. This process can be used for efficient conversion of cast algae biomass to the environmentally friendly fuel, bioethanol.

**BIO-P-12**

## Comparison of seasonal changes in the mesozooplankton community between the subtropical and subarctic North Pacific Ocean

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Seasonal changes in mesozooplankton community down to 1000 m were compared between the subtropical (S1) and subarctic sites (K2) of the North Pacific Ocean. Mesozooplankton abundance and biomass in the water column were higher at K2 compared with those at S1. They reached a maximum in May and a minimum in October at S1, while the seasonal pattern was not clear for those at K2. Averaged individual dry weight was minima in February at S1 and July at K2, indicating the recruitment for the major groups. Depth distribution showed that diel vertical migrations were not clear for mesozooplankton community at both sites because the abundance and biomass were high in the surface layers and at mesopelagic depths throughout the day and the seasons. While copepods were the predominant group among of mesozooplankton abundance and biomass throughout the layers at both sites, the relative composition to the biomass was low at S1 due to the smaller body size and both chaetognaths and euphausiids exhibited the similar contribution to copepods. The mesopelagic peaks of mesozooplankton abundance and biomass were characterized by dormant copepods at both sites. Chaetognaths contributed to the mesopelagic biomass throughout the day, and a slight increase of the surface biomass was produced by euphausiids during night (*i.e.* diel vertical migration). These results suggest that ontogenetically migrating copepods determine the seasonal changes in mesozooplankton abundance and biomass in the water column at both sites and chaetognaths and euphausiids contribute the depth distribution.

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**BIO-P-13**

## Temporal variations in activities of antioxidant enzymes in coelomic fluid of the holothurian *Eupentacta fraudatrix* in Alexeev Bay (Peter the Great Bay), Sea of Japan

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The Holothurian *Eupentacta fraudatrix* is a prospective species for mariculture, as a resource for pharmaceutics. These animals form stable biotopes in coastal waters, and studies of their antioxidant enzyme activities may be useful tools for monitoring pollution of seawater and the health of the animals themselves. To evaluate the role of seasonal- and body-length-dependent components, activities of superoxide dismutase (SOD), glutathione reductase (GR), and catalase were measured in the coelomic fluid of holothurians ("pink" color variant) divided into groups according to their body lengths in spring-autumn 2008. Additionally, gonad indices were determined and larvae were collected. It was shown that SOD and GR activities had maxima in the middle or late July depending on animal body-length. Maximal catalase activity was found in mid July and was independent of body-length. In summer, the lowest activity of all enzymes studied was in animals between 6.1-9 cm body-length. However, GR and SOD, but not catalase activities significantly differed among body-length groups of younger holothurians, *e.g.*, GR activity in the group with body-length of 3.1-4 cm was 2-fold higher compared to that in the group with 4.5-5.5 cm body-length. In contrast, SOD activity was 6-fold higher in the group with body-length of 4.5-5.5 cm compared to the group with 3-4 cm body-length. The appearance of enzyme activity peaks did not depend on seawater temperatures, but coincided with the timing of holothurian spawning. GR activity in the "orange" color variant of the holothurian in this period was significantly lower than that in "pink" animals.

## BIO-P-14

## Distribution of calanoid copepods of the genus *Paracalanus* around the Izu Ridge, south of Japan, and extent of the 'island mass effect' in the region

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The Izu Ridge is an important bottom structure located south of Honshu Island, Japan, where enhanced biological production with an 'island mass effect' is suggested and spawning of pelagic fish, especially the Japanese mackerel, occurs. In order to describe the regional features of the area, we investigated the distribution of *Paracalanus* spp., important fish prey, and environmental variables by field observation in April 2009 and by remote sensing. In the south of the Kuroshio, differences in sea surface temperature (SST) and sea surface chlorophyll concentration (SSChl) were small among Izu ridge and adjacent areas (<0.8˚C in SST, <0.09 $\mu gChlL^{-1}$ in SSChl). In the north of the Kuroshio, the slope water area, SST was lower and SSChl was higher than in the south of the Kuroshio, and showed more different sequences among areas, but the Izu ridge area did not show enhanced biological production in SSChl compared to adjacent areas. Five *Paracalanus* species occurred in the upper 200 m of the study area, among which *P. aculeatus*, *P. nanus*, and *P. parvus* comprised 99.1% of the abundance of mature females. The study area was dominated by *P. parvus*, especially in the slope water area where the species comprised 96.1% of *Paracalanus* females. The high concentrations of *P. parvus* observed in the slope water area around the Izu ridge could be explained by enhanced production in the slope water and regional circulation.

## BIO-P-15

## Development of a new ocean carbon cycle model for the Japan Sea

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A new ocean carbon cycle model, that combines an operational ocean forecast system JADE with a lower-trophic marine ecosystem model ECOS3D, was developed to investigate biogeochemical cycling in the Japan Sea. The computational domain covers the Japan Sea, 126.5 – 142.5°E and 33.0 – 53.0°N, with 1/12-degree resolution in both the longitudinal and latitudinal direction. In the vertical direction, there are 36 levels with the maximal depth of 3,850 m. The ECOS3D considers 54 compartments at most including phytoplankton, zooplankton, nutrients, detritus, bacteria, dissolved oxygen and other inorganic matter; and it can simulate the grazing food web and the microbial food web. We ran the ECOS3D cyclically using the average ocean conditions for each month calculated from the 9-year JADE data (2003-2011) to reproduce seasonal variation of the ecosystem. Sea surface wind and light intensity were specified by data provided by the Japan Meteorological Agency. Our model qualitatively reproduced the seasonal variation in chlorophyll *a*, nutrients ($PO_4$, $NO_3$) and dissolved oxygen concentration in the Japan Sea. For example, phytoplankton showed blooms in spring and autumn; in the northern region, especially in the Peter the Great Bay, high concentration of nutrients and dissolved oxygen were distinct in the cooling season. In future, we will improve this model to obtain more quantitative results focusing on the year-to-year variation in the bacteria biomass and dissolved oxygen concentration. In addition, we expect that our model is applicable to investigating the response of dissolved oxygen concentration in the Japan Sea Proper Water to climate changes.

## BIO-P-16

## A comparative study of sound production in two marine environments monitored by the NEPTUNE Canada undersea observatory network

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The NEPTUNE Canada network, part of the Ocean Networks Canada (ONC) Observatory is the world's first regional-scale cabled ocean observatory network and is located in the Pacific Ocean, off the west coast of Vancouver Island, British Columbia. The network extends from the rocky coast to the deep abyss across the Juan de Fuca plate and it gathers live data from a rich constellation of instruments deployed in a broad spectrum of undersea environments. Data are transmitted via high-speed fibre optic communications from the seafloor to an innovative data archival system at the University of Victoria. Hydrophones were deployed at two NEPTUNE Canada node sites to support research on sound production in the marine environment. These hydrophones are located in Barkley Canyon, on the continental slope (1000 m) and in Folger Passage on the outer coast of Vancouver Island (100 m). Ambient sounds were recorded simultaneously at both sites over the course of one year (2010-2011). Our main objectives were to develop a library of anthropogenic and biogenic (fish, whales) sounds from these locations, and to determine spatial (across locations and depths) and temporal (daily, seasonal) patterns in sound production. We also explored potential correlations between sound production patterns and environmental sensor data and anthropogenic noise levels. The ultimate goal of this ongoing research is to develop a new tool (fish sound analysis) for studying the response of deep-sea ecosystems to short-term and long-term environmental change.

## BIO-P-17

## The Two Ocean Networks Canada (ONC) undersea observatory networks: NEPTUNE Canada and VENUS

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Ocean Networks Canada manages and operates a world-leading ocean observatory for the advancement of science and for the benefit of Canada. It does so on the behalf of the University of Victoria, the lead institution for a national consortium of universities and partner organizations. The Observatory consists of two networks, the VENUS coastal network and the NEPTUNE Canada regional network – and a federal Centre of excellence for commercialization and research, the ONC Centre for Enterprise and Engagement (ONCCEE). The Observatory networks have been designed and built to operate over at least 25 years with the capacity to expand through the addition of new infrastructure and instrumentation. NEPTUNE Canada, the North-East Pacific Time-series Undersea Networked Experiments, is the world's first regional scale cabled deep ocean observing network. It consists of an 800km network of electro-optic cable laid on the seabed across the continental shelf and then onto and across the northern Juan de Fuca tectonic plate, off the coast of British Columbia. This plate-scale regional network serves as an exceptional natural laboratory for ocean observation and experiments. VENUS, or the Victoria Experimental Network Under the Sea, is the world's first operational cabled ocean observing network. Through the Internet, its network of electro-optic cable and instruments provide around-the-clock biological, oceanographic and geoscience observations and images along with an interactive experimental capability. The principal purpose of the ONC Observatory is to support leading edge oceanographic research conducted by university-based researchers, often in partnership with colleagues in other agencies in the public and private sectors.

## BIO-P-18

## Canyonlands: Krill "hotspots" of the northern California Current

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Krill, crustaceans of the family Euphausiacea, are key species in many pelagic food webs globally. Knowledge of the spatial ecology of krill is needed for ecosystem-based approaches to ocean and coastal management, including marine spatial planning and forecasting applications for fisheries and wildlife. Building upon our earlier work in the southern and central sectors of the California Current (Santora *et al.* 2011 Prog. Oceanog.), we tested the hypothesis that krill are concentrated near canyons in the northern California Current. To test this hypothesis we analyzed hydroacoustic data from 11 spring/summer oceanographic surveys from San Francisco, California, to the Straits of Juan de Fuca, Washington from 2005 through 2011. We derived "hotspots" of krill abundance from kernel density utilization distributions based on smoothed, gridded Nautical Area Scattering Coefficient (NASC) statistics. "Hotspots" were found in association with Nitanet (WA), Astoria (WA/OR), Trindad (CA), Delgada (CA), and Bodega (CA) canyons, as well as the Blanco Saddle (OR) and Heceta Bank (OR). "Hotspots" of krill abundance were associated with some, but not all of the canyons in this environment, suggesting that hydrographic factors also play a role in determining krill distribution. Seabirds and other marine top predators showed similar patterns of concentration throughout the region, indicating strong spatial links between trophic levels that may be useful in restoring and protecting this pelagic ecosystem.

## BIO-P-19

## Bioavailability of sea ice-derived iron for phytoplankton growth

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Phytoplankton blooms occur in the Sea of Okhotsk during the sea ice melting season. There is a possibility that the micro-nutrient, iron, is released from the melting sea ice into the surrounding seawater. Although it is known that sea ice contains iron mainly in particulate form, availability of the particulate iron for phytoplankton is not well understood. To assess the bioavailability of iron in sea ice, shipboard bottle incubation experiments were performed with surface water collected from the western subarctic Pacific. Incubation with the addition of sea ice or inorganic iron stimulated growth of large-sized (>10 μm) phytoplankton, while the growth of phytoplankton in control bottles was little changed throughout the incubation. Desferriferioxime B (DFB) plus sea ice addition treatments, in which the strong ligand DFB was added for reducing the bioavailability of iron in the bottles, significantly depressed growth of the large- and small-sized phytoplankton. These results suggest that the iron stored in sea ice is potentially available for phytoplankton.

In order to evaluate the amount of leachable iron from sea ice into seawater, leaching experiments were also conducted. The proportion of leachable/particulate iron in the sea ice was extremely low (~0.03%). Overall, our results indicate that the sea ice-derived particulate iron was utilized by the large-sized phytoplankton during our shipboard bottle incubation experiments. We conclude that particulate iron stored in sea ice over winter could contribute significantly to phytoplankton growth in the seasonal ice zone during the melting season.

## BIO-P-20

## Contribution of HcRNAV viruses against *Heterocapsa circularisquama* bloom by inoculating frozen sediment

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The marine dinoflagellate *Heterocapsa circularisquama* specifically kills bivalves and is one of the most harmful bloom-forming microalgae. HcRNAV is a small icosahedral virus that specifically infects and kills *H. circularisquama*. Thus, the virus is a promising tool for preventing the occurrence of *H. circularisquama* blooms. To estimate the effect of natural HcRNAV on natural host algal populations, an inoculation test was conducted. Briefly, a frozen sediment sample containing a variety of HcRNAV (differing in host intraspecies specificity) was thawed and added to a seawater sample collected from Lake Kamo (Niigata, Japan) where *H. circularisquama* formed a bloom in August 2011. Then, the abundance of *H. circularisquama* and the titer of HcRNAV were enumerated at 0, 3, and 6 day postinoculation. *H. circularisquama* showed a remarkable decrease in cell density (from ca. 7,500 to ca.75 cells/mL) and HcRNAV significantly increased (from 40 to 72,000 infectious units/mL) within the 6 days. Compared to the control cultures (without inoculation or with addition of autoclaved sediment), the factor which caused the decrease in abundance of *H.circularisquama* was presumably HcRNAV in the sediment. The results suggest the usefulness of this method for eliminating *H. circularisquama* blooms. In this presentation, we show that virus from frozen sediment can prevent the *H. circularisquama* bloom. Furthermore, we introduce a new enumeration method for HcRNAV, which was designed to evaluate the viral effects on *H. circularisquama* blooms in natural environment.

## BIO-P-21

## Carbon and nitrogen isotope ratios of euphausiids in the northwestern Pacific

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To clarify the role of euphausiids in carbon transport in the northwestern (NW) Pacific, the spatio-temporal distribution and migration patterns of euphausiids in the Oyashio and Oyashio-Kuroshio Mixed Water Region (OKMWR) have been discussed in the PICES annual meetings of 2010 and 2011. In this study, to clarify the trophic level and carbon sources of euphausiids, the relationship between carbon and nitrogen stable isotope (SI) ratios ($\delta^{15}$N and $\delta^{13}$C) of 5 abundant euphausiid species (*Tessarabrachion oculatum*, *Thysanoessa inspinata*, *Euphausia pacifica*, *Nematoscelis difficilis*, and *Euphausia gibbodes*) were examined. The samples were collected at two stations in March, June, July and October of 2011 to analyze the difference between seasons, water regions, species, and body sizes. Mean values of $\delta^{15}$N were highest in *T. oculatum* (11.10±0.85 ‰), followed by *T. inspinata* (9.28±0.81‰), *N. difficilis* (8.27±1.40‰), *E. pacifica* (7.68±0.5‰), and *E. gibboides* (6.91±0.88‰). Values did not vary throughout the research period. On other hand, $\delta^{13}$C values varied between seasons, water regions, and body sizes. Lower values of $\delta^{13}$C in *T. inspinata* and *E. pacifica* were observed in warm water (summer and the OKMWR) than in cold water (winter and the Oyashio region). In *T. oculatum*, no seasonal variation in the $\delta^{13}$C value was observed but a difference between water regions was observed. The variations in $\delta^{15}$N and $\delta^{13}$C values will be discussed with the spatio-temporal distribution of euphausiid species in the NW Pacific.

## BIO-P-22

## Variability in assimilation efficiency of the copepod *Neocalanus cristatus*: Effect of food

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The large calanoid copepod *Neocalanus cristatus* (8 –10 mm in body size) is a dominant zooplankton species in the Oyashio region of the western subarctic Pacific Ocean, where it accounts for 31% of the annual mean biomass. While its importance in marine ecosystems is well known, there is little information on assimilation efficiency. In this study, we used seven phytoplankton species as foods for *N. cristatus* (five diatoms: *Attheya septentrionalis, Ditylum brightwelli, Pauliela taeniata, Thalassiosira nordenskioeldii*, *Skeletonema* sp., one dinoflagellate: *Alexandrium tamarense*, and one raphidophyte: *Heterosigma akasiwo*) in 32 feeding experiments. Organic (and inorganic) contents of fecal pellets and food were measured, then the assimilation efficiency was calculated by the Ratio method (Conover 1968a, b). Assimilation efficiency of *N. cristatu*s varied between 45% and 66%, depending on the phytoplankton species. Assimilation efficiency of *N. cristatus* ($Y$: %) had a significant negative relationship with the inorganic content of food ($X$: %) ($Y = 93.15 – 0.72 X$; $r = – 0.87$, $p < 0.01$). In NEMURO and other commonly used marine ecosystem models, assimilation efficiency of zooplankton is set as a constant value. In this study, we showed that the assimilation efficiency of copepods varied greatly and can be estimated by the inorganic content of the food. In future, marine ecosystem models should incorporate this variability in assimilation efficiency of zooplankton, which may be predictable as a function of the inorganic content of food.

## BIO-P-23

## Movement of diamond squid in the Sea of Japan revealed using pop-up satellite tags

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The diamond squid (*Thysanoteuthis rhombus*, “sode-ika”) is a large and powerful species that occurs worldwide mainly in tropical and subtropical waters. In Japan, it is the target of a growing fishery, but there have been few studies of its movement in Japanese waters. In this study, self-releasing satellite tags were used to track its movement in the Sea of Japan off Hyogo Prefecture.In November 2011, six squid ranging in mantle length from 43 to 65 cm were captured off Kasumi and tagged with pop-up archival transmitting (PAT) tags (Wildlife Computers, model MK-10), which measured pressure (depth), water temperature and ambient light levelthroughout the deployment. The tags were fixed to the ventral surface of the fin next to the mantle or at the dorsal anterior end of the mantle.To date, we have received data from five of the six tags. Four of the five were judged as successful deployments, and their attachment durations ranged from 3.8 to 8.1 days. Data were logged for a total of about 600 hours. Horizontal movements of 91 km over almost four days were observed. Two of the tags recorded diurnal vertical movement in the upper 150 m. The other two recorded temperatures more than 9°C warmer than the environmental temperature, suggesting they were consumed and warmed in the guts of predators.

## BIO-P-24

### Ontogenetic vertical migration of two tropical-subtropical copepods, *Rhincalanus nasutus* and *Rhincalanus rostrifrons,* in the northwestern Pacific Ocean: Implication for a variety of life history strategies of *Rhincalanus*

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To clarify the life histories of two tropical-subtropical *Rhincalanus* species, *R. nasutus* and *R. rostrifrons*, we investigated the geographical and vertical distributions of their copepodid populations in the northwestern (NW) Pacific Ocean (15°N and 49°N). *Rhincalanus nasutus* was widely distributed from 20°N to 49°N, whereas *R. rostrifrons* was restricted to more southerly latitudes (15–37°N). The occurrence of the two species in the surface layer was associated with seasonal spring ontogenetic vertical migration (OVM). Gonadal analysis indicated that, during spring, both species reproduce in the surface layers of the Kuroshio–Oyashio Transition Area (TA) and the slope water area, which is a region of the continental slope situated north of the Kuroshio axis. Our result suggests that both species might have 1 or 2 year life cycles. In comparison, dormant populations collected below the surface layer were mainly comprised of adult females (50.2% for *R. nasutus* and 57.7% for *R. rostrifrons*). The adult dormancy seems to be an advantageous strategy for the life state of the two species in response to irregular increases of primary production in tropical-subtropical oceans. Furthermore, dormancy in deep waters (500–1,000 m) by *R. nasutus* might indicate a strategy to avoid the relatively high predation risks incurred in shallower waters, due to its larger body size. In contrast, the smaller body size of *R. rostrifrons* facilitates dormancy in shallower waters (200–500 m depth). Our result suggests that life history strategies of *Rhincalanus* specise have been modified in local environments of different latitudinal regions.

## BIO-P-25

### Comparisons of fecal pellet characteristics in the surface layers between the subarctic and subtropical North Pacific Ocean

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Seasonal changes in fecal pellet characteristics and fluxes were compared between the subarctic (K2) and subtropical (S1) North Pacific Ocean from sediment trap samples and on-board experiments to evaluate the changes during sinking. Fecal pellet fluxes at K2 were higher compared with those at S1, but they were a minor contribution to particulate organic carbon flux. They showed a maximum in July at K2 and in February at S1 when large calanoid copepods appeared abundantly in the surface layers. Based on incubations of live copepods, calanoids egested cylindrical pellets and cyclopoids and poecilostmatoids produced oval pellets. Cylindrical pellets comprised more than 63% of total fecal pellets, and oval pellets were next in importance throughout all seasons at both sites. The equivalent spherical diameters (ESDs) of both pellet types were largest in July at K2 and in February at S1, and the average ESDs declined during sinking. Experiments on pellet degradation indicated coprophagy and coprorhexy by copepods at K2 and repackaging by microzooplankton and copepods at S1. These results suggest that fecal pellet flux is increased with the predominance of large calanoid copepods in the surface mesozooplankton community, and fecal pellets are downsized during sinking due to the disappearance of the large pellets, mediated by microzooplankton and copepods.

## BIO-P-26

## A numerical study on predominance of dinoflagellates on the central continental shelf of the East China Sea

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The dinoflagellate, *Prorocentrum dentatum*, was frequently dominant in early summer on the central continental shelf of East China Sea (ECS) during 2004 to 2010. We investigated the cause of this pattern using numerical simulations. We developed a numerical model coupled with a hydrodynamic model and a biogeochemical cycle model. The hydrodynamic model simulated the quasi-3D physical field: currents, pressure, salinity, and temperature. The biogeochemical cycle model evaluated the C-N-P-O coupled cycle in the pelagic and benthic systems. The model variables were phytoplankton (diatom and dinoflagellate), detritus, dissolved organic/inorganic matter, and dissolved oxygen. The model considered dinoflagellate sedimentation depending on buoyancy and gravity determined from our large-scale cultivation experiments in the laboratory. Pollutant loading from the Changjiang River basin, which was the largest source from land, was evaluated using hydrologic and material transport models. Simulation results of currents during spring/early-summer suggested the water mass moved from the southern part of the Changjiang estuary to the central ECS. This implied that *P. dentatum* on the continental shelf in the subsurface layer originated from the Changjiang estuary in the surface layer. Sensitivity analyses to clarify *P. dentatum* responses to pollutant loading indicated decreases in algal blooms in the Changjiang estuary and the Yellow Sea, with only moderate reductions of dinoflagellate biomass in the central ECS. Our results suggest that primary production in the central ECS is highly dependent on the oceanic nutrient supply by horizontal and upward transport.

## BIO-P-27

## Bacterial communities of the sea surface microlayer in the Northern Yellow Sea in China

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Eight representative sites were sampled from the surface microlayer (SML) and subsurface layer in spring, 2011 in the Yellow Sea, China, to examine the diversity, community structure, and ecological significance of microorganisms in the surface microlayer.. The abundance of cultured bacteria, total bacteria, and the bacterial community were compared. The average numbers of cultured bacteria for the SML and subsurface waters were $2.85\times10^5$ CFU/mL and $3.45\times10^3$ CFU/mL, respectively. The average total bacteria in these two layers were $1.76\times10^6$ cells/mL and $1.07\times10^6$ cells/mL, respectively. Therefore, compared with subsurface water, SML concentrated the culturable bacteria. PCR-DGGE analysis of bacteria 16S rDNA showed the bacterial communities of this coast fell into five bacterial phylogenetic groups: *Proteobacteria*, *Bacteroidetes*, *Cyanobacteria*, *Actinobacteria and Verrucomicrobia*, of which *Proteobacteria* was dominant. The bacteria in these sampling sites can be isolated from the Arctic sea, estuaries, sediments, salt marshes, seamounts, *etc.* The results confirmed that the SML has a distinct microbial community structure compared to the corresponding subsurface water. Hence, identifying the species of bacteria in the SML can indirectly trace its source and lead to better understanding of the succession of microorganisms. Furthermore, this study also described a detailed molecular biological analysis of the bacterioneuston in the Yellow Sea in China. Taking oil hydrocarbon-degrading bacteria, denitrifying bacteria and sulfate-reducing bacteria as examples, some functional bacteria were separated from the SML water samples, which provided a significant foundation for studying the role of the functional bacteria in the geochemical cycling of the SML.

## BIO-P-28

### Pesticides and seafood safety in the Russian fish market

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Organochlorine pesticides (POPs)are important pollutants which accumulate in marine organisms. Widespread use of pesticides creates the need for careful control of their harmful effects on human health, taking into account both immediate and long-term effects. Fish and seafood are important protein sources in nutrition of the Primorsky Kray population. Seafood comes on sale to food markets of Primorskiy Kray from different regions of the Russian Far East, including Kamchatka, Sakhalin, and Magadan oblast. Frozen fish are the main type of raw materials– salmon, herring, flat-fish, pollock, navaga, cod and halibut. Frozen squids, crabs, shrimps, mussels, trumpetfish, scallops and seaweeds are also present at domestic fish markets.  Toxicological safety of raw materials are based on the Sanitary Norms of Russian Federation and Technical Standards. Sanitary norms for HCHs and DDT are less than 0.2 mg/kg, and for DDT in fat fish (salmons and herring) are less than 2.0 mg/kg wet weight. Commercial fishes (100 individuals) and seafood samples (60 individuals) entering the food markets of Primorsky Kray in 2004-2005were examined for the presence of HCH and DDT. The total POP concentration in all samples of fish and seafood did not exceed the maximal permitted level established by the Sanitary Norms and Regulations of Russian Federation.Therefore, people arenot exposed to ecological risk fromfish consumption in Primorsky Kray.

## BIO-P-29

### Introduced marine species and their impacts in China seas

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About 126 species have been introduced intentionally and unintentionally into China seas. Among which there are 9 bacteria (virus) species, 7 algal species, 8 plant species, 7 coelenterate species, 1 polychaete species, 17 mollusc species, 8 crustacean species, 4 bryozoan species, 2 echinoderm species, 4 urochordate species, 45 fish species, 4 bird species, and 8 mammal species. Most of them have been introduced for marine culture, aquariums, bait or biomodification, but some of them have become invasive species and cause serious economic and ecological damages.

## BIO-P-30

### Distribution Patterns of the Common Squid (*Todarodes pacificus*) in the Russian EEZ in 2009-2011

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Distribution density of the common squid (*Todarodes pacificus*) was studied in Peter the Great Bay (Japan Sea, Russian EEZ) during three consecutive years 2009-2011 with the aim of relating the observed patterns with oceanographic features. We used the CPUE value (catch per hour per jigging machine) as a measure of squid distribution density. Data on SST and satellite images were used to look at changes in oceanography of the Japan Sea. Squid CPUE values were higher in 2009 and 2011 and lower in 2010. Winters and springs were colder in 2010 and 2011 compared to 2009; however, patterns of the Polar Front meandering were different in these years. In 2009, high CPUE values of *T. pacificus* were due to high abundance of squid from the winter generation, which appeared early in the season due to quick coastal spring warming. In 2011, high CPUE values were mostly due to squid from the autumn generation, which migrated into the bay later in the season. In 2010, there were no strong warm water intrusions in the bay, and squid migrated mainly offshore; therefore, there were low squid CPUE values in Peter the Great Bay. Summing up, squid migrations into the bay were associated with seasonal changes in oceanographic features, such as SST and Polar Front meandering patterns.

## BIO-P-31

# Daily and seasonal activity patterns of horseshoe crabs in the Kasaoka Bay estuary, Seto-Inland Sea, Japan

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The purpose of our study is to determine activity patterns of the horseshoe crab *Tachypleus tridentatus* in the Kasaoka Bay estuary, Seto-Inland Sea, Japan and then seek an understanding of the processes that give rise to these patterns. To investigate the daily activity patterns, crabs with attached acceleration data-loggers were exposed under two conditions: 1) light-dark and tidal cycles and 2) light-dark cycles during the mating season. Daily activity patterns and relationships with light or tidal cycles were investigated. Results showed that the crabs expressed circadian activity rhythms under light and tidal cycles. They were strictly nocturnal and started moving during high tide at night. When exposed to 'light only' conditions, although crabs also expressed circadian activity rhythms, such activity did not synchronize with light-dark cycles. To investigate seasonal activity patterns, crabs with attached ultrasonic transmitters and depth-temperature data-loggers were released in the field and their movement patterns were investigated. Most crabs stayed in the bay estuary during the mating season from June to September, after which period most of these animals subsequently moved out of the bay. Two crabs were recaptured out of the bay after 5 and 9 months, respectively. The data obtained showed both crabs were active until water temperature dropped to 18°C in late November, after which it remained dormant over winter at shallow depth (7-8 m at low tide) near the bay mouth. These findings show that activities of horseshoe crabs are strongly influenced by both daily cycles of light and tides and the seasonal cycle of water temperature.

# FIS Paper Session

***Co-Convenors**: Xianshi Jin (China) and Elizabeth Logerwell (USA)*

This session invites papers addressing general topics in fishery science and fisheries oceanography in the North Pacific and its marginal seas, except those covered by FIS-sponsored Topic Sessions.

### Thursday, October 18 (9:00-16:45)

09:00 ***Introduction by Convenors***

09:05 **Yongjun Tian, Kazuhisa Uchikawa and Yuji Ueda**
A comparison of fish community and trophic structure from three marine ecosystems around Japan: Synchronies, differences and environmental forcing (FIS-P-8661)

09:25 **Osamu Tamaru, Kazushi Miyashita, Nobuo Kimura, Yasuzumi Fujimori, Toshihiro Watanabe, Hideo Takahara and Teisuke Miura**
Fishery income fluctuation due to changing vessel speed from harbor to the fishing ground in the Japanese coastal squid jigging fishery (FIS-P-8334)

09:45 **Xun Zhang, Sei-Ichi Saitoh and Toru Hirawake**
Spatial modeling of the potential fishing zone of Japanese common squid in coastal waters of southwestern Hokkaido, Japan (FIS-P-8501)

10:05 **Sergey V. Prants, M.V. Budyansky and M.Yu. Uleysky**
Lagrangian coherent structures in the ocean favourable for fishing grounds (FIS-P-8325)

10:25 ***Coffee/Tea Break***

10:50 **Cindy A. Tribuzio and Gordon H. Kruse**
Demographic and risk analyses of spiny dogfish in the Gulf of Alaska (FIS-P-8348)

11:10 **Jacquelynne R. King and Romney P. McPhie**
Age, growth and maturity estimates of spotted ratfish (*Hydrolagus colliei*) in British Columbia (FIS-P-8432)

11:30 **Steven J. Barbeaux, John Horne and Jim Ianelli**
A novel approach for estimating location and scale-specific fishing exploitation rates of eastern Bering Sea walleye pollock (*Theragra chalcogramma*) (FIS-P-8508)

11:50 **Alan C. Haynie and Lisa Pfeiffer**
Climate change and fisher behavior in the Bering Sea pollock trawl and Pacific cod longline fisheries (FIS-P-8781)

12:10 **Jeffrey Polovina and Phoebe Woodworth-Jefcoats**
Understanding ecosystem dynamics in the central North Pacific pelagic ecosystem from a size-based perspective (FIS-P-8469)

12:30 ***Lunch***

14:00 **Kai Zhang, Yoshiro Watanabe, Hiroshi Kubota, Atsushi Kawabata and Tomohiko Kawamura**
Growth and survival of juvenile Japanese anchovy *Engraulis japonicus* in the Kuroshio-Oyashio transitional regions in 2010 (FIS-P-8694)

14:20 **Pavel Chernyshkov**
Interannual variability of large-scale hydrometeorological processes in the northern parts of the Pacific and Atlantic Oceans and their probable impact on commercial fish migrations (FIS-P-8833)

14:40 **Chiyuki Sassa, Motomitsu Takahashi, Kou Nishiuchi and Youichi Tsukamoto**
Distribution, growth, and mortality of larval jack mackerel *Trachurus japonicus* in the southern East China Sea in response to habitat conditions (FIS-P-8426)

15:00 **Peng Sun, Zhenlin Liang, Liuyi Huang and Xin He**
Changes in fish phenotypic traits induced by trawl selectivity (FIS-P-8481)

15:20 ***Coffee/Tea Break***

15:50 **Poster Introductions**

16:45 *Session Ends*

## FIS-P Session Posters

FIS-P-1 **Pavel Mikheev**
Relationships between Pacific salmon and residential fish in the Amur River basin

FIS-P-2 **Svetlana Yu. Kordicheva, Alexei M. Orlov, Alexander A. Volkov, Pavel K. Afanasiev and Eugeny G. Shaikhaev**
Preliminary results of the study of sablefish population structure within the Russian waters using DNA-markers

FIS-P-3 **Wen-Bin Huang, Chih-Shin Chen and Wei-Ting Hsu**
The spatio-temporal pattern of Pacific saury *Cololabis saira* abundance in the Northwestern Pacific

FIS-P-4 **Yu-xue Qin, Ryo Koyama, Yosuke Koshino, Hideaki Kudo, Shigehiko Urawa and Masahide Kaeriyama**
Spatiotemporal change in carbon and nitrogen stable isotopes of chum salmon during developmental

FIS-P-5 **Eugene V. Samko and Nafanail V. Bulatov**
The role of a warm anticyclonic eddy at Hokkaido (North-West Pacific) in the formation of saury fishing grounds

FIS-P-6 **Indah Puspitasari and Chulwoong Oh**
Population structure and reproductive biology of the lake prawn *Palaemon paucidens* (Caridea, Palaemonidae) from Goesan Lake, Korea

FIS-P-7 **Oleg Ivanov**
Nekton species structure in the Far East Seas and adjacent waters of the Pacific Ocean in 1980-2009

FIS-P-8 **Ming-Ming Zhang, Chulwoong Oh, Wan-Ok Lee and Kyung-Jun Song**
Reproductive biology of the largemouth bass, *Micropterus salmoides* from Goe-san Lake, Korea

FIS-P-9 **Ming-Ming Zhang, Chulwoong Oh, Wan-Ok Lee and Kyung-Jun Song**
Age and growth of the catfish *Pelteobagrus fulvidraco* in Goe-san Lake, Korea

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| FIS-P-10 | **Youjung Kwon and Chang Ik Zhang**<br>An ecosystem-based assessment and management system in Korean waters |
| FIS-P-11 | **Hiroshi Kuroda, Takashi Setou, Kazuhiro Aoki, Yoshitsugu Hagiwara and Hiroko Akabane**<br>A numerical study of "shirasu" fishing ground formation based on the Kuroshio submesoscale model, south of Japan |
| FIS-P-12 | **Atsushi Tawa, Taku Yoshimura and Noritaka Mochioka**<br>High dispersal of moray eel larvae to the open ocean: Early life history estimated from ocean-wide distribution patterns |
| FIS-P-13 | **Michail Kuznetsov**<br>The influence of underwater vessel noise on fish behaviour and methods of its reduction |
| FIS-P-14 | **Graham E. Gillespie, Tammy Norgard, Sean MacConnachie, Lily Stanton and Jessica Finney**<br>Program to assess the conservation status of the Olympia oyster, *Ostrea lurida*, in Canada |
| FIS-P-15 | **Hideki Nakano**<br>International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean |

# FIS-Paper Session Oral Presentations

### October 18, 09:05 (FIS-P-8661)

## A comparison of fish community and trophic structure from three marine ecosystems around Japan: Synchronies, differences and environmental forcing

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Understanding the mechanisms of change in marine ecosystems is important for ecosystem-based fisheries management. Major features of three marine ecosystems around Japan in the northwestern North Pacific, Tsushima (TWC), Kuroshio (KC) and Oyashio (OC) Current ecosystems, which support one of the largest fisheries production in the world oceans, were analyzed based on a broad range of fisheries, oceanographic and climate datasets during 1955-2010. For each ecosystem, fisheries catches of 25 taxa with different trophic level from small pelagic to large predatory species were selected as indicators, and were applied to PCA (Principal Component Analysis) and GAM (Generalized Additive Model) to identify variation patterns in the fish community and impacts of climate variability. Ecosystem indicators such as mean trophic level (MTL) and ratio of piscivores to zooplanktivores (PS/ZS ratio) were also estimated and compared to discuss the commonalities and differences in trophic structure across the three ecosystems.

Principal components (PCs) from PCA of catches for each ecosystem showed evident decadal variation patterns with a regime shift in PC1 in the late 1980s, indicating synchronies in the dominant mode of variation across the three ecosystems. Abrupt changes also occurred in the mid-1970s in PC2-3 in OC, and in early 1970s in PC2 in both KC and TWC. These results indicate that the most marked change across the three current ecosystems occurred in the late 1980s, but OC responded strongly to the 1976/77 regime shift in comparison with other two ecosystems. The results suggest different responses to climate regime shifts between the northwestern and central-northeastern North pacific, where the 1976/77 regime shift was more evident than the late 1980s regime shift. GAM for PCs and environmental factors showed the PCs were associated largely with SSTs in each ecosystem rather than global climate indices, indicating the importance of regional oceanographic conditions to the variability of fish communities. MTL increased in TWC and KC but decreased in OC since the late 1980s. This result suggests that trophic structures in TWC and KC were dependent largely on the mid-trophic level, small pelagic species, while the demersal species played an important role in OC.

### October 18, 09:25 (FIS-P-8334)

## Fishery income fluctuation due to changing vessel speed from harbor to the fishing ground in the Japanese coastal squid jigging fishery

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In recent years falling fish prices and rising fuel prices have worsened the financial management of many fishery households in Japan. In particular, Japanese coastal squid jigging fishermen would benefit from improvements in the energy efficiency of the squid jigging fishery, because this fishery uses a lot of fuel in comparison with other kinds of fisheries. Many squid jigging fishermen in Japan aim to catch as much squid as possible due to the long duration of squid jigging operations. As a result, many squid jigging vessels move from the harbor to the fishing ground at high speed. This study shows the income fluctuation caused by changing vessel speed from the harbor to the fishing ground by using the Management Simulation Method. We used social factors (such as fuel price and squid price) and fishery operation factors (such as vessel speed, distance from the harbor to the fishing ground, and squid catches) in this simulation. According to the simulation results, when the unit price of squid was low and the unit price of fuel was high, fishery income was increased by moving to the fishing grounds at lower vessel speed. We concluded that, in some situations, moving to the fishing ground at high vessel speed to catch as much squid as possible does not always result it maximum income.

**October 18, 09:45 (FIS-P-8501)**

## Spatial modeling of the potential fishing zone of Japanese common squid in coastal waters of southwestern Hokkaido, Japan

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Japanese common squid (*Todarodes pacificus*) is one of the most commercially important fished species in the southwestern Hokkaido coastal region, Japan. Jigging fishing in this region usually occurs at nighttime from June to December and the lights used for fishing can be detected by DMSP (Defense Meteorological Satellite Program) OLS (Operational Linescan System). We used three years of data (2000, 2001 and 2002) on daily fishing vessel distribution derived from the nighttime DMSP/OLS images to identify the presence and absence of Japanese common squid assemblages along the southwestern Hokkaido coastal region. Corresponding environmental factors were considered to explain squid distribution, including bathymetry, SST (sea surface temperature), chlorophyll *a* concentration and Kd490 (diffuse attenuation coefficients of downwelling irradiance at 490-nm). We tested three different models to predict squid distribution: GAM (Generalized additive model), GLM (Generalized linear model) and BRT (Boosted regression trees). Model performance was validated and compared based on DMSP/OLS data of 2003. The comparisons indicated that the BRT was better than GAM and GLM. Results from the BRT showed that potential fishing zones were closely correlated with the depth of the water. SST and chlorophyll *a* highly contributed to squid occurrence as well, while Kd490 which is related to the transparency of the water was less associated with the distribution. In addition, we applied BRT to detect monthly potential fishing zones between 2004 and 2009 and mechanisms potentially responsible for the spatial and temporal variation.

**October 18, 10:05 (FIS-P-8325)**

## Lagrangian coherent structures in the ocean favourable for fishing grounds

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The aim of this study is to elucidate the role of Lagrangian coherent structures in detecting locations for good fishing. We focus on fishing grounds of Pacific saury (*Cololabis saira*), one of the most important commercial pelagic fishes in the Kuroshio-Oyashio frontal zone. The method we use is based on the Lagrangian approach to study mixing and transport at the sea surface when one follows fluid particle trajectories in a velocity field calculated from altimetric measurements. The Lagrangian coherent structures which are favourable for fishing grounds are identified with the help of Lagrangian indicators. The key role in organizing the flow is the so-called unstable invariant manifolds of hyperbolic trajectories in the ocean that act as transport barriers and attracting material lines separating waters of different origin. We show that the locations with the largest saury catch coincide mainly with the locations of the First and Second Oyashio Intrusions. These fronts can be identified with a good accuracy on the frontal, Lyapunov and driftage synoptic maps computed backward in time with altimetric velocity fields.

## October 18, 10:50 (FIS-P-8348)

## Demographic and risk analyses of spiny dogfish in the Gulf of Alaska

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Spiny dogfish *(Squalus sucklei)* is an abundant, small shark that is broadly distributed throughout the North Pacific Ocean. Although not currently targeted by commercial fisheries in Alaska, dogfish are frequently taken in longline, gillnet and trawl fisheries as bycatch, most of which is discarded at sea. Because of data limitations, allowable shark catches are estimated for dogfish as part of a shark complex, which also includes Pacific sleeper shark and salmon shark. Demographic models are useful tools for assessing data-limited species and may be appropriate for sharks owing to their longevity and slow growth. In this study, age- and stage-based demographic analyses were conducted to examine the intrinsic rebound potential ($r$) and potential risk of fishing for spiny dogfish in the Gulf of Alaska. Monte Carlo simulations were conducted to incorporate input parameter uncertainty. For an unfished population, $r$ was estimated to be 0.02–0.03 per year. Instantaneous rates of fishing mortalities ($F$) of 0.03-0.04 resulted in $r = 0$; that is, populations that are fished at higher rates than this are not sustainable. Harvest strategies targeting juveniles and subadults caused the greatest risk that the population would fall below a threshold, such as $B_{MSY}$, after 20 years. Our age- and stage-based models provided similar estimates of $r$ and sustainable fishing mortality, suggesting that the stage-based model could be substituted for the age-based model in cases of limited age data.

## October 18, 11:10 (FIS-P-8432)

## Age, growth and maturity estimates of spotted ratfish (*Hydrolagus colliei*) in British Columbia

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The spotted ratfish (*Hydrolagus colliei*) is a deepwater chimaera ranging from southeast Alaska to Baja California and is found at depths of up to 1,150 m. There is no commercial fishery for spotted ratfish in British Columbia, but it is one of the dominant species routinely captured in groundfish bottom trawl surveys. Despite being a large component of the ecosystem, few biological parameter estimates exist for spotted ratfish due to a lack of suitable ageing structures to estimate age and growth. We sampled over 234 spotted ratfish captured in trawl surveys off the coast British Columbia ranging in size from 12 cm to 61.7 cm. The size at maturity estimates were larger for females (22.5 cm snout-vent length) than males (17.5 cm). Both estimates are larger than those made for spotted ratfish off of California indicating regional differences in life history traits for this species. We present preliminary results of age estimates based on tritor counts on the vomerine tooth plate. Based on these age estimates, we present growth curve and age-at-maturity estimates for spotted ratfish. The vomerine plates are candidate ageing structures for spotted ratfish, and warrant further investigation.

### October 18, 11:30 (FIS-P-8508)

## A novel approach for estimating location and scale-specific fishing exploitation rates of eastern Bering Sea walleye pollock (*Theragra chalcogramma*)

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Acoustic data collected opportunistically from eastern Bering Sea (EBS) walleye pollock (*Theragra chalcogramma*) fishing vessels was used within spatially-explicit Leslie depletion models in multi-scaled Bayesian analyses to estimate location and scale-specific fishing exploitation rates. Although EBS pollock stock exploitation rates remained at or below management objectives (~6% for the winter fishery), there has been a perception that local fishing may be impacting the recovery of endangered Steller sea lions (*Eumetopias jubatus*). Due to a lack of appropriately scaled data, impacts of the fishery at local scales have not been previously explored. Spatial resolutions ranging from 250,000 km$^2$ to 100 km$^2$ were examined. This study revealed that at finer resolutions (100 km$^2$ to 2,500 km$^2$) fishing exploitation rates often exceeded area-wide rates with the highest rates in the southeastern Bering Sea. In 2002 through 2005 higher fishing exploitation rates occurred within Steller sea lion critical habitat than outside. Even though this study did not determine what a significant impact to the ecosystem is, it did quantify location and scale-specific fishing rates, and was an important step in determining a rational approach to monitoring and managing fishing activities while incorporating ecosystem concerns.

### October 18, 11:50 (FIS-P-8781)

## Climate change and fisher behavior in the Bering Sea pollock trawl and Pacific cod longline fisheries

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The two largest volume commercial fisheries in the US Bering Sea are the pollock and Pacific cod fisheries. In this paper, we build upon work that independently examined the impact of climate change on the pollock and Pacific cod fisheries. We examine how both fisheries have adjusted to economic and environmental variation since 2000. For pollock, the mean location of winter fishing has varied little in warm and cold years, but there has been a northward shift in summer pollock biomass and fishing. This shift is related to the colder than average climate conditions in the latter part of the decade. For Pacific cod, the timing and location of winter fishing has shifted dramatically since 2000.This shift is related to the extent of seasonal sea ice and the timing of its descent and retreat. The summer Pacific cod fishery also shifted to the north, although the timing of the season remained constant. Climate affects relative spatial catch-per-unit-effort (CPUE) in both fisheries by causing a cold pool (water less than 2°C that persists into the summer) that sub-arctic species such as pollock and Pacific cod avoid.

Understanding the relationship between fishing location, climate variables, and economic factors is essential in predicting the effects of future warming on the pollock and Pacific cod fisheries. We discuss key differences in our understanding of fisher behavior, climate conditions, and spatial changes in fish abundance in the two fisheries. This work is part of the BEST-BSIERP Ecosystem Partnership.

**October 18, 12:10 (FIS-P-8469)**

## Understanding ecosystem dynamics in the central North Pacific pelagic ecosystem from a size-based perspective

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Over the past decade pelagic longline observer and logbook data document considerable temporal variation in the catch and catch rates of many of the 22 species caught in the deep-set tuna fishery. Catch rates of some species including snake mackerel, pomfret, mahi mahi, have increased while those for other species, including blue shark, striped marlin, and bigeye tuna, have decreased. Changes in catch rates can be influenced by operational factors including hook type (circle *vs* tuna), as well as species abundance. After accounting for operational changes, the temporal dynamics of 22 species are largely explained by a size-based model. Specifically, fishing results in a top-down ecosystem response where a decline in the abundance of the largest species results in an increase in the abundance of smaller exploited species. This suggests that size-based predation is a dominant factor in the central Pacific pelagic ecosystem and top-down and bottom-up impacts can be modeled with a relatively simple dynamic size-based model. However the type of hook used also appears to modestly alter the composition of the catch. We explore whether hook type may be used as a management action to alter the ecosystem impact of longline fisheries.

**October 18, 14:00 (FIS-P-8694)**

## Growth and survival of juvenile Japanese anchovy *Engraulis japonicus* in the Kuroshio-Oyashio transitional regions in 2010

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Japanese anchovy *Engraulis japonicus* is assumed to migrate from the Kuroshio-Oyashio transitional region to the Oyashio region in spring and summer. Growth and survival of anchovy juveniles during the northward migration were investigated in this study. Young-of-the-year smaller than 80 mm SL (juveniles) and those larger than 90 mm SL (recruits) were collected in early summer in the Kuroshio-Oyashio transitional region and in late summer in Oyashio region in 2010, respectively. Hatch-dates and growth rates were examined by microstructure analyses of sagittal otoliths. We found that juveniles hatched between late March and late April. However, most of the recruits hatched between mid-April and mid-May. Recruits that hatched between late March and early April were small in number but grew faster after 50 days old than the juveniles of the same hatch period. This may imply that a small number of juveniles with high growth rate during and after metamorphosis survived and constituted the recruits from early spawning season. In contrast, no significant difference in growth was observed between juveniles and recruits that were hatched in late spawning season (mid- and late April). Juveniles hatched in the late spawning season grew faster than those hatched in the early spawning season, and this may contribute to a higher probability of survival for the juveniles that hatched in the late spawning season during the northward migration from the Kuroshio-Oyashio transitional region to the Oyashio region.

**October 18, 14:20 (FIS-P-8833)**

## Interannual variability of large-scale hydrometeorological processes in the northern parts of the Pacific and Atlantic Oceans and their probable impact on commercial fish migrations

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Joint analysis of large-scale atmospheric circulation indices, thermal conditions in the upper seawater layer and fluctuations of ocean level based on altimetric data were conducted. Temporal shifts between the studied processes changes have been distinguished.

The results obtained were compared to changes in the migration routes of herring and blue-whiting in the Northern Atlantic Ocean, as well as those of Alaska pollock in the Northern Pacific Ocean.

**October 18, 14:40 (FIS-P-8426)**

## Distribution, growth, and mortality of larval jack mackerel *Trachurus japonicus* in the southern East China Sea in response to habitat conditions

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Distribution, growth, and mortality of jack mackerel *Trachurus japonicus* larvae (<10 mm standard length) were investigated in relation to habitat conditions in the southern East China Sea (ECS) in 2005, 2007, and 2009. In all years, the center of larval distribution shifted northeastward with growth, showing a northeastward transport by the Kuroshio branch current. In 2005, the mean habitat temperature of the larvae was approximately 2°C lower than the other two years. Mean density of the major prey item *Paracalanus* spp. in the larval habitat varied interannually, with the highest and lowest values in 2007 and 2005, respectively. Mean absolute growth rate and weight-specific instantaneous growth coefficient ($G_w$) were highest in 2007 (0.30 mm $d^{-1}$ and 0.217 $d^{-1}$, respectively) and lowest in 2005 (0.19 mm $d^{-1}$ and 0.120 $d^{-1}$, respectively), corresponding with habitat temperature and food availability. There was no significant interannual difference in daily instantaneous mortality coefficients ($Z$), ranging from 0.107 $d^{-1}$ in 2009 to 0.136 $d^{-1}$ in 2007. The $G_w/Z$, an index of the stage-specific survival of larvae, was highest (1.60) in 2007 and lowest (1.02) in 2005. Indices of recruited juveniles (mainly 50–75 mm fork length) in the ECS are reported to be low in 2005, intermediate in 2007, and high in 2009, and the lowest $G_w/Z$ in 2005 corresponded with the lowest recruitment. However, the $G_w/Z$ in 2007 and 2009 did not clearly correspond with the recruitment levels, suggesting that a high $G_w/Z$ is necessary but maybe not a sufficient criterion of a strong year-class.

**October 18, 15:00 (FIS-P-8481)**

## Changes in fish phenotypic traits induced by trawl selectivity

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In recent years increasing evidences demonstrated that the phenotypic traits has changed in many exploited fish populations, mainly because of the intense fishing mortality and the size-selectivity of fishing. Trawl fishing, which has been broadly and intensively used for a long period, has great potential to change the phenotypic traits of fish populations. In this study, we simulate a perennial fish population with multiple age structure to evaluate the effects of long-term trawl fishing. Our results revealed that the body-length distribution and age structure of the simulated fish population irreversibly changed under long-term trawl fishing. The simulated results confirm that after fishing the age-length was turning shorter and the age structure was reduced in fish populations.

# FIS-Paper Session Poster Presentations

## FIS-P-1

### Relationships between Pacific salmon and residential fish in the Amur River basin

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The high abundance of spawning Pacific salmon has a significant impact on the residential fish community in the rivers of the Amur River basin. Many authors described a significant influence of the genus *Oncorhynchus* on the fish community in the rivers in which they spawn.

The feeding efficiency of residential species increases after chum salmon *Oncorhynchus keta* spawning migrate to the rivers. The index of grayling *Thymallus tugarinae* stomach fullness becomes higher. Fish eggs and high-calorie food organisms begin to prevail in grayling stomachs. This leads to an increase in energy consumption of 4-6 times in comparison with these indices measured before salmon spawning migration. Salmon carcasses are an important source of nutrients for benthic invertebrates. Thus, the value of aquatic invertebrate biomass is higher in salmon spawning areas. In spring, during the catadromous migration, chum salmon juveniles play a significant role for feeding residential fish.

The contribution of marine derived nutrients by Pacific salmon has a great influence on the growth rate of Amur river basin residential fish. We established that the growth rate of graylings depends on the dynamics of Amur river fall chum salmon abundance. There is a direct correlation between the annual growth rate of grayling (in terms of body length) and fall chum salmon abundance. Higher growth rates of grayling were marked in the areas with higher abundance of Pacific salmon spawners.

## FIS-P-2

### Preliminary results of the study of sablefish population structure within the Russian waters using DNA-markers

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Sablefish *Anoplopoma fimbria* is an endemic species in the North Pacific Ocean having a continuous range from southern California and Mexico on the American coast to the central Honshu on the Asian coast including the Bering Sea and the Sea of Okhotsk. On the one hand, sablefish in Russian waters is a prospective target of trawl, longline and trap fisheries. On the other hand, its stocks are susceptible to the impact of fisheries since sablefish is a long-lived species with low reproductive potential. The lack of knowledge of sablefish population structure is one of the reasons that the beginning of commercial fishing of this species in Russia is hampered. Currently, there are three hypotheses regarding sablefish population structure within Russian waters: 1) sablefish periodically appears in Russian waters during periods of high abundance in the northeastern Pacific; 2) within Russian waters sablefish from time to time forms dependent populations replenished by fish from the northeastern Pacific during periods of high abundance; 3) sablefish is a permanent resident of Russian waters and forms independent populations. During the experimental deep-water trap fishery in 2011 sablefish samples were collected from 4 different areas in Russian waters (western Bering Sea, underwater Shirshov ridge, southeastern Kamchatka, and Commander Islands) for genetic research of population structure using two types of DNA-markers: highly polymorphic microsatellite loci and mitochondrial DNA. Results of this analysis allowed us to obtain preliminary information about sablefish population structure in Russian waters (to be specified in the process of accumulation of new data) and to evaluate genetic affinity with sablefish populations of the northeastern Pacific.

## FIS-P-3

## The spatio-temporal pattern of Pacific saury *Cololabis saira* abundance in the Northwestern Pacific

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Pacific saury *Cololabis saira* (Brevoort) is an important commercial pelagic species in the Far East. Linear regression models indicated that variations in the distribution and abundance of Pacific saury in the Northwestern Pacific were related to oceanic-climate changes. The present study aims to develop predictive models of saury abundance in relation to spatio-temporal environmental conditions using generalized additive models, models that could ultimately be applied to fishery forecasting. The presence/absence (P/A) of saury and its abundance (CPUE) in areas of presence were modeled separately. Three variables, longitude, latitude and year, were included in the top 5 predictors of the optimal models of both P/A and CPUE. The other 2 variables of the top 5 predictors retained in the optimal models were surface temperature (SST) and bathymetric depth (BD), and Pacific Decadal Oscillation (PDO) and mixed layer depth (MLD) for P/A and CPUE models, respectively. The P/A model suggests that the high probability of saury presence locates at the SST of around 7-15°C and BD of around 5000 meters. The CPUE model suggests that the high abundance of saury is related to the PDO < 1.3, longitude < 155°E and MLD of about 20-30 meters. In short, areas of saury presence are related to water temperature and depth, while abundance of saury in areas of presence is related to climate change, the distance from the coast and nutrient dispersion in the water column. In addition, possible areas of saury aggregation in the Northeastern Pacific were evaluated.

## FIS-P-4

## Spatiotemporal change in carbon and nitrogen stable isotopes of chum salmon during developmental

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Carbon and nitrogen stable isotopes ($\delta^{13}$C and $^{15}\delta$N) of animal tissues can be used to evaluate not only spatiotemporal change in trophic niche, but also nursery temperature and locations during development. Sockeye, *Oncorhynchus nerka,* and chum salmon, *O. keta,* increase their trophic level with growth in the ocean. We aim to clarify spatiotemporal change in trophic dynamics of chum salmon during development based on the analysis of $\delta^{13}$C and $^{15}\delta$N. For adult chum salmon in the Yurappu River, a generalized linear model (GLM) showed that sex and age were not independently-significant predictors of either isotope, but that a wild-population spawning in the lower reach in December displayed higher values of $\delta^{15}$N than hatchery-populations in the upper reach in October and November. Both $\delta^{13}$C and $\delta^{15}$N values correlated positively with fork length ($R^2 > 0.36$, $P < 0.001$). The $\delta^{13}$C and $\delta^{15}$N values in muscle tissue from adult chum salmon in the Yurappu River were higher than in scales, while lower than in eggs. A rearing experiment showed that the turnover rate of muscle of emerged fry was 3 weeks. Wild fry had a higher $\delta^{15}$N value than hatchery fry in the Yurappu River. In the coastal waters off Konbumori, eastern Hokkaido, larger juveniles (FL > 10 cm) were distributed further offshore (> 8 km) and had lower values of $\delta^{15}$N (< 12.5‰) than smaller juveniles (FL < 9 cm) according to differences in their performance such as growth and feeding patterns on the coast. The evidence that wild adult and emerged fry from the Yurappu chum salmon population had a higher trophic level than hatchery adults and fry suggests that wild chum salmon may adapt to feeding behavior and growth activity better than hatchery salmon throughout life history periods.

## FIS-P-5

## The role of a warm anticyclonic eddy at Hokkaido (North-West Pacific) in the formation of saury fishing grounds

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Positions of warm anticyclonic eddies (latitude of their centers) in the North-West Pacific in summer-autumn of 1980-2011 were compared with characteristics of the saury fishery (daily distribution of fishing vessels and daily catch per a vessel). No relationship was found between the position of eddies and the catches, but the fleet distribution depended on the position of an anticyclonic eddy eastward from Hokkaido in the following ways:

1) If the anticyclonic eddy was in a southern position with its center southward of 41°N (as was observed in 2002, 2003, 2007, and 2008), the main fishing grounds of saury formed along the east (ocean) Oyashio Front, in the zone of coastal upwelling at southern Kuril Islands, and at the Subarctic Front, usually in mesoscale cyclonic eddies. The areas of successful fishing were small but stable, obviously because of low migration activity of saury.

2) If the anticyclonic eddiy was in a northern position with its center between 42-43°N (as was observed in 1980, 1981, 1985-1995, 1997-2000, 2004, 2006, and 2010), the main fishing grounds of saury formed along its northern periphery at the fronts with the main flow of Oyashio and with the second branch of Oyashio, also in mesoscale cyclonic eddies. Less significant fishing grounds formed in the zone of coastal upwelling and at the Subarctic Front. In autumn, when saury begins to migrate southward, the main fishing grounds shifted to the east periphery of the anticyclonic eddy and formed at the front of the second branch of Oyashio.

3) If the anticyclonic eddy was in the middle position with its center between 41-42°N (as in 1984, 1996, 2001, 2005, 2009, and 2011), the distribution patterns of saury fishing grounds were intermediate between cases 1 and 2, and the catches were slightly lower than in both cases.

## FIS-P-6

## Population structure and reproductive biology of the lake prawn *Palaemon paucidens* (Caridea, Palaemonidae) from Goesan Lake, Korea

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Population structure and reproductive biology of *Palaemon paucidens* was investigated at Goesan Lake, Korea from May 2010 through October 2011. The sex ratio indicated that females were signficantly more frequent than males (1:0.7). Based on length-frequency distribution, females were larger than males. Significant differences in the slopes of body weight versus carapace length linear regression between sexes indicate sex-specific differences in allometric growth. The gonadosomatic index (GSI) varied monthly, reaching a maximum in May (11.4) and a minimum in September (0.3). Monthly variations in the proportions of ovigerous females showed peaks in April and May. The highest values of the GSI coincided with the breeding period of *P. paucidens* (April–August). No significant difference between the mean GSI of females with non-eyed and eyed eggs indicated that *P. paucidens* is a non-consecutive breeder. The number of eggs was significantly correlated with the carapace length at early egg stages. There was no significant difference in the slope and intercepts of the regressions of the number of eggs versus carapace length between females carrying non-eyed and eyed egg stages, indicating that there was no brood loss during the incubation period. Egg volume increased significantly (by 75.6%) as eggs developed from the non-eyed to eyed egg stage. Based on dry weights in early egg stages, reproductive output was determined 0.20 ± 0.04. This study suggested intra-specific variation of reproductive traits within *P. paucidens* from different geographic areas.

## FIS-P-7

### Nekton species structure in the Far East Seas and adjacent waters of the Pacific Ocean in 1980-2009

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On the basis of data collected during 266 expeditions (about 20 thousand trawl stations) conducted from 1980 to 2009 by the TINRO-center in the northwestern Sea of Japan, the sea of Okhotsk, western Bering Sea and in the Pacific waters of Kamchatka and the Kuril Islands, various aspects of nekton species structure are discussed. Data on taxonomic, biotopical and zoogeographical diversity of nekton species and data on dynamics of relative biomass are shown. The total list of nekton species of the Far Eastern Seas and adjacent waters of the Pacific Ocean include 493 species. Of these, 43 species belong to the Cephalopods (Cephalopoda), 2 species belong to the Lampreys (Petromyzontida), 15 species belong to the Cartilaginous Fishes (Chondrichthyes) and 433 species belong to the Bony Fishes (Actinopterigii). The greatest faunistic similarities are between the Sea of Okhotsk and western Bering Sea, and the smallest are between the north-western part of the Japan Sea and the Pacific waters of Kamchatka and the Kuril Islands. The coefficient of similarity of faunas (coefficient of Sorensen-Czekanowski) in the first case is 0.64, and in the second is 0.35. Changes in nekton species structure during periods of years are noted and conclusions are drawn regarding the reorganization of ecosystems of the Far East seas and adjacent waters of the Pacific Ocean. The total biomass of nekton (averaged for the whole area of research) during the following periods of years is estimated: 1980-1990 – 17.2 t/km$^2$, 1991-1995 – 3.6 t/km$^2$, 1996-2005 – 6.6 t/km$^2$, 2006-2009 – 10.2 t/km$^2$.

## FIS-P-8

### Reproductive biology of the largemouth bass, *Micropterus salmoides* from Goe-san Lake, Korea

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The reproductive biology of *Micropterus salmoides* were examined in Goe-san Lake from March in 2010 to February in 2011. The development of ovary and testies was separated into 5 stages. The ratio of females to males increased with total length. Females were slightly larger in size and greater in number. Mean size and age was greater for females (255 mm total length and 2.03 years, respectively) than males (227 mm and 2.44 years, respectively). The spawning season of *M. salmoides* was from April to June, with a peak in May according to the gonadosomatic indices and the monthly proportions of female and male gonad stages. Ripe females were collected during the spawning period. Mean fecundity was 27656±1424 oocytes per female. Fecundity was positively correlated with total length, and it was described by Fecundity = 202.4 Total length – 38188. Higher fecundity indicated that the largemouth bass has a flexible spawning strategy and has acclimatized well to Goe-san Lake.

## FIS-P-9

## Age and growth of the catfish *Pelteobagrus fulvidraco* in Goe-san Lake, Korea

Ming-Ming **Zhang**[1], Chulwoong Oh[1], Wan-Ok Lee[2] and Kyung-Jun Song[1]

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In order to know the contribution of *Pelteobagrus fulvidraco* to stock management and potential future commercial exploitation, 128 specimens were collected from March in 2010 to February in 2011 in Goe-san Lake to examine age and growth. There was a positive correlation between vertebra radius and body length for females and males. Relationships between body weight and body length were expressed as $W=0.0032L^{2.64}$ for females and $W=0.0028L^{2.37}$ for males, so growth for both sexes was allometric. Age composition was $2^{+}$~$5^{+}$in males and females. The von Bertalanffy growth parameters were, Male: $L_{\infty}=304.2$mm, $K=0.2260$/y, $t_0=-0.0278$y $W_{\infty}=220.4$; Female: $L_{\infty}=277.3$mm, $K=0.2328$/y, $t_0=-0.4525$y, $W_{\infty}=207.5$g. The growth index was $\Phi_M=3.5248$, $\Phi_F=3.7749$ for males and females, respectively. The inflexion point of age and body weight was estimated at 3.3 years and 58.65g for males; and 3.9 years and 54.35g for females.

## FIS-P-10

## An ecosystem-based assessment and management system in Korean waters

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There has been increasing degradation to marine ecosystems resulting from overfishing, coastal development, bycatch, habitat destruction and other human activities. Traditional fisheries management has focused on sustainability, however, biodiversity, habitat, and socio-economy should be considered to effectively manage fisheries resources. The current Korean fisheries management system has focused on traditional strategies in which the sustainability of single species is managed. The Korean TAC-based management system has a five-tier assessment based on available information and data. The ecosystem-based fisheries assessment (EBFA) system has quantitative and qualitative tiers according to available information and data to assess fisheries resources. There are some species, whose assessment needs to be carried out with a quantitative analysis, such as key species of TAC, target species of marine ranches, and main species of stock-rebuilding programs in Korea. However, some species need to be assessed with a qualitative analysis, such as minor species of TAC, minor species of marine ranches, target species of stock-rebuilding programs, and main species of self-management units. Evaluations of management strategies/tactics are conducted to revise management tools and methods with a feed-back mechanism in the system.

## FIS-P-11

## A numerical study of "shirasu" fishing ground formation based on the Kuroshio submesoscale model, south of Japan

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Spawning grounds of many pelagic fish such as sardine and anchovy are distributed over the shelf-slope region between the Kuroshio and the southern coast of Japan. Larvae and juveniles of the pelagic fish (hereafter, "shirasu") are important targets of fisheries in coastal waters of Japan. Fishing-ground formation has been commonly accepted to be related to submesoscale variations such as the Kuroshio frontal disturbances. That is, shirasu can be supplied from the vicinity of the Kuroshio front to a coastal region by an intermittent intrusion of the Kuroshio warm water. However, details have been little elucidated. We conducted numerical simulation to understand the process and mechanism of the shirasu fishing-ground formation. A 1/50-degree submesoscale model was developed under the realistic condition, which is connected by one-way nesting to reanalysis data with a resolution of 1/10 degree by an ocean forecast system of the Fisheries Research Agency (FRA-ROMS). Scale-selective data assimilation (SSDA) technique with spectral nudging and IAU was introduced to control mesoscale variability within the 1/50-degree model. It was confirmed that the 1/50-degree model can simulate a typical intermittent intrusion of the Kuroshio warm water attributed to the frontal disturbance occurring in May 2009. Using the simulated velocity field, we conducted forward and backward particle-tracking experiments by assuming the passive transport of the shirasu to the coastal fishing ground. Details of the SSDA and results from the particle tracking will be demonstrated in our presentation.

## FIS-P-12

## High dispersal of moray eel larvae to the open ocean: Early life history estimated from ocean-wide distribution patterns

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Information on larval fish ecology and early life history is very important for resource management and the conservation of marine biodiversity. In addition, larval recruitment of demersal fishes determines adult distribution patterns. Moray eels are important elements in tropical to temperate coastal ecosystems due to their role as a higher-level predator. Some species are reported to spawn in coastal areas, however, their larval ecology and early life histories are mostly unknown. Therefore, we first examined the distribution patterns of the leptocephali of different species or types in the Indo-Pacific to estimate the general early life history of moray eels. A total of 914 specimens of muraenid leptocephali were collected across a wide range from the western North Pacific to the western Indian Ocean. They were separated into at least 75 species based on morphology and genetic analysis. All species were distributed in the open ocean. The leptocephali of two species, *Gymnothorax minor* and *G. pseudothyrsoideus* were also collected from coastal areas. The specimens collected at moderate distances from coastal areas were small to large size. But the specimens collected at long distances from coastal areas were all large size. Therefore, we estimated that small leptocephali born in the coastal areas were dispersing widely across the open ocean, and then their leptocephali returned to the coastal area after growing. Further research is necessary to clarify their dispersal mechanisms and the timing of when they leave the open ocean, and this will be investigated using otolith microchemistry with LA-ICP-MS.

## FIS-P-13

## The influence of underwater vessel noise on fish behaviour and methods of its reduction

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Underwater vessel noise is a harmful unregulated form of marine environment pollution. Many marine inhabitants perceive vessel noise as a powerful stressor. The noise of approaching vessels causes an avoidance reaction which is accompanied by diving and dispersal of fish schools. It has been experimentally proved that vessel noise can make an essential impact on fishing vessel catch and estimations of fish abundance by trawl or trawl-acoustic surveys. We did research on hearing of some species in the North Pacific and spectral-energy characteristics of underwater noise of various research and fishing vessels. The frequency band with maximum energy from research and fishing vessel noise spectra concur with the hearing sensitivity of the majority of species. Analysis of data determines the distance of reaction of different species to the hydroacoustic field of an approaching ship. The calculated distance of reaction to vessel noise in fish hearing frequency ranges for some species from 10 to 1500 m. Some discrepancies in the assessment of distance reaction are related to differences in levels of the acoustic field emitted by ships and in the auditory abilities of fishes. The noise of large-capacity fishing vessels has a maximum range of action on the behavior of fish. Our data allow the prediction of fish motion activity near vessels with use of behavioral patterns in hydroacoustic fields and swimming abilities. A new arrangement of air-bubble screens is proposed that improves screen sound-absorbing and sound-scattering capabilities and provides spatial continuity in the frequencies of maximal acoustical sensitivity of various fish species.

## FIS-P-14

## Program to assess the conservation status of the Olympia oyster, *Ostrea lurida*, in Canada

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The Olympia oyster, *Ostrea lurida*, is the only oyster native to the Pacific Coast of North America. Olympia oysters supported commercial fisheries in the US and Canada until the early 1900s, but were quickly overharvested and production shifted to culture of Pacific oysters, *Crassostrea gigas*. Olympia oysters were designated Special Concern by the Committee on the Status of Endangered Species in Canada (COSEWIC) in 2000 (confirmed 2010) and listed under the Species At Risk Act in 2003. In response, Fisheries and Oceans Canada published a Management Plan and developed monitoring and research programs. The Management Plan outlines protection, management, research, monitoring and outreach activities. Research included field surveys to verify historic distribution, development of quantitative survey protocols, selection of index sites for long-term monitoring, and collaborative work with the Royal British Columbia Museum to explore population structure using genetic techniques. Monitoring included baseline quantitative surveys of proposed index sites. Outreach included collaborative work with stewardship groups (both in Canada and the US), aquaculturists and academics. Between 2009 and 2011, 195 sites were surveyed to confirm Olympia oyster presence, 13 index sites were designated and baseline surveys were conducted. Tissue samples were collected from 85 sites and work is ongoing to explore population structure in Canada. Results from the program informed an updated COSEWIC Status Report in 2010, confirming the species' status of Special Concern.

**FIS-P-15**

## International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean

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The ISC was established in 1995 through an intergovernmental agreement between Japan and USA. The committee name has been changed to "International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean" since 2005 from "Interim Scientific Committee to study the tuna and tuna-like species of the North Pacific Ocean". The purposes of the Committee to be: 1) To enhance scientific research and cooperation for conservation and rational utilization of the species of tuna and tuna-like fishes which inhabit the North Pacific Ocean during part or all of their life cycle; and, 2) To establish the scientific groundwork, if at some point in the future, it is decided to create a multilateral regime for the conservation and rational utilization of these species in this region. Current ISC Members are Canada, Chinese Taipei, Japan Republic of Korea, Mexico, People's Republic of China and The United States of America. Observers are Inter-American Tropical Tuna Commission (IATTC), Food and Agriculture Organization of the United Nations (FAO), North Pacific Marine Science Organization (PICES), Secretariat of the Pacific Community (SPC), and Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean (WCPFC).

# POC Paper Session

***Co-Convenors**: Kyung-Il Chang (Korea) and Michael Foreman (Canada)*

Papers are invited on all aspects of physical oceanography and climate in the North Pacific and its marginal seas, except those covered by POC-sponsored Topic Sessions.

## Tuesday, October 16 (9:05-18:00)

09:05 ***Introduction by Convenors***

09:10 **Makoto Kashiwai**
TσV analysis on watermass processes in the Sea of Okhotsk (POC-P-8344)

09:30 **Yohei Takano, Taka Ito and Curtis Deutsch**
High-frequency variability of dissolved oxygen in the subpolar North Pacific (POC-P-8562)

09:50 **Michael Foreman, Wendy Callendar, Diane Masson, John Morrison and Isaak Fain**
An update on the IOS regional climate model for the British Columbia continental shelf (POC-P-8613)

10:10 **Evgeny Vyazilov, Evgeny Uraevsky, Igor Rostov, Natalia Rudykh, Vladimir Rostov, Elena Dmitrieva and Andrey Golik**
Far Eastern segment of the Unified State System of Information on the World Ocean (ESIMO) (POC-P-8443)

10:30 ***Coffee/Tea Break***

10:50 **Jae-Hun Park, Hanna Na, D. Randolph Watts, Kathleen A. Donohue and Ho Jin Lee**
Near 13-day barotropic ocean response to atmospheric forcing in the North Pacific (POC-P-8778)

11:10 **Hiroyuki Tsujino, Shiro Nishikawa, Kei Sakamoto, Norihisa Usui, Hideyuki Nakano and Goro Yamanaka**
Effects of large-scale wind variation on the Kuroshio path south of Japan in a 60-year historical GCM simulation (POC-P-8567)

11:30 **Olga Trusenkova**
Intraseasonal SST oscillations in the Japan/East Sea (POC-P-8423)

11:50 **Jun-pen Zhang and Rong-shuo Cai**
Modeling the East China Sea Cold Eddy responses to the inter-decadal climatic jump of the East Asian monsoon around 1976/77 (POC-P-8415)

12:10 **Viktor Kuzin, Gennady Platov and Elena Golubeva**
Influence of interannual variations of Siberian river discharge on the redistribution of freshwater in the Arctic Ocean (POC-P-8346)

12:30 ***Lunch***

14:00 **Vadim Navrotsky and Elena Pavlova**
Biological effects of internal waves in coastal waters (POC-P-8531)

14:20 **Keiichi Yamazaki, Yujiro Kitade, Yosuke Igeta and Tatsuro Watanabe**
Time variations of large amplitude near-inertial internal waves induced by typhoon observed around the Tango Peninsula, Japan (POC-P-8575)

14:40 **Takahiro Tanaka, Ichiro Yasuda, Kenshi Kuma and Jun Nishioka**
Vertical turbulent iron flux sustains the Green Belt along the shelf break in the southeastern Bering Sea (POC-P-8746)

15:00 **Fangli Qiao and Chuan Jiang Huang**
Comparison between vertical shear mixing and surface wave-induced mixing in the extra-tropical ocean (POC-P-8736)

15:20 **Young-Gyu Park, Jae-Hun Park, Ho Jin Lee, Hong Sik Min and Seon-Dong Kim**
The effects of geothermal heating on the East Sea circulation (POC-P-8735)

15:40 **Andrey G. Andreev and Igor A. Zhabin**
Origin of the mesoscale eddies and year-to-year changes of the chlorophyll *a* concentration in the Kuril Basin of the Okhotsk Sea (POC-P-8538)

16:00 ***Coffee/Tea Break***

16:20 **Aigo Takeshige, Tetsuya Takahashi, Hideaki Nakata and Shingo Kimura**
Long-term trends in seawater temperature in Omura Bay, Japan (POC-P-8424)

16:40 **Masanori Konda, Tamami Ono, Kazuyuki Uehara, Kunio Kutsuwada, Osamu Tsukamoto, Fumiyoshi Kondo and Naoto Iwasaka**
Ocean mixing layer variation as indicated by the measurement of the dissipation rate in the Kuroshio Extension region (POC-P-8486)

17:20 **Talgat R. Kilmatov and Olga I. Trinko**
The influence of cumulative cabbeling on the salinity minimum of North Pacific Intermediate Water and future climatic trends (POC-P-8655)

17:40 **Liping Yin and Fangli Qiao**
Observation and simulation of Continental Shelf Waves in the East China Sea (POC-P-8727)

18:00 *Session Ends*

## POC-P Session Posters

POC-P-1 **Igor Rostov, Vladimir Rostov, Natalia Rudykh, Elena Dmitrieva and Andrey Golik**
Components of oceanographic and marine environment management information support in the Far Eastern region of Russia

POC-P-2 **Valentina V. Moroz**
Thermohaline structure peculiarities formed by tides in the Kuril Straits archipelago and adjacent areas

POC-P-3 **Valentina V. Moroz**
Thermohaline structure peculiarities formed in the Kuril Islands area and climate change

POC-P-4 **Yosuke Igeta, Tatsuro Watanabe, Akira Okuno and Naoto Honda**
Strong coastal currents associated with winter monsoon around the Noto Peninsula, Japan

POC-P-5 **Sachihiko Itoh, Ichiro Yasuda, Masahiro Yagi, Satoshi Osafune, Hitoshi Kaneko, Jun Nishioka, Takeshi Nakatsuka and Yuri N. Volkov**
Strong vertical mixing in the Urup Strait, Kuril Islands

POC-P-6 **Hiroshi Kuroda, Daisuke Takahashi, Takashi Setou, Tomonori Azumaya and Humio Mitsudera**
Hindcast experiment for the Okhotsk Sea using the sea-ice-coupled Regional Ocean Modeling System

POC-P-7 **Tatsuro Watanabe and Koji Kakinoki**
Interannual variation in the volume transport through the Sado Strait in the Japan Sea

# POC-Paper Session Oral Presentations

### October 16, 09:10 (POC-P-8344)

## TσV analysis on watermass processes in the Sea of Okhotsk

Makoto **Kashiwai**

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Watermass processes in the Sea of Okhotsk, contributing to the production of North Pacific Intermediate Water (NPIW), have been identified from a number of separate confirmations, such as ventilation, brine rejection, sea ice formation and melt, tidal mixing, and convection. To evaluate the quantitative contribution of these processes, we have extended TSV analyses to TσV analyses and tested them on World Ocean Atlas monthly data with help of Ocean Data View (ODV) software. Defining watermass by physical boundaries: sea surface, pycnocline, sea floor and 0°C, four elemental watermasses, Surface Water (SfW), Subzero Water (SbzW), Intermediate Water (IntW), and Deep Water (DpW), were identified. These four elemental watermasses exhibit a similar magnitude of intra-annual variation of their volume. SfW is the water of surface stratification and its volume decreases during autumnal cooling and stirring. This autumnal mixing mixes SfW with SbzW into IntW and causes the disappearance of SbzW. In January, local cyclonic gyres are spun-up by strong and cold winter monsoons, causing deep convection, which modifies SfW and DpW into SbzW and IntW. These winter processes make IntW cooler and fresher. Along with the development of ice cover, SbzW is rebuilt. In April, at the start of the opening of ice-cover, early spring storms,spin up a strong local cyclonic gyre and drive convection which mixes the Dense Shelf Water (DSW) with IntW, resulting in an increase of IntW salinity. This DSW process is confirmed by changes in nitrate concentration of SbzW and IntW. The boundary between IntW and DpW is the main pycnocline. Thus, the undulation of the main pycnocline, associated with spin-up/down of the Subarctic Gyre, causes a seesaw-like change between the volume of IntW and DpW. As the Oyashio Water lacks SbzW, the IntW of the Okhotsk Water must be mixed into IntW at the Kuril Straits exit.

### October 16, 09:30 (POC-P-8562)

## High-frequency variability of dissolved oxygen in the subpolar North Pacific

Yohei **Takano**[1], Taka Ito[1] and Curtis Deutsch[2]

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Studies of short-term sub-mesoscale processes in the ocean have advanced significantly in the past decade but their influences on biological processes are poorly understood. Recent development of autonomous sensors provides a new opportunity to investigate biogeochemical variability at unprecedented temporal resolution. We investigate intra-seasonal variability of subsurface oxygen in the subpolar North Pacific using a profiling float equipped with CTD, nitrate and oxygen sensors between September 2008 – June 2012. We perform time series analysis of subsurface oxygen and nitrate data from floats deployed in the Gulf of Alaska, focusing on the timescale between five days and a month. Observed high-frequency variability peaks in the upper thermocline where the temporal standard deviation exceeds 10 µM, which accounts for a relatively small fraction (6.7%) of the total variance. Correlation and regression analyses are performed in order to determine physical and biological controls on the subsurface oxygen variability. Comparison of oxygen variability in depth and isopycnal coordinates reveals the dominant role of isopycnal heaving in driving intra-seasonal variability, explaining up to 64% of the variance in the high-frequency band. We also identify a weak but statistically significant correlation (r=0.43, 95% significance) between isopycnal oxygen and spiciness, indicating a possibility of lateral transport of oxygen anomaly. There is no evidence for biologically driven oxygen variability at these frequencies. While isopycnal heaving is clearly the major mechanism of high-frequency variability, physical mechanisms behind the vertical motions at this timescale remain unclear.

**October 16, 09:50 (POC-P-8613)**

## An update on the IOS regional climate model for the British Columbia continental shelf

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A regional, ocean-only, climate model has been developed at the Institute of Ocean Sciences (IOS) for the British Columbia continental shelf and run with downscaled IPCC-AR4 A2 future scenario results from one global/regional climate model pair in the North American Regional Climate Change Assessment Program (NARCCAP) archive. Initial conditions, lateral oceanic boundary conditions, and atmospheric forcing fields were all formed by adding future-minus-contemporary anomalies from the NARCCAP models to the corresponding fields that were used in a 1995-2008 hindcast. Some of the anomaly fields and ensuing model results will be presented and possible impacts on regional marine ecosystems will be briefly discussed.

**October 16, 10:10 (POC-P-8443)**

## Far Eastern segment of the Unified State System of Information on the World Ocean (ESIMO)

Evgeny Vyazilov[1], Evgeny Uraevsky[2], Igor Rostov[3], Natalia **Rudykh**[3], Vladimir Rostov[3], Elena Dmitrieva[3] and Andrey Golik[3]

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The use of high-quality and timely information on the world's oceans is an important element in ensuring the safety of life, marine, economic and other activities. In Russia, the Unified State System of Information on the World Ocean (ESIMO) provides integration and interactive access to diverse and geographically distributed information on the oceans, seas, and coastal regions supplied by the various departmental information systems. A new generation ESIMO technical model inherits the first ESIMO model with component interaction and interoperability in terms of Open Systems Interconnections – Basic Model, ISO/IEC 7498. It operates with relevant Regional Centers of the system. ESIMO Centers provide the interfaces to data sets / data streams of agency information systems, forming the Distributed Data Base System as virtual resources. The Far Eastern Regional department of the ESIMO in Vladivostok is the hardware-software complex-wide means to integrate information on oceans and marine activities on integrated marine and coastal areas of the Far Eastern Seas and North Pacific. It has a data network which is composed of: FEB RAS (Far Eastern Branch of the Russian Academy of Sciences) organizations-data providers and Roshydromet organizations-data providers (Kamchatka, Sakhalin, Primorye and Khabarovsk meteorological agencies). Last research effort is oriented to supporting coastal studies and coastal area management. ESIMO informational resources increase by 10–15% per year. The execution of these projects provides information on complex studies of the processes, characteristics and resources of the Russian Far Eastern Seas, dynamics of the ecosystems, coastal zone conditions for the sound management of natural resources, *etc.*

**October 16, 10:50 (POC-P-8778)**

## Near 13-day barotropic ocean response to atmospheric forcing in the North Pacific

Jae-Hun **Park**[1], Hanna Na[2], D. Randolph Watts[2], Kathleen A. Donohue[2] and Ho Jin Lee[3]

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This talk presents a near 13-day barotropic ocean response to atmospheric forcing in the North Pacific using both in-situ bottom-pressure observations and numerical simulations. In the Kuroshio Extension System Study (KESS) east of Japan, bottom-pressure observations over the 2-year study period exhibit strong high-frequency variability close to 13 days. The first cyclostationary empirical orthogonal function mode for the near 13-day KESS bottom pressure explains about 57% of the variance and exhibits nearly in-phase variability in space with a hint of westward propagation. The 13-day variability is strong during the winter and is driven by the large-scale wind-stress curl over a broad region of the North Pacific. Modeling results over the North Pacific closely follow the observations, and indicate that topography confines the barotropic response to the west of the Emperor Seamount Chain and slows the westward propagation of the near 13-day bottom-pressure variability.

**October 16, 11:10 (POC-P-8567)**

## Effects of large-scale wind variation on the Kuroshio path south of Japan in a 60-year historical GCM simulation

Hiroyuki **Tsujino**[1], Shiro Nishikawa[2], Kei Sakamoto[1], Norihisa Usui[1], Hideyuki Nakano[1] and Goro Yamanaka[1]

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Effects of large-scale wind forcing on the long-term variation of the Kuroshio path south of Japan are studied using a historical simulation (1948–2007) with a high resolution GCM. Because the eddy kinetic energy is kept at a moderate level, the Kuroshio spends a large fraction of time in the non-large meander (NLM) state and several aspects of its long-term path variability are reproduced for the first time in historical GCM simulations. Findings of past studies about the relation between wind forcing (or the Kuroshio transport) and path variations are tested and specific roles of eddies in those variations are investigated using the simulated fields. The long-term variation of the simulated net Kuroshio transport south of Japan is largely explained by the linear baroclinic Rossby wave adjustment to the wind forcing. In the simulated large meander (LM) events, the trigger meander originates from the wind-induced positive sea surface height anomaly (SSHA) hitting the upstream Kuroshio and is enlarged by cyclonic eddies from the recirculation. The trigger meander is followed by a sizable anti-cyclonic eddy on the upstream side. In the subsequent development, a weak (strong) Kuroshio favors the LM (NLM). The LM tends to be maintained when the Kuroshio transport south of Japan is small and the increasing Kuroshio transport promotes decay of a preexisting LM. The intermittent supply of disturbances from the upstream, which is related to the wind-induced SSH variability in low-latitudes, contributes to the maintenance of a preexisting LM. These features are largely consistent with the observed LMs.

### October 16, 11:30 (POC-P-8423)

## Intraseasonal SST oscillations in the Japan/East Sea

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It is now well established that mesoscale variability is extremely high in the Japan/East Sea which is usually full of eddies. In the southern part of the Sea, eddies can be large structures persisting up to or over a year (Ichiye and Takano, 1988; Sugimoto and Tameichi, 1992; Chang *et al.*, 2004), while in the northern area they are smaller, with life times from weeks to months (Lobanov *et al.*, 2007; Nikitin and Yurasov, 2008). Mesoscale eddies are routinely tracked from infrared satellite images and modes of sea surface temperature (SST) variability related to dynamic processes have been revealed, featuring semiannual, annual, and quasi-biennial time scales (Trusenkova *et al.*, 2009). However, intraseasonal SST variability caused by mesoscale structures can be also expected but is probably obscured by longer-term processes. The purpose of this study is to elucidate this variability using daily SST data and filtering out the variability on semiannual and longer time scales. For this purpose, SST from the Japan Meteorological Agency, spanning from October 1993 through March 2012, are used, while filtering is based on wavelet transform, with the Morlet mother wavelet of the 6th order and 4-month cut-off period. Empirical orthogonal functions derived from the filtered SST feature oscillations, with amplitudes up to 0.5°C and time scales of 1–3 months, in the entire Sea. Interannual variability is considerable but, generally, oscillations strengthen in the warm season, simultaneously with the seasonal intensification in circulation and increase in eddy kinetic energy detected from satellite altimetry (Trusenkova *et al.*, 2011).

### October 16, 11:50 (POC-P-8415)

## Modeling the East China Sea Cold Eddy responses to the inter-decadal climatic jump of the East Asian monsoon around 1976/77

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A regional ocean model (ROMS) is used to investigate the impacts of the inter-decadal climatic jump of the East Asia monsoon around 1976/77 on the East China Sea Cold Eddy (ECSCE). Numerical experiment results show firstly, that while the East Asian summer monsoon (EASM) weakens after the climatic jump around 1976/77, ECSCE becomes obviously stronger in summer, which is presented as a negative temperature anomaly centered around the ECSCE region. This is mainly because the cyclonic oceanic circulation anomalies appear in the region of ECSCE and its adjacent waters, which is formed by a strengthening of Taiwan Warm Current and Yellow Sea Warm Current in the region southwest of Jeju island. Secondly, different from the situation in summer, ECSCE tends to weaken slightly in winter due to the anomalous anti-cyclonic oceanic currents occupying the ECSCE region, which is induced by the weakening of the Yellow Sea Warm Current that is closely associated with the weakening of the East Asian winter monsoon (EAWM). Furthermore, the variation features of ECSCE for the periods of 1958–2008 are explored by using Simple Ocean Data Assimilation (SODA) reanalysis data. The analyzed results reveal that ECSCE in summer becomes stronger with the weakening of EASM after 1976/77, while ECSCE in winter weakens with the weakening of EAWM. Those results basically verified the numerical experimental results. Consequently, it is suggested that the climatic jump of EASM and EAWM around 1976/77 could cause the different anomalies of meso-scale oceanic circulation in the East China Sea and cause ECSCE to respond differently in summer and winter.

**October 16, 12:10 (POC-P-8346)**

## Influence of interannual variations of Siberian river discharge on the redistribution of freshwater in the Arctic Ocean

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A numerical simulation with a coupled sea-ice model of the Arctic and North Atlantic oceans is used to study the influence that interannual variations in Siberian river discharge have on the distribution and propagation of freshwater in this region. In our numerical experiments, we compared simulations using observational discharge data of the most significant Siberian rivers (Ob, Yenisey, and Lena) against the model results of seasonally averaged variations of their discharges. This comparison showed that the interannual variations may have significant consequences despite their smallness when compared with oceanic-scale water transport. These consequences include (1) the intensification of either cyclonic or anticyclonic components of motion of the nearsurface Arctic Ocean waters and, as a result, the redistribution of freshwater fluxes from Arctic regions between the Fram Strait and the straits of the Canadian Archipelago. On the other hand, (2) insignificant changes in the propagation direction of freshwater are multiply enhanced during their movement in the North Atlantic as part of the subpolar gyre because of their smaller or greater involvement in the processes of vertical mixing. As a result, anomalies of freshwater develop considerably far from the river mouths, such as in the region of the Azores islands, and are 5–6 times larger than the maximum values of the accumulated variability volumes of the river discharge.

**October 16, 14:00 (POC-P-8531)**

## Biological effects of internal waves in coastal waters

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Long-term measurements of temperature and velocity fluctuations at many levels in the near-bottom thermocline were carried out during the periods when a stable seasonal thermocline was present. Spectral analysis of temperature fluctuations shows that in a shoaling thermocline low-frequency maxima disappear, maxima at higher frequencies appear, and the spectral slope in the high frequency range changes with depth. Comparison with theoretical results leads to the conclusion that highly nonlinear and breaking internal waves in the near-bottom thermocline generate not only three-dimensional small-scale turbulence, but also horizontal turbulence of larger scale. As a result, mixed layers with intermediate density between surface and bottom waters are formed. Due to tidal motions, these waters spread over the shelf at intermediate depths, leading to easier mixing and to higher saturation of shelf waters by nutrients and minerals from land. Concurrent measurements of chlorophyll fluorescence and turbidity show maximum values in zones of thermocline contact with bottom. They are well correlated with temporal and spatial fluctuations of the thermocline and their elevated values spread over the entire shelf zone and beyond. We can conclude that processes in the near-bottom shoaling thermocline are extremely important for biological productivity and ecological state of coastal waters.

### October 16, 14:20 (POC-P-8575)

## Time variations of large amplitude near-inertial internal waves induced by typhoon observed around the Tango Peninsula, Japan.

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The behavior of near-inertial internal waves (NIIWs) associated with two typhoons (T15 and T16) in summer of 2004, were investigated by analyzing current data obtained at 5 mooring stations around the Tango Peninsula, located at southern boundary of the Japan Sea. T15 and T16 advanced northeastward 350 and 150 km north off the TP, respectively. The eastward wind blew after the northward wind associated with T15 around the TP. NIIWs were found as alongshore currents and lasted for 4 days. Eastward flows caused by subinertial coastal-trapped waves (CTW) were also found. The NIIWs and CTWs simultaneously appeared, but energy of the NIIWs increased after attenuation of the CTWs. The northwestward wind blew more than a day before the eastward wind around the TP associated with T16. NIIWs lasted for 2 days and rapidly attenuated when eastward flow with CTWs was amplified. Discrepancy on the properties of NIIWs induced by T15 and T16 was found in duration time of oscillation flows. Although a slab model showed that the aria, where energy flux was injected from T15 to NIIWs, was larger than that from T16, difference of duration time for the generated NIIWs were not explained. From a numerical experiments using idealized bottom topography, we found that the strong eastward flow and its horizontal current shear associated with the CTWs reduced the energy of NIIWs which was propagating toward the coast. Thus, we conclude that the amplification of the NIIWs near the coast was greatly influenced by CTWs induced by typhoons simultaneously.

### October 16, 14:40 (POC-P-8746)

## Vertical turbulent iron flux sustains the Green Belt along the shelf break in the southeastern Bering Sea

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To evaluate the impact of vertical turbulent iron flux on the summertime biological productivity in the Bering Sea Green Belt (GB), we conducted the concurrent observations of dissolved iron (D-Fe) and turbulence in the Bering Sea for the first time. We show that the GB can be sustained by iron supply from an iron-rich, subsurface-thick layer distributed along the southeastern shelf break where the GB is located, via strong turbulent vertical mixing. The flux ratio of D-Fe and nitrate was within the range of the N/Fe uptake ratio by GB phytoplankton, suggesting this flux of nutrients can sustain GB productivity. We also analyzed historical hydrographic data and suggest the thick subsurface layer along the GB is formed by the mixing of relatively warm water with some iron from the Aleutian Passes and iron-rich outer-shelf cold water in which the D-Fe derived from seafloor sediment is suspended due to strong vertical mixing.

**October 16, 15:00 (POC-P-8736)**

## Comparison between vertical shear mixing and surface wave-induced mixing in the extra-tropical ocean

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Most parameterizations of vertical mixing are associated with local shear instability, which does not explicitly include the effects of surface waves. Here, we compared the performance of vertical mixing induced by vertical shear of the mean current and that by non-breaking surface waves in the upper ocean through three numerical experiments. The vertical mixing from vertical shear alone was too weak, especially in the extra-tropical ocean, and failed to produce a reasonable mixed layer depth and seasonal thermocline, which resulted in a large cold bias and an unrealistic seasonal cycle in the subsurface. Surface waves can enhance the vertical mixing in the upper ocean, and induce vertical mixing to sustain a reasonable upper-ocean temperature structure, especially in the extra-tropical ocean. Both the temperature structure and seasonal cycle were significantly improved by including the non-breaking surface wave-induced vertical mixing, no matter whether shear effect was included or not. These results indicate that the vertical mixing from surface waves is more important than that associated with velocity shear of the mean current for the upper ocean, especially in the extra-tropics.

**October 16, 15:20 (POC-P-8735)**

## The effects of geothermal heating on the East Sea circulation

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The magnitude of geothermal heating in the East Sea is about 100 mW/m$^2$, twice that of the open ocean average. On the other hand, bottom stratification in the East Sea is much smaller than that typical of the open ocean. Thus geothermal heating could have more prominent effects in the East Sea and we investigated this using numerical modeling. With less than 100 mW/m$^2$ bottom heat flux, we were able to reproduce bottom mixed layers that are thicker than ~1000 m, as in the observations. Previously no numerical model has been successful in reproducing the bottom mixed layers. Geothermal heating intensifies the bottom flows but the simulated flows are not as strong as the observed ones, suggesting we are still missing important factors. Over the northern part of the East Sea, reduction in deep stratification strengthens deep water mass formation, intensifying cyclonic circulations located over this area so the effects of the heating extend to the surface. As the cyclonic circulation becomes stronger, the water at the center of the gyre is trapped and more exposed to cold air, so it becomes cooler, and colder deep water is produced. When the geothermal heating is strong enough, the surface cooling effect dominates the bottom heating and the deep layer becomes cooler, showing that the effects of geothermal heating are far reaching and cannot be assessed using a simple local heat budget estimation.

**October 16, 15:40 (POC-P-8538)**

## Origin of the mesoscale eddies and year-to-year changes of the chlorophyll *a* concentration in the Kuril Basin of the Okhotsk Sea

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In the post-spring-bloom period (July-September), the high primary production values in the Okhotsk Sea are commonly confined to the dynamically active zone, where nutrients are supplied to the upper mixed layer. Strong tidal mixing in the Kuril Straits area augment nutrients in the euphotic zone, and submesoscale and mesoscale eddies transport high-nutrient coastal waters into the pelagic part of the Okhotsk Sea. We demonstrate that mesoscale eddies originating in the Kuril Basin are related to the baroclinic waves coming from the Pacific Ocean into the Okhotsk Sea through the Kuril Straits. There is a strong relationship between the wind stress curl in the northern North Pacific in winter and the eddy dynamics in the Okhotsk Sea. Increased wind stress curl results in enhanced mesoscale eddy activity and high chlorophyll concentrations in the Okhotsk Sea in late summer and fall with 1-year lag.

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**October 16, 16:20 (POC-P-8424)**

## Long-term trends in seawater temperature in Omura Bay, Japan

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Seawater temperature has fluctuated on long-term timescales with global climate change. Variation in seawater temperature has a significant effect on atmosphere-ocean interaction and marine ecosystems. In this study, we investigated long-term trends in sea surface temperature (SST) in Omura Bay located in northwestern Kyushu, Japan, using heat balance estimates based on 40-year (1955–1995) daily data. The SST during the heating period (from March to August) tended to decrease, whereas that during most of the cooling period (from September to February) has increased. The maximum rates of the SST decrease and increase were found to be 0.020°C year$^{-1}$ in August and 0.028°C year$^{-1}$ in January. The sea surface heat balance analysis revealed that shortwave radiation flux decreased in the heating period due to a decrease in solar radiation, resulting in a decrease in SST. In the cooling period, the increase in SST was attributed to the decrease in latent and sensible heat fluxes due to increased air temperature and decreased wind speed. In addition, it was also revealed that these climatic changes affecting SST in Omura Bay have a close linkage with global dimming and the East Asian monsoon circulation. As a result, we propose that large-scale climate change effects should be considered under the analysis of SST variation, even in local-scale coastal waters.

### October 16, 16:40 (POC-P-8486)

## Ocean mixing layer variation as indicated by the measurement of the dissipation rate in the Kuroshio Extension region

Masanori **Konda**[1,2], Tamami Ono[1], Kazuyuki Uehara[3], Kunio Kutsuwada[3], Osamu Tsukamoto[4], Fumiyoshi Kondo[5] and Naoto Iwasaka[6]

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We conducted the measurement of the surface turbulence on a cruise in the Kuroshio Extension (KE) region in October 2009. A microstructure profiler was used to obtain the dissipation rate of the ocean. With use of the bulk surface turbulent flux corrected by the eddy covariance technique, the turbulent energy balance in the surface layer was evaluated. The cruise was conducted to the north of the KE jet. Results show a discrepancy between the variation of the ocean mixed layer in terms of the density profile and that of the ocean mixing layer in terms of the turbulence. The mixed layer depth was relatively stable, whereas the mixing layer defined by the dissipation rate over $10^{-8}$ W kg$^{-1}$ was likely to be deepened according to the synoptic scale atmospheric disturbance. The change of the buoyancy frequency at the bottom of the mixed layer suggests that eventual deepening of the mixing layer can weaken the stratification at the bottom of the mixed layer. This process probably helps the seasonal deepening of the mixed layer. The vertical profile of the dissipation rate suggests that the surface stratification condition can vertically change the turbulent energy balance in the ocean due to the buoyancy production in the mixing and the mixed layer.

### October 16, 17:20 (POC-P-8655)

## The influence of cumulative cabbeling on the salinity minimum of North Pacific Intermediate Water and future climatic trends

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Possible changes in geometric and thermodynamic parameters of the salinity minimum of North Pacific Intermediate Water due to climate trends are considered. The cabbeling mechanism for the formation of this layer is noted . Calculations of cumulative cabbeling effect (g*cm$^{-3}$*year) along isopycnals 26-27 $s_q$ indicates the deepening of the salinity minimum layer from the north to south. The time scale is 1 year, the velocity scale is 1 cm/s, and the density deformation is $10^{-3}$ or greater . The scenarios of possible temperature and salinity changes in the surface and subsurface subarctic waters are considered. An increase in temperature and decrease in salinity in this area result in changes in the cumulative cabbeling effect and in the modification of the formation of the salinity minimum of North Pacific Intermediate Water. The estimation of climate changes of the geometric and thermodynamic parameters of the intermediate layer as a result of this effect is discussed. These estimations are made separately for the summer and the winter seasons.

**October 16, 17:40 (POC-P-8727)**

## Observation and simulation of Continental Shelf Waves in the East China Sea

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Continental Shelf Waves (CSW) play an important role in understanding the dynamics of the continental shelf area. It is also of great significance for improving the prediction of the sea level and the alongshore current. As one of the widest continental shelves in the world, the East China Sea (ECS) comprises an important component of CSW.

Based on the simultaneous observations of sea level in the coastal area of ECS, we find a group of low-frequency waves by using the Ensemble Empirical Mode Decomposition (EEMD) method. The period of these waves varies from 2 to 10 days, corresponding to different wave modes: the Kelvin Wave (KW) mode, the first Shelf Wave (SW1) mode, and the second Shelf Wave (SW2) mode. An analytical dispersion relation in ECS is obtained by using the free CSW theory for a two piecewise linear bottom topography. This relation agrees well with the observational results. Using the same bottom topography, the wind-forced CSW theory is applied in ECS. Numerical results successfully reproduced the sea level variation and downwind flow. Both the observational and numerical results indicate that there exists a quickly propagating Kelvin wave in ECS, the alongshore wind can induce a positive sea level anomaly and downwind alongshore current, and the free wave develops into a forced wave by the strong alongshore wind.

# POC-Paper Session Poster Presentations

## POC-P-1

## Components of oceanographic and marine environment management information support in the Far Eastern region of Russia

Igor Rostov, Vladimir Rostov, Natalia **Rudykh**, Elena Dmitrieva and Andrey Golik

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With the establishment of the Unified State System of Information on the World Ocean Condition (ESIMO), work is in progress to create a regional, departmental component of ESIMO at V.I. Il'ichev Pacific Oceanological Institute, Far Eastern Branch of the Russian Academy of Sciences (POI FEB RAS) for the arrangement of general and specialized information on oceanographic and marine resources to be accessed through the FEB RAS network and Internet. This multidisciplinary system for the collection, storage, data analysis and dissemination to users of various kinds of information products on oceanography and marine environment of the region, can be obtained through the portal <http://pacificinfo.ru>. Results of the completed works and recommendations for practical use are considered in the paper.

## POC-P-2

## Thermohaline structure peculiarities formed by tides in the Kuril Straits archipelago and adjacent areas

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A summary of multi-year observations shows that the hydrological structure in the Kuril Straits is more complicated than believed earlier. In the Kuril Islands area, there is a characteristic presence of variously scaled non-homogeneous thermocline structures being formed during eddy formation and front-genesis when near-Kuril currents meet on the background of tidal mixing. Tidal events are the dominant factor that determines the dynamics of waters, and alternating vertical and horizontal water structures in the straits of the Kuril archipelago. The tides in the Kuril Islands area and in the Okhotsk Sea are generally formed by tidal waves that are coming from the Pacific. Owing to the tidal waves being reflected back from the coast of the Okhotsk Sea, complex progressive-height waves occur in the straits. It was found that the change of phases in tidal and ebb currents occurs non-simultaneously and in relation with it, the current dynamics is very complex. The Pacific Oceanological Institute of the Russian Academy of Sciences Far Eastern Branch has created an electronic atlas of the North Pacific marginal seas tides. Descriptions of tidal peculiarities of the Bering, Okhotsk, Japan, and East China Seas are presented in the atlas. Maps of the main tidal constituents $M_2$, $S_2$, $K_1$, and $O_1$ and tide character for each sea are shown separately. In modern conditions, such knowledge is required for the sensible use and management of natural resources in the sea and coastal areas.

## POC-P-3

## Thermohaline structure peculiarities formed in the Kuril Islands area and climate change

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Thermohaline anomaly fields forming in the Kuril Island Straits zone were analyzed from the resources of the Pacific Oceanological Institute (POI FEB RAS) data bank, including the archive and modern research cruise materials of the semi-centennial period oceanological observations in the Kuril Islands zone, adjacent Okhotsk Sea and Pacific areas. It was revealed that the water structure forming peculiarities in the Oyashio Current zone depends on water exchange through the straits and on atmospheric circulation variability. The variability of temporal temperature anomalies in the Bussol Strait, as related to climate change, was analyzed. It was shown that as a result of the variability of water flowing to the ocean through the strait, the thermohaline characteristics of the current zone vary in the sub-strait area. Such variability is both seasonal and interannual. The close connection between the variability in the intensity of one or another currents system links in the Kuril Islands region (which, in turn, significantly determines the formation of water temperature in the region) and peculiarities of atmospheric circulation was elucidated. New information about the variety of hydrological water characteristics has been obtained.

## POC-P-4

## Strong coastal currents associated with winter monsoon around the Noto Peninsula, Japan

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Strong coastal currents (SCC) often occur in coastal regions around Japan, where they have attracted attention from the fisheries industry because of the damage they can cause in setting nets used in fishing. To clarify the vertical structure of SCC near the eastern coast of the Noto Peninsula extending northward from the southern boundary of the Japan Sea, where a lot of nets are set, mooring observations using an acoustic Doppler current profiler were performed on continental slopes (water depth of 1000m) from August 4, 2009 to March 5, 2010. In winter, the SCC (larger than 50 cm $s^{-1}$) with the coast on the left were observed several times associated with a strong southward wind due to the winter monsoon. Such SCC had 100m thickness in the surface layer, lasted for 4 days, and were accompanied with upwelling. To clarify the observed characteristics, we carried out a numerical experiment using a three-dimensional level model with realistic bottom topography and wind. The result represented the observed characteristics. It was clarified that the SCC are induced by large-amplitude coastal-trapped waves (CTW) accompanied by currents with the coast on the left. The CTWs were generated around the western coast of the peninsula by the southward wind, on the opposite side of the mooring site, and propagated with the coast on the right from the generation area to the mooring site. After passing through the mooring site, the CTWs were weakened by topographical scattering due to a shelf edge off the mouth of the Sado Strait and Sado Island.

## POC-P-5

## Strong vertical mixing in the Urup Strait, Kuril Islands

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Microstructure measurements were conducted in one of the Kuril Straits in the summer of 2007. Over the course of 1 day of repeated observations across the Pacific side of the steep sill of the Urup Strait, extremely strong mixing was observed during periods of Pacific-ward (down-sill) flows and during the transition from Pacific-ward to Okhotsk-ward (up-sill) flows, with a turbulent energy dissipation rate $\varepsilon$ of $10^{-6}$ to $10^{-5}$ W kg$^{-1}$ and vertical diffusivity of $10^{-1}$ to $5 \sim 10^{-1}$ m$^2$ s$^{-1}$. During the period of strong mixing, we observed homogeneous layers with a thickness of 300–600 m and potential density of 26.6–26.7 $\sigma_\theta$, occupying the entire water column in one case. High values of $\varepsilon$ within this layer indicate the injection of diapycnal flows from the upper and lower layers, possibly contributing to the southward intrusion of intermediate water into the subtropical gyre.

## POC-P-6

## Hindcast experiment for the Okhotsk Sea using the sea-ice-coupled Regional Ocean Modeling System

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Since May 2012, the Fisheries Research Agency has operated a new ocean forecast system (FRA-ROMS) based on the Regional Ocean Modeling System (ROMS) coupled with a 3D-var data assimilation model. The target of this system is mesoscale variability in the northwestern Pacific region. The nowcast and forecast are updated every week and posted on the open website. The problem at this stage is that temperature and salinity over the Okhotsk and Bering Seas are restored to monthly mean climatology due to lack of a sea-ice model. To upgrade the dynamical model framework of the FRA-ROMS, we construct a sea-ice-coupled regional ocean model for the Okhotsk Sea based on ROMS and test its capability through a hindcast experiment in 1990–2010. The model is driven by 6-hourly meteorological reanalysis products (JRA25/JCDAS). We also incorporate two effects into the model, which are essential for the circulation in the Okhotsk Sea, such as diapycnal vertical diffusivity attributed to dissipation of tidal currents and freshwater flux from the land (*e.g.*, Amur River). The former is estimated from a barotropic tide model adjusted by energy conversion into internal waves. It is found that the sea-ice-coupled model successfully simulates not only seasonal but also year-to-year variations of the sea ice extent over the Okhotsk Sea. Meanwhile, the sea-ice concentration in the simulation tends to be smaller than an observed value. That is, sea-ice area and its production are underestimated in the simulation. Other aspects of the model output are demonstrated in our presentation through comparison with observation and other model results.

## POC-P-7

# Interannual variation in the volume transport through the Sado Strait in the Japan Sea

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Interannual variation in the volume transport of the coastal branch of the Tsushima Warm Current (TWC) through the Sado Strait, which is located in the central part of the Japanese coast of the Japan Sea, was examined by using shipboard acoustic Doppler current profiler (ADCP) data and sea-level differences across the Sado Strait. Snap shots of the volume transport through the Sado Strait were directly estimated from 15 cruises of the shipboard ADCP observations. To remove diurnal and semidiurnal tidal currents, four round-trip ADCP cruises per lunar day were carried out. As the result, the volume transport varied from –0.22 to 0.73 Sv, and a good relationship between the volume transport and the sea-level difference across the Sado Strait was found. Based on this relationship, interannual variation in the volume transport was estimated from time series of the sea-level difference. During 2002–2009, the average transport was estimated as 0.40 Sv. The maximum and the minimum yearly transports were estimated as 0.52 Sv and 0.28 Sv, respectively. Both water mass structure in the offshore area and the sea-surface height data suggested that this interannual variation in the volume transport was caused by the variation of the current path of the coastal branch of the TWC.

# GP

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# General Poster Session Presentations

## GP-1

## Intraspecific genetic variation among spawning aggregations of the Pacific herring (*Clupea pallasii*) from the Okhotsk Sea

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Pacific herring (*Clupea pallasii*) is a pelagic-foraging marine fish that inhabits coastal waters and marginal seas on both sides of the North Pacific Ocean, at latitudes ranging from nearly subtropical to Arctic. Genetic analysis of Pacific herring based on allozyme and mitochondrial DNA (mtDNA) markers have detected limited genetic differentiations among populations at different spatial scales. Analysis using only the mitochondrial DNA can trace the history of the formation of haplotypes across time and space, but is poorly suited for the separation of herring spawning groups. Here we applied three microsatellite loci (cpa106, cpa111, cpa114) with fluorescent dyes in real-time polymerase chain reaction by melting curve temperature and fragment analysis on 3500 Genetic Analyzer (Applied Biosystems) to detect allelic differentiation between pacific herring aggregations in the Okhotsk Sea. The survey included over 300 fish sampled from 2 sites – northwestern (Aldoma Bay) and northeastern (Gigiginskaya Bay) parts of the Okhotsk Sea. The expected heterozygosity (He) across loci and populations ranged from 0.55 to 0.92 and was typically larger for the Aldoma Bay samples. The observed and expected heterozygosity differed significantly ($P \leq 0.05$) at two loci in both populations. These microsatellites should prove useful for a number of genetic applications in Pacific herring including estimating genetic variation on a fine geographical scale.

## GP-2

## Testicular toxicity of an antifouling biocide 4,5-dichloro-2-n-octyl-3(2H)-isothiazolone (Sea-Nine 211) to the marine teleost mummichog *Fundulus heteroclitus*

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The antifouling biocide 4,5-dichloro-2-n-octyl-3(2H)-isothiazolone (Sea-Nine 211) has been widely used as an effective biocide. We investigated testicular toxicity in the mummichog *Fundulus heteroclitus* after exposure to Sea-Nine 211 at concentrations (0.11, 0.33, 1.0, and 3.0 mg/L) under continuous flow-through conditions for 28 days. After Sea-Nine 211 exposure, the incidence of apoptotic spermatocytes was significantly greater in the 1.0-mg/L groups than in the control groups. We conducted immunohistochemistry to analyze expression levels of apoptosis-associated proteins. The numbers of cysts expressing caspases -2, -3, -6, and -8 were significantly increased in the 1.0-mg/L group compared with those for the control groups. Especially, the numbers of caspase-3- and -2-positive cysts in the 1.0-mg/L group were similar to that of apoptotic cysts and were markedly higher than those of caspase-8- and -6-positive cysts. On the other hand, the signal intensity of an anti-apoptotic protein Bcl-xL tended to decrease in a dose-dependent manner with the exposure concentration of Sea-Nine 211. The number of nitric oxide synthase-positive cysts was twofold higher in the 1.0-mg/L group than in the control groups, and the signal intensity in spermatogonia tended to be highest. These results suggest that prolonged exposure to Sea-Nine 211 induces apoptosis in the testis of mummichogs via a caspase-dependent pathway, and that oxidative stress via nitric oxide synthesized by nitric oxide synthase is one of the triggers involved in this induction.

## GP-3

## Radioactive substance effects on marine products in Fukushima Prefecture

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During April 2011 – March 2012, marine products of 157 types and 3,126 specimens were inspected, revealing that 1,085 specimens exceeded 100 Bq/kg in the amounts of radioactive cesium 134 and 137. Radioactive cesium concentrations in marine products were high in shallower water areas from a water depth of 50 m in the Fukushima Prefecture offshore to the south of Fukushima No. 1 nuclear plant and low in the northern marine areas. Regarding fish types, concentrations tended to be high in common skates and rockfish. However, for migratory fish and deep-sea fish, the radioactive cesium was often below 100 Bq/kg. Concentrations were very low or not detected in squids and octopuses, shells, and sea cucumbers. In relation to the number of days elapsed after the accident, concentrations tended to drop in young fish of anchovy and Sakhalin surf clams. However, most fish have not shown a clear tendency. Regarding seawater, radioactive cesium of approximately 10 Bq/L was detected in shallow water areas to the south of Fukushima No. 1 in May 2011, but no concentration was detected at any point in September. For marine soil, a few thousand Bq/kg was detected in shallow water areas to the south of Fukushima No. 1 in May and June 2011. Therefore, concentrations tended to drop but there were points measuring a few hundred Bq/kg even in March 2012. Although concentrations have tended to decrease in coastal areas, they tend to be high offshore. Therefore, offshore diffusion is expected to continue.

## GP-4

## Great East Japan Earthquake effects on coastal fishing grounds of Iwaki City, Fukushima, Japan

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The tsunami triggered by the Great East Japan Earthquake on 11 March 2011 caused serious damage in the coastal areas of Iwaki City, Fukushima Prefecture, Japan. In the fishing grounds around there, effects on seafloor habitat not only of changes in seafloor topography by crustal movement associated with the earthquake, but also of suspended particles diffuse and debris carried by the tsunami were concerned, as well as interference with fishing operation and navigation of fishing boat. This study reported observations of seafloor habitats in coastal fishing grounds around Iwaki City after the tsunami struck. Sea bottom topographic observations conducted using portable side-scan sonar (Structure scan) provided acoustic images of the seabed. Large debris was found on the seafloor at several survey points in the coastal fishing grounds, but physical damage by the tsunami to artificial reefs and other submarine structures appeared to be less, despite great damage to port facilities, such as destruction of the quay. Observations by scuba diving and with underwater cameras of marine organisms on rock reefs around Iwaki City during June–November 2011 revealed no severe tsunami damage to rock reef seaweed in the seaweed bed. In fact, seaweed on several rock reefs grew more thickly than it did before the earthquake. In contrast, the sea urchin density was very low, even on the rock reef where fishery workers had transplanted thousands of sea urchins before the tsunami occurred, which suggests that the tsunami washed sea urchins away from the rock reef.

## GP-5

## Distribution of calanoid copepod eggs in seabed sediments of Masan Bay, Korea

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The distribution of calanoid copepod eggs was studied in the bottom sediment of Masan Bay (South Sea, Korea), where hypoxic conditions develop every summer, during a hopoxic period (August 2011) and a normoxic period (April 2012). In addition, an analysis was carried out concerning the relationship between seabed environments and the distribution pattern of morphologically normal and abnormal eggs. In August all stations showed hypoxic condition with sea bottom dissolved oxygen below 1.2 mg $L^{-1}$, whereas in April they showed normoxic condition with sea bottom dissolved oxygen above 5.0 mg $L^{-1}$. A measurement taken in the inner part of the bay during the hypoxic period gave a low pH (< 7.7) and a high concentration of $H_2S$ (> 20 mmol $L^{-1}$) at sediment–water interface, whereas during the normoxic period there was no significant difference between stations. As for the abundance of eggs found in sediment, a higher range of density (between 0.61 and $2.01 \times 10^6$ eggs $m^{-2}$) was observed during the hypoxic period compared to the normoxic period, and this level of abundance was higher than the levels reported to be observed at various global locations. The hypoxic period showed high proportion (maximum 77.1%) of abnormal eggs, including empty egg shells, in the inner part of the bay; whereas the normoxic period showed homogeneous distribution of normal eggs (> 80%) among all stations. The generation of abnormal eggs that either failed to develop to hatching or hatched into deformed nauplii is presumed to be related to the high concentration of $H_2S$ and low pH caused by hypoxia. This study will discuss the influences of hypoxia and seabed environments on hatching success of calanoid copepod eggs.

## GP-6

## Population dynamics of *Archaeomysis vulgaris* (Crustacea: Mysidacea) after Hebei spirit oil spill accident

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This study investipated to understand about pattern of Surf-zone of intertidal ecosystem changes at the Hebei spirit oil accident through variations of population of *A. vulgaris* (mysid). mysid were collected by self-made sledge net at surfzone on Hakampo in Taean in May 2009 to November 2011. We compared with results in Hakampo (experimental group) and Ggotji (control group).

Water tamperature and salinity were not difference between Hakampo and Ggotji. The density of mysid in Ggotji was higher than its in Hakampo. The monthly female sex ratio of mysid in Ggotji was higher than its in Hakampo. A period of high density of juvenile and immatures was around the same time that recruited period of new generation in population of mysid in Ggotji, But Hakampo was not obviously pattern of recruitment. The recruitment rate of Ggotji were higher than its in Hakampo. The density of ovigerous female, juvenile and immatures in Ggotji were higher than its in Hakampo. The period of recruitment at spring-generation and summer-generation in Ggotji was about one month faster than its in Hakampo. The growths of carapace-length of mysid was not difference between Hakampo and Ggotji, but period of development of the secondary sexual-characters of juvenile in Hakampo was longer than its in Ggotji. Number of eggs in marsupium at same carapace-length of mysid in Ggotji was more than its in Hakampo. The mean number of eggs of mysid in Hakampo has been slowly increasing.

## GP-7

## Interannual and seasonal changes in zooplankton community in a monsoonal coastal bay

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Environmental and zooplankton data were analyzed over a 10-year period (2001–2010) to investigate interannual and seasonal patterns of zooplankton dynamics and to identify major factors controlling these dynamics at an estuarine station in the southern coastal waters of Korea. There was a strong positive association in the interannual variation between freshwater discharge and copepod abundance, even though phytoplankton biomass was negatively associated with runoff. Copepod abundance was lowest in the summer when the abundance of predators such as chaetognaths and *Noctiluca scintillans* was highest. The high density of heterotrophic dinoflagellates (>$10^3$ cells $m^{-3}$) adversely affected both the copepod abundance and, more markedly, the zooplankton diversity. Both the interannual pattern of zooplankton richness and the ratio of gelatinous zooplankton abundance to that of copepods increased with the increase in salinity and temperature following reduced river discharge. The overall shift in the zooplankton community during the study period may indicate range expansion of warm water zooplankton from offshore waters as well as better environmental conditions for them to grow in this bay water. This outcome also appears to reflect ecological processes related to the increase in sea surface temperature that has been underway in the offshore waters.

## GP-8

## Seasonal and annual fluctuations in the abundance and biomass of *Neocalanus plumchrus* in Japan Sea off northern Hokkaido

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Seasonal and annual fluctuations in the abundance and biomass of a calanoid copepod, *Neocalanus plumchrus* in northern Japan Sea were investigated from 1990 to 2011. Zooplankton samplings were done by vertical tows from 150m to the surface using a 45 cm diameter, 0.335 mm mesh-size NORPAC net, equipped with a flow meter at one fixed station (561m depth, 45°30N, 140°40E) at interval of two months (February, April, late May or early June, late July or early August). Abundances of *N. plumchrus* fluctuated from 0 to 407 inds./$m^3$ (average 36 inds./$m^3$). The maximum abundance was observed in 2001 (407 inds./$m^3$ in late May), and the second was in 2010 (316 inds./$m^3$ in early June), which were corresponding to the sharp decreasing of average water temperature of 0 - 50m depth in April. The continuous increasing phases of *N. plumchrus* abundance were observed during 1998 to 2001. The populations in those phases nearly consisted of individuals in C5 stages (ca. 57~96%). Seasonal peaks of *N. plumchrus* abundances changed in late May or late July in each year. An another prominent feature was that the peaks of biomass in *N. plumchrus* was observed in late May during early 1990s, however, it shifted in late July after late 1990s. The shift of peak in *N. plumchrus* biomass might has caused the recent delay of peaks during spring fisheries in arabesque greenling, *Pleurogrammus azonus*, which is the most important species for fisheries in northern Japan Sea of Hokkaido.

## GP-9

## Effect of preceding and adjacent typhoons on the intensity and track prediction of typhoon in the western North Pacific

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This study investigates the impact of preceding and adjacent typhoons on the track and intensity prediction of a typhoon in western North Pacific. For this, we developed a regional coupled model (WRF+ROMS) using a MPI (Message Passing Interface) II coupler. After determining optimal physical parameterizations of WRF based on sensitivity tests, we conducted two numerical experiments: one is to examine the sea surface cooling effect of a preceding typhoon, Ewiniar (0603), on the intensity prediction of typhoon Bilis (0604) and the other is to examine the bogussing effect for adjacent typhoons, Namtheun (1008) and Lionrock (1006), on the track prediction of Kompasu (1007). The results show that the intensity of Bilis (0604), passed over the region where a significant surface cooling occurred by the preceding typhoon Ewiniar (0603), was greatly reduced, compared to the experiment without considering the cooling effect, resulting in the improvement of intensity prediction. For the track prediction of Kompasu (1007), additional consideration of a bogussing scheme to adjacent typhoons reduced the track errors, mainly due to an improvement of initial condition. These results suggest that for not only the targeted typhoon but also the preceding and adjunct typhoons, accurate simulations of oceanic and atmospheric conditions are required for the improvement of typhoon prediction.

## GP-10

## Tohoku Tsunami effects on Matsukawa-ura Lagoon, Fukushima, Japan

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The Tohoku tsunami, caused by the Great East Japan Earthquake on 11 March 2011, brought huge damage to a brackish lagoon in Fukushima Prefecture: Matsukawa-ura (6.46 km$^2$). In the lagoon, aquaculture of marine green algae *Monostroma nitidum* (annual catch: ca. 1200 metric ton) and Short-neck clam *Ruditapes philippinarum* (ca. 120 metric ton) had been conducted. However, the gigantic tsunami itself and the subsequent flows of seawater and marine sediments through the collapsed sandbar destroyed the aquaculture facilities completely and changed the physical environments drastically. In this study, horizontal changes in bottom sediment compositions and juvenile Short-neck clam densities were evaluated by comparing data obtained before and after the tsunami disaster. Measurements of the particle size distribution of bottom sediments in January 2012 revealed that areas having a less than 10% silt/clay fraction spread in the north and central part of the lagoon, did not change in the southern part, and decreased in the western part. The muddy areas decreased, while sandy areas that are probably suitable for Short-neck clams increased in the lagoon. The density of Short-neck clams in the 2010 year class was extremely low during the June 2011 – June 2012 period, strongly suggesting that almost all juveniles in the 2010 year class died during the tsunami disaster. In contrast, the density of the 2011 year class was almost an equal level to that before the tsunami, indicating that Short-neck clam populations in the lagoon recovered quickly during the subsequent year.

## GP-11

## Population dynamics of Kuro Shrimp *Argis lar* from the East Sea of Korea

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The common kuro shrimp, *Argis lar* is widely distributed in the North Pacific, Alaska, Bering Sea and predominantly inhabits the East Sea of Korea and Hokkaido waters of Japan. This species from the East Sea of Korea was collected over a 12 month period with total sample of 3,496 shrimp. The sample included 41 males (size range: 11.95-25.12 mm carapace length, CL) and 3,455 females (size range: 17.48-37.15 mm carapace length, CL). Size differed significantly between males and females. Moreover, females appeared every month, whereas males did not show in July, August, October and November. The asymptotic length ($L_\infty$) was 41.85 mm CL. The curvature parameter (K) of the von Bertalanffy growth equation was 0.51 per year. The amplitude of the seasonal growth oscillation of the von Bertalanffy growth equation (C = 0.7) and the Winter Point (WP = 0.8) indicated a seasonality in the growth pattern, being slowest at the September. The instantaneous rate of total mortality (Z) estimated by the length converted catch curve method described by Pauly was 3.2831 $yr^{-1}$.

## GP-12

## Effects of the great earthquake and tsunami on the running upstream, growth and maturation of ayu *Plecoglossus altivelis altivelis* in the Natori and Hirose Rivers, Northeastern Japan

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The tsunami in 2011 should have badly damaged the ayu *Plecoglossus altivelis altivelis* running upstream the Natori and Hirose Rivers, Miyagi. This study investigated the upstream running, growth and maturation of the ayu population.

Fish were collected using a casting net at three stations in 2011; the confluence of the two rivers (St.1: about 8 km upstream from the river mouth), Koriyama-seki weir (St.2: about 10 km upstream) and Atago-seki weir (St.3: about 14 km upstream). The CPUE, frequency body length distribution, hatch date composition and GSI were compared with previous ones. St.1 showed low CPUEs of 1.1 - 4.5 individuals per cast during early May to late June, as is lowest in the past five years. The CPUEs at St.2 remained below 1.0 fish per cast even after late May. Ayus running upstream can usually be observed from early May, but which seems to have delayed in 2011. The hatch date composition showed remarkable absence of fish having hatched before late October, 2010. These might relate to the tsunami.

The mean length of adult fish at St.2 in July, 2011 didn't differ from those in 2006-2008. Female gonads also developed as usual. Regardless of the negative influence of the tsunami on the ayu population when running upstream, the ayu population seems to have carried out the subsequent growth and reproduction in the rivers as usual. The researchs in 2012 denotes large amount of fish running up, suggesting not to suffer from any effects of the disturbance on its reproduction.

## GP-13

## Mass balance of dioxins from pesticides in Sendai Bay, Japan

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We estimate the flux of major dioxin congeners from Miyagi Prefecture to Sendai Bay. Large quantities of dioxins from chloronitrophen (CNP) and pentachlorophenol (PCP) sources were introduced into the terrestrial environment (30.7 t). As the rivers and drainage ditches acted as transport bottlenecks, their inflow from the terrestrial environment to Sendai Bay was limited (241 kg). The bulk of dioxins from CNP and PCP sources remained in the terrestrial environment. Almost all dioxins entering Sendai Bay (7.7 kg/y) either flowed out of the bay (6.17 kg/y) or settled to the bay bottom (3.0 kg/y). The amount that bioaccumulated in marine organisms (3.2 g/y) was much less than the amount inflowing from the terrestrial environment to the bay (0.04 %). The major dioxin congeners from impurities in CNP and PCP have much lower toxicities and bioaccumulation rates in marine organisms than low-chlorine 2,3,7,8-substituted PCDD/Fs such as 2,3,7,8-TeCDD, which has an extremely high TEF. Therefore, although the influx of dioxins of CNP and PCP origin to Sendai Bay will continue in the future, their bioaccumulation in marine organisms in Sendai Bay will not be a serious problem for fisheries resources.

## GP-14

## Range expansion of calanoid copepod *Acartia hongi* known as endemic species to the coastal waters of the Yellow Sea

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Even though calanoid copepod *Acartia hongi* has been known as species which mostly inhabit in the coastal waters of the Yellow Sea, information about potential dispersion range of the species is lack. Thus, we investigated distributional pattern of *A. hongi* seasonally at three seaports during 2007-2009 and in offshore waters of the Yellow Sea in spring and summer of 2010-2012. Zooplankton samples were collected with standard net (200µm mesh, 60cm diameter) in offshore waters and at Incheon seaport in the Yellow Sea, Gwangyang seaport in the South Sea, and Ulsan seaport in the southwestern East Sea.

Occurrence of the species with high abundances (1-10,867 inds.m$^{-3}$) at Incheon seaport was coincident with previous records, whereas its occurrence at seaports of Gwangyang and Ulsan was unusual beyond their bioregion. Especially, the species showed up in the high range (102-1,654 inds.m$^{-3}$) of abundance at Gwangyang seaport in spring 2007, while abundances less than 10 inds.m$^{-3}$ occurred transiently at Ulsan seaport in 2007. At two latitudes from coastal waters to seaward stations (34.5 and 36°N, 124.5 and 125.5°E) in the Yellow Sea, *A. hongi* occurred only at coastal station of north latitude whereas it distributed at all stations of south latitude with decreasing abundances seaward in the range of 1-302 inds.m$^{-3}$ during 2010-2012. These results indicate that distributional range of *A. hongi* was not limited to the coastal waters of the Yellow Sea. Thus, potential distributional range of the copepod could be re-described based on the natural or anthropogenic dispersion.

## GP-15

## An update on CeNCOOS, the central and northern California Ocean Observing System

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CeNCOOS is one of 11 regional ocean observing systems that together with a Federal backbone and national program office make up the Integrated Ocean Observing System (U.S. IOOS®), the U.S. contribution to the Global Ocean Observing System. The CeNCOOS region extends from Pt. Conception to the Oregon border, from the coast through the Exclusive Economic Zone. CeNCOOS coordinates closely with the regional ocean observing systems to its north and south, NANOOS and SCCOOS, respectively. CeNCOOS is a consortium of 50 members, and currently provides support to 15 principal investigators at 13 institutions. CeNCOOS supports a dozen automated shore stations, more than 20 high frequency (HF) radars, a continuously operating profiling glider, atmosphere and ocean numerical models, and a data management system. Most importantly, CeNCOOS serves data and information products to aid in informed decision-making concerning ocean ecosystems, fisheries, and water quality; climate change; maritime operations; and coastal hazards. For example, CeNCOOS water quality stations provide measurements of dissolved oxygen, pH, chlorophyll, and harmful algal blooms which are used by shellfish growers to aid in maximizing their yield. CeNCOOS is assisting in the evaluation of Marine Protected Areas by characterizing the physical environment, including winds, currents, temperature, and waves, of these areas over time. CeNCOOS is also participating in the development of methods for monitoring acidification in the coastal ocean. The surface currents derived from the HF radar measurements are used to inform, among other things: ship navigation and safety of maritime operations, search and rescue operations, and oil spill response.

## GP-16

## Population trends of the Kuril harbor seal *Phoca vitulina stejnegeri* from 1974 to 2011 in southeastern Hokkaido, Japan

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The Kuril harbor seal *Phoca vitulina stejnegeri* is an endangered species living in southeastern Hokkaido, Japan. Its population declined precipitously from approximately 1,500–4,800 to a few hundred individuals from the 1940s to the early 1970s. The causes of this decline are thought to be commercial harvesting, rock blasting for the konbu *Laminaria* seaweed fishery, and bycatch in autumn set-net salmon fishing. To evaluate their status in more recent years, a population data set was compiled from counts collected each year at their haul-out sites during 1 week of their pupping season from 1974 to 2011 and during molting season from 1982 to 2011. The average population growth rate was approximately 5%, which appears to have quadrupled over the past 38 years.

Two haul-out sites (Kenbokki Island and Hattaushi) that had disappeared in the early 1980s showed no signs of recovery as pupping/molting sites. The commercial harvest and rock blasting activities ended in the late 1980s. However, bycatch of seals during the autumn set-net salmon fishery in the 2000s remained similar to or slightly greater than during the 1980s. Recently, seals have been observed at 9 haul-out sites during the pupping/molting season along the coast of southeastern Hokkaido, Japan. Approximately 70% of the seals found were at Cape Erimo (approximately 500 seals) and Daikoku Island, Akkeshi (approximately 250 seals).

## GP-17

## Seasonal variability of the mixed layer depth in the East Sea(Japan Sea)

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A climatology for the mixed layer depth (MLD) in the East Sea (Japan Sea) was produced using most available profile data collected from 1931 to 2005. MLD is defined as the depth at which the temperature differs from that at 10 m depth by 0.2°C. It varies seasonally with a range of about 20 m, a minimum, near the subpolar front (SPF, 38°–41°N), 60–100 m in south of 38°N and north of 41°N, and about 200 m near the winter convection region (132°–135°E & 41°–43°N). The weaker seasonality near the SPF seems to result from year–round strong stratification sustained largely by advected warm water of the East Korean Warm Current and a result of complex dynamic process of frontogenesis including lateral dynamics or wind–induced friction. The temperature–based MLD does not shows any significant difference (mostly less than 20 m) from the density–based values over most of the East/Japan Sea except a few localized regions near the Russian and Japanese coasts where barrier layers form from late fall through early spring. This study confirms that atmospheric forcing largely dominates the overall magnitude of MLD seasonal variability in most of the East Sea (Japan Sea).

## GP-18

## Difference with transporting patterns of MDN from salmon to the riparian ecosystems caused by structure and function of river system

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Pacific salmon (*Oncorhynchus* spp.) play an important role as enhancement of biodiversity and productivity in the North Pacific ecosystem. To evaluate how salmon contribute the ecosystem, we need to verify many case studies on the effect of marine-derived nutrients (MDN) in various watershed environments. In this study, we clarify the transporting patterns of MDN to riparian organisms in different river ecosystems using the stable isotope analysis. The Uyoro River (UR) is a middle-scale river in southwestern Hokkaido, Japan. Many chum salmon (*O. keta*) naturally spawn between September and December. Small mammals utilize salmon as a seasonal food in this river. The Rusha River (RR) is a small mountain-stream in the Shiretoko Peninsula, eastern Hokkaido. Pink salmon (*O. gorbuscha*) run up RR during September and October. Brown bear (*Ursus arcto*s) distributes in high density and prey on many salmon around RR. 80% of chum carcasses observed in water of UR. While 56% of pink carcasses were carried to riverbank of RR by brown bears and high flow. Nitrogen flux derived from carcasses was similar in quantity between UR and RR, because biomass of chum salmon in UR was close to pink salmon abundance in RR. Aquatic organisms received 31% and 14% of their nitrogen from salmon in UR and RR respectively. While riparian willow (*Salix* spp.) assimilated more MDN (21%) in RR than in UR (6%). These results suggested that the mechanism and framework on MDN transportation from salmon will differ with structure and function of the riparian ecosystems.

## GP-19

## Spatiotemporal distribution of meso- and micro-plastics on a sand beach in South Korea

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Substantial amount of plastics end up and accumulated in the marine environment. Among plastic marine debris, there is growing concern about small plastics less than 5 mm in size because their environmental consequences are expected to be different from larger plastics. The smaller are plastics, the more bioavailable to marine animals. However, the abundance and distribution data on small plastics are very limited, especially in Asian region and in microplastics. In this study, mesoplastics (1 mm < size < 5 mm) and microplastics (1 mm < size < 1 mm) were quantitatively determined in Heungnam beach which is located at east coast of Goeje Island and directly affected by both the land- and sea-based marine debris. Their spatiotemporal distribution pattern was evaluated on high-stranded line (10 sites) and cross-section (44 or 62 sites) of the beach in April (dry season) and in September (rainy season), 2011. Expanded polystyrene (EPS) spherules fragmented from aquaculture buoy were major meso-plastics at all the sampling sites and time on the beach. Its abundance reached up to 160,000 particles/m$^2$. The highest abundance of the other meso-plastics such as resin pellets, plastic fragments and fibers was about 640 particles/m$^2$. Microplastic abundance was determined up to 1,500,000 particles/m$^3$. The abundances of meso- and microplastics in the beach were the highest in the world. FT-IR analysis demonstrated that polyethylene and polypropylene were major polymer types except for EPS spherules. Cross-sectional and seasonal distributions of EPS, the other meso-plastics and microplastics on the beach were different each other.

## GP-20

## Occurrence and distribution of microplastics in surface bulk water and microlayer in southern coast of South Korea

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Microplastics, less than 1 mm in size, have been recently recognized as marine pollutants of significant concern due to their persistence, ubiquity, toxic potential, and potential to act as vectors for transfer of absorbed and additive toxic chemicals to marine organisms. There is growing requirement for global assessment of presence and distribution of microplastics. However, there is still a big data gap to be filled for global assessment of contamination of microplastics. In this study, microplastic debris was quantitatively determined in surface bulk water (top 20 cm at 3 stations) and surface microlayer (50-60 mm at 21 stations) in southern coast of South Korea in May, 2012, which is receiving Nakdong River discharge. Abundance of microplastics in bulk water samples ranged from 8,117 to 21,475 particles/m$^3$. Two stations located in semi-enclosed bays showed higher abundance than one at open off-shore station. Microplastic abundances in microlayer are in the range of 30,357-154,231 particles/m$^3$. The average abundance of microplastics in surface microlayer (73,423 particles/m$^3$) is about 5 times higher than that of surface bulk water (13,769 particles/m$^3$). Relatively high abundances of microplastics were found at Stations 14-17 off-shore with patchness. Two stations located in semi-enclosed bays also showed relatively high abundance like as the bulk water samples. Among four categories of microplastics (fragment, fiber, sheet and spherule), fragment type accounted for 96-100% in microlayer samples. Abundances of microplastics in surface microlayer in this study were orders of magnitude higher than those in surface waters reported in the world.

## GP-21

## Significance of the Krusenstern expedition to Japan in the early 19th century: Its contribution to the development of ichthyology from biological and historical perspectives

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The Krusenstern expedition is known as Russia's First Round-the-World expedition (1803-1806). Based on first-hand investigations of the fish specimens and drawings brought back from Japan to the European academic institutions in Berlin, St. Petersburg and Leipzig, this presentation focuses on the progress of ichthyology in the context of East-West contacts in the early 19th century. The Krusenstern expedition had two major missions. One was closely related to the political and economic expansion of the Russian Empire. On behalf of Russian government, Rezanov negotiated with Japanese authorities to establish trading. The other was to pursue scientific investigations on natural sciences, including zoology, botany, ethnology, meteorology, geophysics, *etc.* For this reason, three natural scientists, Langsdorff, Tilesius and Horner, joined the expedition. After crossing the North Pacific, the ship *Nadezhda* arrived in Nagasaki in September 1804. During their stay in Japan for about half a year, the Russian embassy was not allowed to act on their own. In the end, although Rezanov failed to establish trading with Japan, Langsdorff and Tilesius were successful in collecting materials for their scientific investigations. Some of the zoological drawings by Tilesius were first published in the Krusenstern Atlas in 1813. Fish specimens in Berlin were used to describe Japanese species by French biologists, Cuvier and Valenciennes for their monumental work, *Histoire Naturelle des Poissons* (1828-1850). Thus, many of them have been designated as type specimens, which still hold significant academic value in biology.

## GP-22

## Sea ice classification using polarimetric information and texture features of RADARSAT-2 quad-polarization data

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The annually frozen sea ice over Bohai Sea threatens coastal industry and leads severe economic loss to China. Several high-resolution synthetic aperture radars(SAR) have been used in the sea ice observation. With the launch of RADARSAT-2, the dual and fully polarimetric modes data enhances the ability to measure the sea ice parameters. In this study, the polarimetric information and texture features based on RADARSAT-2 quad-polarization data were analyzed. With different polarimetric information and texture features as inputs of Wishart classifier, the classification results are compared. By introducing the texture features, the new ice and gray ice is segmented successfully.

## GP-23

## Contributions from the IMBER "Human Dimensions Working Group" to the effects of anthropogenic stressors in marine ecosystems

Bernard Avril[1], Kenneth F. **Drinkwater**[2], Alida Bundy[3] and IMBER HDWG members

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The main goal of "Integrated Marine Biogeochemistry and Ecosystem Research" (IMBER) is to investigate the sensitivity of marine biogeochemical cycles and ecosystems to global change, on time scales ranging from years to decades. Through thematic working groups, national and regional research programmes, IMBER focuses on understanding the physical, biological, and chemical oceanographic processes that regulate biogeochemical cycling and feedbacks to marine food webs. One of the IMBER science themes entitled "Responses of the Society" is focused on understanding the changing marine biogeochemical cycles and ecosystems in the Anthropocene, and incorporating the related drivers, impacts and challenges into integrated conceptual frameworks and models of the human-natural interactions. Humans are both a driver, through activities such as fishing and global consumption of fossil fuels, and a recipient of such changes observed in ocean systems for goods and services. It has become increasingly critical to understand, at multiple scales, how ecosystems, societies, institutions and individuals, might respond to these changes in order to help manage transitions towards sustainability. Composed by a mix of natural and social scientists and practitioners, the IMBER "Human Dimensions Working Group" (HDWG, 2011) helps create a strong natural-social science, marine research community, and helps understand and forecast human-ocean interactions with respect to global change. Issues related to the adaptive capacity of socio-ecological systems, governance, food security, global markets and the physical linkages from ocean biogeochemistry to humans are explored using a comparative case-study approach at multiple scales. This presentation provides an overview of the IMBER HDWG.

## GP-24

## Contributions from the IMBER "Data Management Committee" to the scientific challenges of the changing marine ecosystems

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How can we tell that the global environment is changing? Because data have been recorded, calibrated and then preserved long after the research experiments were done. Nobody questions that research must publish based on evidence, so why is organizing data often the weak link in the knowledge production cycle? Because marine research is essential to help understand the global change occurring on our planet "Ocean", the "Integrated Marine Biogeochemistry and Ecosystem Research" (IMBER)'s Data Management Committee (DMC) seeks to change this ethos in all marine research endeavours related to IMBER and beyond. The DMC promotes a cooperative data management approach that includes involving experienced data management specialists from the start of a project, and also training young scientists in good data management procedures. Good data management, which starts right from the start of your project design phase, has many benefits, speeds up research, improves data sets, enhances publications and increases visibility to other researchers. The "IMBER Data Policy" provides broad guidelines to the IMBER community and the "IMBER Data Management CookBook" is a step-by-step "Project Guide to good Data practices". In addition, Data Management tutorials have been elaborated after an IMBER Dry Cruise workshop organised to increase awareness of the importance and benefits of establishing and following data management procedures, and to provide hands-on training on data management and data preservation. Finally, the IMBER Metadata Portal provides an overview of IMBER endorsed- and related projects, using the Directory Interchange Format (DIF) as a discovery metadata standard and the NASA's Global Change Master Directory (GCMD) as the main data interface. This presentation provides an overview of the IMBER DMC.

## GP-25

## Development of a high-resolution Japanese coastal ocean model toward operational monitoring and forecasting

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We have been developing a Japanese coastal ocean model to provide a platform for the next-generation monitoring and forecasting system of the coastal seas which is planned by Japan Meteorological Agency (JMA) for upgrading of information service about disaster prevention and oceanic conditions. With the horizontal resolution of approximately 2 km, which is five times as high as that of the current ocean model of JMA, the new model can represent explicitly coastal topographies and phenomena with scale of 10 km, which are almost ignored in the current model. In addition, several physical schemes important for coastal seas, such as a vertical mixing scheme suited for bottom boundary mixing, are incorporated into the model. Especially, tidal motion, which is a dominant phenomenon in coastal and shelf seas, is introduced explicitly and precisely into the model by developing an original scheme. Some experiments using this scheme verified that tidal height variation in the model corresponds well with coastal tidal observations by JMA, and showed that strong tidal currents (up to 1 m/s) in coastal areas and active internal tides in offshore areas are represented realistically. Results of an experiment for the seasonal variation over one year will be also shown with focus on roles of tide in the presentation.

## GP-26

## Organic micropollutants in plastic resin pellets from sand beaches of South Korea

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In order to assess the occurrence and distribution of microplastic debris in the coastal regions of South Korea, beach monitoring survey was conducted at four beaches in September and October, 2011. Among the plastic samples collected in that survey, plastic resin pellet was selected and used for the chemical analysis of persistent organic pollutants (POPs). The FT-IR analysis showed that the primary synthetic polymers collected on the beaches were polypropylene (PP) and polyethylene (PE). According to their polymer type and the degree of weathering, the pellet samples were sorted into four groups: aged PP, fresh PP, aged PE, and fresh PE. The overall concentration (ng/g pellet) of POPs in pellet samples were in the range of 0.06-18.6 (median value: 1.75) for HCB, nd-163 (0.14) for HCHs, nd-116 (0.13) for CHLs, nd-193 (15) for endosulfans, 0.39-6,800 (8.6) for DDTs, 0.3-55.3 (10.3) for PCBs, and 0.25-510 (8.16) for PBDEs. Extremely high concentration of DDT was determined in the aged PE pellets collected from Deokheung and Heungnam beaches. In general, PE accumulated larger amounts of POPs than PP. And aged pellet accumulated more contaminants than the fresh. Among the target compounds, DDTs, PCBs, and endosulfans showed the highest concentration, followed by PBDEs and HCB. Hexachlorocyclohexanes and chlordans were detected with a low concentration. The profile of POPs detected in the pellet is relatively similar to those in marine sediment from the Korean coasts. Among four locations, significantly high level of deca-BDE was detected at the beach nearby big city.

Birds have long been considered as a valuable monitoring species for persistent organic pollutant (POP) contamination. As 'bird of prey' birds occupy the top position in a food chain. This leads to severe bioaccumulation and biomagnification with a contamination load that cause concern regarding their survival. They are sensitive to environmental contamination. However, there is very little information on POPs contamination of birds in Korea. In order to understand the status of POP contamination in bird, we analyzed muscle tissues of marine and terrestrial resident birds in this study. Black tailed gull and domestic pigeon were selected as target species for monitoring marine and terrestrial ecosystem, respectively.

## GP-27

## The Pacific Arctic Group (PAG): A Pacific perspective on Arctic science

Jacqueline M. Grebmeier[1] and Takashi **Kikuchi**[2]

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The Pacific Arctic Group (PAG) is a consortium of institutes and individuals having a Pacific perspective on Arctic science. Organized under the International Arctic Science Committee (IASC), the PAG has as its mission to serve as a Pacific Arctic regional partnership to plan, coordinate, and collaborate on science activities of mutual interest. The four PAG principle science themes are climate, contaminants, human dimensions and structure and function of Arctic ecosystems. The PAG membership is led by an Executive Committee consisting of a Chair, two Vice Chairs, one Executive Member and the Project Coordinator. The general membership of the PAG may form project groups to address specific issues linked to the PAG objectives. Members are chosen to represent regional variety and breadth of scientific expertise required in PAG. Examples of current PAG activities include: 1) undertaking a Pacific Arctic region multidisciplinary synthesis of scientific findings in the marine region relevant to ongoing scientific objectives at the core of the PAG, 2) development of a Distributed Biological Observatory (DBO) of environmental and biological sampling at stations on transect lines located along a latitudinal gradient extending from the northern Bering Sea to the Barrow Arch, and 3) sampling in the Chukchi Borderland and western Canada Basin region to investigate climate, oceanographic and sea ice interactions in a developing time series format. All aspects of PAG are undertaken via international and national collaborations and project coordination. This presentation will outline the goals of PAG and highlight ongoing projects.

## GP-28

## Effect of mussel ecology on organic-carbon deposition around seawalls in Osaka Bay

Ryoichi **Yamanaka**[1], Yasunori Kozuki[1] and Machi Miyoshi[2]

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Large amount of *Mytilus galloprovincialis* (mussel) attached on vertical concrete seawall in closed-off section of Osaka Bay, Japan. Recently, we suggest a “from-sea-to-land” material cycle which achieves nutrient removal from sea water by catching attached mussels just before occurrence of mussel’s drop-off and using as composted material for land plant. For this reason, we have conducted field survey from 2007 to clarify annual changes in biomass of mussels and biogenic organic carbon flow of mussels. In this study, biogenic organic carbon deposition around seawalls was estimated by ecosystem model considering formation of mussel colony.

Hindcast simulation was conducted from March to September 2007 in Amagasaki Port located in closed-off section of Osaka Bay. Firstly, quasi-three dimensional baroclinic flow model was applied for Osaka Bay. Secondly, ecosystem model was applied only for Amagasaki Port. Carbon cycle was computed and the other nutrient parameters, for example nitrogen, phosphorus, chlorophyll *a*, were given by observation data. Biomass of attached and drop-off mussels was also set by observation data as organic carbon. In this study, to consider feed intake reduction induced by formation of mussel colony, we set up a reduction rate estimated by thickness of mussel colony from seawall and an averaged shell length. Verification of ecosystem model was evaluated by carbon deposition rate. As a result of numerical simulation, we found that mussels increased carbon deposition to sea bottom near seawalls by five times comparing to center of the port and 60% of carbon deposition was induced by mussel drop-off.

## GP-29

## Projected sea level change in the North Pacific Ocean based on IPCC AR4 A1B Scenario

Minwoo **Kim**, Cheol-Ho Kim and Jang Chan Joo

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Many studies have reported sea level change including Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) scenario. Most model studies have pivoted on the global ocean, but they have not explicitly included density-driven sea level change. This study would estimate North Pacific sea level change by using Geophysical Fluid Dynamics Laboratory (GFDL) Modular Ocean Model 4.1 (MOM4p1), which is developed to calculate both steric and non-steric effect explicitly. The model used in this study is Ocean-Ice coupled model and has higher resolution (0.5°×0.5°×50 layer) than most of the CMIP3 models. Initial data is from Coordinated Ocean Reference Experiment (CORE) data and forcing data is from A1B scenario model results. Our model projects relatively high sea rises in the subtropical gyre and warm-pool region, mainly due to thermal expansion. Salinity decrease additionally contributes to the sea level rise in the warm-pool region. Our model projection shows similar patterns in sea level changes to those of CMIP3 projection. Some areas, however, shows substantial differences from CMIP3 projections. For example, both Warm Pool and Kuroshio current area show higher sea level changes than the AR4 result. Furthermore, sea levels in Kamchatka Peninsula and Aleutian Islands area are projected to be risen in opposition to AR4 result.

## GP-30

## The distribution and the seasonal variability of the nutrient on the O-line (138E-line)

Yutaka **Hiroe**[1], Tadafumi Ichikawa[1], Akihiro Shiomoto[2], Tomowo Watanabe[1], Ichiro Yasuda[3] and Kosei Komatsu[4,3]

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For understanding the condition and its seasonal variability of the nutrient near the Kuroshio, we observed the physical structure and the distribution of the nutrient on the O-line (30–34N, 138E) every each season from 2002. In spring, we found the high nitrate in the layer of the potential density 24.0-25.0 at the area near the Kuroshio, like the Nutrient Stream in the north Atlantic. In summer and autumn, the nitrate is increased in the north area of the Kuroshio. The depth of this layer is deepening from spring to autumn, so this increase of the nitrate suggest the possibility that the water mass in this layer is different. From spring to autumn the water is warmed in this layer, so the water with high nutrient in the deeper layer is lightened and located in this potential density range.

## GP-31

# The Effects of Dams on Fish Biology in the Amur River Basin

Denis V. **Kotsyuk**

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The first dam on the Amur River was built in 1975. In recent years dams construction has been intensified. In 2004 Bureyskaya hydropower plant was launched. Currently plants at Nizhnebureyask, Nizhneseisk, on the Argun and the Niman rivers are projected.

Dam construction has the significant effects on fish habitat conditions which lead to changes in ecology and biology of the ichthyofauna, its composition and structure. A qualitative composition of the indigenous species has reduced from 38 to 24 species in the flooded areas of the Zeisk hydro station, and has declined from 29 to 15 species in the Bureyskaya dam area. Lake species have become dominant there, as river species have disappeared.

A length size is the main indicator of changes in fish biology. After the dam had been built an average length of 3 year old pike increased from 381 to 648 mm. Increase in length size, as well as in weight (an average pike weight changed from 503 g to 2622 g), was marked almost in all age groups. Asymptotic length size increased from 604 mm to 1104 mm, as well as asymptotic weight changed from 2618 g to 18749 g after the dam construction.

In the dam area Amur pike has higher fatness coefficients. The species reaches a sexual maturity 1 year earlier here in comparison with fishes from the river. Spawning occurs in the dam area 1 month later. A higher fertility was marked for a pike in this area. We can conclude that in the dam waters there are favorable conditions for some species, such as a pike, which led to an increase in size-weight indices, growth rate, fatness, fertility, as at the same time other species have disappeared from the area because of the unfavorable conditions.

# W1

## BIO Workshop
## Identifying critical multiple stressors of North Pacific marine ecosystems and indicators to assess their impacts

***Co-Convenors**: Jennifer Boldt (Canada), Vladimir Kulik (Russia), Chaolun Li (China), Jameal Samhouri (USA), Motomitsu Takahashi (Japan) and Chang-Ik Zhang (Korea)*

***Invited Speaker**:*
*Natalie Ban (James Cook University, Australia)*

Multiple natural and human stressors on marine ecosystems are common throughout the North Pacific, and may act synergistically to change ecosystem structure, function and dynamics in unexpected ways that can differ from responses to single stressors. Further, these stressors can be expected to vary by region, and over time. This workshop seeks to understand responses of various marine ecosystems to multiple stressors, and to identify and characterize critical stressors in PICES regional ecosystems including appropriate indicators of their impacts. The goal is to help determine how ecosystems might change in the future and to identify ecosystems that may be vulnerable to the combine impacts of natural and anthropogenic forcing. Contributions are invited which identify and characterize the spatial and temporal extent of critical stressors in marine ecosystems (both coastal and offshore regions) of PICES member countries, and in particular the locations at which multiple stressors interact. Contributions will include a review and identification of broad categories of indicators which document the status and trends of ecosystem change at the most appropriate spatial scale (*e.g.*, coastal, regional, basin) in response to these multiple stressors. This workshop is linked with the topic session titled "*Ecosystem responses to multiple stressors in the North Pacific*" but is designed to provide more in-depth examination and discussion of the spatial and temporal extents of critical marine ecosystem stressors and their potential indicators. It will assist with progress towards the goals of PICES WG 28 on *Development of Ecosystem Indicators to Characterize Ecosystem Responses to Multiple Stressors* (http://www.pices.int/members/working_groups/wg28.aspx).

### Friday, October 12 (9:00-18:00)

09:00 ***Introduction by Convenors***

09:00 **Papers:**

**Natalie C. Ban, Stephen S. Ban and Hussein M. Alidina**
Combining stressor information – Experiences from Canada's Pacific waters and Australia's Great Barrier Reef (W1-8513), Invited

**Olga N. Lukyanova, Elena V. Zhuravel, Sergey A. Cherkashin, Denis N. Chulchekov, Viktor A. Nadtochyi and Olga V. Podgurskaya**
Bioindicators of multiple stressors interaction in the North-Eastern shelf of Sakhalin Island (Sea of Okhotsk) (W1-8472)

**Stephani Zador, Kirstin Holsman, Sarah Gaichas and Kerim Aydin**
Developing indicator-based ecosystem assessments for diverse marine ecosystems in Alaska (W1-8638)

10:30 ***Coffee/Tea Break***

10:50 **Papers:**

**Christopher Mulanda Aura, Sei-Ichi Saitoh, Yang Liu and Toru Hirawake**
Spatio-temporal model for mariculture suitability of Japanese scallop (*Mizuhopecten yessoensis*) in Funka and Mutsu Bays, Japan (W1-8451)

**Elliott L. Hazen, Jameal F. Samhouri, Isaac D. Schroeder, Brian K. Wells, Steven J. Bograd, David G. Foley, Nick Tolmieri, Phillip S. Levin, Greg Williams, Kelly Andrews, Sam McClatchie, William T. Peterson, Jay Peterson, Jessica Redfern, John C. Field, Ric Brodeur and Kurt Fresh**
Ecosystem indicators for the California Current: A Quantitative Approach Towards Indicator Development (W1-8505)

11:40 *Discussion*

12:30 ***Lunch***

14:00 **Papers:**

**Jameal F. Samhouri**
Much ado about everything: Comparison of expert-based vulnerability assessments for coastal habitats along the U.S. west coast (W1-8806)

**Jennifer Boldt, Alida Bundy, Caihong Fu, Lynne Shannon and Yunne Shin**
An overview of IndiSeas2: Evaluating the status of marine ecosystems in a changing world (W1-8431)

15:30 ***Coffee/Tea Break***

15:50 *Break out Group Discussions*

17:00 *Group Discussion*

18:00 *Workshop Ends*

## W1 Workshop Poster

W1-1 **Nadezhda L. Aseeva**
Reconstructions of flounder community on the shelf of West Kamchatka (Okhotsk Sea) under influence of environmental changes and interspecies relationships

# W1 Workshop Oral Presentations

### October 12, 09:00 (W1-8513), Invited

## Combining stressor information – Experiences from Canada's Pacific waters and Australia's Great Barrier Reef

Natalie C. **Ban**[1], Stephen S. Ban[1] and Hussein M. Alidina[2]

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This talk will discuss approaches to developing indicators for multiple stressors, drawing upon experience in Canada's Pacific waters and Australia's Great Barrier Reef. Approaches to combining stressors vary depending on the objective. If a regional synthesis is desired, simplifying assumptions can be made to provide a regional overview of stressors and likely interactions, given available data. This approach was taken in a study that mapped cumulative impacts in British Columbia, Canada. A similar, though non-spatial, approach comprised the Great Barrier Reef Marine Park Authority's Outlook Report in 2009. However, more detailed information and empirical bases for stressor interactions are needed if management measures are to result from indicators of multiple stressors. When enough empirical information exists, meta-analyses can inform stressor interactions. When such data are absent, expert-based elicitation can be used, for example using Bayesian methods. Both of the latter approaches were taken in a study in the Great Barrier Reef when examining effects of multiple stressors on coral mortality. Thus the aim of this talk is to inform PICES Working Group 28 by presenting some options of methods for combining multiple stressors.

### October 12, 10:00 (W1-8472)

## Bioindicators of multiple stressors interaction in the North-Eastern shelf of Sakhalin Island (Sea of Okhotsk)

Olga N. **Lukyanova**[1,2], Elena V. Zhuravel[2,3], Sergey A. Cherkashin[1], Denis N. Chulchekov[1], Viktor A. Nadtochyi[1] and Olga V. Podgurskaya[3]

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North-eastern offshore zone of Sakhalin Island is located from 52° to 53°N and from 143° to 144°E. This area is allocated by active hydrodynamics and lythodynamics. The main types of sediments are sands and gravels. Since 1996 offshore oil exploration has been started and at present time oil is being drill 24/7 on oil-extracting platforms. Oil drilling products affect the marine biota condition. The total biomass and ability of nekton and benthos have not changed significantly during last 15 years. However, the changes on the early stages of marine organisms' ontogenesis are more evident. In 2002 the amount of normal embryos of pollock *Theragra chalcogramma* and yellow-fin sole *Limanda aspera* in seawater near the oil drilling platforms was 10 times less than in adjacent waters. In 2011 the bioassay of seawater quality was conducted using embryos and larvae of sea urchin *Scaphechinus mirabilis*. A higher number of abnormalities at gastrula and pluteus stages were detected at the stations around oil platforms in comparison with the offshore areas. Eggs, embryos and larvae of marine fish and echinoderms may be used as bioindicators of early disturbances due to multiple stressor interactions in vulnerable ecosystems.

### October 12, 10:30 (W1-8638)

## Developing indicator-based ecosystem assessments for diverse marine ecosystems in Alaska

Stephani **Zador**[1], Kirstin Holsman[2], Sarah Gaichas[3] and Kerim Aydin[1]

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Although there are mandates for implementing ecosystem-based fisheries management (EBFM), guidance on how to implement it is still in development. Recently, NOAA has proposed the Integrated Ecosystem Assessment to provide a framework that allows for a diversity of objectives, indicators, and approaches. Our goal in this presentation is to describe lessons learned from a collaborative process used to develop indicator-based ecosystem assessments for the eastern Bering Sea (EBS) and the Aleutian Islands (AI) in order to inform EBFM efforts in other marine ecosystems. For each region, we used a team-based synthesis approach that involved convening Ecosystem Assessment Synthesis (EAS) teams composed of regional scientific experts, fisheries managers, and others. Their goal was to determine the best ecosystem indicators to serve as vital signs for regional fisheries managers. We draw three conclusions from our experience that are of broad interest: (1) the physiological and biological nature of the ecosystem, the extent of scientific knowledge about the ecosystem, and the particular expertise of the EAS team members will influence the final assessment product; (2) EAS team discussion of assessment structuring themes should occur before indicator selection, and (3) developing the assessments should be an iterative process with frequent review by managers. Further, we found that for large well-studied systems like the EBS, primary indicators that reflect changes in structuring processes and impacts were most informative. In contrast, for the data-poor and highly complex AI system, a mix of primary and integrative indicators helps inform managers of ecosystem-wide changes when data are intermittent or lacking.

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### October 12, 10:50 (W1-8451)

## Spatio-temporal model for mariculture suitability of Japanese scallop (*Mizuhopecten yessoensis*) in Funka and Mutsu Bays, Japan

Christopher Mulanda **Aura**[1,2], Sei-Ichi Saitoh[1], Yang Liu[1] and Toru Hirawake[1]

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Japanese scallop (*Mizuhopecten yessoensis*) provides good quality food and is a high productivity species cultured mainly in Funka and Mutsu Bays, Japan. In order to ascertain the stressors and impacts to such an industry and the marine ecosystem and to ensure long-term sustainability, there is need to assess mariculture performance and determine the most suitable sites for culture using robust suitability models. In the development of a site suitability model, this study was conducted using a geographic information system (GIS)-based multi-criteria evaluation (MCE) using a weighted linear combination to assess suitable sites for scallop culture in Funka and Mutsu Bays. Data sources for possible ecosystem indicators comprised Moderate Resolution Imaging Spectroradiometer (MODIS 2008-2011) and Advanced Land Observing Satellite (ALOS 2011). Basic requisites for scallop culture included biophysical (sea temperature, chlorophyll *a*, secchi disk depth and bathymetry) and social-infrastructure (distance to pier and town) parameters that formed thematic layers limited by a constraint layer (including areas near the river mouth, harbour and land facilities) that excluded potential areas in the model. The indicators and stressors delineated the coastal mariculture area, limited by bottom depths of $\leq 60$ m, under the ranking scale of 1 (least suitable) to 8 (most suitable). In the final model, about 34-43 % of the total potential area had score of 6 (suitable) out of 8, although Funka Bay region showed a high score of 7 (most suitable) whereas Mutsu Bay recorded a high score of 6. In validation, its comparison with the existing scallop culture was found to be consistent.

### October 12, 11:15 (W1-8505)

## Ecosystem indicators for the California Current: A Quantitative Approach Towards Indicator Development

Elliott L. **Hazen**[1,2], Jameal F. Samhouri[3], Isaac D. Schroeder[4,5], Brian K. Wells[5], Steven J. Bograd[2], David G. Foley[1,2], Nick Tolmieri[3], Phillip S. Levin[3], Greg Williams[3], Kelly Andrews[3], Sam McClatchie[6], William T. Peterson[7], Jay Peterson[7], Jessica Redfern[8], John C. Field[5], Richard D. Brodeur[7] and Kurt Fresh[3]

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The CCLME is a dynamic eastern boundary current driven ecosystem, influenced by waters from the northern and western Pacific and tropical eastern North Pacific. There are three ecotones from Baja, Mexico to Point Conception, Point Conception to Cape Mendocino, and Cape Mendocino to Vancouver Island. Coastal upwelling, El Niño, and decadal-scale climate forcing result in highly variable productivity in the region and consequently increased variability in many fisheries. Anthropogenic drivers including fisheries pressure also act upon the CCLME affecting ecological processes and biomass trends. One of the primary goals of the CC Integrated Ecosystem Assessment is identification and selection of indicators that best represent underlying ecosystem attributes and environmental variability. Indicators also provide a practical means to judge changes in ecosystem attributes related to the achievement of management objectives and for predicting ecosystem change and assessing risk. In this study we develop a quantitative indicator selection framework by looking for composite indices and links between pressure and state variables. The ultimate goal of this approach is to understand which indicators are the most correlated with ecosystem state, variability, and long term change at various spatial scales in the CCLME.

### October 12, 14:00 (W1-8806)

## Much ado about everything: Comparison of expert-based vulnerability assessments for coastal habitats along the U.S. west coast

Jameal F. **Samhouri**

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The oceans are subject to a wide variety of stressors, due to natural causes as well as people's activities on land and in the sea. A fundamental question facing those tasked with marine management and conservation is: which of these stressors, alone or in combination, matters most? Unfortunately, rigorous and quantitative data to inform the answer to this question is often lacking at appropriate spatial and temporal scales. In lieu of data, expert elicitation methods have been used to estimate vulnerability of marine ecosystems, defined here as the potential for negative impacts that jeopardize their persistence. In this talk, I will compare and contrast results from multiple efforts to elicit the opinions of regional experts about the vulnerability of coastal habitats along the U.S. west coast. These assessments encompass stressors as varied as pollution, climate change, invasive species, and overharvest in relationship to habitats from rocky shorelines and sandy beaches to the deep sea. The presentation is a contribution to the work of PICES Working Group 28 on the development of ecosystem indicators to characterize ecosystem responses to multiple stressors.

**October 12, 14:30 (W1-8431)**

## An overview of IndiSeas2: Evaluating the status of marine ecosystems in a changing world

Jennifer **Boldt**[1], Alida Bundy[2], Caihong Fu[1], Lynne Shannon[3] and Yunne Shin[4]

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This presentation will give an overview of the multinational collaborative efforts of Indicators for the Seas Phase 2 (IndiSeas2). The IndiSeas project is co-funded by IOC/UNESCO, the European Network of Excellence Euroceans (www.eur-oceans.eu), IRD (Institut de Recherche pour le Développement, www.ird.fr) and the European MEECE project (www.meece.eu). This overview will inform PICES Working Group (WG) 28 members of ongoing research that is pertinent to their efforts at identifying critical multiple stressors of North Pacific marine ecosystems and indicators to assess the impacts of those stressors. The goal of IndiSeas2 is to evaluate the status of marine ecosystems in a changing world using a suite of indicators that reflect effects of multiple drivers on the states and trends of exploited marine ecosystems. The first phase of IndiSeas identified a suite of eight ecological indicators to evaluate the effects of fishing on 19 exploited marine ecosystems. IndiSeas2 has extended the number of ecosystems compared, is examining additional indicators of climate, biodiversity and socio-economics, and is now exploring and testing the expanded suites of indicators, their performance, possible reference levels with links to management, and ways of integrating across these indicators for communication of ecosystem status. IndiSeas2 research will also include the use of models to explore combined effects of fishing and climate on indicator trends, and to test the responsiveness of indicators. A general overview and summary of initial results will support the work of PICES WG 28 members.

# W1 Workshop Poster Presentation

### W1-1

## Reconstructions of flounder community on the shelf of West Kamchatka (Okhotsk Sea) under influence of environmental changes and interspecies relationships

Nadezhda L. **Aseeva**

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Fluctuations of the flounders species composition on the shelf of West Kamchatka within their environments are analyzed. The proportion of sakhalin sole was rather low during 1960-1970s, high in the early 1980s when it reached 1/3 of the total biomass of flounders, low again during 1983-1997, and partially restored in the last decade. These fluctuations coincide roughly with environmental changes, but relationships between different species of flounders should be taken into account, as well. The deep-water sakhalin sole endures cold water that is wide-spread over the upper shelf of West Kamchatka within spring and summer after cold (and icy) winters. In the bottom "cold spots" with the temperature below 0°C, the sakhalin sole is usually dominant and up to 50-70% of its annual catch is taken there. If the "cold spots" expand to the upper shelf, where the more abundant yellowfin sole spawns, yellowfin sole eggs could be grazed by sakhalin sole. The environment on the shelf was favorable for yellowfin sole reproduction ("cold spots" were very limited) until the shift to cooler temperatures in 1993, and this species dominated in the bottom community. After the temperature shift, yellowfin sole still dominated, but its reproduction was not successful because of later hatching times and higher mortality due to grazing by the Sakhalin sole. So, in 6-7 years after the shift, the structure of the bottom fish community changed from a monodominant type with absolute domination of yellowfin sole to the polydominant type, when the abundances of yellowfin sole and sakhalin sole were comparable. Some years in the last decade were favorable for reproduction of yellowfin sole, but the community is still polydominant because of its low spawning stock. Supposedly, the steady growth of the yellowfin sole stock and total biomass of flounders at West Kamchatka could be expected after a definite shift to warmer environments.

# W2

## BIO Workshop
## Secondary production: Measurement methodology and its application on natural zooplankton community

***Co-Convenors**: Toru Kobari (Japan) and William Peterson (USA)*

***Invited Speaker**:*
*Lidia Yebra (Oceanographic Center of Málaga, Instituto Español de Oceanografía (IEO), Spain)*

Zooplankton communities play important roles on the transfer of primary production to higher trophic levels of marine ecosystems. In the past two decades, the quantitative evaluation of the energy flow has been emphasized for better understanding how marine ecosystems respond to climate change and global warming. To date, primary production can be globally estimated with remote sensing techniques and validated with *in situ* experiments using radio or stable isotope. Although secondary production has been estimated with various methods (natural cohort, artificial cohort, molting rate, egg production, nucleic acids ratio, enzyme activity and empirical models), there is little information which method is relevant for natural zooplankton population or community. Thereby, we have little knowledge or confidence of secondary production measurements compared with that of primary production. In this workshop, we intend to review current methodologies to measure secondary production. Through published reports of secondary production on natural zooplankton population or community, this workshop will clarify the assumptions, advantages and disadvantages for each method. We will also discuss new techniques (nucleic acids ratio, enzyme activity, chitobiase, or other methods) and challenges in the calibration between the estimates using different methods.

### Friday, October 12 (9:00-18:00)

09:00 ***Introduction by Convenors***

09:15 **Lidia Yebra**
Biochemical indices of zooplankton production (W2-8355), Invited

10:00 **Akash R. Sastri**
Chitobiase-based measurements of crustacean zooplankton community biomass production rates: Method development and application in the NE subarctic Pacific (W2-8666)

10:40 ***Coffee/Tea Break***

11:00 **William T. Peterson, Jay Peterson and Jennifer L. Fisher**
Use egg production of adult female copepods as a measure of secondary production (W2-8686)

11:40 **Hyung-Ku Kang**
Secondary production of *Acartia steueri* and *A. omorii* (Copepoda: Calanoida) in a small bay, southeastern coast of Korea: The growth rate approach (W2-8764)

12:20 ***Lunch***

14:00 **Ruben Escribano and Pamela Hidalgo**
Can temperature-dependent growth be used to measure secondary production of copepods in coastal upwelling systems? (W2-8734)

14:40 **Pamela Hidalgo and Ruben Escribano**
The importance of rapid development to produce more biomass on a year cycle: Comparing some copepod species from the Humboldt Current (W2-8733)

15:20 ***Coffee/Tea Break***

15:40 **Yasuhide Nakamura, Atsushi Yamaguchi and Noritoshi Suzuki**
Characteristics of zooplankton community in the Japan Sea: Biomass, stable isotope ratio and dominant taxa (W2-8354)

16:20 *Discussion*

18:00 *Workshop Ends*

## W2 Workshop Posters

W2-1 **Lidia Yebra, Elisa Berdalet, Rodrigo Almeda, Verónica Pérez, Albert Calbet and Enric Saiz**
AARS activity and RNA/DNA ratio as proxies for growth and fitness of *Oithona davisae* early developmental stages

W2-2 **Lidia Yebra, Sébastien Putzeys, Dolores Cortés, Ana Luisa Da Cruz, Francisco Gómez, Pablo León, Jesús M. Mercado and Soluna Salles**
Application of biochemical tools to assess zooplankton metabolism in the coastal North Alboran Sea (SW Mediterranean)

W2-3 **Toru Kobari, Shigeki Kori and Haruko Mori**
Nucleic acids and protein contents as proxies for protein-specific growth of *Artemia salina*

W2-4 **Sachi Miyake and Toru Kobari**
Nucleic acids and protein contents as proxies for starvation of marine copepods

W2-5 **Andrew G. Hirst, Julie E. Keister and numerous contributors**
Assessing copepod growth rates using the Modified Moult Rate Method

# W2 Workshop Oral Presentations

### October 12, 09:15 (W2-8355), Invited

## Biochemical indices of zooplankton production

Lidia **Yebra**

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Zooplankton are the main link between marine primary production and higher trophic levels. For this reason, the quantification of secondary production and the factors controlling it is one of the important objectives of marine ecology. Traditionally, copepod growth has been studied through incubations (*e.g.* artificial cohort method, egg production rate). However, such incubations imply manipulation of the organisms and are time consuming. As an alternative, the biochemical methods, most of them based on the estimation of protein or nucleic acid related compounds, have been proposed as proxies of somatic growth. Yet, it was not until the last 15 years that such methods have experienced a major development with the availability of new probes and assays with high sensitivity and low toxicity. In general, the biochemical approaches constitute an instantaneous picture of the immediate past physiology of the organism. These indices have the advantages of biochemical assays (sensitivity, precision and repeatability) but also the disadvantages of indirect measurements (they need to be calibrated). Usefulness of current biochemical indices of zooplankton production will be discussed in relation to other methods in use.

### October 12, 10:00 (W2-8666)

## Chitobiase-based measurements of crustacean zooplankton community biomass production rates: Method development and application in the NE subarctic Pacific

Akash R. **Sastri**

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Increasingly, ecologists have become concerned with estimates of ecosystem functioning and its drivers. One of such measurements is the production rate of zooplankton communities. Zooplankton communities occupy a central food-web role in the transfer of energy between primary producers and higher trophic levels (*e.g.* fishes and seabirds). Quantifying this role demands measures of community-level productivity. However, application of conventional methods at the community-level is often logistically difficult and this difficulty has prompted the exploration of alternative approaches. The chitobiase method is a potential alternative that is based on measurements of the water column activity and rate of production of the crustacean moulting enzyme chitobiase. Here I discuss the rationale behind this approach and how secondary production rates may be measured and calculated from short-term (<24 hour) incubations of seawater. Discussion of productivity estimates from the field measurements made in the NE subarctic Pacific will focus on an evaluation of measured rates and future directions for the development of this *in situ* measurement of crustacean zooplankton productivity.

**October 12, 11:00 (W2-8686)**

## Use egg production of adult female copepods as a measure of secondary production

William T. **Peterson**[1], Jay Peterson[2] and Jennifer L. Fisher[2]

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We have been measuring egg production rates of female *Calanus marshallae* and *Calanus pacificus* for the past eight years on a biweekly-monthly basis during cruises at Newport, Oregon. We are finding that both the availability of females for incubations and the egg production rates themselves are highly-dependent on the phase of the Pacific Decadal Oscillation (PDO). When in positive phase, *C. pacificus* are captured frequently and nearly year-round; during negative phase, we only catch *C. pacificus* during the winter and they are quire fecund at that time. *Calanus marshallae* are most abundant during months of negative phase. Egg production rates by *C. marshallae* are very high in winter, immediately after they awaken from diapause, with rates on the order of 50 eggs per female per day. Energy fueling this event must come from their stored lipids. Rates are usually as high during the summer upwelling season as well, however, egg production rate is not correlated with chlorophyll *a*, or with the > 5μm size fraction of chlorophyll *a*, suggesting phytoplankton alone are not their only food source. Oddly, the best correlate with *C. marshallae* egg production rate is the PDO, with the highest rates during months when the PDO is negative.

**October 12, 11:40 (W2-8764)**

## Secondary production of *Acartia steueri* and *A. omorii* (Copepoda: Calanoida) in a small bay, southeastern coast of Korea: The growth rate approach

Hyung-Ku **Kang**

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Secondary production of marine calanoid copepod *Acartia steueri* and *A. omorii* were measured from 2 October 1991 to 8 October 1992 at a station in a small bay on the southeastern coast of Korea, using the traditional growth rate method. Phytoplankton standing stock ranged from 1.0 to 9.3 mg chl.*a* $m^{-3}$. The two *Acartia* species were present throughout the year, while seasonal variation was found for their abundance. Biomass of *A. steueri* was averaged at 0.68 mgC $m^{-3}$ with peaks in November, February, May, and July-early August, and relatively low biomass in September-January. For *A. omorii*, the biomass was averaged at 0.44 mgC $m^{-3}$, with peaks in February and July, and relatively low biomass in late summer and fall. Instantaneous growth rates in the nauplius stages of both species were higher than in the copepodid stages. Annual production of *A. steueri* was 25.1 mgC $m^{-3}$ $yr^{-1}$ (or 166 mgC $m^{-2}$ $yr^{-1}$), showing peaks in November, May, and July-August with a small peak in February, and low production in December-April and September-October. For *A. omorii*, annual production was 33.5 mgC $m^{-3}$ $yr^{-1}$ (or 221 mgC $m^{-2}$ $yr^{-1}$), with peaks in February and July. There was no significant relationship of the daily production rate of *A. steueri* to water temperature or chlorophyll *a* concentration. However, the daily production rate of *A. omorii* was significantly correlated with chlorophyll *a* concentration, indicating that phytoplankton was the major influencing factor for seasonal variation of production of *A.omorii* in the bay.

**October 12, 14:00 (W2-8734)**

## Can temperature-dependent growth be used to measure secondary production of copepods in coastal upwelling systems?

Ruben **Escribano** and Pamela Hidalgo

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Copepods comprise the majority of zooplankton biomass in most ocean systems. In highly-productive coastal upwelling zones, copepods may encounter sufficient food year-round, at least to sustain their reproduction at any season. Although somatic growth does exhibit a yearly cycle, egg production (EPR) appears continuous year-round and the number of generations a year seems to be a function of mean temperature of the photic zone. In the Humboldt Current, same species withan extensive latitudinal distribution can show the year cycles, the generation times and the number of generations peryear, which are all dependent on the annual temperature regime attheirhabitat. However, the EPR seems independent of ambient temperature. The effect of temperature on generation time, but not on EPR, is the basis as to develop a simple temperature-dependent model to estimate annual production of a given copepod population. We used EPR data, empirical development rates, *in situ* growth rates (estimated by molting rate method), and time series data of copepod abundances, to show and test the potential application of this model for 3 dominant copepods inthe Humboldt Current. The extension and applicability of this approach for other systems are discussed.

**October 12, 14:40 (W2-8733)**

## The importance of rapid development to produce more biomass on a year cycle: Comparing some copepod species from the Humboldt Current

Pamela **Hidalgo** and Ruben Escribano

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*Calanus chilensis*, *Acartia tonsa* and *Paracalanus indicus* are dominant copepods in the northern Humboldt Current. They exhibit year-round reproduction and may grow under non-limiting condition of food, and their abundances seem to be not affected by warming El Niño events. We estimated annual production of these species in the coastal upwelling area of northern Chile (23° S) during 2010. Moulting rate experiments were used to calculate the stage-specific growth rate (*g*) for each species for three seasonal periods, based on monthly sampling. Mean annual *g*´s were 0.20, 0.21 and 0.24 $d^{-1}$ for *C. chilensis*, *A. tonsa* and *P.indicus*, respectively, whereas the annual productions estimated from monthly abundances were 14.2, 6.8 and 16.4 g C $m^{-2}$ $y^{-1}$ for same species, respectively. The smallest-sized *P. indicus* became numerically dominant, and its greater production was resulted from a very rapid growth, especially for the younger copepodid stages (C1 and C2). The rapid growth at the earlier stages was reflected in the high moulting rates (>0.3 $d^{-1}$), compared to those for the other species at an average temperature of 15°C. This rapid growth resulted in the advantage of having more generations a year, and hence more annual production. We suggest that rapid growth allows *P. indicus* to become the most successful and dominant copepod in the coastal upwelling zone.

**October 12, 15:40 (W2-8354)**

### Characteristics of zooplankton community in the Japan Sea: Biomass, stable isotope ratio and dominant taxa

Yasuhide **Nakamura**[1], Atsushi Yamaguchi[1] and Noritoshi Suzuki[2]

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Hydrography of the Japan Sea is different from those of the adjacent North Pacific Ocean, especially for the Japan Sea Proper Water below 300 m which low temperature (<1°C) and stable salinity (ca. 34.05) are found. While their importance, there is few study to compare the zooplankton community structure of the Japan Sea with those in the adjacent seas. The aim of this study is to clarify the characteristics of zooplankton community in the Japan Sea, comparing their biomass, stable isotope ratio and dominant taxa. From 8 June to 2 August 2011, zooplankton was collected using a Twin NORPAC net in the 0-150 m layer at 60 stations of 5 different areas around Japan (Japan Sea, Okhotsk Sea, East China Sea, Subarctic and Subtropical North Pacific Oceans). Within the 14 stations, we also conducted 12-layer vertical stratified samplings down to 3000 m using a VMPS. Zooplankton wet mass in the 0-150 m layer of the northern Japan Sea was higher than those in the southern Japan Sea and in the Subarctic North Pacific at the same latitude. In terms of vertical profiles of zooplankton dry mass, the biomass below 1500 m in the Japan Sea was remarkably lower than those in the other areas. The $\delta^{15}$N value was increased for the most taxa with increasing depth because the deep-sea zooplankton were dependent on their food on organic materials sinking from the upper layers.

# W2 Workshop Poster Presentations

**W2-1**

### AARS activity and RNA/DNA ratio as proxies for growth and fitness of *Oithona davisae* early developmental stages

Lidia **Yebra**[1,2], Elisa Berdalet[1], Rodrigo Almeda[1], Verónica Pérez[1], Albert Calbet[1] and Enric Saiz[1]

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*Oithona* is one of the most abundant marine planktonic copepod genera, and constitutes a major food source for fish larvae. While important advances have been attained on the ecology and metabolism of adults, little is known about the early developmental stages. In this work, we combined two biochemical indices, which were already used in calanoid copepods, to estimate growth and fitness of *Oithona davisae* nauplii and copepodites: i) the specific aminoacyl-tRNA synthetases (spAARS) activity (proxy of protein synthesis rate) and ii) the RNA/DNA ratio (indicative of overall metabolic activity). We provide a first insight into the variability of these parameters on *O. davisae* nauplii growing under different temperature and food conditions. Somatic growth rates (based on direct estimates of individuals' length), spAARS activity and RNA/DNA ratio showed a positive correlation with temperature. The RNA/DNA ratio was more sensitive to starvation than the spAARS activity. Both the spAARS activity and RNA/DNA ratio are adequate indices of somatic growth. However, the RNA/DNA ratio relationships with both somatic growth rates and spAARS activity were different for nauplii and copepodites and hence might not be a suitable growth index for mixed populations. The methodological development presented simplifies the study of small copepod nauplii physiology.

## W2-2

## Application of biochemical tools to assess zooplankton metabolism in the coastal North Alboran Sea (SW Mediterranean)

Lidia **Yebra**, Sébastien Putzeys, Dolores Cortés, Ana Luisa Da Cruz, Francisco Gómez, Pablo León, Jesús M. Mercado and Soluna Salles

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The Alboran Sea is characterized by a complex hydrography due to the confluence of Atlantic and Mediterranean waters, permanent gyres and wind-driven upwelling events. The environmental conditions affect zooplankton directly and indirectly, by modifying the availability and quality of food (*e.g.* phytoplankton, microzooplankton). In turn, zooplankton appears to control the abundance and composition of the phytoplankton communities, probably via phytoplankton-ciliate-zooplankton interactions. Both phytoplankton and zooplankton production are a determinant factor on the survival of commercially important planktivorous fish larvae (*e.g.* sardine, anchovy). The trophic relationships among these different plankton functional groups could play a key role in regulating the whole pelagic ecosystem response to environmental changes. In order to determine the role of zooplankton in the functioning of the pelagic trophic webs in the coastal Alboran Sea, their metabolic rates were determined over a two year period (2010-2012). The application of biochemical tools allowed us to study the seasonal variability of biomass and rates of grazing, respiration and growth for different size fractions of zooplankton (100-2000 µm). The relationship between the variability of zooplankton metabolic rates and the abundance and composition of phytoplankton is analyzed in the present study.

## W2-3

## Nucleic acids and protein contents as proxies for protein-specific growth of *Artemia salina*

Toru **Kobari**[1], Shigeki Kori[1] and Haruko Mori[2]

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Nucleic acids and protein contents have been reported as indicators for growth and nutritional conditions of marine copepods for the last decade. This biochemical method can be globally applied for measurements of *in situ* growth rate for zooplankton population or community, because not only the measurement is simple and rapid but also the methodology can be widely applied for various taxonomic groups. Here we report that nucleic acids and protein contents and the ratio with development of planktonic crustacean, *Artemia salina*. Individual DNA content showed an exponential increase with development stages and incubation days. RNA and protein (PRO) contents slightly declined or were stable at early life stages and early incubation periods. Especially, individual RNA content was considerably high for first naupliar stage just after egg hatching. RNA/DNA and RNA/PRO ratios revealed slight decline or were stable during a few days after egg hatching, and then exponentially increased. Protein-specific growth rate was significantly correlated with RNA/DNA and RNA/PRO ratios (Pearson correlation, $p<0.01$). Protein-specific growth rate could be fitted with non-linear regression equations and saturated at the higher ratios. However, weight-specific (dry mass) growth rate showed no significant correlation with RNA/DNA and RNA/PRO. These results indicate that RNA/DNA and RNA/PRO ratios are well associated with protein syntheses but not synchronized with weight-specific increment. We suggest that RNA/DNA and RNA/PRO ratios are useful proxies for protein-specific growth but do not reflect weight-specific growth.

## W2-4

## Nucleic acids and protein contents as proxies for starvation of marine copepods

Sachi **Miyake**[1] and Toru Kobari[2]

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While nucleic acids and protein contents have been focused as proxies for nutritional and physiological conditions of zooplankton for the last decade, we have little knowledge on the possibility of the application to natural zooplankton. This biochemical approach can be globally applicable for zooplankton population and community due to not only the simple and quick measurement but also the widely applicable methodology for various taxonomic groups. In the present study, we investigated the ratios of individual content of nucleic acids (DNA and RNA) and protein (PRO) and the ratios (RNA/DNA and RNA/PRO) as proxies for starvation of zooplankton. RNA/DNA and RNA/PRO ratios declined significantly for starved metanauplius stage of *Artemia salina* with actively swimming and no lipid accumulation, while such decline was unclear for RNA/PRO ratio at the copepodite stage 5 for *Calanus sinicus* with hop and sink swimming and lipid accumulation. Compared the biochemical ratios of starved copepods appearing between the two different sites of the North Pacific Ocean, significant decline was found for both RNA/DNA and RNA/PRO of the starved copepods appearing at the subtropical site and for only RNA/DNA ratio of the subarctic copepods at the subarctic site. RNA/PRO ratio showed no substantial decline for some subarctic copepods even under starvation for 5 days. These results suggest that marine copepods decline quickly RNA/DNA ratio under starvation but RNA/PRO ratio is insignificantly changed for some copepods accumulating lipids and protein. We propose RNA/DNA ratio as a proxy for simple and quick identification of starvation for natural marine copepods.

## W2-5

## Assessing copepod growth rates using the Modified Moult Rate Method

Andrew G. Hirst[1], Julie E. **Keister**[2] and numerous contributors

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Over the last 30 years, growth rates of copepod juveniles have been determined using the ‘Moult Rate’ (MR) method. Results from this approach have been presented in over 40 papers, and dominate the available data on juvenile growth rates under field conditions. These studies have greatly influenced our appreciation of zooplankton production. However, the MR method has recently been shown to be flawed: increase in weight between stages (typically two consecutive stages, $i$ and $i$+1) is assigned as having accumulated in a period equal to the duration of stage $i$, which is not necessarily the case. In this study, we re-determine growth rates in many previously published studies, using the original weight and stage duration data, but applying a Modified Moult Rate (MMR) equation. Our results show that the MR method has typically over-estimated growth rates, often by more than 2-fold. Moreover, it is not possible to correct the growth rates for copepodite stage 5 (C5), or to apply the MMR method to this stage. This is a significant drawback as this stage contributes greatly to non-adult biomass, and is critical to adult supply. We therefore present a practical method for determining growth rates of the C5 stages in the field, and apply this to *Calanus pacificus*. These results indicate that the MR method may under-estimate the growth rate at the C5 stage by as much as an order of magnitude.

# W3 BIO Workshop
# The feasibility of updating prey consumption by marine birds, marine mammals, and large predatory fish in PICES regions

***Co-Convenors**: George Hunt, Jr. (USA), Hidehiro Kato (Japan) and Michael Seki (USA)*

***Invited Speaker**:*
*Robert Olson (Inter-American Tropical Tuna Commission, USA)*

It has been 12 years since the publication of PICES Scientific Report No. 14 on "*Predation by marine birds and mammals in the subarctic North Pacific Ocean*" edited by Hunt, G.L. Jr., Kato, H., and McKinnell, S.M. This publication is the sole overview of the trophic requirements and trophic roles of marine birds and mammals for the North Pacific, and has been a much used reference by a wide variety of scientists including those interested in modeling the roles of marine birds and mammals. As of 2012, Google Scholar lists 49 citations of this report. In the 12 years since its publication, it has become rather considerably out of date. Our knowledge of the distribution and abundance of marine birds and mammals has advanced greatly, as has our knowledge of the food habits of a number of species. Additionally, there has been an increase in interest in the roles of large predatory fish in the world's oceans. Thus it would seem timely to provide an update of PICES Scientific Publication 14, and, if there is interest for it, to include information on prey consumption by large predatory fishes.

## Friday, October 12 (9:00-18:00)

| | |
|---|---|
| 09:00 | ***Introduction by Convenors*** |
| 09:05 | **Robert J. Olson**<br>Data availability for estimating prey consumption by large pelagic fishes, particularly tunas, in the PICES region (W3-8823), Invited |
| 09:30 | **Tsutomu Tamura and Kenji Konishi**<br>Prey consumption and feeding habits of three baleen whale species in the western North Pacific (W3-8669) |
| 09:50 | **Kaoru Hattori, Yoko Goto, Mari Kobayashi and Orio Yamamura**<br>Food habits of pinnipeds in Japanese waters: A review (W3-8762) |
| 10:30 | ***Coffee/Tea Break*** |
| 10:50 | **Yutaka Watanuki**<br>Diet study of seabirds breeding in Japan (W3-8466) |
| 11:20 | **Sayaka Nakatsuka, Daisuke Ochi, Yukiko Inoue, Kotaro Yokawa, Hiroshi Ohizumi, Yasuaki Niizuma and Hiroshi Minami**<br>The food composition of Laysan and Black-footed Albatrosses in the North Pacific from 2010 to 2011 (W3-8368) |
| 11:40 | **George L. Hunt, Jr., Martin Renner, Kathy Kuletz, Gary Drew and John Piatt**<br>Seabird numbers, days of occupancy, and prey habits in the Gulf of Alaska and the eastern Bering Sea (W3-8818) |
| 12:00 | *Discussion* |
| 12:30 | ***Lunch*** |
| 14:00 | **Mike Seki** Lead<br>*Discussion:* Should we Include Fish, and if so, what species? |
| 14:30 | **Yutaka Watanuke** Lead<br>*Discussion:* How much can we add about seabirds in the Western Pacific? |

15:00 **George L. Hunt, Jr.** Lead
Discussion: How much can we add about seabirds in the Eastern Pacific?

15:30 ***Coffee/Tea Break***

15:50 **Hidehiro Kato** Lead
*Discussion:* How much do we know about cetaceans in the Western Pacific?

16:20 **Kaoru Hattori** Lead
*Discussion:* How much do we know about pinnipeds in the Western Pacfic?

16:50 **Rolf Ream** Lead
*Discussion:* How much do we know about pinnipeds in the Eastern Pacfic?

17:20 **Rolf Ream** Lead
*Discussion:* How much do we know about cetaceans in the Eastern Pacific?

17:50 *Wrap up by Convenors*

18:00 *Workshop Ends*

# W3 Workshop Oral Presentations

### October 12, 09:05 (W3-8823), Invited

## Data availability for estimating prey consumption by large pelagic fishes, particularly tunas, in the PICES region

Robert J. **Olson**

Inter-American Tropical Tuna Commission, 8604 La Jolla Shores Dr., La Jolla, CA, 92037, USA

Several large pelagic fishes are important components of the North Pacific ecosystem. The temperate tunas, Pacific bluefin (*Thunnus orientalis*) and albacore (*T. alalunga*) inhabit PICES subregions during portions of the year. These tunas are highly migratory, capable of trans-Pacific migrations. Approximate population abundance estimates for these species should be available from stock assessments done by the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC). Scant information exists on consumption rates from diverse sources, such as captive research and bioenergetics modeling. The tropical tunas, on the other hand, are not common in the PICES regions. The Inter-American Tropical Tuna Commission (IATTC) does stock assessments annually for the yellowfin (*Thunnus albacares*), skipjack (*Katsuwonus pelamis*), bigeye (*Thunnus obesus*) tuna stocks in the tropical and sub-tropical eastern Pacific Ocean, but the northern extent of their ranges barely overlap into the southern part of the PICES region. Catch per unit of effort by 1-degree or 5-degree areas might be used for partitioning population estimates into approximations for PICES sub-regions.In general, more informationis available on the tropical tunas than the temperate species in the Pacific. Bioenergetics and daily ration estimates have been produced, although for warmer regions. Diet data for these wide-ranging generalist predators are available, but little direct diet informationfor the tropical tunas is known for the PICES regions.

### October 12, 09:30 (W3-8669)

## Prey consumption and feeding habits of three baleen whale species in the western North Pacific

Tsutomu **Tamura** and Kenji Konishi

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Waters of the Pacific side of Japan can be considered as Japan's richest fishing grounds and provide an ideal area to study the interaction between cetaceans and fisheries. The evaluation of such interaction is important for the development of management policies for fisheries resources that are based on an ecosystem approach. To this end, the systematic collection of data on the feeding ecology of top predators is important. The Second Phase of the Japanese Whale Research Program under Special Permit in the western North Pacific (JARPN II) has been collecting such data for large whales occurring in this productive area. In this study we examined the feeding habits and the prey consumption rates of three baleen whale species, common minke, Bryde's and sei whales, based on data collected by the JARPN II between 2000 and 2007. Given their high abundance, it is likely that these cetacean species play an important role in the ecosystem. The main prey species of common minke whale consisted of one copepod, two krill, two squids and eight fish species. The main prey species of sei whale consisted of two copepods, three krill and four fish species. The main prey species of Bryde's whale consisted of five krill, one squid and four fish species. The Japanese anchovy is one the of important prey species of these three whale species. The annual total prey consumption during spring-summer by the three baleen whale species in the western North Pacific was estimated to be over 1.5 million tons.

### October 12, 09:50 (W3-8762)

## Food habits of pinnipeds in Japanese waters: A review

Kaoru **Hattori**[1], Yoko Goto[2], Mari Kobayashi[3] and Orio Yamamura[1]

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There are 7 species of pinnipeds, 2 otariids and 5 phosids, in the Japanese coastal waters. Diets of these species have been studied since the 1950s. Steller sea lions (SSLs, *Eumetopias jubatus*) and northern fur seals (NFSs, *Callorhinus ursinus*) migrate to Hokkaido Island and the Pacific coast of northeastern Japan from October through June (non-breeding season) to avoid sea ice in the Sea of Okhotsk, and to meet their energetic demands for growth and reproduction in the following seasons. They are opportunistic feeders preying primarily on demersal and pelagic fishes and cephalopods. The diets of the otariids have shifted decadally in response to variation in prey resources, including the decline of gadids (SSLs; Goto *et al*. 2011) and the species alternation in small pelagics (NFSs; Yonezaki *et al*. 2008). Ribbon seals (*Histriophoca fasciata*) and most spotted seals (*Phoca largha*) migrate to the Hokkaido Islands during winter (breeding season), while harbor seals (*Phoca vitulina*) and some spotted seals are resident along the eastern coast of Hokkaido Island. Their food habits are similar to that of the SSLs, with a slightly higher dependence on coastal and benthic animals by harbor seals (Nakaoka *et al*. 1986).

### October 12, 10:50 (W3-8466)

## Diet study of seabirds breeding in Japan

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Information on seabird diets has been collected from species breeding on the islands in the northern Japan Sea and along the Pacific coast of Japan since 2000. Chick diets of Rhinoceros Auklets *Cerorhinca monocerata*, Japanese Cormorants *Phalacrocorax filamentosus* and Black-tailed Gulls *Larus crassirostris* on Teuri Island have been monitored for more than 20 years. During 1992-2009, Rhinoceros Auklet fed on Japanese Anchovy *Engrauris japonicus* and juvenile greenling *Pleurogrammus azonus*, Japanese Cormorant on sandlance *Ammodytes personatus*, anchovy, adult greenling and various demersal fish, and Black-tailed Gulls on sandlance. To determine the diets of adult Rhinoceros Auklets, we also collected information of stomach contents using the water-offloading technique and stable isotopes of blood cells. We found that the adults fed on krill and fish in the spring, and on the same species of fish as were in chick diets during summer. Stomach contents of Streaked Shearwaters *Calonectris leucomelas* breeding on the Pacific islands (Mikura, Sangan) and on a Japan Sea island (Awa) were collected. The shearwaters fed mainly on anchovy, squid and flying fish during short trips and on anchovy and saury during long trips to northern Pacific coast. Fatty-acid analyses of stomach oil that reflected diets during the long trips indicated that anchovy and saury were the main prey.

### October 12, 11:20 (W3-8368)

## The food composition of Laysan and Black-footed Albatrosses in the North Pacific from 2010 to 2011

Sayaka **Nakatsuka**[1], Daisuke Ochi[1], Yukiko Inoue[1], Kotaro Yokawa[1], Hiroshi Ohizumi[2], Yasuaki Niizuma[3] and Hiroshi Minami[1]

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Prey items from the stomachs of Laysan *Phoebastria immutabilis* and Black-footed *P. nigripes* albatrosses were examined. These albatrosses were caught by the pelagic longline fisheries in the North Pacific between April 2010 and March 2011. The proventriculus and gizzard of each bird species were examined separately because the condition of the prey items differed between those organs. Each prey item was classified into four periods: Apr.–June (late breeding period), July–Sept. (post-breeding period), Oct.–Dec. (pre-breeding period) and Jan.–Mar. (former breeding period) according to the phenology of these albatrosses. Undigested fish or cephalopods were found in the proventriculus, while the hard objects such as the beaks of cephalopod, plastics, and stones were found in the gizzard. The differing stages of digestion suggested that the residence-time differed for each part of a prey item. The main prey of the both albatrosses was cephalopods; small fish were also a major prey of Laysan Albatross. The diets of both species of albatrosses were dominated by Gonatidae, Histioteuthidae and Onychoteuthida. Estimated dorsal mantle length (DML) of squids preyed upon by albatrosses were below 200mm, which was smaller than the matured sizes of those squids, and the size of whale prey. The species and estimated DML of squids varied with the seasons. We suggest that these albatrosses foraged on the immature stages of squid, which float in the surface layer, and changed the species of taken with the seasons.

### October 12, 11:40 (W3-8818)

## Seabird numbers, days of occupancy, and prey habits in the Gulf of Alaska and the eastern Bering Sea

George L. **Hunt**[1], Jr., Martin Renner, Kathy Kuletz, Gary Drew and John Piatt

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We report on the status of data available to assess the numbers of seabirds occupying the Gulf of Alaska and the Eastern Bering Sea, the amount of time that they are present and the status of information on food habits. We will compare the quantity and quality of information available with that which was available for the production of PICES Scientific Report 14 on the Consumption of Prey by Marine Birds and Mammals, and evaluate whether there is sufficient new information to warrant an update of PICES Scientific Report 14.

# W4 ESSAS/PICES Workshop Subarctic–Arctic interactions

***Co-Convenors**: Kenneth Drinkwater (ESSAS/Norway), Jackie Grebmeier (ESSAS/USA), James Overland (PICES/USA) and Sei-Ichi Saitoh (PICES/Japan)*

***Invited Speakers**:*
*Seth Danielson (University of Alaska Fairbanks, USA)*
*Ichiro Imai (Hokkaido University, Japan)*
*Eiji Watanabe (JAMSTEC, Japan)*

Exchanges of water masses and their associated flora and fauna strongly link the marine Arctic and the Subarctic. Both regions have undergone significant warming, and there has been reduced sea-ice in recent years in some regions. Climate change scenarios indicate that these regions are likely to experience even greater warming and transformation in the future. To better understand how climate variability and change will affect these marine ecosystems from biogeochemical processes, through the food web to the highest tropic levels, it is essential to improve our knowledge of the role of physical and biological fluxes between the Subarctic and Arctic and the fate of the transported organisms. Therefore, this workshop will examine the influence of the warm Subarctic inflows on the physical conditions and biology in the Arctic basin and shelves, as well as the role of fluxes of water from the Arctic basin onto the surrounding shallow shelves and into the Subarctic. Papers that cover multiple trophic levels or investigate biophysical coupling are especially sought. Also, we encourage presentations on the observed changes that are occurring as well as those on possible scenarios under climate change. Relevant experimental studies, field programs and modeling of Arctic-Subarctic interactions will be considered. Emphasis will be on the Arctic-Pacific Ocean linkages but those considering the exchanges in the Atlantic are also welcome.

## Friday, October 12 (9:00-15:30)

09:00 ***Introduction by Convenors***

09:15 **Seth L. Danielson, Tom Weingartner, Kate Hedstrom, Knut Aagaard, Enrique N. Curchitser, Jinlun Zhang and Rebecca A. Woodgate**
The Bering Sea shelf circulation and its role in Pacific-Arctic exchanges (W4-8396), Invited

09:40 **Ichiro Imai, Chiko Tsukazaki, Kohei Matsuno, Ken-Ichiro Ishii and Atsushi Yamaguchi**
Abundant distribution of diatom resting stage cells in bottom sediments of Bering Sea and Chuckchi Sea: Possible seed populations for blooms (W4-8646), Invited

10:05 **Eiji Watanabe, Michio J. Kishi, Akio Ishida, Maki N. Aita and Takeshi Terui**
Biological hot spots emerging along the pathway of Pacific summer water in the western Beaufort Sea (W4-8525), Invited

10:30 ***Coffee/Tea Break***

11:00 **Atsushi Yamaguchi, Rie Ohashi, Kohei Matsuno and Ichiro Imai**
Interannual changes in the zooplankton community structure on the southeastern Bering Sea shelf and Chukchi Sea during summers of 1991–2009 (W4-8339)

11:20 **Yasunori Sakurai, HaeKyun Yoo and Jun Yamamoto**
A comparison of reproductive characteristics and strategies between walleye pollock (*Theragra chalcogramma*) and Arctic cod (*Boreogadus saida*) (W4-8743)

11:40 **Franz J. Mueter, Mike A. Litzow, Seth L. Danielson, Paul D. Spencer and Robert R. Lauth**
The roles of temperature, abundance and advection in modifying the spatial dynamics of groundfish at the Subarctic-Arctic boundary in the eastern Bering Sea (W4-8624)

12:00 **Jacqueline M. Grebmeier**
The Distributed Biological Observatory (DBO): A change detection array in the Pacific Arctic region (W4-8793)

12:20 **Poster Descriptions**

12:30 ***Lunch***

14:00 **George L. Hunt, Jr., Arny Blanchard, Peter Boveng, Padmini Dalpadado, Kenneth F. Drinkwater, Lisa Eisner, Russ Hopcrofb, Kit Kovacs, Brenda Norcross, Paul Renaud, Marit Reigstad, Martin Renner, Hein Rune Skjoldal, Andy Whitehouse and Rebecca A. Woodgate**
The Barents and Chukchi Seas: Comparison of two Arctic shelf ecosystems (W4-8433)

14:20 **Kenneth F. Drinkwater**
On the role of advection on the interaction between the Arctic and Subarctic seas: Comparing the Atlantic and Pacific Sectors (W4-8640)

14:40 *Discussion*

15:30 *Workshop Ends*

## W4 Workshop Posters

W4-1 **Zhongyong Gao, Heng Sun and Liqi Chen**
Comparison of decadal changes in the carbon sink and potential responses to climate change in the Taiwan Strait, Bering Sea and bipolar regions

W4-2 **Jacqueline M. Grebmeier and Takashi Kikuchi**
The Pacific Arctic Group (PAG): A Pacific perspective on Arctic science

# W4 Workshop Oral Presentations

### October 12, 09:00 (W4-8640)

## On the role of advection on the interaction between the Arctic and Subarctic seas: Comparing the Atlantic and Pacific Sectors

Kenneth F. **Drinkwater**

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A brief review of water mass advection between Arctic and Subarctic regions and the effects on their ecology will be presented. The influence of Arctic outflows through Fram Strait, the Barents Sea and the Canadian Archipelago on the subarctic regions and the inflow of Pacific waters through the Bering Strait and of Atlantic Waters through the Fram Strait and the Barents Sea on the Arctic will be discussed. Results from recent ESSAS related activities on Arctic-Subarctic interactions held during a Workshop in Yeosu, Korea and within a Theme Session at the ICES Annual Science Conference in Bergen will be described. In addition to describing temperature and freshwater fluxes between the two regions, the role of advection of sea ice from the Arctic and its associated flora and fauna to the Subarctic will be mentioned. Nutrient fluxes and influences on stratification will be presented in terms of their effects on phytoplankton production. Advection of water masses also transports zooplankton communities between the two regions, as well as some ichthyoplankton. Brief mention will be made on the role of fronts between outflowing Arctic Water and inflowing Pacific and Atlantic Water. Possible future changes in advective fluxes between the Arctic and Subarctic will be highlighted along with their possible effects on the marine ecosystem.

### October 12, 09:15 (W4-8396), Invited

## The Bering Sea shelf circulation and its role in Pacific-Arctic exchanges

Seth L. **Danielson**[1], Tom Weingartner, Kate Hedstrom, Knut Aagaard, Enrique N. Curchitser, Jinlun Zhang and Rebecca A. Woodgate

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The western Arctic and North Pacific atmospheric pressure fields vary synoptically, seasonally and inter-annually and set the wind speed and direction over the Bering Sea shelf. Recent work shows that flow across the Bering shelf is particularly sensitive to the wind direction relative to the orientation of the coastline and shelf bathymetry. Waters flowing northward through Bering Strait are drawn either eastward from the Gulf of Anadyr, northward from the central shelf, or from some combination of the two. Because these two source regions exhibit different temperatures, salinities, nutrient concentrations, and plankton communities, prolonged wind direction anomalies can lead to variations in the Bering Sea's northward exports to the Arctic. Using mooring data, atmospheric hindcasts, and numerical model results, I provide details about the structure of the Bering shelf flow field under various forcing conditions and examine implications to the Chukchi and Bering Sea shelves.

**October 12, 09:40 (W4-8646), Invited**

## Abundant distribution of diatom resting stage cells in bottom sediments of Bering Sea and Chuckchi Sea: Possible seed populations for blooms

Ichiro **Imai**[1], Chiko Tsukazaki[1], Kohei Matsuno[1], Ken-Ichiro Ishii[2] and Atsushi Yamaguchi[1]

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Information on resting stage cells (RSCs) of diatoms is fundamentally important to understand the population dynamics of diatoms including bloom formation. The distributions of viable diatom RSCs in bottom sediments of the eastern Bering Sea in July 2009 and Chuckchi Sea in October 2010 were investigated by the most probable number method. The densities of diatom RSCs were revealed to be $1.7 \times 10^3 \sim 1.2 \times 10^6$ MPN cells $cm^{-3}$ wet sediment in the Bering Sea and $3.5 \times 10^5 \sim 6.8 \times 10^6$ MPN cells $cm^{-3}$ wet sediment in the Chuckchi Sea, being comparable to those in temperate shallow eutrophic areas where massive blooms frequently occur. Common species during the spring phytoplankton blooms in the water columns are also dominant in sediments as resting stage cells. Dominant genera were *Attheya*, *Chaetoceros* and *Thalassiosira. Chaetoceros socialis* was the most abundant species in sediments followed by *Thalassiosira nordenskioeldii* and *Attheya longicornis*. It should be noted that relatively high densities of ice-algae, especially ribbon-like chain forming pennate diatoms (the genera *Fragilariopsis* and *Fragilaria*, $\sim 1.1 \times 10^5$ MPN cells $cm^{-3}$ wet sediment) were also found in the sediments at the site of the Chuckchi Sea close to Bering Strait and the sites of south east part of the Bering Sea. The employment of RSCs in life cycle enable both planktonic and ice-algal species to survive the unfavorable environments such as dark and cold winter season, and potentially contribute to form blooms of different phases (subsurface of ice, ice edge and plankton) through the process of vertical mixing.

**October 12, 10:05 (W4-8525), Invited**

## Biological hot spots emerging along the pathway of Pacific summer water in the western Beaufort Sea

Eiji **Watanabe**[1], Michio J. Kishi[1,2], Akio Ishida[1,3], Maki N. Aita[1] and Takeshi Terui[1,4]

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Western Arctic basin ecosystem is addressed in the viewpoint of Pacific water transport with heat and biogeochemical materials. The eddy-resolving coupled sea ice-ocean model demonstrates that early sea ice reduction during summer promotes the eddy-induced transport of warm Pacific summer water from Chukchi shelf to Canada Basin. In a lower-trophic marine ecosystem configuration of the western Arctic model, the Beaufort shelf-break warm eddies produce hot spots of primary productivity, which were detected by satellite remote sensing and ship-based measurements. One of control mechanisms is found to be internal eddy dynamics such as turbulent vertical mixing with underlying nutrient-rich water. In addition, the time lag between phytoplankton bloom following summertime sea ice retreat in Chukchi shelf region and eddy generation north of Barrow Canyon is an important index to determine biological regimes in Beaufort Sea. Interannual variations in eddy performance probably have a significant impact on the bottom-up control of food chains. The possible future consequences proposed by a series of high-resolution modeling studies are the enhancement of ocean heat intrusion and zooplankton activity in the downstream region of Pacific water pathway, especially around Northwind Ridge.

### October 12, 11:00 (W4-8339)

## Interannual changes in the zooplankton community structure on the southeastern Bering Sea shelf and Chukchi Sea during summers of 1991–2009

Atsushi **Yamaguchi**, Rie Ohashi, Kohei Matsuno and Ichiro Imai

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Annual changes in mesozooplankton community were evaluated at two locations: SE Bering Sea Shelf (subarctic) during 1994-2009 and Chukchi Sea (arctic) in 1991/1992 and 2007/2008. In both locations, samples were collected with vertical tows of Norpac net from near-bottom depth during July-August. Species identification, enumeration and biomass determination were made for each sample. Cluster analysis based on abundance identified that there were four (Chukchi Sea) or six (SE Bering Sea) types of zooplankton communities. Annual changes in zooplankton community was related with climate change (cold regime (1994–2000) to a warm regime (2001–2005)) in the SE Bering Sea, while was related with the sea ice coverage area in the Chukchi Sea. For Chukchi Sea, geographic distributions of each group in 1991 and 1992 were similar but those in 2007 and 2008 were shifted northward. Abundance and biomass in 2007/2008 were higher than in 1991/1992, indicating that further sea ice reduction would have a positive effect on zooplankton production (*e.g.* invasion of large Pacific species and temperature effects on their growth rate). The northern shift in geographic distribution of the zooplankton community in 2007/2008 indicates that sea ice reduction would have a negative effect on the zooplankton community (loss of characteristic Arctic species) in part of the Chukchi Sea. These apparently contradictory effects of sea ice reduction on zooplankton community emphasize the critical need for continued monitoring in this area.

### October 12, 11:20 (W4-8743)

## A comparison of reproductive characteristics and strategies between walleye pollock (*Theragra chalcogramma*) and Arctic cod (*Boreogadus saida)*

Yasunori **Sakurai**[1], HaeKyun Yoo[1] and Jun Yamamoto[2]

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Arctic cod have a circumpolar distribution and are a key component in arctic food webs. In the northern Bering Sea, their distribution overlaps with that of another important gadid species, walleye pollock. The distribution and abundance of these species in the Bering and Chukchi Seas is strongly affected by environmental change, such as temperature-driven regime shifts, due to changes that occur in reproduction and recruitment. Walleye pollock spawn pelagic eggs at mid-water depths over a several-day period each spawning season. The hatching rate of normal larvae is low below 2°C and high between 2 and 7°C. On the other hand, arctic cod spawn all of their pelagic eggs in a single spawning under the sea ice and most spawned fish die. Normal embryonic development occurs between -1.5 and 3°C, with the highest survival rates occurring between 0.5 and 3°C. In this talk, the reproductive characteristics and strategies of both species will be compared and discussed based on the results of captive experiments and field surveys by Hokkaido University's training ship *Oshoro Maru*.

**October 12, 11:40 (W4-8624)**

## The roles of temperature, abundance and advection in modifying the spatial dynamics of groundfish at the Subarctic-Arctic boundary in the eastern Bering Sea

Franz J. **Mueter**[1], Mike A. Litzow[2], Seth L. Danielson[3], Paul D. Spencer[4] and Robert R. Lauth[4]

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The summer distribution of groundfish on the eastern Bering Sea shelf reflects complex responses to the availability of suitable prey and the abundance of predators and competitors. For example, the mean distribution of aggregate groundfish biomass peaks near two persistent oceanographic fronts near the 50m and 100m isobaths, possibly reflecting physical mechanisms that concentrate prey. These spatial dynamics are modified by species-specific temperature preferences that can lead to pronounced changes in distribution in response to variable temperature conditions. Bottom temperatures over the middle domain (~ 50-100m) are largely determined by the extent of sea ice during the previous winter, which forms a "cold pool" of water on the shelf. The extent of this cold pool determines the southern limit for several Arctic species and constrains the northward expansion of subarctic species. The well-mixed waters of the inner domain (~ 0-50m) provide a corridor for the seasonal migration of shallow-water species to bypass the cold pool into the northern Bering Sea, while the deeper and consistently warmer waters of the outer shelf and slope provide a refuge for subarctic species. Advection may further modify the feeding distributions of Bering Sea fish and shellfish either indirectly, through the re-distribution of suitable prey and water masses, or directly by advecting early life stages or facilitating active migrations. Here we quantify the relative importance of density-dependent factors (abundance of conspecifics), temperature, and advection in regulating the spatial dynamics of groundfish species and discuss the implications of climate change for their future distribution.

**October 12, 12:00 (W4-8793)**

## The Distributed Biological Observatory (DBO): A change detection array in the Pacific Arctic region

Jacqueline M. **Grebmeier**

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The Pacific sector of the Arctic Ocean is experiencing major reductions in seasonal sea ice extent and increases in sea surface temperatures. Observations indicate that changes in the timing of sea ice formation and retreat, along with increasing seawater temperatures, can drive shifts in marine species composition that may result in large-scale marine ecosystem reorganization. To more systematically track the broad biological response to sea ice retreat and associated environmental change, an international consortium of scientists through the Pacific Arctic Group (PAG) are developing a coordinated “Distributed Biological Observatory” (DBO) that includes selected biological measurements at multiple trophic levels, coincident with hydrographic surveys and satellite observations, in the Pacific Arctic. The DBO currently occupies five regional biological “hotspot” locations along a latitudinal gradient from the northern Bering Sea to the Barrow Arc. Hydrographic transects were occupied from spring to fall in 2010 through 2012 during a pilot program focused at two sites in the southern Chukchi Sea and Barrow Canyon that provide repeat collections of water parameters and multiple biological trophic level parameters seasonally. This sampling indicates freshening and warming as Pacific seawater transits northward over the spring to fall season as sea ice retreats, with impacts on both plankton and benthic prey bases for larger marine mammals and seabirds. As the DBO moves to an implementation phase, the intent is to serve as a change detection array for the identification and consistent monitoring of biophysical responses to climate change. Further information on the DBO is available at http://www.arctic.noaa.gov/dbo/.

**October 12, 12:20 (W4-8433)**

## The Barents and Chukchi Seas: Comparison of two Arctic shelf ecosystems

George L. **Hunt, Jr.**[1], Arny Blanchard, Peter Boveng, Padmini Dalpadado, Kenneth F. Drinkwater, Lisa Eisner, Russ Hopcrofb, Kit Kovacs, Brenda Norcross, Paul Renaud, Marit Reigstad, Martin Renner, Hein Rune Skjoldal, Andy Whitehouse and Rebecca A. Woodgate

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We compare and contrast two Arctic shelf seas, the Barents and Chukchi Seas. The Barents supports much larger fisheries and higher biomass of fish than the Chukchi, despite the fact that primary production per unit area is similar in both seas, as is the export of carbon to the benthos. Both seas are at similarly high latitudes, are seasonally ice covered, and have strongly advective regimes. The water entering the Barents comes from the deep, ice-free and relatively warm Norwegian Sea. It contains not only heat, which keeps the southwestern Barents ice-free year around, but also rich supplies of plankton that support larval fish growth in spring. In contrast, the nutrient and phytoplankton-rich water entering the Chukchi Sea in spring and early summer is cold, having traversed the shallow northern Bering Sea, which is ice-covered in winter. In spring, this Bering Sea water is depleted of large, lipid-rich zooplankton, many species of which need deeper water for over-wintering, resulting in relatively low availability of zooplankton for fish in spring. Thus, we hypothesize that the difference in fish abundance is driven by differences in the heat and plankton advected into these seas. The heat maintains Barents Sea water temperatures within the physiological limits of the fish. The early arrival of advected zooplankton also promotes high fish production in the Barents Sea, but without the heat, the commercially important fish would not survive in this region and conditions would be more similar to the Chukchi Sea.

# W4 Workshop Poster Presentations

### W4-1

## Comparison of decadal changes in the carbon sink and potential responses to climate change in the Taiwan Strait, Bering Sea and bipolar regions

Zhongyong **Gao**, Heng Sun and Liqi Chen

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Almost 10 years data of partial pressure of CO2 ($p\text{CO}_2$) observation between air and the surface sea water in different seas were compared along the Chinese National Arctic and Antarctic Research Expedition (CHINARE) cruises from 1999 to 2010. Our results shows that the decadal changes varied from different latitude seas. Though $p\text{CO}_2$ in the air were all simply slightly increased in global scale, $p\text{CO}_2$ in surface sea water in different seas took on different change. The typical seas such as Taiwan Strait, Bering Sea, Prydz Bay in the Antarctic, Chukchi Sea in the Western Arctic and the Southern Ocean were selected to compare the difference of their response to the global change and the increasing of $p\text{CO}_2$ in the air. The results shows that Taiwan Strait spring carbon sink was weakened, on the contrary, the Prydz Bay carbon sink was enhanced. In contrast, Bering basin maintained relatively stable during the last 11years, *i.e.* $p\text{CO}_2$ increased from $p\text{CO}_2$ in the air. However, They fluctuated sharp in the Bering Shelf and Bering Slope regions. Same situation happened in the Chukchi sea in the western Arctic Ocean, and the high latitude central Arctic Ocean were maintained stale.

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### W4-2

## The Pacific Arctic Group (PAG): A Pacific perspective on Arctic science

Jacqueline M. **Grebmeier**[1] and Takashi Kikuchi[2]

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The Pacific Arctic Group (PAG) is a consortium of institutes and individuals having a Pacific perspective on Arctic science. Organized under the International Arctic Science Committee (IASC), the PAG has as its mission to serve as a Pacific Arctic regional partnership to plan, coordinate, and collaborate on science activities of mutual interest. The four PAG principle science themes are climate, contaminants, human dimensions and structure and function of Arctic ecosystems. The PAG membership is led by an Executive Committee consisting of a Chair, two Vice Chairs, one Executive Member and the Project Coordinator. The general membership of the PAG may form project groups to address specific issues linked to the PAG objectives. Members are chosen to represent regional variety and breadth of scientific expertise required in PAG. Examples of current PAG activities include: 1) undertaking a Pacific Arctic region multidisciplinary synthesis of scientific findings in the marine region relevant to ongoing scientific objectives at the core of the PAG, 2) development of a Distributed Biological Observatory (DBO) of environmental and biological sampling at stations on transect lines located along a latitudinal gradient extending from the northern Bering Sea to the Barrow Arch, and 3) sampling in the Chukchi Borderland and western Canada Basin region to investigate climate, oceanographic and sea ice interactions in a developing time series format. All aspects of PAG are undertaken via international and national collaborations and project coordination. This presentation will outline the goals of PAG and highlight ongoing projects.

# W5 BIO Workshop
# Comparison of multiple ecosystem models in several North Pacific shelf ecosystems (MEMIP-IV)

***Co-Convenors**: Harold Batchelder (USA), Shin-Ichi Ito (Japan), Angelica Pena (Canada) and Yvette Spitz (USA)*

This will be the first MEMIP (Marine Ecosystem Model Intercomparison Project) workshop where we have completed model comparisons within single shelf systems; *e.g.*, within the Northern California Shelf, Gulf of Alaska shelf and Oyashio shelf and offshore, individually. The workshop tasks will be to undertake quantitative assessment of the successes and shortcomings of individual models within regions and across regions. This formal skill assessment is a key activity to enable MEMIP to identify which, if any, of the various ecosystem models have broad skill spatially and temporally in multiple North Pacific shelf ecosystems. The observations (nutrients, chlorophyll and zooplankton biomass) from the key years of simulation (2000-2003) have been compiled to enable model-data comparisons for each of the three regions. To our knowledge this will be the first multiple model skill assessment that extends to zooplankton, *e.g.*, beyond phytoplankton, and the first that focuses on ecosystem models applied to coastal systems. We anticipate one or several peer-reviewed scientific papers and a MEMIP report to result from this workshop.

## Day 1, Friday, October 12 (9:00-18:00)

09:00 ***Introduction by Convenors***

09:20 **Jarrod A. Santora, William J. Sydeman,Monique Messié, Fei Chai, Sarah Ann Thompson, Brian K. Wells and Francisco P. Chavez**
Triple check: Spatio-temporal observations of krill and seabirds verifies structural realism of an ocean ecosystem model (W5-8418)

09:45 **Yvette Spitz (Chair)**
Work Session 1: Overview of MEMIP Model Status. Update on progress since Oct 2011.

10:30 ***Coffee/Tea Break***

10:50 **Hal Batchelder (Chair) / Angelica Peña (Chair)**
Work Session 2: MEMIP Impressions, Recommendations, Stumbling Blocks

11:30 **Hal Batchelder (Chair)**
Coupled model results/new simulations/*etc.*

12:30 ***Lunch***

14:00 **Shin-ichi Ito (Chair)**
Work Session 3: Coupled model results/new simulations/*etc.* (*continued*)

15:30 ***Coffee/Tea Break***

15:50 **Angelica Peña (Chair)**
Work Session 4: Coupled model results/new simulations/*etc.* (*continued*)

17:30 **Workshop Convenors**
Day 1 Wrap-up: Open Discussion of Progress and Planning Day 2

18:00 *Day 1 Workshop Ends*

## Day 2, Saturday, October 13 (9:00-18:00)

09:00 ***Introduction by Convenors***

09:10 **Yvette Spitz (Chair) / Hal Batchelder (Chair)**
Skill Assessment: Example of SA using Newport Spitz model

09:45 **Hal Batchelder (Chair) / Angelica Peña (Chair)**
Work Session 5: Continue model simulations and/or skill assessments

10:30 ***Coffee/Tea Break***

10:50 **Yvette Spitz (Chair) / Hal Batchelder (Chair)**
Work Session 6: Continue model simulations and/or skill assessments

12:30 ***Lunch***

14:00 **Yvette Spitz (Chair) / Hal Batchelder (Chair)**
Work Session 7: Continue model simulations and/or skill assessments

15:30 ***Coffee/Tea Break***

15:50 **Yvette Spitz (Chair) / Hal Batchelder (Chair)**
Work Session 8: Continue model simulations and/or skill assessments

17:00 **Workshop Convenors**
Workshop Wrap-up: Accomplishments, Progress Report, Future Steps, Requests to BIO (if any)

18:00 *Workshop Ends*

# W5 Workshop Oral Presentation

### October 12, 09:20 (W5-8418)

## Triple check: Spatio-temporal observations of krill and seabirds verifies structural realism of an ocean ecosystem model

Jarrod A. **Santora**[1], William J. Sydeman[1], Monique Messié[2], Fei Chai[3], Sarah Ann Thompson[1], Brian K. Wells[4] and Francisco P. Chavez[2]

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Knowledge of spatio-temporal variability in krill abundance and distribution can be used to predict numerical responses of marine top predators in many pelagic ecosystems worldwide. Consequently, significant improvements in fisheries and ecosystem management could be made if predicting zooplankton, and specifically krill, were possible using ocean ecosystem models. To examine structural realism in an ocean ecosystem model (ROMS-CoSINE), we compared the distribution of modeled mesozooplankton from an independently-designed modeling framework to observed patterns of krill and fluctuations in krill and seabird abundance off central California. Spatial observations of krill and modeled zooplankton (Z2) displayed latitudinal coherence, but distinct longitudinal offsets. Temporal observations indicated coherence between Z2 and *Thysannoessa spinifera* (a neritic krill species) and seabird abundance and reproductive performance. Despite having basin-scale resolution, the CoSINE model captures structural realism of mesozooplankton dynamics in this region, and relates well to top marine predators, suggesting its utility for management of shelf ecosystems.

# W6 MEQ Workshop
# The contrasting cases of HABs in the eastern and western Pacific in 2007 and 2011

***Co-Convenors**: Changkyu Lee (Korea) and Mark Wells (USA)*

***Invited Speakers**:*
*Sanae Chiba (JAMSTEC, Japan)*
*William Peterson (Hatfield Marine Science Center, NMFS, USA)*

Harmful algal blooms reached historic levels along coastlines of the eastern Pacific in 2011, but similar blooms were minimal to non-existent in Japan, Korea and Russia. The situation was largely reversed in 2007, and this disparity between these years offers a unique opportunity to compare and contrast the basic environmental parameters and HAB dynamics during these regimes. Combining these observations with a broader overview of the basin-scale physical dynamics during this time frame would provide new insights to the factors enhancing these blooms. The workshop foundation will be the pre-submission of available data from member countries, including but not limited to: HAB species presence and abundance, time of year, temperature range, salinity range, water clarity, wind, river flow (flooding), and upwelling indices. Workshop participants will review and discuss the trends and patterns in these data over the first day, and integrate them with information on the basin-scale physical dynamics. Participants will develop a detailed outline for manuscript preparation during the second day, with agreed writing assignments and draft submission deadlines. The manuscript will be targeted for the appropriate international journal decided upon by participants.

## Day 1, Friday, October 12 (9:00-17:40)

09:00 ***Introduction by Convenors***

09:15 **Takashi Kamiyama, Hiroyuki Yamauchi, Shinnosuke Kaga, Satoshi Nagai and Mineo Yamaguchi**
Effects of the tsunami by the Great East Japan Earthquake on distribution of *Alexandrium* cysts and risk of PSP occurrence in Tohoku coastal areas in Japan (W6-8476)

09:45 **Ruixiang Li, Zongling Wang and Mingyuan Zhu**
Harmful Algal Blooms in coastal water of China in 2011 (W6-8697)

10:15 ***Coffee/Tea Break***

11:00 **William T. Peterson**
The potential influence of local physical forcing (factors related to coastal upwelling) and basin-scale forcing (factors related to ENSO and the PDO) on harmful algal bloom in the Oregon upwelling zone (W6-8687), Invited

11:40 **Sanae Chiba**
Contrast of the lower trophic level responses to climatic forcing over the eastern and western North Pacific (W6-8406), Invited

12:10 ***Lunch***

13:30 **Tatyana Yu. Orlova, O.G. Shevchenko, Inna V. Stonik and Vladimir M. Shulkin**
Cases of HABs in 2007 and 2011 in Peter the Great Bay (East/Japan Sea), Russia (W6-8537)

14:00 **Svetlana Esenkulova and Nicola Haigh**
Bloom dynamics of *Heterosigma akashiwo* in coastal waters of British Columbia (BC), Canada in 2007 and 2011; Data from the Harmful Algae Monitoring Program (W6-8614)

14:30 **Chang-Hoon Kim and Ji Hoe Kim**
Monitoring and development of PSP toxins along the south coast of Korea (W6-8754)

15:30 ***Coffee/Tea Break***

16:00 **Changkyu Lee**
HAB DATA 2007 and 2011 - Korea

16:20 **Shigeru Itakura**
HAB DATA 2007 and 2011 - Japan

16:40 **Charles Trick**
HAB DATA 2007 and 2011 - Canada

17:00 **Vera Trainer**
HAB DATA 2007 and 2011 - USA

17:20 *Discussion and Day 2 Plan*

17:40 *Workshop Ends*

### Day 2, Saturday, October 13 (9:00-12:30)

09:00 Session Plan
Identification of Central Findings
Discussion of Outcome

10:30 ***Coffee/Tea Break***

10:50 Identification of Lead Author
Detailed Outline of Manuscript
Assignment of Tasks and Timeline
Summary

12:30 *Workshop Ends*

## W6 Workshop Posters

W6-1 **Junya Tomita, Tomoki Nishiguchi, Motoaki Yagi, Daekyung Kim and Tatsuya Oda**
Evaluation of toxic potential of newly isolated *Chattonella antiqua*, by laboratory exposure experiments and micro-bioassay using cultured cells

W6-2 **Hao Guo, Xu Xiao-man and Li Xia**
Red tide survey and information system in Dalian Port

W6-3 **Feng-ao Lin, Hao Guo, Yongjian Liu, Daoyan Xu and Xingwang Lu**
High-incidence HAB**s** species in China Coastal Waters and the forewarning method based on the HAB**s** Risk Index

W6-4 **Lijian Shi, Bin Zou, Qimao Wang and Maohua Guo**
The application of multi-sensor to Red Tide monitoring over the Yellow Sea

# W6 Workshop Oral Presentations

### October 12, 09:15 (W6-8476)

## Effects of the tsunami by the Great East Japan Earthquake on distribution of *Alexandrium* cysts and risk of PSP occurrence in Tohoku coastal areas in Japan

Takashi **Kamiyama**[1], Hiroyuki Yamauchi[2], Shinnosuke Kaga[3], Satoshi Nagai[4] and Mineo Yamaguchi[5]

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Information on abundance and distribution of *Alexandrium* cysts is important to evaluate the risk of area and scale of paralytic shellfish poisoning (PSP). The tsunami by the East Japan Earthquake on 3.11 in 2011 greatly influenced the coastal bottom environment on the northern Pacific coast in Japan. We investigated changes in abundance and distribution of *Alexandrium* (*A. tamarense* and *A. catenella*) cysts in Sendai Bay after the tsunami using the direct count method, and discuss the risk of PSP in Tohoku region of Japan after the tsunami based on the results and other related data. Densities of *Alexandrium* cysts in sediments collected in summer 2011 ranged from 0 to 8,190 cysts $cm^{-3}$. The highest density was approximately 10 times higher than the value recorded in 1995 and considerably higher densities than data in 1995 were observed in the western part of the bay. These drastic changes were probably caused by the vertical and horizontal accumulation of the cysts in sediments after the tsunami. Additionally, in Ofunato Bay, higher concentration of the planktonic *A. tamarense* than the previous record in this bay was observed in May to June in 2011 and high contamination of PSP toxins was recorded from mussels. In northern Japan, the number of PSP occurrence exceeding the quarantine level since 2008 has been in low level (6-8 incidences) compared with the value (14-18 incidences) during 2003-2007. However, results in the present study imply that the risk of PSP increases in east coast of Tohoku region after the earthquake.

### October 12, 09:45 (W6-8697)

## Harmful Algal Blooms in coastal water of China in 2011

Ruixiang **Li,** Zongling Wang and Mingyuan Zhu

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There are 55 HAB events in coastal water of China in 2011 with total affected area of 6076 $km^2$. Among them, 23 HAB events occurred in East China Sea, 13 in Bohai Sea, 11 in South China Sea and 8 in Yellow Sea. Compared with HAB in recent 5 years, HABs in 2011 were lowest both in frequency and area affected. The season with frequent HAB was from April to August. There are 21 species, which formed HAB in 2011. The main HAB organisms include *Prorocentrum donghaiense*, *Noctiluca scintillans* and *Skeletonema costatum* etc. The HAB caused by dinoflagellates and other flagellates increased in 2011.

**October 12, 11:00 (W6-8687), Invited**

## The potential influence of local physical forcing (factors related to coastal upwelling) and basin-scale forcing (factors related to ENSO and the PDO) on harmful algal bloom in the Oregon upwelling zone

William T. **Peterson**

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This presentation will be an overview of mechanisms, data and best guesses as to what causes harmful (and non-harmful) algal blooms in the Oregon upwelling zone with a focus on *Pseudonitzschia* blooms as well as the oceanographic conditions that led up to the very unusual and massive bloom of *Akaishiwo sanguinea* that occurred off Washington and Oregon in autumn 2009. Many of the results that will be presented will be based on biweekly oceanographic cruises made off Newport Oregon since 1996 and on the project MOCHA (Monitoring Oregon Coast Harmful Algae) funded by NOAA.

**October 12, 11:40 (W6-8406), Invited**

## Contrast of the lower trophic level responses to climatic forcing over the eastern and western North Pacific

Sanae **Chiba**

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This presentation is to review the contrast of lower trophic level ecosystem and its response to the climatic forcing in the eastern and western North Pacific, and attempt to examine the link between the observed changes in offshore and coastal ecosystems. It has been well reported the difference in phytoplankton composition and seasonality; HNCL condition and less distinctive bloom dominated by pennate diatom in the east, and extensive bloom dominated by centric diatom in the west. Lifecycle timing of dominant zooplankton slightly differs also. In interannual to decadal scale, plankton phenology and biogeography varies at roughly same timing but in opposite phase in east and west, responding to the east-west gradient in physical environment derived by a common climatic forcing *e.g.* Aleutian Low dynamics, which is indicated by PDO index. While coastal HAB occurrence can be attributed to multiple stressors including various human activities, *e.g.* nutrients overloading, land use, *etc.*, rather than the large scale natural climatic oscillation, PDO related signal have been often observed even in an inner coastal bay (*e.g.* Tokyo Bay). We observed the strong negative PDO signal in 2011 when extensive HAB was observed along the coast of the eastern NP yet in the western NP. As negative PDO indicates to derive warm and cool conditions in the east and western NP, respectively, possible mechanisms that caused the observed regional difference in HAB occurrence will be discussed.

**October 12, 13:30 (W6-8537)**

## Cases of HABs in 2007 and 2011 in Peter the Great Bay (East/Japan Sea), Russia

Tatyana Yu. **Orlova**[1], O.G. Shevchenko[1], Inna V. Stonik[1] and Vladimir M. Shulkin[2]

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HAB dynamics in Peter the Great Bay Amursky Bay (East/Japan Sea) in 2007 and 2011 were analyzed. This area is exposed to continuous anthropogenic influence due to input of urban and agricultural runoff. The revealed changes in the composition and abundance of the phytoplankton are as follows: there are species-specific changes in the abundance and seasonal dynamic of HABs taxa; a list of species causing blooms of water and toxin producers was expanded; the biomass of the non-diatom component of the phytoplankton increased. The relationship between river runoff variability and the time and intensity of phytoplankton blooms was analyzed. The factors controlling the present situation and future trends in the study area were discussed.

## October 12, 14:00 (W6-8614)

## Bloom dynamics of *Heterosigma akashiwo* in coastal waters of British Columbia (BC), Canada in 2007 and 2011; Data from the Harmful Algae Monitoring Program

Svetlana **Esenkulova** and Nicola Haigh

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The Harmful Algae Monitoring Program (HAMP) has been working with the salmon aquaculture industry on the west coast of Canada (Northeast Pacific) to monitor harmful algal blooms since 1999. *Heterosigma akashiwo* is the most significant fish-killing algae species in BC; here we present data from 2007 and 2011 of *H. akashiwo* concentrations and abundances from weekly samples taken at sites around Vancouver Island. In 2007 *H. akashiwo* arrived early, with the first significant bloom of 160,000 cells/mL recorded in Departure Bay in late May. The blooms were thick, persistent, and remarkable in extent. In 2011 *H. akashiwo* blooms began late, with the first significant bloom of 22,000 cells/mL recorded in Jervis Inlet in mid June. Blooms were patchy and locally distributed. In both years the timing, frequency, and duration of *H. akashiwo* blooms appeared to be strongly influenced by spring and summer temperatures, precipitation, and Fraser River discharge.

## October 12, 14:30 (W6-8754)

## Monitoring and development of PSP toxins along the south coast of Korea

Chang-Hoon **Kim**[1] and Ji Hoe Kim[2]

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Since the 1980s, forty-four cases of PSP, of which five were fatal, were reported from the south coast of Korea, and all those who died had consumed toxic wild mussels. Since 1990s, the PSP monitoring area was expanded to the east and west coasts of Korea. Marine biotoxins are analyzed at the National Fisheries Research and Development Institute, Busan. Local governments act to prevent shellfish poisoning caused by marine biotoxins, for example by closing harvesting areas. Presently, PSP is measured by the mouse bioassay, and the official regulatory limit for biotoxin in shellfish is 800 $mg•kg^{-1}$ for PSP. When concentrations exceed the regulatory limit, shellfish harvesting areas are temporarily closed; recreational harvesting is also prohibited. PSP has occurred in the spring season, mainly from March to May, on the southeast coast of Korea. Jinhae Bay is especially affected by exceeding the regulatory limit every year. Therefore, a number of studies have been performed over the last two decades to verify the toxin production by PSP causative organisms. Also PSP toxin composition has been used as a practical biomarker to differentiate among *Alexandrium* isolates from different geographical locations, of which *A. tamarense* and *A. catenella* from coastal areas contained carbamate toxins as their major toxin component, were clearly distinguishable from those from offshore areas, which contained *N*-sulfocarbamoyl toxins as their major toxin component. This variation can be attributed to differences in environmental regimes; these relationships will be discussed in relation to long-term toxicity changes.

# W6 Workshop Poster Presentations

## W6-1

### Evaluation of toxic potential of newly isolated *Chattonella antiqua*, by laboratory exposure experiments and micro-bioassay using cultured cells

Junya Tomita[1], Tomoki Nishiguchi[1], Motoaki Yagi[2], Daekyung Kim[3] and Tatsuya **Oda**[1]

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*Chattonella antiqua*, a raphidophycean flagellate, is a highly toxic red tide phytoplankton which causes severe damage to fish farming in Japan. Although several hypotheses on the ichthyotoxic mechanism have been proposed, precise fish-killing mechanism of this phytoplankton is still controversial. Physiological and histological studies of fish exposed to *Chattonella* spp. suggested that blockade of respiratory water flow through gill lamellae that may be caused by excessively secreted mucus in gill tissue, resulted in suppression of $O_2$ transfer, and eventual asphyxia. In 2010, we isolated *C. antiqua* (Shi-strain) at Shimabara, Japan. Exposure experiments using this strain against Japanese horse-mackerel (*Trachurus japonicus*) and Red sea bream (*Pagellus bogaraveo*) showed that Shi-strain was highly toxic to both fish species, and all fishes were died within a few houses after exposure at 1 x $10^4$ cells/ml. Shi-strain showed potent ROS ($O_2^-$) generation activity. Furthermore, we applied lactate dehydrogenase (LDH)-release assay to estimate toxic potential of Shi-strain by using Vero (African green monkey kidney) cells as target cells. Live cell suspension of Shi-strain induced the release of LDH from Vero cells in cell-density and time-dependent manners, and the activity was inhibited by SOD. Our results suggest that Shi-strain with potent ichthyotoxic activity induced membrane damage of Vero cells in which ROS may be partly responsible.

## W6-2

### Red tide survey and information system in Dalian Port

Hao **Guo**[1], Xu Xiao-man[2] and Li Xia[2]

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Red tide (HAB) is an important environmental problem in coastal areas and may do great harm to society and economy. Some species of red tide can survive and be transferred in ship's ballast water from its source to other regions. China has conducted investigations on the red tide outbreaks along its coastline for several years, and to assist in implementing IMO Guidelines on ballast water safety a red tide information system has been developed for ships by the China Liaoning MSA under the GloBallast Programme. This system helps ships take precautionary measures when loading ballast water in places where red tides are reported. The results of the investigation in the Port of Dalian showed that ballast water inorganic nitrogen, phosphorus and oil concentrations were high and that the seawater presented eutrophication problems. Ballast waters contained 58 red tide organisms of which 8 species had bloomed in 31 cases of red tide in the Dalian region. In addition, 3 divisions, 40 species of phytoplankton were identified and 3/4 species were red tide algae, which also included 1 toxic alga in this survey.

## W6-3

## High-incidence HABs species in China Coastal Waters and the forewarning method based on the HABs Risk Index

Feng-ao **Lin**[1], Hao Guo[1], Yongjian Liu[1], Daoyan Xu[1] and Xingwang Lu[2]

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HABs causative species in China Coastal Waters were divided into three categories: high, frequent and common bloom-forming species, based on their average annual number and total area of occurrence from 2006 to 2010.These data were obtained from HABs database of Chinese National Marine Environmental Monitoring Center. There were 4 high occurrence HAB species (*Prorocentrumdonghaiense*, *Skeleonemacostatum*, *Noctilucascintillans* and *Kareniamikimotoi*),4 frequent occurrence HAB species (*Phaeocystisglobosa*, *Chaetoceros* sp., *Heterosigmaakashiwo* and *Rhodomonas* sp.), and 8 common bloom-forming species (*Thalassiosira* sp., *Mesodiniumrubrum*, *Scrippsiellatrochoidea*, *Ceratium* sp., *Gonyaulaxspinifera*, *Akashiwosanguinea*, *Chattonella marina* and *Gymnodinium* sp.) in China Coastal Waters. In addition, the bloom occurrence threshold was defined according to the cell size of HABs causative species. The HABs Risk Index was also assessed based on the abundance of HABs causative species or the concentration of chlorophyll *a* in sea water. Furthermore, by using the HABs Risk Index and the Eutrophic Index, a graded HABs forecasting method was established in this study.

## W6-4

## The application of multi-sensor to Red Tide monitoring over the Yellow Sea

Lijian **Shi**, Bin Zou, Qimao Wang and Maohua Guo

National Satellite Ocean Application Service, Beijing, PR China. E-mail: shilj@mail.nsoas.gov.cn

Based on the spectral characteristics, Red Tides occurring in the waters of Rizhao, a coastal city of the Yellow sea, wasremotely monitored by the multi-sensors of MODIS and HJ-1A/1B satellites. Our findings show that MODIS data provides large-scale information on Red Tides, such as distribution and coverage range. The data of CCD of HJ-1A/1B can be used to get the detailed information of Red Tide. The drift trend can be inverted with multi-temporal satellite image.

# W7 SCOR/PICES Workshop
# Global patterns of phytoplankton dynamics in coastal ecosystems

***Co-Convenors**: Hans Paerl (USA) and Kedong Yin (China)*

***Invited Speaker**:*
*William Li (Bedford Institute of Oceanography, DFO, Canada)*

Phytoplankton biomass and community structure have undergone dramatic changes in coastal ecosystems over the past several decades in response to climate variability and human disturbance. These changes have short- and longer-term impacts on global carbon and nutrient cycling, food web structure and productivity, and coastal ecosystem services. There is a need to identify the underlying processes and measure rates at which they alter coastal ecosystems on a global scale. Hence, the Scientific Committee on Ocean Research (SCOR) formed Working Group 137 (WG 137) on *Global Patterns of Phytoplankton Dynamics in Coastal Ecosystems: Comparative Analysis of Time Series Observations* (http://wg137.net/). To address fundamental questions that emerged, WG 137 will use data compiled from 84 sampling stations, representing research and monitoring programs spread across five continents, and is seeking additional time series of coastal/estuarine/near-shore phytoplankton and relevant hydrographic data. Investigators with decadal observational data are encouraged to contribute to this growing compilation and discuss interests in collaboration. The wealth of information in these data sets provides an unprecedented opportunity to develop a global analysis and investigation of the dynamics and status of ecosystems where land and sea meet. The workshop will cover conceptual models of phytoplankton community variability and quantitative approaches for extracting patterns from time series.

## Day 1, Friday, October 12 (9:00-18:00)

09:00 ***Introduction by Convenors***

09:05 **William K.W. Li, Todd D. O'Brien and Xosé Anxelu G. Morán**
An ecological status report for phytoplankton and microbial plankton in the North Atlantic and adjacent seas (W7-8704), Invited

10:30 ***Coffee/Tea Break***

10:50 **Jacob Carstensen, Hans W. Paerl and James E. Cloern**
The phytoplankton composition across the world's coastal ecosystems (W7-8602)

12:30 ***Lunch***

14:00 **Todd D. O'Brien**
COPEPODITE: An online toolkit for plankton time series analysis and visualization (W7-8787)

15:30 ***Coffee/Tea Break***

15:50 **N. Ramaiah**
Anthropogenic influences on phytoplankton compositional variability in coastal waters (W7-8715)

18:00 *Day 1 Workshop Ends*

### Day 2, Saturday, October 13 (9:00-18:00)

09:00 ***Introduction by Convenors***

09:05 **Kedong Yin and Paul J. Harrison**
Anthropogenic influence on phytoplankton community structure: Long time series data analysis in Hong Kong coastal waters (W7-8759)

10:30 ***Coffee/Tea Break***

10:50 **Yury I. Zuenko**
Conditions of phytoplankton blooms at Primorye coast (Japan/East Sea) and year-to-year change of their timing (W7-8551)

12:30 ***Lunch***

14:00 **Poster Presentations**

15:30 ***Coffee/Tea Break***

15:50 **Poster Presentations (continued)**

18:00 *Workshop Ends*

## W7 Workshop Posters

W7-1 **Hyeon Ho Shin, Jong Sick Park, Young-Ok Kim, Seung Ho Baek, Dhongil Lim and Yang Ho Yoon**
Dinoflagellate cyst production and flux in Gamak Bay: A sediment trap study

W7-2 **Dolores Cortés, Ana Luisa Da Cruz, Francisco Gómez, Pablo León, Jesús M. Mercado, Sébastien Putzeys, Iria Sala, Soluna Salles and Lidia Yebra**
Time variability of the taxonomical composition and the physiological performance of diatom-dominated assemblages in an area affected by coastal upwelling

W7-3 **Inna V. Stonik and Tatyana Yu. Orlova**
Population dynamics and toxicity of the diatom species of the genus *Pseudo-nitzschia* in Peter the Great Bay, the northwestern part of the Sea of Japan

W7-4 **Ah-Ra Ko, Se-Jong Ju, Ho Young Soh and Kyoungsoon Shin**
Understanding seasonal variation of the source of particulate organic matter in relationship with plankton community in the estuary of Sumjin River, Korea

W7-5 **Juyun Lee, Mirinae Kim, Jun-mo Lee and Man Chang**
Phytoplankton composition under low temperature period at East Sea in Korea

W7-6 **Juyun Lee, Mirinae Kim, Jun-mo Lee and Man Chang**
The evaluation for the fast cell division with non-uniform cell cycles

W7-7 **Juyun Lee, Jun-mo Lee, Mirinae Kim and Man Chang**
Different growth pattern of *Heterosigma akashiwo* with salinity and micronutrients gradient by geology

# W7 Workshop Oral Presentations

### October 12, 09:05 (W7-8704), Invited

## An ecological status report for phytoplankton and microbial plankton in the North Atlantic and adjacent seas

William K.W. **Li**[1], Todd D. O'Brien[2] and Xosé Anxelu G. Morán[3]

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The ICES status report on climate change in the North Atlantic is a review of the scientific literature, including a consideration of long-term physical variability, chlorophyll and primary production, and an overview of trends in plankton communities. The knowledge-base underlying this literature continually expands through regular status reports from the Working Group on Oceanic Hydrography, and from the Working Group on Zooplankton Ecology. The Working Group on Phytoplankton and Microbial Ecology (WGPME) emerged in response to an ICES need for linkage between hydrography and zooplankton. Here, we present a first report on the ecological status of phytoplankton and microbial plankton of the North Atlantic and adjacent seas by reference to 7 geographic regions containing 61 monitoring locations, and to 40 standard areas of the Continuous Plankton Recorder survey. The coverage stretches from the subpolar waters of the Labrador Sea to the subtropical waters of southwestern Iberia, and extends into the Mediterranean Sea.

### October 12, 10:50 (W7-8602)

## The phytoplankton composition across the world's coastal ecosystems

Jacob **Carstensen**[1], Hans W. Paerl[2] and James E. Cloern[3]

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Ten regional data sets of phytoplankton counts have been collected for the work of the SCOR WG137 aiming at comparatively analyzing global patterns of phytoplankton dynamics in coastal ecosystems. The regional data sets, which mostly covered Northern Europe and North America, totals about 40,000 samples of either volume or carbon biomass, and have been combined with hydrochemistry data. The coastal ecosystems ranged from brackish water with salinity <5 in the Baltic Sea to salinity >30 in Dutch coastal waters. Mean annual temperatures ranged from about 6°C in the boreal coastal ecosystems in the northern Baltic Sea to about 20°C in the subtropical Patos Lagoon in Brazil and Neuse River Estuary in North Carolina. Mean nutrient concentrations also ranged over several orders of magnitude. The mean phytoplankton composition of an ecosystem, partitioned into 5 functional groups (diatoms, dinoflagellates, cyanobacteria, cryptophytes and chlorophytes), was estimated for each of the 83 coastal ecosystems in the database. The proportions of the different functional groups were then correlated with mean characteristics of the hydrochemistry data. Diatoms dominated most coastal ecosystems and were literally always present in the samples, whereas the proportion of dinoflagellates decreased with increasing nutrient concentrations. The abundance of cyanobacteria and chlorophytes was strongly coupled to salinity, and mostly found in the Baltic Sea. Although some significant pattern emerged from the correlation analysis, there was also a large amount of unexplained variation.

## October 12, 14:00 (W7-8787)

## COPEPODITE: An online toolkit for plankton time series analysis and visualization

Todd D. **O'Brien**

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The Coastal & Oceanic Plankton Ecology, Production, & Observation Database (COPEPOD) has been providing data handling and programming support to ICES and SCOR plankton time series working groups for over ten years. Through this collaboration, a large collection of specialized time series data analysis, intercomparison, and visualization tools have been developed and featured in a variety of working group publications and monitoring reports. While this tool assortment was originally only available to the working group members, the full toolkit is now available online as part of COPEPOD's Interactive Time-series Explorer (COPEPODITE, http://www.st.nmfs.noaa.gov/copepodite). COPEPODITE's web-based toolkit does not require an expensive software license or a computer-genius graduate student to install, operate, and interpret it. With internet access and a generic web browser, any user can upload their data and quickly produce a variety of time series visualize plots and result sets. Seven tool modules are currently available to help investigate seasonal cycles and interannual trends, and to help highlight correlations between variables within a monitoring site as well as against long-term temperature, salinity, and climate indices relevant to that site's region. COPEPODITE also features the Plankton Time-series Metabase (http://www.st.nmfs.noaa.gov/copepodite/time-series), which provides information on, and contact information for, over 300 zooplankton and phytoplankton time series, all searchable via a variety of interactive maps and other content-based searching options. Continued and ongoing collaboration with ICES and SCOR time series working groups means that new tool modules and metabase entries will be added to the project regularly.

## October 12, 15:50 (W7-8715)

## Anthropogenic influences on phytoplankton compositional variability in coastal waters

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With rapid strides of industrial growth, many coastal regions, in particular of the developing world across the globe have undergone modifications. Among the many components affected, alterations to biotic components, can specifically be recognized as positive feedback due to adverse human-interventions and unplanned activities that have led to imbalances in their abundance, composition and productivity potential. An analysis of 1985-2005-period phytoplankton data sets from certain global sites, and locations along the Indian coasts, imply richness of diatom genera such as *Skeletonema, Navicula, Thalassiosira* and *Nitzschia* and some dinoflagellates, especially the peridinids. These forms appear to have become successful at the cost of highly diverse, evenly represented and syntrophic populations earlier on. For instance, the common primer to denser preponderance of *Skeletonema* at most coastal locations seems to be the burgeoning discharges of domestic sewage among many other effluent loadings. Experimental observations suggest not only its high tolerance to mixed toxic-waste compositions [Hg, Cd, Cr or Fe up to 20/30 ppm in f/2 medium] but also rapid multiplication rates even in higher concentrations of many toxic solutions. In a mixed culture set up with over 10 genera, *Skeletonema* proliferated far greater than initially preponderant *Navicula, Thalassiosira* or *Amphora*. In recent years, there are increasing incidences of unusual blooms of phytoplankton from different classes. Instances of damage to local fisheries, habitat alterations and, concerns of public health are reported. Socio-economic and ecological implications of such occurrences will be discussed keeping the impacts in the upwelling regions sustaining large-scale fisheries.

### October 13, 09:05 (W7-8759)

## Anthropogenic influence on phytoplankton community structure: Long time series data analysis in Hong Kong coastal waters

Kedong **Yin**[1,2] and Paul J. Harrison[3]

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Species diversity plays an important role in biological communities and ecological systems. Species diversity consists of species richness and their relative abundance. To express species diversity, many diversity indices have been developed and a few of them gained their wide-spread applications. These common indices include Shannon, Simpson, and Shannon Evenness. Those indices are rather informational and bear little ecological meaning. They are usually one directional, meaning that a community (a set of species composition and abundance) results in one index value, but the same index value could be derived from many different communities. They are insufficient to describe the community structure. In order to characterize the species community structure, species abundance distributions (SADs) have been developed. Many models have been built to fit SADs and explain biological diversity formation mechanisms. However, SADs have not advanced beyond the SADs themselves and hence, the relationship between the SADs models and environmental drivers has not been well studied. In this study, based on time series data set of phytoplankton species composition in Hong kong, we relate SADs to environmental variables to understand environmental conditions shape up phytoplankton species community structure and how anthropogenic input of nutrients may influence the phytoplankton species.

### October 13, 10:50 (W7-8551)

## Conditions of phytoplankton blooms at Primorye coast (Japan/East Sea) and year-to-year change of their timing

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As almost everywhere in the subpolar seas, there are two main blooms of phytoplankton at Primorye coast: in spring and autumn, but several additional blooms could be observed at the coast, as winter and summer blooms, and the bloom is permanent in estuaries. All blooms are conditioned by light and nutrients ability; the mixed layer depth (MLD) could be considered as a factor of irradiance (the thinner, the better) and the density stratification – as a factor of nutrients supply (the weaker, the better), with exception of spring and estuarine processes where nutrients are not limited. However, different taxonomic groups of phytoplankton need different values of these factors for their mass development, that's why a succession of certain species blooms is observed in the coastal waters of Primorye during the year. Timing of blooms depends mostly on rate of the sea surface warming or/and precipitation (both factors influence on density stratification). Year-to-year changes of the timing of each bloom defined from the SeaWiFS data.

# W7 Workshop Poster Presentations

### W7-1

### Dinoflagellate cyst production and flux in Gamak Bay: A sediment trap study

Hyeon Ho **Shin**[1], Jong Sick Park[2], Young-Ok Kim[3], Seung Ho Baek[3], Dhongil Lim[1] and Yang Ho Yoon[2]

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To develop a better understanding of the species composition and production of dinoflagellate cysts, including the ecological characteristics of *Polykrikos* species, a sediment trap study was conducted from June 2005 to June 2006 in Gamak Bay, Korea. Thirty-two dinoflagellate cyst taxa were identified in the sediment trap samples, and the dinoflagellate cyst assemblages were found to be dominated by cysts of *Polykrikos kofoidii*, *Scrippsiella trochoidea*, *Protoperidinium* spp., *Polykrikos schwartzii*, *Gymnodinium catenatum* and *Ensiculifera carinata*. The flux of dinoflagellate cysts ranged from $0.10 \times 10^5$ to $35.97 \times 10^5$ cysts $m^{-2}$ $day^{-1}$, and the highest flux occurred during summer, and was driven completely by the flux in the production of *P. kofoidii* and *P. schwartzii* cysts. The timing of the production of cysts of *Polykrikos* species seemed to be related to the appearance of *G. catenatum* as prey. The assemblages of dinoflagellate cysts in surface sediments from Gamak Bay, and their seasonal changes, were very similar to those in the sediment trap samples, which suggested that the monitoring of dinoflagellate cysts in sediment samples can provide information on the environmental conditions in Gamak Bay.

### W7-2

### Time variability of the taxonomical composition and the physiological performance of diatom-dominated assemblages in an area affected by coastal upwelling

Dolores Cortés, Ana Luisa Da Cruz, Francisco Gómez, Pablo León, Jesús M. Mercado, Sébastien Putzeys, Iria Sala, Soluna Salles and Lidia **Yebra**

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Diatoms contribute by 30% to 40% to the marine primary productivity at global scale since they are often dominant in the most productive oceanic areas. Laboratory studies indicate that the dominance of diatoms under a wide variety of hydrological conditions could be due to their high physiological plasticity. However, reports demonstrating this acclimation capacity in natural assemblages are scarce. In the present study, the diatom communities inhabiting a costal area episodically affected by wind-driven upwelling (the north-western Alboran Sea, which is the westernmost basin in the Mediterranean) were characterized both taxonomically and physiologically. Data collected in several research cruises performed from 1994 to 2010 were studied. The analysis of the seasonal and inter-annual variability patterns permitted us to identify four main types of communities dominated by diatoms. The four community types grew under high nutrient concentrations, although two of them were isolated close to the lower limit of the mixed layer while the other two communities grew in the surface layer, within the mixed layer. These last two communities were associated with the earlier phases of bloom development induced by upwelling. Each community type was characterized by different light absorption properties, nitrate uptake rates and primary productivity. The possible role of the shape traits and/or taxonomic composition in determining these differences in the physiological performance among the four community types is discussed.

## W7-3

## Population dynamics and toxicity of the diatom species of the genus *Pseudo-nitzschia* in Peter the Great Bay, the northwestern part of the Sea of Japan

Inna V. **Stonik** and Tatyana Yu. Orlova

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Population dynamics and toxicity of the diatom species belonging to the genus *Pseudo-nitzschia* (potential producers of the neurotoxin domoic acid) found in nortwestern Sea of Japan were studied. Abundances of *Pseudo-nitzschia* species and concentration of domoic acid (DA) in the bivalve *Crenomytilus grayanus* were determined from January 2009 to December 2011 at monitoring station situated in Amurskii Bay. DA analysis of unialgal cultures of *Pseudo-nitzschia* (seven isolates) collected from Peter the Great Bay between August 2010 and November 2011 has been performed. The peaks of the *Pseudo-nitzschia* spp. density were recorded in summer and in autumn. Morhological analysis revealed potentially toxic *P. pungens*, *P. calliantha* and *P. delicatissima* as the dominant species. Population densities were highest in October 2010 and September 2011 ($2.1\text{-}2.5 \cdot 10^4$ cells $l^{-1}$). The outbursts were determined presumably by *P. calliantha* and *P. delicatissima* respectively. Domoic acid was detected in *C. grayanus* in concentrations below regulatory limits, ranging from 0.1 to 0.5 mg kg$^{-1}$.Total DA was found in “whole-culture” samples in cultures of *P. delicatissima* (two isolates) collected from Golden Horn Bay (86,7-628 pg ml$^{-1}$) and isolate of *P. multistriata* from Amurskii Bay (1082 pg ml$^{-1}$). No domoic acid has been detected in two isolates of *P. delicatissima*, and in isolates of *P. pungens* and *P.* cf. *mannii*. Phytoplankton and shellfish toxicity monitoring is warranted in these waters, where bivalves are commercially harvested for human consumption.

## W7-4

## Understanding seasonal variation of the source of particulate organic matter in relationship with plankton community in the estuary of Sumjin River, Korea

Ah-Ra **Ko**[1], Se-Jong Ju[1], Ho Young Soh[2] and Kyoungsoon Shin[3]

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The estuary is not only physically very dynamic environment but also one of the most productive natural habitats. In the aspects of carbon cycle, it is one of key boundaries of different sources of organic carbons are transported, deposit, and recycled with high biological activities. Therefore, we bi-monthly examined the biochemical compositions (*i.e.* Chl-*a*, POC/N and lipid biomarkers) of suspended particles (>0.7μm) to understand the seasonal changes of the relative contribution of different source of organic carbon comparing with plankton community and other water parameters (nutrients, temperature, salinity, rainfall, etc) in the drowned river valley estuary of Sumjin River, Korea, for a year 2010. The unusual winter-bloom of *Skeletonema costatum* occurred in January (Chl-*a*: 12.2μg/L) with the low C:N ratio (≈6.0). However, the C:N ratios (>10) was high in the summer and fall with the same level of POC as that in winter. It means that the other sources of organic carbon (*i.e.* terrestrial and urban source) could be significantly contributed during the summer and fall. According to the result of lipid biomarkers, the relative abundance of 22:6(n-3), used as a marker for dinoflagellate, was seasonally varied, especially well corresponding with the abundance of Dinophyceae. The results of this study will provide valuable information to understand the seasonal variation of the relative contribution of autochthonous *vs.* allochthonous sources of organic carbon and the role of biology for the carbon cycle in this dynamic system.

## W7-5

## Phytoplankton composition under low temperature period at East Sea in Korea

Juyun **Lee**, Mirinae Kim, Jun-mo Lee and Man Chang

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Nano and picoplankton (<20$\mu$m) account for more than 50% of primary product in an ocean. In Korea, the biomass of <20 and >20$\mu$m plankton were investigated at the East sea because the ‘East sea’ has similar characteristics of ocean. Especially, the biomass of <20 $\mu$m plankton was over 50% for primary product in low temperature period. Thus, this study investigated phytoplankton composition in low temperature period. The sampling was conducted at 10 sites which locate between Sokcho Bay and Ulsan Bay 2 times during March 2012. We divided phytoplankton by size, <20 and >20 µm plankton, and <20 µm phytoplankton divided by type, F(filament), O(oval), OF(oval & flagella), R(rod), S(spherical) type. Water temperature were ranged from 8.24~13.05°C, salinity were ranged from 26.25~35.35 PSU during sampling periods. The phytoplankton abundances were $1.94\times10^5$~$4.36\times10^6$ cells $L^{-1}$ and the biomass of <20 $\mu$m plankton were over 80% of primary products and it were observed at least 20 species. Diatom was most dominant for>20$\mu$m plankton and S type was most dominant for <20$\mu$m plankton. From this study, we could know the importance of the <20$\mu$m plankton for the primary products and bio-diversity. We suggest it’ll be needed for the identification and ecological study for them.

## W7-6

## The evaluation for the fast cell division with non-uniform cell cycles

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To obtain a better understanding of the bloom development mechanism in the aquatic systems, accurate estimates of species-specific *in situ* growth rates are needed for the migration and bloom mechanisms of red tide. The harmful algal blooms caused by fast cell division of microorganisms. To estimate accurate *in situ* growth rate of *H. akashiwo* which has non-uniform and irregular cell cycles, we modified equation based on the cell cycle and calculated the *in situ* growth rate to describe their bloom developmental process in nature. Sampling was conducted every three hours from 15:00 on August 2 to 7:00 on August 4, 2006 in Pohang Bay, Korea. DNA amounts in the *H. akashiwo* were measured with a flow cytometer following tyramide signal amplification-fluorescence *in situ* hybridization (TSA-FISH). During the first night, the percentage of G1 phase cells decreased from 15:00 to 19:00 and increased until 22:00. It dramatically decreased from 22:00 on 2 August and increased from 7:00 to10:00 on 3 August. These results suggest the capability of dividing more than once $d^{-1}$. Similar results were obtained the following night but division did not occur twice during the second night. Based on the results, *in situ* growth rates ranged from 0.31 to 0.53 $d^{-1}$. We conclude that, with the aid of this newly derived equation, the blooming formation by fast cell division could estimate more accurate.

## W7-7

# Different growth pattern of *Heterosigma akashiwo* with salinity and micronutrients gradient by geology

Juyun **Lee**, Jun-mo Lee, Mirinae Kim and Man Chang

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*H. akashiwo,* one of famous HABs (harmful algal blooms species), blooms are characterized by a high growth rate. Especially, rapid growth is important in dense bloom formation (Bearon *et al.*, 2006). Physicochemical factors, such as water temperature, salinity, light intensity and nutrients, strongly affect bloom formation (Tilman *et al*. 1982; Erga and Heimdal 1984; Smayda 1998; Diehl *et al*. 2002). Thus, we report the comparisons of different geological originated *H. akashiwo* strain for influence on salinity, light intensity and micronutrient. For this study, physiological characteristic of vegetative strain from cyst (HYM06HA) and the other strains from southern eastern coastal water in Korea (NFHTS-AK-1) and Ling Island Sound, USA (CCMP 452) are compared. To compare the different geological difference, we estimate the maximum growth rates during the exponential phase. The CCMP 452 strain was grows well at all salinity gradients except extreme condition like 5 and 40 psu. Uniquely, the optimal growth rate conditions for salinity of Korean strains were 10 and from 25 to 30 psu. It seems to be the bimodal distribution. The NFHTS-AK-1 was shown maximum growth rate at 50 µmol photons $m^{-2}$ $s^{-1}$ and HYM06HA was 125 µmol photons $m^{-2}$ $s^{-1}$. CCMP 452 grows well from 50 µmol photons $m^{-2}$ $s^{-1}$. Phosphate source affected a lot to the growth rate of Korean strains. In contrast the strain, which originated USA affected a lot to the nitrogen source. The Korean strains were not affected their growth rate at the $10^{-1}$ nM Se. However, the strain which originated USA was inhibited their growth rate at the 100 nM. In these experimental conditions, two Korean strains seem to be different characteristic compared with USA strain. The strains which have various characteristics might be the ecological strategies for the survival and formation of bloom.

# W8 FIS Workshop Recruitment of juvenile Japanese eel (*Anguilla japonica*) in eastern Asia

**Co-Sponsored by FRA**

***Co-Convenors***: *Ruizhang Guan (China), Tatsu Kishida (FRA, Japan), Akihiro Mae (Japan), Tae Won Lee (Korea), Wann-Nian Tzeng (Chinese Taipei) and Kazuo Uchida (FRA, Japan)*

The production of Japanese eel relies mainly on the aquaculture of natural juveniles (glass eel). In recent years, the catch of glass eel has been fluctuating from year to year but remained at the low level. The purpose of this workshop is to discuss the reasons and mechanisms for the inter-annual variation in glass eel recruitment in the coastal area of eastern Asia in order to sustain the stock of Japanese eel. Discussion is also expected on international collaboration and effective measures for sustaining glass eel recruitment.

## Saturday, October 20 (10:00-17:10)

10:00 ***Introduction by Convenors***

*Chair: Wann-Nian Tzeng*

10:05 **Kazuo Uchida**
Life history of Japanese eel (review) (W8-8839)

10:35 **Seinen Chow, Toshihiro Yamamoto, Hiroaki Kurogi, Makoto Okazaki and Tomoo Watanabe**
Discovery of mature freshwater eels in the spawning area and remarks on the oceanic migration (W8-8822)

11:05 **Daisuke Ambe, Makoto Okazaki, Tomowo Watanabe, Hiroaki Kurogi and Seinen Chow**
Oceanographic conditions in spawning ground and larvae transportation area of the Japanese eel (W8-8840)

*Chair: Tae Won Lee*

11:35 **Hiroaki Kurogi**
Ecology and annual recruitment levels of Japanese eel in Japan (W8-8842)

12:15 ***Lunch***

13:35 **Tae Won Lee**
Ecology and recruitment of Japanese eel in Korea (W8-8682)

14:15 **Ruizhang Guan**
Ecology and annual recruitment levels of Japanese eel in continent China (W8-8841)

14:55 **Wann-Nian Tzeng and Yu-San Han**
Spatial and temporal variations in the recruitment of Japanese eel (*A. japonica*) in Taiwan (W8-8692)

15:35 ***Coffee/Tea Break***

*Chair: Ruizhang Guan*

16:00 **Tatsu Kishida and Kazuo Uchida**
Management measures for eel in Europe (W8-8843)

16:30 *General Discussion*

17:10 *Workshop Ends*

# W8 Workshop Oral Presentations

### October 20, 10:05 (W8-8839)

## Life history of Japanese eel (review)

Kazuo **Uchida**

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The Japanese eel, *Anguilla japonica*, is an important species for aquaculture and fisheries, distributed around the East Asia. However the glass eel and yellow eel fisheries and management activities are locally operated within each country. Catch of glass eel in Japan is declining to low level and fluctuating during these two decades. In order to form the management plans of the Japanese eel, this paper overviews the life history of this species. They spawn and hatch during new moon near a salinity front in the North Equatorial Current (NEC), west of Mariana Island. The larvae (leptocephali) grow in NEC and Kuroshio Current to 60 mm and metamorphose into juvenile (glass eel). The glass eel then migrate to the coastal area of East Asia. The yellow eel are distributed over all water bodies including fresh, brackish and sea waters, and grow to 400-1000 mm for 5-10 years until the silver eel, returning to their spawning area. Total of 13 individuals of spawning adult were recently caught in their spawning area. Seven individuals of them have the life history of fresh or blackish waters in their yellow eel stage, while the other six have mainly sea living history. Of those seven individuals, the three eels were identified to be from Japanese river basin. These results suggest that all the above mentioned water bodies in East Asia, including Japan, are important for maintenance of the eel stock. Estimation of eel abundance in coastal and river areas has to be done under international collaboration.

### October 20, 10:35 (W8-8822)

## Discovery of mature freshwater eels in the spawning area and remarks on the oceanic migration

Seinen **Chow**[1], Toshihiro Yamamoto[1], Hiroaki Kurogi[1], Makoto Okazaki[2] and Tomoo Watanabe[2]

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In order to study spawning ecology of the Japanese eel (*Anguilla japonica*), Fisheries Agency and Fisheries Research Agency of Japan performed research cruise in the southern part of the West Mariana Ridge (northwest Pacific) during 2008 to 2010. The first discovery of matured freshwater eels in the open ocean was realized using large mid-water trawl. A total of thirteen Japanese eel (seven males and six females) and three giant mottled eel (*A. marmorata*)(two males and one female) were captured during the three years project. The trawl net was towed at subsurface (shallower than 300m) over deep area (2,000-3,000m), indicating that the eels were pelagic and not residents of sea mounts. Histological examination on the ovary revealed that the females may spawn at least twice during the reproductive season. Tracking the Japanese eel (*Anguilla japonica*) using ultrasonic transmitter was also attempted. Five wild eels (captured at Tone River, Japan) displayed clear diel vertical movement (DVM), in which they started descent at dawn and ascent at dusk. Doppler current profiler revealed that direction and speed of these eels were almost the same with those of surrounding water, indicating that the eels were passively drifted. Although the passive drifting suggests the migration route to be northern bound route *via* the Kuroshio Current extension followed by southward eddy current, the passive drifting alone would not take the eels to their spawning area and subsidiary cues such as geomagnetic or celestial navigation must be necessary.

**October 20, 11:05 (W8-8840)**

## Oceanographic conditions in spawning ground and larvae transportation area of the Japanese eel

Daisuke Ambe[1], Makoto Okazaki[1], Tomowo **Watanabe**[1], Hiroaki Kurogi[2] and Seinen Chow[2]

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The natural environment of adults and larvae of the Japanese eel were analyzed by using oceanographic data collected in Japanese eel spawning ground survey. The survey was conducted in the southwest area of the Mariana Islands by the Fisheries Agency of Japan in 2008, 2009 and 2010. Adults and larvae were mainly captured in 100 - 300m depth layer. The acoustic tracking showed that an adult eel swam in 500 -700m depth layer in the daytime and in 150 - 300m depth layer in the night. These results suggest that the subsurface oceanographic conditions, which are characterized by the intrusion of the North Pacific Tropical Water, are important for spawning ecology of the Japanese eel. The vertical structure of the water mass of the area can be affected by the long-term warming and freshening of the surface water those were observed in the western tropical Pacific. Furthermore, the latitudinal position of the NPTW inter-annually fluctuated with a range of a few degrees. Because the latitudinal position of the spawning area has been recognized as a crucial factor for the success of larval transport as initial condition, the relationship between the spawning area of the Japanese eel and those oceanographic conditions are needed to be revealed. On the other hand, the transportation process is also thought to be influenced by the mesoscale eddies around the North Equatorial Current. The effect of mesoscale eddies exerted on transportation of larvae are discussed for the year-to-year variation of the recruitment of glass eel.

**October 20, 11:35 (W8-8842)**

## Ecology and annual recruitment levels of Japanese eel in Japan

Hiroaki **Kurogi**

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Significant progress on research of the spawning ecology of the Japanese eel (*Anguilla japonica*) was made by capturing the adults and the eggs along the West Mariana Ridge during 2008 to 2010. However, fundamental information for stock management such as regional origin of spawning adults, annual amount of spawning adults and quantitative relationship between adults and recruitment levels remain unclear. Annual commercial catch of glass eel along the Japanese coast (statistics data from Ministry of Agriculture, Forestry and Fisheries, Japan), which are the only available indicator of the recruitment levels in Japan at present, peaked at 100-200 metric tons (mt) in 1960s, and consecutively decreased to around 20 mt by 1980s. Recent 25 years, catch of glass eel have leveled off in lower level fluctuating between 6 - 27 mt. These statistics may indicate actual recruitment levels, but the influence of social and economical dimensions such as a decline in the population of eel fisherman and illegal and/or unreported catch can not be ruled out. On the other hands, it was discovered recently that appreciable amounts of glass eel migrate to coast out of fishing season (May to June). To understand the actual recruitment levels of the Japanese eel, it is necessary to investigate year-round occurrence of glass eel in various parts of the East Asia, which provide a better understanding of the recruitment mechanisms of the Japanese eel and help to construct future international management scheme.

**October 20, 13:35 (W8-8682)**

## Ecology and recruitment of Japanese eel in Korea

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Glass eels mainly occur in Korean estuaries from January to March in the Jeju Island, from February to April in the southern coast and from March to May in the mid-western coast. However, season and peak time of occurrence showed an annual variation. Glass eels have been collected by a deep net in JeJu estuaries, and by set nets operated by tidal current in the southern and western coasts. Few glass eel fishery have been made in Jeju estuaries since 2000 due to the low catch rate. Annual glass eel catch varied around 7 mt in 1990s, and varied greatly in low level since 2000. Annual demand attained up to 15 mt and foreign glass eels have been imported about 6 mt/yr since 1998. Annual domestic catch fluctuated at ca. 2 mt in recent 3 years. Middle and long term research and management plan are under preparation.

**October 20, 14:15 (W8-8841)**

## Ecology and annual recruitment levels of Japanese eel in continent China

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Glass eels (*Anguilla japonica*) arrive in the all estuaries of continent China mainly from November to April every year. The main catches are from the estuaries of Jiangsu province, Shanghai municipality Zhejiang province, Fujian province, Guangdong province. The total annual catch of the glass eels in the continent China has gradually decreased from more than 50 metric tons to less than 20 metric tons in the recent 32 years, though the Chinese government has made the policy that only allowed fish men to catch the glass eels in a restricted fishing period (16th December to 15th March before 2009, 16th January to 15th March after 2009). The cause for the decreasing catch of the glass eels should be mainly due to the environment pollution, over fishing of glass eels and adult eels. To guarantee the sustainable recruitment of the glass eels and development of A. japonica industry, we must take the following measures: (1) strengthening the environment protection and water pollution control, (2) making more scientific forbidding fishing period and a maximum fishing quantity of the glass eels, (3) prohibiting fishing the juvenile and adult eels, (4) reasonably exploiting the other eel species for aquaculture, *e.g. A. Anguilla, A. rostrata, A. marmorata and A. bicolor pacifica,* (5) enduringly studying on the artificial propagation of *A. japonica* with international cooperation if possible.

**October 20, 14:55 (W8-8692)**

## Spatial and temporal variations in the recruitment of Japanese eel (*A. japonica*) in Taiwan

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Understanding the recruitment dynamics of anguillid eels is crucial for resource conservation and a sustainable eel aquaculture industry. Long-term (1967–2008) glass eel catches were used to investigate climatic effects on the annual recruitment of Japanese eel to Taiwan. Significant correlations were found between catches and climate indices that affect ocean productivity and eddy activities, such as the Quasi Biennial Oscillation, North Pacific Gyre Oscillation, Pacific Decadal Oscillation, and Western Pacific Oscillation. Wavelet analysis reveals three periodicities of eel catches: 2.7, 5.4, and 10.3 years. The recruitment abundance of the Japanese eel may be influenced by multi-timescale climate variability.

Japanese glass eel catches from 1985 to 2009 are also positively correlated across eastern Asian countries, implying that the earlier recruitment of Japanese eels in Taiwan could be a good predictor for the subsequent catch in other Asian countries along the Kuroshio Current. The positive correlation of the catch in northern and western areas of Taiwan from 1968 to 2008 and the sequential occurrence of glass eel from southwestern to northwestern coasts of Taiwan suggests that the leptocephali might be transported in winter to the western coast of Taiwan by the the sub-surface layer of the Taiwan Strait Current.

**October 20, 16:00 (W8-8843)**

## Management measures for eel in Europe

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Since the European eel (*Anguilla anguilla*) stock is severely depleted through recent 30 years, management activities for stock recovery of the eel have been taken place in European countries. In 2003, ICES proposed a limit reference point of 50% for the escapement of silver eels from the continent in comparison of pristine condition. In 2007, the management framework for the European eel stock was established through an EU Regulation. The objective of the EU Regulation is to allow an escapement to the sea of the biomass of silver eel of at least 40% pristine level. European eel was also included in CITES Appendix II in 2007 and listed in 2009. To achieve the objective of EU Regulation, member countries have developed eel management plans at river basin level by measures described below; *i.e.* reducing commercial fishing activity, restricting recreational fishing, restocking, improve habitat, transportation o silver eel from inland to sea, combating predators, temporary switching off of hydro power turbines and measures related to aquaculture. Following the eel management plans, national reports from member States on their implementation practices are expected in 2012 and then the first post-evaluation of the regulation is expected. It is considered that monitoring on recruitment and development of the methods for the assessment of the eel stock and the impact of fisheries and other anthropogenic impacts are important to evaluate the effectiveness of the management plans and manage eel stock properly.

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| **APN** | Asia-Pacific Network for Global Change Research<br>www.apn-gcr.org/ |
| **Argo** | International Project for Deployment of Profiling Floats<br>www.argo.net/ |
| **BEST-BSIERP** | NPRB/NSF Bering Sea Project<br>http://bsierp.nprb.org/ |
| **CeNCOOS** | The Central and Northern California Ocean Observing System<br>www.cencoos.org/ |
| **CLIVAR** | Climate Variability and Predictability<br>www.clivar.org/ |
| **COBSEA** | Coordinating Body on the Seas of East Asia<br>www.cobsea.org/ |
| **ESSAS** | Ecosystem Studies of Sub-Arctic Seas<br>www.imr.no/essas |
| **FAO** | Food and Agriculture Organization<br>www.fao.org/index_en.htm |
| **GEOHAB** | IOC/SCOR Research Program on the Global Ecology and Oceanography of Harmful Algal Blooms<br>www.geohab.info/ |
| **GESAMP** | Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection<br>www.gesamp.org/ |
| **GOOS** | Global Ocean Observing System<br>www.ioc-goos.org |
| **IATTC** | Inter-American Tropical Tuna Commission<br>www.iattc.org/ |
| **ICES** | International Council for the Exploration of the Sea<br>www.ices.dk/indexfla.asp |
| **IMBER** | Integrated Marine Biogeochemistry and Ecosystem Research<br>www.imber.info/ |
| **IOC** | Intergovernmental Oceanographic Commission of UNESCO<br>http://ioc-unesco.org |
| **IOCCP** | International Ocean Carbon Coordination Project<br>www.ioccp.org/ |
| **IODE** | IOC International Oceanographic Data and Information Exchange<br>www.iode.org/ |
| **IPHAB** | IOC Intergovernmental Panel on Harmful Algal Blooms<br>http://www.ioc-unesco.org/hab/ |

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| **ISC** | International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean<br>http://isc.ac.affrc.go.jp |
| **IWC** | International Whaling Commission<br>http://iwcoffice.org/ |
| **NANOOS** | Northwest Association of Networked Ocean Observing Systems<br>www.nanoos.org/ |
| **NEAR-GOOS** | North-East Asian Regional GOOS program<br>http://near-goos.coi.gov.cn/ |
| **NOWPAP** | Action Plan for the Protection, Management and Development of the Marine and Coastal Environment of the Northwest Pacific Region<br>www.nowpap.org/ |
| **NPAFC** | North Pacific Anadromous Fish Commission<br>www.npafc.org |
| **NPFMC** | North Pacific Fishery Management Council<br>www.fakr.noaa.gov/npfmc |
| **NPRB** | North Pacific Research Board<br>www.nprb.org/ |
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| **SCCOOS** | Southern California Coastal Ocean Observing System<br>www.sccoos.org/ |
| **SCOR** | Scientific Committee on Oceanic Research<br>www.scor-int.org/ |
| **SOLAS** | Surface Ocean - Lower Atmosphere Study<br>www.solas-int.org/ |
| **WCRP** | World Climate Research Programme<br>www.wcrp-climate.org/ |
| **WESTPAC** | IOC Sub-Commission for the Western Pacific<br>www.unescobkk.org/westpac/about-us/ioc-westpac/ioc-westpac/ |

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