PICES-2020 Virtual Annual Meeting

Book of Abstracts

October 13-29, 2020, Victoria, BC, Canada

Prepared by the PICES Secretariat

Table of Contents

Abstracts

Sessions Presentations

Workshops Presentations

List of Sessions and Workshops

VS1	Oct. 26-27	How does 30 years of research on changing North Pacific ecosystems inform the UN Decade of Ocean Science for Sustainable Development Goals (SDGs)?
VS3	Oct. 28	Using eDNA to assess and manage non-indigenous species in the North Pacific
VS4	Oct. 28	Implementing a collaborative, integrated ecosystem high seas survey program to determine climate/ocean mechanisms affecting the productivity and distribution of salmon and associated pelagic fishes across the North Pacific Ocean
VS5	Oct. 29	Atmospheric nutrient deposition and microbial community responses, and predictions for the future in the North Pacific Ocean
GP		General Poster Session
VW4	Oct. 13	How does the Pacific Arctic gateway affect the marine system in the Central Arctic Ocean (CAO)?
VW6	Oct. 14	Research priorities for understanding the population dynamics of small pelagic fish in the North Pacific
VW9	Oct. 15	Building a PICES early career professional network

Abstracts

VIRTUAL SESSION 1

How does 30 years of research on changing North Pacific ecosystems inform the UN Decade of Ocean Science for Sustainable Development Goals (SDGs)

(VS1-15011) Live Talk

PICES Engagement with the UN Decade of Ocean Science for Sustainable Development

Steven J. **Bograd**

NOAA NMFS SWFSC, Monterey, CA, USA. E-mail: steven.bograd@noaa.gov

In December 2017, the United Nations General Assembly proclaimed the Decade of Ocean Science for Sustainable Development (2021-2030) to "support efforts to reverse the cycle of decline in ocean health and gather ocean stakeholders worldwide behind a common framework that will ensure ocean science can fully support countries in creating improved conditions for sustainable development of the Ocean". The Decade is designed to "facilitate stronger international cooperation to bolster scientific research and innovative technologies to ensure science responds to the needs of society". The FUTURE Science Program, and PICES more generally, shares many of the goals of the Ocean Decade. Furthermore, as the key inter-governmental marine science organization in the North Pacific, PICES has the aspiration and capacity to be the key regional partner of the Ocean Decade. Here we will highlight some ongoing PICES activities aimed at providing the scientific and organizational infrastructure to implement the activities of the Ocean Decade, including activities to be conducted jointly with ICES. We encourage the PICES community to provide suggestions for how PICES can most effectively engage with the UN Ocean Decade.

(VS1-15010) Live Talk

The contributions of Early Career Ocean Professionals to PICES within the context of the UN Decade of Ocean Science for Sustainable Development (2021-2030)

Erin Vera Satterthwaite[1], Aoi Sugimoto[2] and Pengbin **Wang**[3]

[1]   National Center for Ecological Analysis and Synthesis & Future Earth, USA
[2]   Japan Fisheries Research and Education Agency, Japan
[3]   Second Institute of Oceanography of the Ministry of Natural Resources, People's Republic of China. E-mail: algae@sio.org.cn

Intergenerational diversity is vital to ensure a sustainable ocean future, since it requires addressing the pressing needs of the present while sustaining essential resources for future generations. The UN Decade of Ocean Science for Sustainable Development (Ocean Decade) has identified Early Career Ocean Professional (ECOP) engagement as an important facet of the Ocean Decade to not only secure its immediate success, but its continuation beyond 2030. PICES is well positioned to be a key player in the Ocean Decade, due to its role in generating ocean knowledge over the entire North Pacific, and its demonstrated support of ECOPs. To explore the benefits, needs, and priorities for ECOPs in PICES, we conducted a survey of current and past PICES ECOPs and hosted an online Workshop prior to PICES-2020. Some needs that emerged for early career professionals in PICES included: international scientific collaborations and policy engagement, mentorship and professional opportunities, science communication, ECOP coordination & networking, and diversity and inclusion. In addition, many respondents highlighted scientific challenges and knowledge gaps related to climate change effects on ecosystems and human communities, sustainable social-ecological systems, diverse forms of knowledge generation and sharing (e.g. local and traditional ecological knowledge), cross-sector collaborations, science outreach and communication, and policy and science diplomacy. Moving forward, we hope that the PICES ECOP and mentor community continues to evolve around these priority topics to ensure that early career professionals will continue to develop the essential skills and relationships they will need to contribute novel ideas to the next chapter of scientific discovery.

(VS1-14999) Live Talk

The International Year of the Salmon Pan Pacific High Seas Expedition 2021: A collaborative international approach to understanding how a rapidly changing ocean affects Pacific salmon

Stephanie **Taylor**[1], Mark Saunders[1], Vladimir Radchenko[1], Ed Farley[2], Laurie Weitkamp[3], Jackie King[4], Chrys Neville[4], Richard Beamish[4], Brian Riddell[5], Evgeny Pakhomov[6], Shunpei Sato[7], Shigehiko Urawa[7], Aleksey Somov[8] and Sang-Seon Yun[9]

[1]   North Pacific Anadromous Fish Commission, Vancouver, BC, Canada. E-mail: staylor@npafc.org
[2]   Alaska Fisheries Science Center, NOAA Fisheries, Juneau, AK, USA
[3]   Northwest Fisheries Science Centre, NOAA Fisheries, Newport OR, USA
[4]   Pacific Biological Station, Fisheries and Oceans Canada, Nanaimo, BC, Canada
[5]   Pacific Salmon Foundation, Vancouver, BC, Canada
[6]   Institute for the Ocean and Fisheries, University of British Columbia, Vancouver, BC, Canada
[7]   Hokkaido National Fisheries Research Institute, Japan Fisheries Research Agency, Sapporo, Japan
[8]   Pacific branch of Russian Federal Research Institute of Fisheries and Oceanography, «VNIRO» («TINRO»), Vladivostok, Russia
[9]   Big River Scientific LLC, Mukilteo, WA, USA

Salmon and the people that depend on them are faced with increasing uncertainty from changing climate and ecosystems with serious social and ecological implications. As conditions become more and more variable and productivity continues to decline, the need to understand factors affecting salmon during all life history stages intensifies. Decision-makers require answers to complex scientific questions that demand efficient processes to mobilize interdisciplinary researchers across countries and institutions.

The North Pacific Anadromous Fish Commission (NPAFC) with its five member countries (Canada, Japan, the Republic of Korea, Russia and the United States) is planning a Pan-Pacific High Seas research expedition in late winter 2021 to build upon the 2019 and 2020 winter expeditions to the Gulf of Alaska. that can be considered a case study in the conditions required for effective interdisciplinary ocean-science collaboration on a broad scale. The IYS Pan Pacific Winter High Seas Expedition 2021 will use up to five vessels to survey the entire breadth of the North Pacific Ocean (NPO) in winter 2021. The overall goal of the expedition is "To demonstrate the utility of an international, pan-Pacific winter ecosystem survey to understand how increasingly extreme climate variability in the North Pacific Ocean and associated changes in the physical environment influence the abundance, distribution, migration, growth, fitness, and survival of Pacific salmon and surrounding species." This expedition will promote the collaboration and involvement of scientists across multiple disciplines to test related hypotheses and provide the information needed by decision makers to manage salmon in a rapidly changing environment. This presentation will outline the collaborative process and the research that will be conducted during this survey.

(VS1-14995) Live Talk

Collaborative research with Indigenous partners: Meeting them on their waters

Misty **Peacock**, Rachel Arnold, Rosa Hunter and Thayne Yazzie

Northwest Indian College, Bellingham, Washington, USA. E-mail: mpeacock@nwic.edu

The Salish Sea Research Center (SSRC) at Northwest Indian College (NWIC) increases the presence and influence of Native American leadership in environmental sciences. As a tribal college research institution, the SSRC has deep ties with Lummi Nation. We work closely with our Indigenous partners to advance the research goals, needs, and interests of Lummi Nation regarding food sovereignty and healthy water issues. We understand the necessity to collaborate with our Indigenous partners at project conception, before engaging in any research— meeting them on their waters. In collaborative fashion, we work with Lummi Natural Resources researchers and administration, as well as cultural knowledge holders at NWIC to identify areas of research that are important to Coast Salish communities. Some of our projects include population dynamics of forage fish, Indigenizing outreach materials for community members and youth, and providing support for tribal communities to monitor for harmful algae and biotoxins in the North Pacific. We intend the SSRC will provide research expertise, LNR management implementation, and the Coast Salish Institute guidance on cultural traditions and ceremonial practices of the Lummi people that influences management design and implementation. The knowledge gained through these investigations emphasizes community input, and this type of blueprint is necessary to facilitate coordination and collaboration with Indigenous groups engaging in solutions in the North Pacific. Incorporating

Indigenous research partners will provide a framework for other scientists with similar environmental issues to involve Indigenous communities in their research, as solutions to environmental degradation require attention to both science and culture.

(VS1-15000) Live Talk

Where are we now and where can we go with ocean technology for addressing climate change impacts on the North Pacific?

John A. **Barth**[1] and co-authors (to be confirmed)

[1]   Oregon State University, Corvallis, OR, USA. E-mail: jack.barth@oregonstate.edu

The last 30 years has seen tremendous growth in our ability to observe the ocean. On the largest spatial scales, new advances include the global Argo array and a variety of satellite sensors. Permanent underwater observatories are located off many PICES nation's coasts, sometimes reaching to full-ocean depth. Underwater gliders make regular measurements in boundary currents and frontal regions. Fish and fisheries observations include advanced acoustic sensors and measurements facilitated through cooperation with fishing fleets. New biological imaging techniques for phytoplankton, zooplankton and larval fish, as well as eDNA have proven effective. We discuss how these observing platforms and sensors have led to new scientific insights about ocean processes and ecosystem responses to climate variability. The international ocean observing community, most recently through the OceanObs19 meeting in September 2019, is committed to expanding our ability to observe the ocean. These commitments include expanding the measurement of Essential Ocean Variables to include those for biogeochemistry, biology and ecosystems. To help find solutions to the challenges facing North Pacific marine ecosystems and the socioeconomic systems they support in the coming decades, we suggest ways that ocean observing can be improved. These include improved efficiencies, low-cost sensors for widespread use, cooperative observations with industry, as well as efforts to increase the diversity of ocean observers and promote partnerships. We suggest that what is needed most is the commitment and resolve of our PICES nations to support widespread ocean observing in order to help us solve upcoming ocean challenges.

(VS1-14907) Recorded Talk

Population trends of the Kuril harbor seal *Phoca vitulina stejnegeri* from 1974 to 2020 in southeastern Hokkaido, Japan

Yumi **Kobayashi**[1], Jun Chishima[2], Tamura Kyohei[2], Toyota Masaki[3], Matsuda Nao[3], Nori Sasaki[3], Sekitani Yuta[3] and Ayumi Yamada[3]

[1]   Laboratory of Animal Ecology, Research Faculty of Agriculture, Hokkaido University, Kita-9, Nishi-9, Kita-ku, Sapporo, Hokkaido, 060-8589, Japan. E-mail: kobayumi_kotomasu@hotmail.com
[2]   Eastern Seabird Research Institute, Obihiro, Hokkaido, 080-0835, Japan
[3]   Obihirio University of Agriculture and Veterinary Medicine Kuril Harbor Seal Research Group, Obihiro, Hokkaido, 080-0835, Japan

The Kuril harbor seal *Phoca vitulina* is 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 2020 and during molting season from 1982 to 2019. The average population growth rate was approximately 3-5%, which appears to have quadrupled over the past 40 years. Two haul-out sites (Kenbokki Island and Hattaushi) that had disappeared in the early 1980s showed no signs of recovery as stable haul-out 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 2015s remained similar to or slightly greater than during the 1980s. Recently, seals have been observed at 10 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). Recently, the eastern area population size stable or little decreased. It is supposed environmental change affect the population size.

(VS1-14927) Recorded Talk

Yearly changes in mesozooplankton biomass in the southeastern Bering Sea shelf during the summer of 1955-2013: Insights from T/S *Oshoro-Maru* data

Atsushi **Yamaguchi**, Hikaru Hikichi, Kohei Matsuno and Hiromichi Ueno

Hokkaido University, Hakodate, Japan. E-mail: a-yama@fish.hokudai.ac.jp

The T/S *Oshoro-Maru* visited the southeastern Bering Sea shelf during the summers of 1955-2013. During the visiting, mesozooplankton samples were collected from the same methods: vertical tow of NORPAC net (335 μm mesh) from 150 m depths or near-bottom. Biomass in wet weights was measured for each sample. Using these data, we studied yearly changes of mesozooplankton biomass and analyzed effects of the environmental parameters: temperature, salinity, stratification index, pycnocline depths, and interactions with the climate indices. Based on depth topography, sampling stations were divided into two regions: middle shelf (bottom 50-100 m) and outer shelf (bottom 100-200 m). For both regions, mesozooplankton biomass showed common yearly changing patterns related to climate regime shifts. Thus, as climate regime shifts during the study period, the four changing timings have reported: 1976/77, 1988/89, 1998/99, and 2005/06. For both regions, mesozooplankton biomasses were the lowest for the warmest period (2000-2005). The highest biomasses were observed for the cold period (2007-2013). Interactions between environmental parameters and mesozooplankton biomass were analyzed by the structural equation model (SEM). Through SEM analysis, it is revealed that the mesozooplankton biomass had strong negative interactions with the temperature above pycnocline for both middle and outer shelves. The regional differences were observed for the effect of ice retreat timing on environmental variables. Thus, the interactions were stronger in the middle shelf than in the outer shelf. Because of the close couplings of the environmental variables in the middle shelf, goodness-of-fit of SEM was higher for the middle shelf.

(VS1-14942) Recorded Talk - Changed to Eposter

Phytoplankton community structure and environmental factors in the East China Sea

Minbo **Luo**[1] and Tingting Jian[1,2]

[1]   East China Sea Fisheries Research Institute, Chinese Academy of Fishery Sciences, Shanghai, China. E-mail: luomb@ecsf.ac.cn
[2]   Shanghai Ocean University, Shanghai, China

The phytoplankton community structure and environmental elements in the East China Sea have been studied in recent years. The phytoplankton abundance in the East China Sea has shown a downward trend. The relationship between phytoplankton community structure and environmental factors in the East China Sea has been clarified based on the changes of the basic elements of the marine environment (water temperature, nutrient content and structure, COD and suspended matter concentration) in the East China Sea. The results showed that the dominant species of phytoplankton appeared in spring, and the dominant species consisted of *Coscinodiscus oculus-iridis*, *Coscinodiscus jonesianus* and *Skeletonema costatum* were replaced by *Skeletonema costatum*, and the dominant species was *Skeletonema costatum* in summer. From 2015 to 2017, phytoplankton abundance decreased from 51.91 x 10^3 cell/L to 5.41 x 10^3 cell/L, and community species diversity index increased from 1.08 to 1.20. A large number of terrestrial pollutants were discharged into the coastal waters of the East China Sea, resulting in eutrophication in the coastal waters of the East China Sea, providing a material basis for the growth of dominant species of phytoplankton, such as *Skeletonema costatum*. Redundancy analysis (RDA) and canonical correspondence analysis (CCA) were performed on the relationship between phytoplankton and environmental factors in 2015-2017. The results showed that inorganic nitrogen, water temperature, dissolved oxygen, chemical oxygen demand and active phosphate had important impact on the plankton population structure in the East China Sea.

Key words: phytoplankton, environment factors, East China Sea

(VS1-14948) Recorded Talk

Changes in fish communities due to benthic habitat shifts under ocean acidification conditions

Carlo **Cattano**[1,2], Sylvain Agostini[3], Ben P. Harvey[3], Shigeki Wada[3], Federico Quattrocchi[4], Gabriele Turco[1], Kazuo Inaba[3], Jason M. Hall-Spencer[3,5] and Marco Milazzo[1]

[1]   Department of Earth and Marine Sciences (DiSTeM), University of Palermo, Palermo, Italy. E-mail: carlo.cattano@unipa.it
[2]   Department of Integrative Marine Ecology, Sicily, Stazione Zoologica Anton Dohrn, 90149, Palermo, Italy
[3]   Shimoda Marine Research Center, University of Tsukuba, 5-10-1 Shimoda, Japan
[4]   IRBIM - Istituto per le Risorse Biologiche e le Biotecnologie Marine, CNR - National Research Council, Mazara del Vallo, TP, Italy
[5]   Marine Biology and Ecology Research Centre, University of Plymouth, Plymouth, UK

Ecosystem consequences of ocean acidification are still poorly understood. Here we coupled fish and benthic surveys along a pCO2/pH gradient off volcanic seeps in Japan to assess how CO2 concentrations expected to occur in the next decades may affect biogenic habitat composition and the spatio-temporal dynamics of associated fish species. We hypothesize that CO2-elevated sites would lack complex corals and macroalgae relative to control ambient CO2 sites and thus would exhibit functionally different fish communities. Our data support this hypothesis and further show that the most dramatic decrease in habitat complexity already occurred at relatively small increases in pCO2 levels expected in the next few decades (i.e., around ~500μatm), leading to decreased fish diversity and dominance of fish species better adapted to simplified ecosystems. Loss of habitat forming corals under ocean acidification conditions also caused decreasing number of tropical fish species and increasing herbivore abundance. We suggest that habitat alterations due to near-future projected ocean acidification conditions will change the structure and functioning of coastal marine ecosystems. Finally we speculate that ocean acidification, by severely limiting coral growth, could limit the on-going poleward range expansion of coral reef-associated fish species in Japan and elsewhere that is driven by ocean warming.

(VS1-14984) Recorded Talk

Vulnerable Marine Ecosystems of the Emperor Chain Seamounts: Indicator Taxa, Landscapes, and new data regarding the status and health of the North Pacific Ocean

Tatiana **Dautova**

Zhirmunsky National Scientific Center of Marine Biology, Far East Branch, Russian Academy of Sciences, Vladivostok, 690041 Russia. E-mail: tndaut@mail.ru

The first comprehensive study of the deep-sea ecosystems of the Emperor Chain seamounts (the northwestern Pacific Ocean) was conducted in July–August 2019 by A.V. Zhirmunsky National Scientific Center of Marine Biology, FEB RAS. The expedition, using a remote-operated Comanche 18 underwater vehicle, was aimed at the study of distribution of typical underwater landscapes and key taxa of Octocorallia corals and Hexactinellida sponges in the vulnerable marine ecosystem of the seamounts. New data on the macrobenthos biodiversity and biogeographic characteristics of deep-sea corals and sponges, which are the dominant animals in the studied area, are presented. The survey has shown changes of the coral fauna in the latitudinal direction and obtained new data on the biogeographic boundary in the area of the Emperor Chain seamounts.

(VS1-14906) E-poster

Long-term variations in fish community structure under multiple stressors in a semi-closed marine ecosystem in the South China Sea

Kui **Zhang**, Jianzhong Guo, Youwei Xu, Jiangtao Fan, Shannan Xu and Zuozhi Chen

South China Sea Fisheries Research Institute, Chinese Academy of Fishery Sciences, Guangzhou, China. E-mail: zhangkui@scsfri.ac.cn

Daya Bay is an ecologically and economically crucial semi-closed bay along the southern coast of China. It is proven to be a stressed ecosystem and therefore obviously vulnerable to further extrinsic disturbance. This study used fish data from bottom-trawl surveys, conducted from 1985 to 2018, to analyze variations in the fish community structure over the past 30 years. The results showed that warm-water fish species were overwhelmingly dominant during all years, suggesting the bay's tropical to subtropical characteristic. By 2015, the number of fish species had decreased by 29.44% of that caught in 1987, moreover, values of the Shannon–Wiener diversity index and the Margalef richness index were lower in 2015 compared to 2004. There were evident shifts in the fish community composition from pelagic to demersal species, as suggested by the dominant species found in springtime, the dominant families, and percentages denoting the numbers of species in the main orders. Average fish body weight in landings declined from 13.4 g to 7.58 g, the body sizes of four typical commercial fish species decreased by varying degrees over the last 30 years. Abundance–biomass comparison curves suggested that the Daya Bay fish community was more stressed in 2015 than in 2004 during all seasons, except winter. In general, the fish community structure in Daya Bay is consequently in an unsteady state. Multiple anthropogenic disturbances, such as fishing (including overfishing and changes in the main fishing gears), the destruction of natural habitats, pollutants, and anthropogenically induced temperature changes, are likely to have caused obvious shifts in the bay's fish community structure. Therefore, we emphasize the need for integrating management of multiple anthropogenic stressors to achieve ecosystem-based management.

(VS1-14970) E-poster

PICES TCODE Catalog Service

Igor I. **Shevchenko**[1, 2]

[1]   Pacific branch of VNIRO (TINRO), Vladivostok, Russia. E-mail: igor.shevchenko@tinro-center.ru
[2]   Far Eastern Federal University, Vladivostok, Russia

PICES science is done by small groups and individuals. Its advancement heavily depends on current and past data collection, curation and management efforts of community members, and their willingness to share data and information resources. PICES tries to guide expert groups on how to handle collected data. In this respect, along with the data management policy, PICES provides the catalog service that allows individuals and expert groups to describe data or information resources, make them searchable and citable. The PICES data inventory could be implemented with the use of this service. FUTURE may create a catalog of all its products as a finalizing task. Also, the next PICES integrative program oriented towards the UN Ocean Decade may benefit considerably from using this knowledge sharing tool. Ideally, data/information/services sharing issues should become an essential part of the curriculum for the PICES-sponsored summer schools and training courses and be widely discussed by early-career scientists groups. In our e-poster, we will describe the PICES TCODE catalog service, its history and status quo, and also demonstrate how to prepare, publish, and search metadata records from different sub-catalogs through the web interface.

VIRTUAL SESSION 3

Using eDNA to assess and manage non-indigenous species in the North Pacific

(VS3-14924) Invited-Live Talk

Environmental DNA for identifying "red zone" of endangered/invasive species

Hitoshi **Araki**[1], Hiroki Yamanaka[2], Kimiko Uchii[3], Michinobu Kuwae[4] and Hideyuki Doi[5]

[1]   Hokkaido University, Sapporo, Japan. E-mail: arakih@res.agr.hokudai.ac.jp
[2]   Ryukoku University, Otsu, Japan
[3]   Osaka Ohtani University, Tondabayashi, Japan
[4]   Ehime University, Matsuyama, Japan
[5]   University of Hyogo, Kobe, Japan

This talk introduces our current project with Ministry of the Environment, Japan, in which endangered and invasive fish species are specifically targeted. At this moment, we have 169 endangered fish species recognized by the Japanese government, as well as 26 invasive alien fish species. In this project, we first evaluate applicability of existing primer sets for environmental DNA (eDNA) metabarcoding to these species, followed by their real-world applications and designing of new primer sets if necessary. Next, we investigate possibilities of new eDNA applications for evaluations of intra-genetic variation, population genetic status, and long-term population dynamics of these species. Getting the information from eDNA analyses together, we aim to develop new indices for conservation of endangered species and prioritization of "red zone" against invasive species.

(VS3-14973) Invited-Live Talk

Recent progress of eukaryotic metabarcoding in Japanese coastal waters

Satoshi **Nagai**[1], Sirje Sildever[1,2], Noriko Nishi[3], Satoshi Tazawa[3], Hiromi Kasai[4], Akihiro Shiomoto[5] and Seiji Katakura[6]

[1]   Japan Fisheries Research and Education Agency, Yokohama, Japan. E-mail: snagai@affrc.go.jp
[2]   Tallinn University of Technology, Akadeemia tee 15A, 12618 Tallinn, Estonia
[3]   AXIOHELIX Co. Ltd, Chiyoda-ku, Tokyo, Japan
[4]   Hokkaido National Fisheries Research Institute, Hokkaido, Japan
[5]   Tokyo University of Agriculture, Hokkaido, Japan
[6]   City of Mombetsu, Hokkaido, Japan

We introduce results of time series monitoring using the metabarcoding technique in the eastern part of Hokkaido facing the Okhotsk Sea, Japan is where the coldest water ($-2°C$) flows in from Sakhalin in winter. During summer, the area is influenced by the Soya warm current (7- 22 ºC) flowing in from the Sea of Japan. Since the perturbation of biodiversity with environmental parameters is considered an environmental sensor, therefore, Mombetsu city is recognized as the most important monitoring base for observing eukaryote species which appear in the coldest waters in Japan. To study the relationship between the change of biodiversity and long-term changes in environmental parameters, weekly monitoring has been carried out at one location off the coast of Mombetsu city from Apr 2012 to Mar 2019 (n = 394). Universal primers for eukaryotes targeting 18S and 28S ribosomal RNA were used to detect as many taxa as possible. We succeeded in identifying 1,799 species, i.e. 509, 342, 199, 173, 127, 83, 210, and 156 species in Fungi, Metazoa, Bacillariophyceae, Dinophyceae, Ciliophora, Chlorophyceae, other microalgae, and other eukaryotes, respectively. The frequency of OTUs, which were identified as a single species, was 11.9–41.2%. The taxonomic identification power was high for Archaeplastida, Opisthokonta, and Viridiplantae, but relatively low for Alveolata and Rhizaria. The results of this study demonstrate the usefulness of the metabarcoding techniques for biodiversity monitoring and in combination with the environmental data providing more information on the species/groups ecology, which is especially relevant for elusive, harmful and non-indigenous species.

(VS3-14988) Invited-Live Talk

Early detection and quantification of non-indigenous protists using environmental DNA (eDNA)

Kwang Young **Kim**

Chonnam National University, Gwangju, Republic of Korea. E-mail: kykim@chonnam.ac.kr

To minimize damages associated with invasive alien species or harmful algal blooms, a routine monitoring program of marine environments must be implemented with a suitable analytical technique for their identification and quantification. However, the quantification of such species based on their external morphology under a light microscope, or by using conventional molecular approaches have limited sensitivity, specificity, and reproducibility. To address these challenges, the digital-droplet PCR (ddPCR) assay has been developed to enumerate the fish-killing *Margalefidinium* (*Cochlodinium*) *polykrikoides* and two paralytic shellfish toxin (PST) producing *Alexandrium catenella* and *A. pacificum* in environmental samples. Copies of species-specific internal transcribed spacer (ITS) per cell, which were calculated from environmental samples spiked with a known number of culture cells, were used to estimate the cell abundance of planktonic dinoflagellates. A novel ddPCR protocol was applied to determine the temporal and spatial distribution of those populations in the southern coastal waters of Korea. This highly sensitive assay can precisely quantify the target species of protists in complex marine environmental samples, and might be appropriated for the monitoring of various invasive alien or harmful species that require high sample throughput and low detection limit, even at very low abundance in nature.

(VS3-14954) Live Talk

A preliminary report on the implementation of eDNA-based techniques to biodiversity monitoring of fish from the Far East of Russia

Sergei V. **Turanov**[1,2] and Olesya A. Rutenko [1,3]

[1]   A.V. Zhirmunsky National Scientific Center of Marine Biology, Vladivostok, Russia. E-mail: sturcoal@mail.ru
[2]   Far Eastern State Technical Fisheries University, Vladivostok, Russia
[3]   Far Eastern Federal University, Vladivostok, Russia

Non-invasive methods for monitoring biodiversity in the aquatic environment include the hydroacoustic, image recognition approach by pretrained neural networks, as well as the use of environmental DNA. While the first 2 methods help to make a real-time evaluation, DNA from the aquatic environment is being introduced into biodiversity monitoring practices around the world as an additional tool capable of assessing the presence of water creatures in a given location even when they are small and inaccessible to other approaches. In this talk we will present the preliminary data on our experience in using environmental DNA to monitor fish diversity focusing on the three main topics: development of the test system for endangered species (*Acipenser mikadoi*) identification, using mock-communities in aquarium to calibrate our ability to deal with eDNA as well as monitoring natural diversity of marine and freshwater fish.

(VS3-14993) Live Talk

Applied molecular biosurveillance in the Northeast Pacific part I: integrating a new eDNA tool for broad detection capacity.

Kristen Marie Westfall, Thomas W. **Therriault** and Cathryn L. Abbott

Fisheries and Oceans Canada, Pacific Biological Station, Nanaimo, BC, Canada. E-mail: Cathryn.Abbott@dfo-mpo.gc.ca

There are over 360 non-indigenous species (NIS) across 12 phyla in the Northeast Pacific Ocean. A new eDNA metabarcoding assay targeting the most economically and environmentally significant NIS enables early and rapid detection of new incursions, and monitors existing populations for secondary spread. Important considerations for integrating this tool into existing monitoring programs are: (1) interpret the data collected from eDNA with in comparison with traditional NIS sampling methods; (2) empirically assess eDNA sampling methods for each targeted taxonomic group; and (3) incorporate knowledge gained from eDNA into management and policy. In surveys around southwestern BC, eDNA detected 27 NIS in six phyla compared to 8 NIS in three phyla detected

from traditional settlement plates. NIS communities on settlement plates were generally uniform across all study sites and restricted to the most abundant sessile and encrusting species. In contrast, NIS communities detected from eDNA had higher species diversity and were significantly different from each other across study sites. We uncovered significant differences in community composition between zooplankton and seawater eDNA samples and both were necessary to detect highly important NIS. Additionally, spring may be the best season to sample as we noted early to mid summer declines in NIS species richness across most phyla. Identification of new NIS from eDNA should be a starting point for more intensive investigations of population status. We highlight the importance of capitalizing on the efficiency of eDNA for discerning fine-scale spatiotemporal patterns of NIS communities to inform management.

(VS3-14994) Live Talk

Applied molecular biosurveillance in the Northeast Pacific part II: Improving targeted detection and quantification

Kristen Marie **Westfall**, Thomas W. Therriault and Cathryn L. Abbott

Fisheries and Oceans Canada, Pacific Biological Station, Nanaimo, BC, Canada. E-mail: Cathryn.Abbott@dfo-mpo.gc.ca

Non-indigenous species are scarce or rare during initial incursions or secondary spread, and detection in these phases is paramount to quick implementation of eradication. A new quantitative eDNA approach called targeted next generation sequencing (tNGS), presented here for invasive green crab (*Carcinus maenas*), is 10-100 times more sensitive than quantitative PCR (qPCR) and increases detection probability by 7-10% at low abundances. We confirm that eDNA concentration in seawater is positively correlated with green crab abundance, and is less variable within sites than between sites with differential abundance. The tNGS assay is more accurate at predicting green crab CPUE than qPCR and in both cases detection probabilities increase with abundance. The accuracy of predicting green crab CPUE from eDNA concentration increases with the number of field replicates sampled within a site, and sampling across a 24 hour tidal cycle does not weaken this relationship. Demonstrating that green crab eDNA concentration behaves similarly to CPUE creates a robust framework for quantifying abundance levels and allows implementation of this assay in regular detection and monitoring surveys. This highly sensitive assay will facilitate efficient assessment of green crab spread in high interest regions such as the Salish Sea, where founding populations may be patchy and small. The tNGS assay is easily accessible for surveying other species with existing qPCR assays and can thus be an important tool for detection and quantification of any rare or scarce species.

(VS3-15002) Live Talk

The use of eDNA as an intergovernmental approach to tracking and managing nonindigenous species in the USA

Jeanette **Davis**

National Oceanic and Atmospheric Administration, Silver Spring, MD, USA. E-mail: jeanette.davis@noaa.gov

Marine non-indigenous (NIS) species threaten the diversity or abundance of native species, the ecological stability of infested waters, and commercial or recreational activities dependent on such waters. Through legislation and the establishment of several interagency groups, the United States government takes a collaborative approach to prevent the introduction and dispersal of NIS, conducts research on methods to monitor, manage, and eradicate such species, and educates the general public and stakeholders about prevention and control of NIS. The use of environmental DNA (eDNA) is a new and rapidly growing tool to detect and monitor NIS and is of interest conservation to management. Many government agencies in the US are pursuing the development and implementation of eDNA tools for invasive species management however, agencies have mandates that target specific species in different environments which require different sampling standards and protocols. Through collaboration, government agencies are working together to establish technical eDNA considerations such as sampling, laboratory protocols and sampling as well as potential management outcomes based on eDNA results. Overall, there is much synergy for the use of eDNA to track NIS and opportunities for lessons learned and shared methodologies for data collection and analyses. These collaborative efforts have implications for management of NIS within the US government.

(VS3-14931) E-poster

Influencing factors and quantitative evaluation of environmental DNA metabarcoding

Shufang **Liu**[1,2], Ming Mu[1,2] and Zhimeng Zhuang[1,2]

[1]   Yellow Sea Fisheries Research Institute, CAFS, Qingdao, China. E-mail: liusf@ysfri.ac.cn
[2]   Qingdao National Laboratory for Marine Science and Technology, Qingdao, China

eDNA metabarcoding has the potential to rapidly assess species abundances in communities, making it a promising investigation tool in resource conservation and management. However, in the field and laboratory, the enrichment efficiency of eDNA is difficult to evaluate. Meanwhile, primer bias inevitably occurs in the eDNA amplification process, resulting in uncertainty in the eDNA results, which restricts the application of eDNA metabarcoding for biological resource investigations. Assuming that the eDNA is completely recovered, and there is no primer bias during PCR amplification, an ideal state for deciphering whether there is a linear relationship between the eDNA and HTS reads is created. In this study, a sister group was selected (*Penaeus vannamei* and *Penaeus merguiensis*) and their DNA samples were mixed in different proportions to simulate eDNA samples enriched from natural waters. Then, it was used to explore the accuracy of eDNA metabarcoding in detecting species biomass. The results showed when the concentration ratio of the DNA templates of two species was 1:1, the HTS ratio of *P. merguiensis*/*P. vannamei* was 13/24. Therefore, even between the closest relatives there is still a slight primer bias. At the same time, the HTS results from the seven test groups showed an obvious linear relationship between the composition of eDNA in the water and the number of high-throughput sequencing reads, $y=0.0716x+0.7043(r^2=0.9824)$. In summary, this study provides direct evidence to verify the feasibility of eDNA metabarcoding in monitoring aquatic biological resources, and also provides ideas for the subsequent quantitative study of DNA metabarcoding.

(VS3-14968) E-poster

Distribution and Occupancy Status of Alien Barnacles in South Korea

Yun-Sik **Lee**[1,2], Michael Dadole Ubagan[2,3], Taekjun Lee[2], Seung Bin Park[3], Bal Dev Bhattrai[2] and Sook Shin[2,3]

[1]   Eco-Resilience Institute, Korea University, Seoul, Korea
[2]   Marine Biological Resource Institute, Sahmyook University, Seoul, Korea
[3]   Department of Animal Biotechnology and Resource, Sahmyook University, Seoul, Korea. E-mail: shins@syu.ac.kr

The barnacles have free-swimming larval life in the sea and then sessile life from juvenile to adulthood. This feature allows them to enter various marine ecosystems through the bottom of the ship and ship hulls, which has the potential to cause disturbances in the marine ecosystem. In this study, the distribution and occupied area (%) of four alien and one indigenous barnacle species in 14 ports of South Korea were monitored. At each port, ten acrylic attachment plates (30x30cm) were installed, which were submerged from May 2017 to October (warm season), and from November 2017 to April 2018 (cold season). The occupancy ratio of all five species was 11.17% in the summer and 7.59% in the winter, showing a higher occupancy in summer. *Balanus trigonus*, an indigenous species, appeared in all regions except Incheon area, with the highest occupancy ratio was observed in the southern sea mainly including Busan, Yeosu and Gwangyang. In the case of four invasive species, *Perforatus perforatus*, *Amphibalanus eburneus*, and *A. improvisus* in the East Sea, *A. amphitrite*, *P. perforatus*, *A. eburneus* and *A. improvisus* in the South Sea, and *A. amphitrite* and *A. improvisus* in the West Sea, distributed respectively. As a result of nonparametric multidimensional scale method, significant differences occurred in the species composition of the East Sea and the South Sea, and the East Sea and the West Sea in both summer and winter periods, and the results well explained by the water temperature and salinity.

(VS3-14969) E-poster

First record of non-indigenous colonial ascidian in the Korean coasts, confirmed by DNA Barcoding

Taekjun **Lee**[1], Michael Dadole Ubagan[1, 2], Seung Bin Park[2], Bal Dev Bhattrai[1] and Sook Shin[1, 2]

[1]   Marine Biological Resource Institute, Sahmyook University, Seoul, Korea
[2]   Department of Animal Biotechnology and Resource, Sahmyook University, Seoul, Korea. E-mail: shins@syu.ac.kr

The colonial ascidian *Botrylloides diegensis* Ritter and Forsyth, 1917 is known as possibly native to the west side of North America and distributed in North America, Ireland and the southern UK in present. Molecular tools have been extensively used in recent decades to examine biological invasion processes, and are increasingly being adopted as efficient tools to support non-indigenous species surveys, notably through barcoding approaches. The ascidian genus *Botrylloides* have been recognized at least three global marine invaders, including *B. violaceus* and *B. diegensis*. We obtained partial sequences of COI (658 bp) from colonies of *Botrylloides* spp. in 14 harbors of the Korean coastline. The results of phylogenetic analysis clearly distinguished our targeted taxa [*B. violaceus* (native) and *B. diegensis*]. Based on these results, we analyzed all monitoring image data during the past year and as a result, we have confirmed a biological volume change of *B. diagenesis* in Korea. Altogether, this study presents comparison photos of *B. violaceus* and *B. diegensis* in the field and suggests the advantage of molecular barcoding in surveys and studies of non-indigenous monitoring.

(VS3-14989) E-poster

Monitoring of drifting seaweed (*Sargassum horneri*) in Liaodong Bay in 2020

Chunjiang **Guan**, Yanlong Chen, Yongjian Liu, Yujuan Ma, Lu Yang, Jialu Shi and Jingfang Zhang

National Marine Environmental Monitoring Center, Ministry of Ecology and Environment, 42 Linghe St., Dalian City 116023, PR China. E-mail: cjguan@189.cn

From 2015 to 2020, satellite remote sensing methods are used to monitor drifting seaweed, mainly monitoring the distribution area and drifting path. The measurement frequency is once every 3 days. As of mid-August 2020, the monitoring results found that the distribution area of drifting seaweed (Sargassum horneri) in Liaodong Bay in 2020 was the largest in six years since 2015, In 2020, on June 28th, the largest distribution area of *Sargassum horneriin* Liaodong Bay was monitored to be 640km^2; on July 7th, 2020, the source of drifting was monitored from the northern part of the Yellow Sea. On August 8th, the ship's on-site investigation found that there were still *Sargassum horneri* drifting in the area, and every drifting seaweed cluster was entangled with artificial floating bodies such as foaming foam. Perhaps the buoyancy of the seaweed itself was not sufficient for long-distance drifting. With the help of external floating objects, it can maintain long-term growth and drifting. Many young fish can be seen under the *Sargassum horneri* mass. The resource of Spanish mackerel in the Yellow Sea and Bohai Sea have increased significantly this year, which may be related to the surge of drifting seaweed and the large number of fish eggs and juveniles transported. Drifting seaweed and the fish eggs or juveniles it carries, drifting and spreading over long distances across the sea, are all non-native species (NIS) wherever they go, and may be an ideal model organism for studying environmental DNA (eDNA) technology.

Keywords: drifting seaweed, Sargassum horneri

VIRTUAL SESSION 4

Implementing a collaborative, integrated ecosystem high seas survey program to determine climate/ocean mechanisms affecting the productivity and distribution of salmon and associated pelagic fishes across the North Pacific Ocean

(VS4-14951) Live Talk

Co-variability of Fraser River sockeye productivity and phytoplankton biomass distributions in the NE Subarctic Pacific Ocean

Sarah Z. **Rosengard**[1], Cameron Freshwater[2], Skip McKinnell[3], Yi Xu[4] and Philippe Tortell[1,5]

[1] Department of Earth, Ocean and Atmospheric Sciences, University of British Columbia, Canada. E-mail: srosengard@eoas.ubc.ca
[2] Pacific Biological Station, Fisheries and Oceans Canada, Canada
[3] Salmoforsk International Environmental Consulting, Canada
[4] Stock Assessment Division, Fraser and Interior Area, Fisheries and Oceans Canada, Canada
[5] Department of Botany, University of British Columbia, Canada

We leverage the wide coverage of satellite ocean color measurements to examine the association between phytoplankton biomass and Fraser River sockeye salmon productivity across the Gulf of Alaska. Using data collected between 1997 and 2016, our analysis reveals a statistically significant, positive linear relationship between Fraser River sockeye productivity and satellite-derived summertime chlorophyll-a (Chl-a) concentrations in the northern portion of our study region. The correlation is strongest for the area adjacent to the continental shelf near Kodiak Island during late summer of the year in which sockeye salmon out-migrate to the ocean. We found that including [Chl-a] data from this region significantly improved the performance of Ricker stock-recruitment models for ten out of eighteen Fraser River stocks (decrease in AIC > 4 units). Elevated [Chl-a] anomalies in the offshore waters near Kodiak Island are generally associated with positive sea level anomalies, suggesting that summertime eddies may transport higher nutrient concentrations and phytoplankton biomass to this region. Taken together, our analysis supports the hypothesis that juvenile survival during early marine residence could be a critical period to sockeye productivity, which in turn may be influenced by variations in late summertime primary production in the northwestern Gulf of Alaska. These results provide a potential mechanism linking Northeast Pacific mesoscale dynamics to sockeye salmon productivity, and a regional and temporal focus for future studies of Fraser River sockeye salmon survival.

(VS4-14983) Live Talk

Food web structure and salmon trophic ecology in late winter in the Gulf of Alaska

Brian P.V. **Hunt**[1,2,3], Evgeny A. Pakhomov[1,2,3], Alexei Somov[4], Albina Kanzeparova[4], Mikhail Zuev[4] and Vladimir Radchenko[5]

[1] Institute for Oceans and Fisheries, University of British Columbia, 2202 Main Mall, Vancouver, British Columbia V6T 1Z4, Canada.
     E-mail: b.hunt@oceans.ubc.ca
[2] Department of Earth, Ocean, and Atmospheric Sciences, University of British Columbia, 2207 Main Mall, Vancouver, British
     Columbia V6T 1Z4, Canada
[3] Hakai Institute, PO Box 25039, Campbell River, British Columbia V9W 0B7, Canada
[4] TINRO, Shevchenko Alley 4, Vladivostok, 690091, Russia
[5] North Pacific Anadromous Fish Commission, Suite 502, 889 West Pender Street, Vancouver, British Columbia V6C 3B2, Canada

Between February 16 and March 18, 2019 the inaugural voyage of the International Year of the Salmon undertook a mesoscale survey of the Gulf of Alaska to research the winter ecology of the North Pacific salmon ecosystem. A total of 60 stations were sampled across a ~ 1 x 1 degree survey grid, covering an area of approximately 700,000 km^2. An integrated fisheries oceanography approach was used to sample all components of the pelagic food web, from the bottom up drivers of physics and chemistry, to biota spanning microbes to salmon. Nekton sampling was completed using a midwater trawl towed for one hour at ~ 4.5 knots. Tissues samples were collected from all components of the pelagic food web across the survey area, including Particulate Organic Matter (POM – phytoplankton), zooplankton, micronekton and nekton (including sockeye, chum, pink, coho and chinook

salmon). These tissue samples were subsequently analyzed for their carbon and nitrogen stable isotope values. Here we report on multiple food web metrics using these isotope data, including: 1) isotope trophic baseline, 2) food chain length, 3) organism trophic level. We specifically focus on the trophic ecology of Pacific salmon, including estimates of trophic niche overlap, and comment on the large scale movement dynamics between shelf and high seas habitats.

(VS4-14997) Live Talk

Potential effects of wounds and sea lice on the health of Pacific salmon on the high seas

Laurie **Weitkamp**[1], Chrys Neville[2], Alexey A. Somov[3] and Albina Kanzeparova[3].

[1]   NOAA Fisheries, Northwest Fisheries Science Center, Newport, OR, USA. E-mail: laurie.weitkamp@noaa.gov
[2]   Fisheries and Oceans Canada, Pacific Biological Station, Nanaimo, BC, Canada
[3]   Russian Federal Research Institute of Fisheries and Oceanography, Pacific Branch (TINRO), Vladivostok, Russia

The winter period of ocean residence remains a "black box" for Pacific salmon. Many details of the basic biology during this potentially critical period are poorly understood. For example, we know little about how or why stocks are distributed across the North Pacific Ocean, what they eat (versus what is available), or whether predation is a major source of mortality. During winter expeditions in 2019 and 2020 to study salmon and their ecosystems across the Gulf of Alaska, we noted the presence of external marks on salmon captured in the trawl, such as wounds, sea lice, and other unusual features. While collecting the data at sea, it did not appear that some species or sizes of fish had more marks than others, but a rigorous analysis wasn't conducted. However, we speculated that the presence of severe wounds might negatively affect the health of individual fish. This talk will provide a summary of marks observed on fish by species and size. We will also relate mark presence and severity to fish condition and bioenergetic assessments to explore whether it appears to compromise with fish health. While the presence of wounds and sea lice is simple metric to collect and evaluate, it may be an important contributor to the health and therefore survival of Pacific salmon on the high seas.

(VS4-14998) Live Talk

Way out there: Pathogens and stressors of overwintering salmon in the Gulf of Alaska

Christoph M. **Deeg**[1,2], Albina Kanzeparova[3], Alexei Somov[3], Svetlana Esenkulova[2], Emiliano Di Cicco[2], Karia H. Kaukinen[4], Amy Tabata[4], Tobi J. Ming[4], Shaorong Li[4], Richard J. Beamish[4] and Kristina M. Miller[1,4]

[4]   [1]Department of Forest & Conservation Science, University of British Columbia, Vancouver, BC, Canada. E-mail: chdeeg@mail.ubc.ca
[5]   [2]Pacific Salmon Foundation, Vancouver, BC, Canada
[6]   [3]Pacific branch of VNIRO ("TINRO"), Vladivostok, Russia
[7]   [4]Fisheries and Oceans Canada, Pacific Biological Station, Nanaimo, BC, Canada

Wild Pacific salmon stocks have experienced significant declines, most notably towards their southern range limits. While most restoration efforts focus on fresh and coastal waters, little is known about the open ocean where salmon spend most of their life and gain most of their biomass. Here we provide the first report on the health and condition of Coho, Chum, Pink, and Sockeye salmon in the Gulf of Alaska (GoA) at the end of the winter. We found that pathogen diversity in the GoA was lower compared to coastal waters with fewer agents detected in all species but Coho. Most pathogens with high prevalence and load in the GoA are likely acquired via trophic transmission. Stock of origin significantly influenced pathogen profiles in Coho salmon, the species with the highest pathogen diversity. Transcriptome profiling using Salmon Fit-Chips revealed that relative infection burden, and occasionally single pathogens, were correlated with stress, size, condition factor, and imminent mortality. A subset of Chum, Pink, and Sockeye salmon showed pronounced signatures of imminent mortality which was related to pathogen burden in Pink and Chum. A third of Chum salmon showed signs of imminent mortality. Capture location influenced gene expression in all species presumably caused by heterogeneous environmental conditions across the GoA. Together, we provide the first report highlighting key factors influencing survival of Pacific Salmon in the GoA. We expect this data to serve as a baseline for future surveys to guide data driven stewardship of Pacific Salmon populations in a changing ocean.

(VS4-15007) Live Talk

Comparative oceanographic conditions during the International Gulf of Alaska Expedition 2019 and 2020

Evgeny A. **Pakhomov**[1,2,3], Albina Kanzeparova[4] and International TEAM of the 2019 and 2020 Gulf of Alaska Expeditions

[1]   Department of Earth, Ocean & Atmospheric Sciences, University of British Columbia, BC, Canada. E-mail: epakhomov@eoas.ubc.ca
[2]   Institute for the Oceans and Fisheries, University of British Columbia, BC, Canada
[3]   Hakai Institute, BC, Canada
[4]   TINRO, Vladivostok, Russia

During February-March of 2019 and 2020 international, integrated pelagic ecosystem research surveys were carried out onboard RVs *Professor Kaganovskiy* and *Pacific Legacy*. The expeditions covered an area of approximately 650,000 – 700,000 km^2 of the Gulf of Alaska (GoA). Both surveys were conducted in the transitional zone of the Sub-Arctic Current with surface currents flowing predominantly south-eastwards. Jet-like currents were evident in the northern and southern parts of the survey. In both years, the GoA waters were warmer than the long-term (1993-2015) mean. Overall, distribution of sea surface properties were similar in both years. A strong south-east to north-west gradient was evident in surface and subsurface ocean properties off the continental shelf, temperature decreasing and salinity and oxygen increasing, mixed layer depth deepening, and the decreasing depth of the 2.5 ml.l^{-1} oxygen horizon (concentrations below this level may affect salmon and other micronekton physiological performance). A divergence between currents to the west and east was visible at ~48°N – 50°N along survey transects with surface 7°C isotherm demarcating colder and warmer parts of surveys. Chlorophyll-*a* concentrations generally did not exceed 1 mgChl-*a*.m^{-3}. Unevenly distributed, elevated phytoplankton biomass was observed in central and southern parts of surveys. Total zooplankton biomass averaged ~150 mgWW.m^{-3} reaching up to 0.8 gWW.m^{-3}. North-south gradients of biota, e.g. productivity, mesozooplankton composition, macroplankton and micronekton, as well as nekton distributional patterns, appeared to correlate with the environmental characteristics of water masses. Between-year specifics in oceanographic settings in the GoA discussed in relation to the salmon winter habitat.

(VS4-15009) Live Talk

Winter energetic status of Pacific salmon in the Gulf of Alaska

Charles D. **Waters**[1], Chrys Neville[2], Todd Miller[1], Emily Fergusson[1], Dion Oxman[3] and Edward Farley Jr.[1]

[1]   Auke Bay Laboratories, Alaska Fisheries Science Center, National Oceanic and Atmospheric Administration, Juneau, AK, USA. E-mail: Charlie.Waters@noaa.gov
[2]   Fisheries and Oceans Canada, Pacific Biological Station, Nanaimo, BC, Canada
[3]   Mark Tag and Age Laboratory, Division of Commercial Fisheries, Alaska Department of Fish and Game, Juneau, AK, USA

Overwinter survival of Pacific salmon is likely influenced by their ability to acquire sufficient lipid reserves in the preceding summer and fall. Additionally, winter is considered a period when competition for prey resources among species and stocks is highest due to low prey biomass. To better understand this critical winter period, which may regulate the productivity of salmon in the high seas environment, we analyzed samples collected from the 2019 winter NPAFC-International Year of the Salmon Gulf of Alaska Expedition. Specifically, we investigated the winter fitness of 412 chum, coho, pink, and sockeye salmon by estimating their lipid content, protein content, and energy density. We also compared energy density values obtained from two international labs to determine if results differed between processing methods, which may be used to develop a correction factor for results from future international collaborations. Last, we differentiated hatchery- and wild-origin salmon using thermal marks and compared the energetic status of these two groups. The results will be used to develop indices of winter fitness for Pacific salmon and will contribute to our understanding of intra- and inter-species competition that occurs during the critical winter period.

(VS4-15012) Live Talk

Gulf of Alaska expeditions in 2019 and 2020

Dick **Beamish**[1] and Brian **Riddell**[2]

[1]   Emeritus Scientist, Department of Fisheries and Oceans, Nanaimo, BC, Canada. E-mail: rabeamish@shaw.ca
[2]   Science Advisor, Pacific Salmon Foundation, Vancouver, BC, Canada

The abundance of Pacific salmon is mostly determined in the ocean with the possibility that fish that survive the first ocean winter are an index of total returns. Very little is known about the ocean ecology of Pacific salmon after they leave the coastal areas and migrate into the Gulf of Alaska; yet, it is what happens here that mostly determines the abundance of returning Pacific salmon. To begin to understand the mechanisms that regulate abundances of Pacific salmon and possibly develop a method of better forecasting returns, Brian and I organized studies of the winter ecology of Pacific salmon in 2019 and 2020. Preliminary results indicate that the surveys may provide an early warning of return abundances. For example, in 2019 there were relatively few chum salmon of the age that would return to spawn in the fall of 2019 and the return in the fall of 2019 was extremely poor over a wide area of the Pacific northeastern rivers. In 2020, there were a number of unexpected results such as vast areas with few salmon to no salmon caught, versus a few areas of exceptionally high catches, but abundances of prey was much more widely distributed. We suggest that multi-vessel surveys are required to increase sampling intensity to quantify the repeatability of results in time and space. In some cases, what we did not find will be as important as what was found but we have to be confident these results aren't attributable to sampling methods. To share information, the data from both surveys will be shared openly through the Global Ocean Observing System.

(VS4-14909) Recorded Talk

Simultaneous evaluations on the spatio-temporal dynamics of major fish stocks: a case study of the Bohai Sea ecosystem in China

Lisha **Guan**[1,2], Xiujuan Shan[1,2], Xianshi Jin[1,2], Tao Yang[1,2], Zhongyi Li[1,2] and Harry Gorfine[3]

[1]   Key Laboratory of Sustainable Development of Marine Fisheries, Ministry of Agriculture; Shandong Provincial Key Laboratory of Fishery Resources and Ecological Environment, Yellow Sea Fisheries Research Institute, Chinese Academy of Fishery Sciences, Qingdao 266071, China. E-mail: guanls@ysfri.ac.cn
[2]   Laboratory for Marine Fisheries Science and Food Production Processes, Pilot National Laboratory for Marine Science and Technology, Qingdao 266237, China
[3]   School of Biosciences, The University of Melbourne, Parkville 3010, Australia

Joint species distribution models are rarely used to simultaneously evaluate the spatio-temporal dynamics of dominant fish stocks in an ecosystem. This study aims to fill this gap with a case study of the Bohai Sea ecosystem in China. A joint dynamic species distribution model was developed to estimate the distributions of 13 biomass-dominant fish stocks comprising 7 teleost and 6 invertebrate species in the Bohai Sea, using data from bottom trawl surveys conducted in spring during 2014 to 2018. We calculated the spatial ranges (i.e., the distance within which correlation coefficients between locations are larger than 10%) for spatial variation and spatio-temporal variation in species-specific densities of this fished community. Moreover, the model-based density estimates for these stocks were used to calculate the center of gravity (COG), effective area occupied, and total abundance index for each stock by year. Results showed that the spatial ranges were respectively 84 km and 94 km for spatial and spatio-temporal variation in the distributions of targeted stocks, suggesting large variability in the community structure at a distance > 100 km. Fish stocks showed larger fluctuations in the COG and effective area occupied than crustaceans and cephalopods, while most of the 13 stocks tended to shift northeastwards in their COG. Additionally, 12 of the 13 stocks showed a sharp increase in total abundance in the spring of 2017. In 2018, the total abundance indices remained high for most stocks of fish species but showed an abrupt decrease for all six of the invertebrate stocks.

(VS4- 14911) Recorded Talk - CANCELLED

Time-varying epipelagic community seascapes: assessing and predicting species composition in the Northeastern Pacific Ocean

Caren **Barceló**[1], Richard D. Brodeur[2], Lorenzo Ciannelli[3], Elizabeth A. Daly[4], Craig M. Risien[3], Gonzalo S. Saldias[5], and Jameal F. Samhouri[6]

[1]   Department of Wildlife, Fish and Conservation Biology, University of California, Davis, CA, USA. E-mail: cbarcelo@ucdavis.edu
[2]   NOAA Northwest Fisheries Science Center, Hatfield Marine Science Center, Newport, OR, USA
[3]   College of Earth, Ocean and Atmospheric Sciences, Oregon State University, Corvallis, OR, USA
[4]   Cooperative Institute of Marine Resource Studies, Oregon State University, Hatfield Marine Science Center, Newport, OR, USA
[5]   Departamento de Fisica, Facultad de Ciencias, Universidad del Bio-Bio, Casilla-5C, 4051381, Concepcion, Chile
[6]   NOAA Northwest Fisheries Science Center, Montlake Lab, Seattle, WA, USA

A current interdisciplinary challenge is to effectively track multiple facets of biodiversity of the marine ecosystem from a remote perspective with the ultimate goal of developing ecosystem indicators for management. In this study, we use generalize additive mixed models to quantify the relationship between spatially and temporally explicit community data using both in-situ and remotely sensed oceanographic data over three different months and 10 years. With the modeling, and concurrent satellite data summarized for species-specific positive catch only locations, we demonstrate the utility of using the Rrs555 data field in order to understand to higher trophic level biology associated with freshwater input into this region. Further, using these community gradients and the modeled functional relationships, we predict one community gradient (warm and offshore - cold and nearshore) onto satellite data from 2003-2012 and based on community predictions outside of sampled species data, between 2013-2015. From these spatial maps, we develop a new community-level, temporally and spatially explicit indicator that assesses variations in the epipelagic community. This index of community differences is useful for regional ecosystem status reports and could be useful within a broader ecosystem-based fisheries management context.

(VS4-14933) Recorded Talk

A regional vulnerability assessment for the Dungeness crab (*Metacarcinus magister*) to changing ocean conditions: insights from model projections and empirical experiments

Halle **Berger**[1], Samantha Siedlecki[1], Catherine Matassa[1], Simone Alin[2], Isaac Kaplan[3], Emma Hodgson[4], Darren Pilcher[5], Emily Norton[5] and Jan Newton[6]

[1]   Department of Marine Sciences, University of Connecticut, Groton, CT, USA. E-mail: halle.berger@uconn.edu
[2]   Pacific Marine Environmental Laboratory, NOAA, Seattle, WA, USA
[3]   Northwest Fisheries Science Center, NOAA, Seattle, WA, USA
[4]   Simon Fraser University, Burnaby, BC, Canada
[5]   Cooperative Institute for Climate, Ocean, and Ecosystem Studies, University of Washington, Seattle, WA, USA
[6]   Applied Physics Laboratory, University of Washington, Seattle, WA, USA

The Northern California Current System (N-CCS) experiences effects from ocean acidification and hypoxia during summer upwelling. Oxygen, pH, and temperature conditions are expected to become more stressful under global climate change, posing a serious threat to the region's fisheries. N-CCS fishing communities rely heavily on the economically and culturally important Dungeness crab (*Metacarcinus magister*). While the fishery is currently sustainably managed, potential negative impacts from changing conditions could have adverse effects for the fishery and the communities that rely on it. To quantify the vulnerability of Dungeness crab life stages and populations to predicted future conditions, both model projections and empirical experiments need to be employed. A semi-quantitative, life stage-specific framework was adapted to assess the vulnerability of Dungeness crab to low pH, low dissolved oxygen, and high temperature under present and future projected conditions. This was achieved using a combination of regional ocean models, species distribution maps, larval transport models, a population matrix model, and a literature review. Our multi-faceted approach revealed that crab vulnerability to the three stressors will increase in the future (year 2100) with vulnerability to low oxygen being the most severe overall. Increases in vulnerability were largely driven by the adult stage, which contributes the most to population growth. Empirical experiments demonstrated that adult crab respiration rates increase exponentially with temperature, potentially making this stage more susceptible to hypoxia in the future. Together, this work provides novel insights into the effects of changing conditions on Dungeness crab populations, which may help inform fishery management.

(VS4-14946) Recorded Talk

Strengthened Ocean-desert Process in the North Pacific over the Past Two Decades

Siyu **Meng**[1,2], Xun Gong[3,4,5,6], Yang Yu[1], Xiaohong Yao[1], Xiang Gong[7], Keyu Lu[2], Chao Zhang[1], Jie Shi[1], Xiaojie Yu[1] and Huiwang Gao[1,2]

[1] Frontiers Science Center for Deep Ocean Multispheres and Earth System, and Key Laboratory of Marine Environment and Ecology, Ministry of Education of China, Ocean University of China, Qingdao, China. E-mail: hwgao@ouc.edu.cn
[2] Laboratory for Marine Ecology and Environmental Sciences, Qingdao National Laboratory for Marine Science and Technology, Qingdao, China
[3] Hubei Key Laboratory of Marine Geological Resources, China University of Geosciences, Wuhan, China
[4] Laboratory for Regional Oceanography and Numerical Modeling, Qingdao National Laboratory for Marine Science and Technology, Qingdao, China
[5] Laboratory for Marine Geology, Qingdao National Laboratory for Marine Science and Technology, Qingdao, China
[6] Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, Bussestr. 24, 27570 Bremerhaven, Germany
[7] School of Mathematics and Physics, Qingdao University of Science and Technology, Qingdao, China

North Pacific Ocean Desert (NPOD) refers to the subtropical North Pacific Ocean of low chlorophyll-a (Chl-a) concentrations, as the largest ocean desert globally. Studies have suggested a development of NPOD over recent decades based on limited evidences from in-field measurements and yet elusive mechanism. In this study, we characterize intensity, area and position of the NPOD from Year 1998 to 2018, and investigate its control by the coherent climate processes, based on an available, longest satellite observations of Chl-a concentration. Our results suggested that NPOD oligotrophication and expansion processes are dominated by warming upper oceans in most part of the NPOD, except for the SW NPOD area where the Chl-a variations dominantly correlate to regional change in sea surface heights. Moreover, based on our analysis, insignificant shift but only NW-SE variability of the NPOD mean position is controlled by the Pacific Decadal Oscillation processes.

(VS4- 14974) Recorded Talk

GIMS technology in remote monitoring of ocean ecosystems

Ferdenant A. **Mkrtchyan** and Vladimir F. Krapivin

Kotelnikov Institute of Radioengineering and Electronics, Russian Academy of Sciences, Moscow, Russia. E-mail: ferd47@mail.ru

The basic scheme of collection and processing of the information in geoinformation monitoring system(GIMS) recognizes that effective monitoring researched object is possible at complex use of methods of simulation modeling, collection and processing of the information. From the position of system analysis, the system of collection and processing of the information in geoinformation monitoring represents the structure uniting the computers of various classes, databases and the advanced problem-oriented software. Creation of such system demands the development of formalized description of the information flows and unique methodology of its processing. Ocean ecosystems are one of the important objects of geoinfomational monitoring.

GIMS - technology develops GIS technology towards the realization of the formula = GIMS + GIS model. In other words, the functions of GIS enlivened by the introduction of a new grid - time scale. One of the important functions of geoinformation monitoring is the detection and identification of emergency situations that may arise in the environment. The rich experience of solving this problem with the use of radio-physical, acoustic, optical and other methods suggests that a successful outcome is required to synthesize a wide range of multi-channel measurement and use a hierarchical search and processing of information from different levels of the monitoring system.

In this paper presented, a remote monitoring system for detecting anomalies on the sea surface is considered. Its block diagram is analyzed, which consists of a Holder, Resolver and Searcher. As an informative sign of waiting for the detection of anomalies on the sea surface, a model of the "spotting" of the surveyed surface was developed on the basis of empirical data. The experimental verification of the effectiveness of the algorithms considered is based on data from the Kosmos-1500 satellite for the Arctic regions.

(VS4- 14975) Recorded Talk

Some aspects of the microwave radiometry and spectroellipsometric technologies for monitoring aquatic systems

Ferdenant A. **Mkrtchyan**, Vladimir F. Krapivin, Vladimir V. Klimov and Vladimir Yu. Soldatov

Kotelnikov Institute of Radioengineering and Electronics, Russian Academy of Sciences, Moscow, Russia. E-mail: ferd47@mail.ru

Results of the investigations are stated in connection with the assessment of capabilities to use the sensors of optical and microwave ranges for the diagnostics of hydrophysical and hydrochemical systems having various spatial scales. Structure of multi-functional information-modeling system (MFIMS) MFIMS consists the sensors of optical and microwave ranges and it realizes functions for the diagnostics and adaptive identification of the liquids. The system is based on the base formation of spectral standards for the liquid solutions delivered by means of multi-channel spectrophotometer or spectroellipsometer and used for adaptive recognition of spectral images.

Education process and following recognition are realized in accordance with the certain series of the methods, algorithms and procedures for accumulation, analysis, sorting and processing observation data. Assembly of all tools forms the information-modeling system oriented on the operative diagnostics of the state of the water objects when multi-channel information is delivered by the on-site and remote sensors and high-performance information technologies are used for the solution of the tasks related to the classification and identification of the water objects.

A solution of operative multi-pronged task of the water quality control and state of hydrochemical systems when their spatial heterogeneity is taken into consideration and series of physical, chemical and biological factors exist to be as influencing on them is realized by means of the collection of computer algorithms and models that are the hydrochemical monitoring system. This collection gives a possibility to parameterize typical water balance on restricted territory that reflects an interaction between hydrological cycle components. Under this, the system has adaptation function to the real hydrophysical object or process.

(VS4-14986) Recorded Talk

Vertical habitat changes of juvenile Japanese jack mackerel (*Trachurus japonicus*) estimated by otolith microchemistry

Megumi **Enomoto**[1], Shin-ichi Ito[1], Motomitsu Takahashi[2], Chiyuki Sassa[2], Tomihiko Higuchi[1] and Kotaro Shirai[1]

[1]   Atmosphere and Ocean Research Institute, the University of Tokyo, Chiba, Japan. E-mail: menomoto@aori.u-tokyo.ac.jp
[2]   Seikai National Fisheries Research Institute, Japan Fisheries Research and Education Agency, Nagasaki, Japan

Japanese jack mackerel (*Trachurus japonicus*) is distributed in the semi-demersal layer, while larvae are distributed in the surface layer in the East China Sea. It is considered that smooth vertical habitat layer change (HLC) is important for their survival. However, details (start timing and duration) of HLC have been undetermined. To elucidate HLC, otolith oxygen stable isotope ratio ($\delta^{18}O_{oto}$), of which the value increases at lower temperature and higher salinity, were analyzed in high resolution by 5 days segment. From the history of $\delta^{18}O_{oto}$, HLC timing were estimated by two types of indices; HLC moment and HLC duration, which represented the highest $\delta^{18}O_{oto}$ gap signal and gradual $\delta^{18}O_{oto}$ change, respectively. In addition, daily ages and water temperature variances fish experienced were compared among three life history traits; the metamorphosis, the behavioral change to self-swimming from flotsam and the swimming ability increase. As a result, average HLC moment was estimated to be 42.2±18.2 daily age. HLC started at 28.0±11.0 daily age and average HLC duration was 27.9±16.2 day. The start of HLC duration corresponded to the start of metamorphosis, and development of swimming ability was happened simultaneously with HLC moment. From the $\delta^{18}O_{oto}$ result and observation data in this study, an equation between $\delta^{18}O$ ($\delta^{18}O_{oto}$ - $\delta^{18}O_{sw}$ ($\delta^{18}O$ of sea water)) and temperature was estimated; Temperature(°C) = -3.51 (±0.49) × $\delta^{18}O$ (‰) + 14.84 (±0.40). Temperature variance converted from $\delta^{18}O_{oto}$ suggested that juveniles gradually change habitat layer as they experience early life history traits, not suddenly after specific trait.

(VS4-14992) Recorded Talk

An ecosystem-science approach to support salmon management

Brian K. **Wells**[1,2], Nate J. Mantua[1], Brian J. Burke[3] and Jerome Feichter[4]

[1]   Southwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Santa Cruz, CA, USA. E-mail: brian.wells@noaa.gov
[2]   Northwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Newport, OR, USA
[3]   Northwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Seattle, WA, USA
[4]   Department of Ocean Sciences, University of California at Santa Cruz, Santa Cruz, CA, USA

A great deal of research has been dedicated to quantifying salmon ecology at sea with the goal of improving tactical salmon management, largely focusing on improving assessment models. Unfortunately, ecosystem-relevant information has failed to improve quality of salmon assessment beyond inclusion of salmon demographics. Likely, this results from a complex ecosystem with which salmon interact. More recently, we have succeeded at identifying a number of mechanisms in the ocean that, while sometimes nonintuitive, have dramatic effects on salmon mortality. The inclusion of these mechanisms to improve salmon recovery and protection efforts goes beyond simple demographic assessments and requires an ecosystem perspective and the adoption of appropriate strategic management efforts. Plans for and actions dedicated to building improved life-cycle models and management strategies will benefit from 1) designing purpose-built conceptual models representing understanding of the ecosystem for developing research objectives and applying results to management, 2) improving understanding of salmon behavior, growth, and mortality during winter, 3) improvements to salmon assessment models by including cumulative risk across ecosystem components and consideration of variability in ecosystem structure and trophic pathways, and 4) development of life-cycle models to evaluate tradeoffs associated with management alternatives. Finally, we acknowledge the ecosystem is not static, the variability in its structure and function must be considered, and the outcome of a successfully coupled research-management effort must be re-evaluated and adapted as needed.

(VS4-15005) Recorded Talk

Study on the response mechanism of Yellowfin Tuna (*Thunnus albacores)* to the ocean heat content in the Indian Ocean

Peng **Lian**[1], Zelin Chen[1], Jiayue Gu[3], Suwen Ye[4], Hao Xun[5], Fan Yang[5], Yinxing Liu[5] and Meiqi Zhang[6]

[1]   Institute of Oceanography, Chinese Academy of Sciences, Qingdao, China. E-mail: fisheries@foxmail.com
[2]   University of Tasmania, Hobart, Australia
[3]   Monash University, Melbourne, Australia
[4]   Shanghai Ocean University, Shanghai, China
[5]   Ocean University of China, Qingdao, China
[6]   The First Institute of Oceanography, Ministry of Natural Resources, Qingdao, China

As one of the most intense areas of ocean-atmosphere interactions, the Indian Ocean, featuring warming water and monsoon phenomenon, is the main fishing ground of many economical tuna species. This study reveals the response process of yellowfin tuna (*Thunnus albacores*) in the Indian Ocean by analyzing the marine thermal factors such as sea surface temperature (SST), thermocline, ocean heat content (OHC), etc. on interdecadal, decadal, and interannual time scales. Based on the 50-year long-term sequence spatial-temporal distribution data of the yellowfin tuna, Argo profile data and remote sensing data. We use cross-wavelet analysis and machine learning method to find the relation between the environmental factors and yellowfin tuna. The analyses showing that the heat-induced periodic mode and time lag effects of tuna variations are obviously important, as well as the asynchronous response effects of yellowfin tuna on long-term scales. meanwhile, we explore the spatial heterogeneity of the suitable habitat index of Indian Ocean tuna by analyzing the correlation between tuna production and Tropic Indian Ocean Dipole Index (IOD) in different regions. The result shows that tuna is most susceptible to the positive and negative phase of IOD. There are also a changing periodic phenomenon of 4-7 years and a 1-2 year time lag effect. Last but not the least, influence of ocean heat content on the suitable habitat of tuna has become increasingly important in recent years (r=0.436, p<0.05), which tend to be related to the subsurface thermo-signals of Indian ocean. As a result of climate changes, we find that yellowfin tuna may migrate deeper and deeper in Indian ocean.

(VS4-14900) E-poster

Use of natural food attractants in the diet of Pacific salmon fish (Oncorhynchus kisutch) on Kamchatka

Nina **Okrestina**, Maxim Zharkov and Olga Isaeva

Kamchatka State Technical University, Petropavlovsk-Kamchatski, Russia. E-mail: olisa24@bk.ru

The study of chemosensory systems and chemical ecology of marine fish is becoming one of the leading area in marine biology - a promising and actively developed area in many countries around the world. The work was carried out in 2020 at the Research Laboratory of the Department of Aquatic Bioresources, Fisheries and Aquaculture of Kamchatka State Technological University (Petropavlovsk-Kamchatsky, Russia). The purpose of the study was to, using the example of one of the species of salmon fish – coho salmon (Oncorchinchus kisuch) (total length 5-10 cm), to find in its diet attracting substances (attractants) capable of increasing the eaten artificial food. Using the methodology of behavioral test- reactions of fish to extracts of marine aquatic organisms, it was possible to find out that extracts of marine aquatic organisms can affect the feeding of salmon fish. The results showed that water extracts of marine aquatic organisms and algae: kelp *Saccharina bongardiana*, northern chilli shrimp *Pandalus eous*, bloodworm larvae (fam. Chironomidae), and crab-shear of the gen. *Chionoecetes* have an attractive taste and increase the consumption of artificial feed pellets. It turned out that the shrimp water extract caused the maximum taste responses - more than 97%; granules with water extract of shear crab also had a high percentage of consumption - more than 90%; the consumption of granules with water extracts of kelp (stem and thallus) was also higher than the control - more than 90%. The results of testing granules with an extract from bloodworm larvae (family Chironomidae) showed the least attractive response to the consumption of granules, this extract had an indifferent property.

(VS4-14901) E-poster

Oceanological conditions on the southeastern Sakhalin shelf according to surveys on standard sections and satellite SST observations

Georgy **Shevchenko**[1,2], Zhanna Tshay[1] and Valery Chastikov[1]

[1]	Sakhalin Branch of All-Russian Research Institute of Fisheries and Oceanography, Yuzhno-Sakhalinsk, Russia. E-mail: shevchenko_zhora@mail.ru
[2]	Institute of Marine Geology & Geophysics FEB RAS, Yuzhno-Sakhalinsk, Russia

The average monthly temperature and salinity distributions are analyzed for 7 standard sections crossing the area off the southeast coast of Sakhalin Island, built for the navigation period (June-November) were analyzed. The most significant seasonal changes in oceanological conditions occur in the fall, when the modified Amur River water transported by the East Sakhalin Current fills the northern and western parts of the study area, and surface waters are deepened to a depth of 50 m. Interannual variations in thermal conditions were determined by satellite SST data. In the spring months (May – June) of 1998-2002 positive temperature anomalies prevailed, and negative anomalies in 2011 – 2018. In summer season (July - August) the temperature of the surface layer is more stable, however significant anomalies also occurred. Such anomalies may adversely affect pink salmon catch on the southeast Sakhalin coast. The spatial distribution of the first EOF mode from satellite SST data is identical to the distribution of water temperature in the surface layer according to ship surveys and is characterized by higher values in the northern and western shallow and southeastern deep-sea parts of the study area. In its amplitude, cyclic variations with a period of 6–7 years were found expressed in modulation of the annual harmonic. In the amplitude of the second mode, the climate shift that occurred in 2010 and expressed in a change in its sign from positive to negative is of great interest.

(VS4-14902) E-poster

Amur River water and sea ice on northeastern Sakhalin shelf in June

Georgy **Shevchenko**[1,2] and Valery Chastikov[1]

[1]   Sakhalin Branch of All-Russian Research Institute of Fisheries and Oceanography, 196 Komsomolskaya street, 693023 Yuzhno-Sakhalinsk, Russia. E-mail: shevchenko_zhora@mail.ru
[2]   Institute of Marine Geology & Geophysics FEB RAS, 1-B Nauki street, 693022 Yuzhno-Sakhalinsk, Russia

The data of CTD-measurements performed during the pollock ichthyoplankton surveys on the northeastern Sakhalin shelf in June were used to study specific hydrological conditions in this area in spring. The low salinity water formed by the Amur River runoff are shown to appear on the northeastern shelf in the first half of June after the heavy sea-ice breaking in the southern Sakhalin Bay (typically in the last decade of May). This water has a low density and therefore it goes around Smidt Peninsula and moves southward, carrying heavy ice with it. By this time, sea ice is already melting on the northeastern shelf. The mixture of warm water from the Amur River runoff and heavy ice from the Sakhalin Gulf is the main specific feature of the oceanological conditions in this area in June. Low salinity water is also formed as a result of ice melting. However, this water is cold in contrast to the warm water of the Amur River runoff. Therefore, it usually deepens to a depth of 10-15 m. Low salinity water and ice are pushed off toward the deep sea under the influence of the southern winds which are typical for a warm season (summer monsoon), and an oceanological front is formed near the 52°N. This front prevents the low-salinity water from flowing southward until the second half of September, when changes into a winter monsoon with the prevailing northerly winds take place. These features of oceanological conditions affect the maturation of pollock larvae

(VS4-14903) E-poster

SST lowering in the Sea of Okhotsk as the result of global warming

Dmitry **Lozhkin**[1] and Georgy Shevchenko [1,2]

[1]   Sakhalin Branch of All-Russian Research Institute of Fisheries and Oceanography, Yuzhno-Sakhalinsk, Russia. E-mail: shevchenko_zhora@mail.ru
[2]   Institute of Marine Geology & Geophysics FEB RAS, Yuzhno-Sakhalinsk, Russia

Global warming is most pronounced in Arctic air temperature increase. The consequence of this is a steady decrease in the ice cover of the Sea of Okhotsk, which is formed under the influence of the northerly and west-northerly winds which are typical for cold season (winter monsoon). We examined SST changes in the Sea of Okhotsk in connection with these factors. Time series of monthly mean SST have been formed from 21-year-long satellite measurements (1998–2018). Coefficients of the linear trend are determined in each spatial cell with a size of 2 x 2 km using the least squares method. Such coefficients are calculated for each month separately, for the annual mean values, and for seasonally average SST values. We analyzed the relationship of these coefficients with observed decrease in the ice cover in the Sea of Okhotsk in the last 21 years. It is shown that SST in this area is reduced; the most significant lowering is observed in its northern and western parts (0.5 – 1.5°C per 10 years). Negative trend is especially pronounced in spring (most significant cooling in May), which may be due to stronger water cooling as result of the deeper winter convection in the areas not covered by sea ice. The obtained results are important for studying the living conditions of pink salmon and other pelagic fish.

(VS4-14949) E-poster

Microevolutionary processes in Asian sockeye salmon *Oncorhynchus nerka* populations during Late Pleistocene climatic oscillations

Anastasia M. **Khrustaleva**[1], Ekaterina V. Ponomareva[2] and Marya V. Ponomareva[2]

[1]   Institute of Gene Biology Russian Academy of Sciences (FSBIS IGB RAS), Moscow, Russia. E-mail: mailfed@mail.ru
[2]   M.V.Lomonosov Moscow State University (MSU), Moscow, Russia

Study of patterns of contemporary genetic diversity and their link to the demographic and microevolutionary processes in populations is the key point in insight into extremely complex intraspecific structure common to pacific salmon. The diversity and distribution of mtDNA control region haplotypes in sockeye salmon from 19 river systems across the species Asian range (from Chukchi Peninsula to the South Kuril Islands) was investigated. Two mass haplotypes (Hap_1_10T and Hap_2_13T) were revealed. All the sequence variants were distributed among two haplogroups in compliance with the dominant haplotypes. Along the Asian coast of the Pacific Ocean there was no clearly pronounced clinal character in the change in haplotypes frequencies. However, the presence of both haplogroups in most populations in approximately equal proportions indicates that the entire Asian part of the sockeye range is a zone of secondary contact. The diversity of the first haplogroup was higher, but its main fraction fell on the samples from the middle reach of Kamchatka River, which could be a refugium during the last glaciation. We have every reason to believe that Hap_2_13T had more ancient origin and the Hap_1_10T was formed somewhat later, apparently in Asia. We hypothesize that the beginning of the Holocene transgression marked the extremely rapid (explosive) distribution of this species throughout the entire modern range, and watersheds were colonized simultaneously by individuals from different geographical areas, both northern (Alaska or the Beringia region) and southern (Japan and the South Kuril Islands), as well as from the Central Kamchatka refugium.

VIRTUAL SESSION 5
Atmospheric nutrient deposition and microbial community responses, and predictions for the future in the North Pacific Ocean

(VS5-14947) Live Talk

Atmospheric aerosol iron from coal combustion

Clarissa **Baldo**[1], Akinori Ito[2] and Zongbo Shi[1]

[1] University of Birmingham, Birmingham, U.K. E-mail: cxb637@student.bham.ac.uk
[2] Yokohama Institute for Earth Sciences, JAMSTEC, Yokohama, Japan

The atmospheric iron (Fe) deposition alters biogeochemical cycles in the global ocean, possibly affecting the marine carbon budgets and consequently the climate. Modelling studies suggest that the atmospheric deposition of soluble Fe doubled since the Industrial Revolution. The uptake of acidic gases during long-range transport is a key factor affecting the Fe solubility in atmospheric aerosols. Here we investigate the Fe dissolution kinetic of anthropogenic aerosol sources (e.g., coal fly ash) in acidic aqueous solutions which simulate chemical processes in the atmosphere. Coal fly ash samples were collected from three coal-fired power stations at different locations: UK, Poland, and China. Samples were aerosolised to separate the PM_{10} fraction. The PM_{10} fractions were then exposed to sulphuric acid solutions at low pH 1, 2 or 3, in presence of oxalate and/or ammonium sulphate to simulate aerosol conditions. A mineral dust sample from Libya was used for comparison. Our results indicate that the Fe dissolution process is affected by the activity of protons and ligands in solution. The Fe dissolution behaviour varied significantly among the coal fly ash samples, depending on their physicochemical properties. Overall, coal fly ash showed higher Fe solubility at different experimental conditions compared to the natural Saharan dust, which may be attributed to the considerably higer fraction (6-20 times) of highly reactive Fe (ascorbate Fe). The next step is to define a Fe release scheme for anthropogenic emissions to be applied in global atmospheric chemistry modelling to estimate the atmospheric concentration and deposition flux of soluble Fe.

(VS5-14928) Live Talk

Atmospheric outflow of anthropogenic iron and its deposition to China adjacent seas

Chunqiang Chen, Lei **Huang**, Jinhui Shi, Yang Zhou, Jiao Wang, Xiaohong Yao, Huiwang Gao, Yayong Liu, Jia Xing and Xiaohuan Liu

Ocean University of China, Qingdao, China. E-mail: 395855548@qq.com

Atmospheric deposition of iron (Fe) can increase marine primary productivity, consequently affect ocean biogeochemical cycles and climate change. In this study, we develop an adaptor to generate anthropogenic Fe emission inventories for China in 2012 and 2016 via anthropogenic $PM_{2.5}$ emissions from Multi-resolution Emission Inventory for China (MEIC) using local source-specific mass fractions of Fe in $PM_{2.5}$. Using the generated emission inventories, we simulated Fe concentrations as well as dry deposition fluxes to China marginal adjacent seas using a WRF-CMAQ model during four campaign periods. The simulated Fe concentrations are in good agreement with observations except for those in presence of severe dust-intrusion events (NMB -13% ~ -13%), indicating a reasonably good performance of the generated Fe emissions. The total anthropogenic emissions of Fe over China in 2012 and 2016 are estimated as 5.5×10^2 Gg and 3.3×10^2 Gg, respectively. Simulated Fe concentrations over China marginal seas are in the range of 62 - 6.5×10^2 ng m^{-3}, providing 2.0 - 12.5 µg m^{-2} d^{-1} to the seas during the study periods. Due to lower Fe solubility in nature mineral aerosols than in anthropogenic aerosols, dry deposition fluxes of bioavailable Fe on haze days almost double that in dust days and 4.7 times in less polluted days. We also estimated the primary productivity derived by dry atmospheric deposition of assumed bioavailable Fe over China marginal seas as 3.3, 15.4 and 8.7 mg C m^{-2} d^{-1} in less polluted days, haze and dust event, respectively.

Keywords: WRF-CMAQ; Iron emission inventory; Iron Deposition; Primary production; China adjacent seas

(VS5-14944) Live Talk

Impact of atmospheric deposition on phytoplankton community structure in the Yellow Sea

Qin **Wang**[1, 2], Haoyu Jin[1, 2], Chao Zhang[1, 2] and Huiwang Gao[1, 2]

[1]   Key Laboratory of Marine Environment and Ecology, Ministry of Education of China, Ocean University of China, Qingdao, China.
       E-mail: hwgao@ouc.edu.cn
[2]   Laboratory for Marine Ecology and Environmental Sciences, Qingdao National Laboratory for Marine Science and Technology, Qingdao, China.

Atmospheric deposition has been regarded as an important nutrient source to the Yellow Sea (YS). However, its impact on the community structure of phytoplankton is still poorly understood. In this study, we conducted three onboard incubation experiments in the YS to explore the competition between different species using different schemes with and without micro- (>20 μm) sized phytoplankton. A certain amount of haze particle and reference nutrients including nitrogen(N) and phosphorus (P) were added to the incubated seawater. A high-throughput sequencing (MiSeq) based on Illumina's 18S ribosomal DNA (rDNA) hypervariable region V4 was used to study the community structure. The results showed that haze particle promoted the growth of all sized phytoplankton and increase phytoplankton diversity by speeding up the conversion rate of organophosphorus, in comparison with the nutrient treatments. Community structure tends to shift towards large size cells (such as micro- and nano- (2-20 μm) sized cells) when treat with haze. Sequenced data also revealed a negative correlation between the abundance of Hexanauplia and phytoplankton, which may the reason that changed the community structure.

(VS5-14981) Live Talk

High-frequency observation of the spring bloom in the western North Pacific by Himawari-8

Asuto **Sakai** and Kosei Komatsu

Atmosphere and Ocean Research Institute, The University of Tokyo, Chiba, Japan. E-mail: sutosakai@aori.u-tokyo.ac.jp

Spring bloom, a sharp increase of phytoplankton biomass, is a common phenomenon in the temperate and subpolar regions Many studies have tried to explain the processes of its formation and persistence for a long time, as represented by Sverdrup's critical depth hypothesis presented in 1953. However, even the real situation of the spring bloom has still not been comprehended mainly due to coarse temporal-resolution of in situ observations, although recent studies clarify several processes of nutrient supply to the euphotic layers. This study aims to present variability of the spring bloom observed by Himawari-8, a geostationary weather satellite operated by Japan Meteorological Agency, with focus on the western North Pacific (35-45oN, 140-150oE) since 2016 to 2019. In this study, we converted an originally hourly-interval product of Chlorophyll–a concentration (Chla) of Himawari-8 supplied by the P-Tree system to a 5-days interval product by an objective analysis, in order to suppress influences of clouds and to resolve characteristics of the bloom adequately without fatal deterioration of accuracy attributed to the filtering. In the northern area (40-45oN), Chla increases gradually in early May to a maximum, 1.0 mg m-3. On the other hand, in the southern area (35-40oN), Chla increases sharply in early March to a maximum 1.0 mgm-3, and interestingly it presents a sharp increase again in early May. The results revealed that spring bloom occurs multiple times in the southern area of the target region.

(VS5-15004) Live Talk

Spatial and temporal variations in copper ligand concentration along Line P

Andrew R.S. **Ross**[1,2], Richard L. Nixon[2], Jasper George[2], Kyle G. Simpson[1] and Marie Robert[1]

[1]   Institute of Ocean Sciences, Fisheries and Oceans Canada, Sidney, BC, Canada. E-mail: Andrew.Ross@dfo-mpo.gc.ca
[2]   Department of Biochemistry and Microbiology, University of Victoria, Victoria, BC, Canada

Marine phytoplankton, which form the basis of the oceanic food web, require small amounts of iron, copper and other micronutrient trace metals to act as enzyme co-factors in key biological processes. The bioavailability of trace metals introduced by rivers, sediments or airborne dust depends in part upon complexation by dissolved organic ligands, a process likely to be affected significantly by ocean acidification and climate change. We used immobilized copper(II)-ion affinity chromatography (IMAC) to isolate and obtain information about the distribution and potential sources of copper-complexing ligands along Line P. Filtered seawater samples were collected from up to five stations in June 2016, June 2017, August 2017, and September 2018. Copper ligand concentrations measured by IMAC were consistently higher at coastal station P4 than at other stations, particularly in surface waters. Variations in ligand concentration were also greater at P4 than at outer station P26, where depth profiles in June 2017 and September 2018 were remarkably similar. At all stations, the depth of highest ligand concentration generally coincided with the chlorophyll maximum depth, implying that marine phytoplankton may be a significant source of copper ligands along Line P. Comparisons with hydrographic data and published results from the Canadian Arctic and NE Pacific suggest that marine and terrestrial humic substances also contribute to the pool of copper ligands captured by IMAC. The apparent stability of this pool at station P26 may have implications for the bioavailability of trace metals deposited periodically by airborne dust, a significant source of micronutrients in these waters.

(VS5-14943) Live Talk

Air pollutants promote the utilization of dissolved organic phosphorus (DOP) by phytoplankton in China coastal seas

Haoyu **Jin**[1,2], Chao Zhang[1,2] and Huiwang Gao[1,2]

[1]   Key Laboratory of Marine Environment and Ecology, Ministry of Education of China, Ocean University of China, Qingdao 266100, China. E-mail: 1174799018@qq.com
[2]   Laboratory for Marine Ecology and Environmental Sciences, Qingdao National Laboratory for Marine Science and Technology, Qingdao 266071, China

Atmospheric deposition can promote the utilization of DOP. Such promotion is generally observed in oligotrophic regions, while few are reported in coastal seas with higher trophic status. Due to the substantial nutrient inputs with high ratios of N versus P (N:P >> 16:1), areas of P limitation in China coastal seas have been expanded obviously in recent years. In such condition, the impact of atmospheric deposition characterized by higher N:P ratios on phytoplankton is poorly understood. In this study, eight on-board microcosm experiments amended with haze particle, riverine water, and nutrients were implemented in the Bohai Sea and Yellow Sea during the spring and summer of 2018 and 2019. The results showed that haze particle supplied lots of DIN and negligible DIP, but could promote phytoplankton growth under various nutrient- limited condition, indicating there might be other bioavailable P sources. We further found the alkaline phosphatase activities, reflecting DOP utilization, was mainly controlled by DIP and increased significantly when DIP concentration was below a certain threshold. We also found that DOP accounted for more than 90% of the P consumed by phytoplankton in Bohai Sea, while varied from 0% to 96% in Yellow Sea during incubation. DOP utilization could be promoted after haze addition, and the promotion was mainly happened when Chl-a/DIP, representing P pressure on phytoplankton, higher than 10. Our study suggests that promoting DOP utilization is an important mechanism for atmospheric deposition to affect primary production in China coastal seas.

(VS5-14958) Live Talk

Elucidating the role of climate and emission in modulating the atmospheric nitrogen deposition over the North Pacific Ocean

Yang **Gao**, Shuhui Guan, Xiaohong Yao and Huiwang Gao

Key Laboratory of Marine Environment and Ecology, Ministry of Education of China, Ocean University of China, Qingdao, Shandong, 266100, China. E-mail: yanggao@ouc.edu.cn

The atmospheric nitrogen deposition plays a vital role in affecting the marine ecosystems, while a number of studies focused on the effect over the marginal seas, the understanding at the remote area such as North Pacific Ocean (NPO) is very limited. Utilizing the multi-model ensemble of global chemistry model results generated in the Atmospheric Chemistry and Climate Model Intercomparison Project (ACCMIP), we aim to isolate the potential influence of climate and emission on the atmospheric nitrogen deposition over NPO. Both the near future in 2030s and far future in 2100s under Representative Concentration Pathway (RCP) 4.5 and RCP 8.5 was used in the analysis. We primarily focus on the atmospheric deposition of dry and wet oxidized nitrogen (NO_y) and reduced nitrogen (NH_x). The climate may strongly affect the wet deposition of NO_y and NH_x through the modulation in the precipitation. Whereas the uncertainty of projection in future precipitation, the uncertainty in affecting the wet deposition was thereby discussed in terms of the model consensus as well as disagreement. Changes in ship emission over NPO inevitably play a role together with the transport from the upwind continental area. At the end, the potential effect of atmospheric nitrogen deposition on the marine primary production is discussed.

(VS5-14908) RecordedOral

Elevated nutrient supply caused by the Kuroshio approaching to the continental shelf in the south of Japan associated with submesoscale flows and near-inertial waves

Gloria S. **Duran Gomez** and Takeyoshi Nagai

Tokyo University of Marine Science and Technology, Tokyo, Japan. E-mail: silvanadg20@hotmail.com

While surface layers of the Kuroshio Current have been known for being nutrient poor, previous studies reported that the Kuroshio carries a large amount of nutrients in dark subsurface layers as a nutrient stream. This nutrient conduit supports primary production and probably maintains in the Kuroshio downstream regions as a major net CO2 sink of the Earth's ocean. Also results published recently showed that the Kuroshio flowing on the continental shelf induces very strong turbulence and a large diffusive nitrate flux to euphotic zone of >O(1 mmol N m-2 day-1), suggesting a nutrient supply before it reaches the downstream. Nevertheless, since this previous study was conducted for just one transect survey, questions remain of how long this enhanced turbulent diffusive nitrate flux extends further to the downstream and how the Kuroshio path modulations influence on the nutrient injection. In this study, using a high-resolution nested simulation coupled with a N2PZD2 ecosystem model, we successfully reproduced these observed features. When the model Kuroshio flows closer to the southern coast of Japan, it hits the small bump in the upstream region producing disturbances that seem to generate near-inertial waves which are trapped, elevating the internal wave energy and mixing, and then diffusing up the subsurface nitrate to shallow layers. The results of this study can improve our understanding of the role of the Kuroshio in providing nutrients and enhancing biological productions, therefore contributing to the CO2 uptake by the ocean along the Kuroshio to the downstream regions.

(VS5-14930) RecordedOral

Anthropogenic nitrogen-induced changes in seasonal carbonate dynamics in a productive coastal environment

Ja-Myung **Kim**[1], Kitack Lee[1], In-Seong Han[2], Joon-Soo Lee[2], Yang-Ho Choi[3], Ju Hyeon Lee[1] and Ji-Young Moon[1]

[1]   Pohang University of Science and Technology, Pohang, Republic of Korea. E-mail: ktl@postech.ac.kr
[2]   National Institute of Fisheries Science, Busan, Republic of Korea
[3]   National Institute of Fisheries Science, Yeosu, Republic of Korea

We estimated the seasonal extremes in pH and the aragonite saturation state (Ω_{arag}) for the Yellow Sea over the past 30 years using recent (2015–2018) carbonate datasets, along with historical datasets of surface N and bottom water dissolved O_2 concentrations. The rate of increase in surface N was assumed to set the post-bloom surface dissolved inorganic C concentration resulting from the complete utilization of N by phytoplankton, while the decrease in bottom water O_2 was assumed to reflect the pre-bloom surface C, as a consequence of C-rich bottom water (resulting from the transport of greater amounts of organic matter from the surface) being brought to the surface. With the increasing loads of anthropogenic N, the net community metabolism (an increase in organic matter production at the surface and subsequent remineralization at the seafloor) has lowered the seasonal amplitude of pH by 0.14, but increased the amplitude of Ω_{arag} by 0.8.

(VS5-14962) RecordedOral

Herbaria macroalgae as a proxy for historical upwelling trends in Central California

Emily A. **Miller**[1,2], Susan E. Lisin[1], Celia M. Smith[3] and Kyle S. Van Houtan[1,4]

[1]   Conservation Research Department, Monterey Bay Aquarium, 886 Cannery Row, Monterey, CA 93940, USA. E-mail: emiller@mbari.org
[2]   Current affiliation: Monterey Bay Aquarium Research Institute, 7700 Sandholdt Rd, Moss Landing, CA 95039, USA
[3]   Botany Department, University of Hawai'i at Manoa, 3190 Maile Way, Honolulu, Hawai'i 96822, USA
[4]   Nicholas School of the Environment, Duke University, Box 90328, Durham, NC 27708, USA

Planning for future ocean conditions requires historical data to establish more informed ecological baselines. To date, this process has been largely limited to instrument records and observations that begin around 1950. Here, we show how marine macroalgae specimens from herbaria repositories may document long-term ecosystem processes and extend historical information records into the nineteenth century. We tested the effect of drying and pressing six macroalgae species on amino acid, heavy metal

and bulk stable isotope values over 1 year using modern and archived paper. We found historical paper composition did not consistently affect values. Certain species, however, had higher variability in particular metrics while others were more consistent. Multiple herbaria provided Gelidium (Rhodophyta) samples collected in southern Monterey Bay from 1878 to 2018. We examined environmental relationships and found $\delta^{15}N$ correlated with the Bakun upwelling index, the productivity regime of this ecosystem, from 1946 to 2018. Then, we hindcasted the Bakun index using its derived relationship with Gelidium $\delta^{15}N$ from 1878 to 1945. This hindcast provided new information, observing an upwelling decrease mid-century leading up to the well-known sardine fishery crash. Our case study suggests marine macroalgae from herbaria are an underused resource of the marine environment that precedes modern scientific data streams.

(VS5-14979) RecordedOral

New ocean-atmosphere biogenic nitrogen recycling in the equatorial Pacific

Kazuki **Kamezaki**[1,2] Shohei Hattori[1], Yoko Iwamoto[3], Sakiko Ishino[1,4], Hiroshi Furutani[5,6], Mitsuo Uematsu[7], Kazuhiko Miura[8] and Naohiro Yoshida[9]

[1] School of Materials and Chemical Technology, Tokyo Institute of Technology, Yokohama, Kanagawa, Japan. E-mail: kame3974@gmail.com
[2] Faculty of Science and Technology, Sophia University, Chiyoda-ku, Tokyo, Japan
[3] Graduate School of Integrated Science for Life, Hiroshima University, Higashi-Hiroshima, Hiroshima, Japan
[4] National Institute of Polar Research, Tachikawa, Tokyo, Japan
[5] Graduate School of Science, Osaka University, Toyonaka, Osaka, Japan
[6] Center for Scientific Instrument Renovation and Manufacturing Support, Osaka University, Toyonaka, Osaka, Japan
[7] Atmosphere and Ocean Research Institute, The University of Tokyo, Kashiwa, Chiba, Japan
[8] Graduate School of Science, Tokyo University of Science, Shinjuku-ku, Tokyo, Japan
[9] Earth-Life Science Institute, Tokyo Institute of Technology, Meguro-ku, Tokyo, Japan

We observed a remarkably low $\delta^{15}N(NO_x)$ values in atmospheric particulate nitrate (p-NO_3^-) over the equatorial Pacific regions, compared to those in other regions over the Pacific Ocean. Considering the equatorial Pacific is not strongly influenced by the continental air, the low $\delta^{15}N(NO_x)$ values cannot be met using conventional nitrogen oxides (NO_x) apportionment delivered from the continent (Kamezaki et al., 2019 Atmos. Environ.). The low $\delta^{15}N(NO_x)$ value could be explained only by the p-NO_3^- production from the oxidation of biological ammonia and alkyl nitrate emitted from the equatorial Pacific since only marine biological production yields these low-$\delta^{15}N$ nitrogen compounds in the equatorial Pacific region. Our new finding implies that nitrogen originates from outside the productive layer if either atmospheric ammonia or alkyl nitrate are the sources of atmospheric p-NO_3^-; however, its nitrogen source is based on oceanic primary production. Consequently, nitrogen deposits to the equatorial Pacific can be considered as "new production", which is defined as production based on nutrients newly delivered from outside of the productive layer, supplied from the atmosphere, but also as "regenerated production", which is production based on nutrients from organic decomposition within the productive layer, supplied from local oceanic nitrogen. This self-recycling process suggests that the traditional paradigm regarding the ocean as a passive recipient of p-NO_3^- deposition transported from the continent may be overly simplistic.

(VS5-14985) RecordedOral

Diving classification of lactating northern fur seals based on three-dimensional movements

Yuta **Sakuragi**[1], Vladimir N. Burkanov[2,3], Russel D. Andrews[4,5] and Yoko Mitani[6]

[1] Graduate School of Environmental Science, Hokkaido University, Hakodate, Japan. E-mail: spottedseal7gomasio@eis.hokudai.ac.jp
[2] Marine Mammal Laboratory, AFSC, NMFS, NOAA, Seattle, WA, USA.
[3] Kamchatka Branch the Pacific Geographical Institute, FEB RAS, Petropavlovsk-Kamchatsky, Russia.
[4] Marine Ecology and Telemetry Research, Seabeck, WA, USA.
[5] University of Alaska Fairbanks, Fairbanks, Alaska, USA.
[6] Field Science Center for Northern Biosphere, Hokkaido University, Hakodate, Japan.

Air-breathing marine predators make various dive types associated with different purposes (e.g. foraging, travelling and resting). Some studies based on foraging theory showed that diving animals forage depend on a single dive scale and a succession dives (bout) scale of prey patch quality. Lactating northern fur seals (NFS, *Callorhinus ursinus*) exhibit successions of dives (bouts) for foraging. However, the characteristics of their dive types did not clarify in previous studies. Hence, we classified each dive of NFS based on their three-dimensional movements which provide us detail diving behavior. In 2006, three lactating NFS were instrumented with GPS and 3D data loggers, and their 3D dive path was reconstructed by using depth, tri-axis acceleration, tri-axis magnetometry and swim speed. The total of 3,086 dives were classified into five clusters by using hierarchical cluster analysis. Each cluster was identified into three foraging dive types, one transiting dive type and one resting dive type. Three foraging dive types differed in the linearity of swimming pass and were characterized into Tortuous, Straight and Slow foraging dive type. Tortuous foraging dive type was the most major foraging style of NFS. In present study, NFS also rested during diving like other pinnipeds. It suggested that dives of NFS do not only for foraging but also for resting. This is the first study to investigate 3D diving and will provide new insight of foraging strategy of NFS.

(VS5-14912) E-poster

Fe redox status and its bioavailability in the East China Sea shelf break area

Koki **Yamanaka**[1], Yoshiko Kondo[1], Natsuho Fujita[2], Yudai Sunahara[1] and Hajime Obata[3]

[1] Graduate School of Fisheries and Environmental Sciences, Nagasaki University, Nagasaki, Japan. E-mail: yoshikondo@nagasaki-u.ac.jp
[2] Faculty of Fisheries, Nagasaki University, Nagasaki, Japan.
[3] Atmosphere and Ocean Research Institute, The University of Tokyo, Chiba, Japan.

The bioavailability of Fe is controlled by its chemical speciation in seawater. Since the reduced form of Fe, Fe(II), is more bioavailable than Fe(III)-ligand complexes, the existence of Fe(II) has important implication on Fe biogeochemical cycles. In this study, the distributions of Fe(II) and its half-life were investigated in the upper 500-m of the East China Sea shelf/shelf break area in July 2019. The maxima of Fe(II) were observed in the surface layer, comprising up to 21% of dissolved Fe; these high Fe(II) in the surface water could be derived from photochemical reaction. The Fe(II) minima around chlorophyll *a* maximum suggested an active uptake of Fe(II) by in-situ phytoplankton communities. In this study area, the Fe(II) half-life within the euphotic layers was relatively longer than that in the oceanic region such as the subtropical South Pacific. These results suggested that bioavailability of Fe was high in the East China Sea shelf/shelf break area.

(VS5-14914) E-poster

Microbiome Composition of Azooxanthellate Coral and Seawater in the South Sea

Seonock **Woo**

Korea Institute of Ocean Science and Technology, Busan 49111, Republic of Korea. E-mail: cwoo@kiost.ac.kr

The warm current running from tropical Philippines through subtropical Taiwan to the temperate region Korea, the Kuroshio transfers heat from lower to higher latitudes. It warmed most rapidly in 1981–1998, when sea surface temperatures rose by 1.5°C (0.9°C/decade), almost 7 times the global rate. This affected the physiological responses of corals as well as the corals habitat range. We chose *Eleutherobia rubra,* a azooxanthellate soft coral around Korea to investigate the microbiome composition and to compare with the habitat seawater microbiome change along the year. This study focused on the identification of the microbiome from *E. rubra* and seawater from its habitat and its diversity and the microbiome composition change in four seasons. As results, Proteobacteria was mainly found with 53.5% and secondly Bacteroidetes with 9.9% from all coral samples and Proteobacteria with 47.6% and Bacteroidetes with 25.6% from seawater. The family, Endozoicomonadaceae with 26% and Spirochaetaceae with 8.5% were found from the coral samples along the four seasons and the family, Flavobacteriaceae with 16.4% and Pseudomonadaceae with 10.8% from seawater. *Endozoicomonas elysicola* was the species showing the highest count rate from the coral samples and *Psuedomonas gramnis* was the species showing the highest count rate from the seawater samples and any endozoicomonas species were found in the seawater samples.

(VS5-14915) E-poster

Change of dominant phytoplankton groups in the eutrophic coastal sea due to atmospheric deposition

Haowen **Li**[1], Ying Chen[1,2,3], Shengqian Zhou[1], Fanghui Wang[1], Tianjiao Yang[1], Yucheng Zhu[1] and Qingwei Ma[1]

[1]   Shanghai Key Laboratory of Atmospheric Particle Pollution Prevention, Department of Environmental Science & Engineering, Fudan University Jiangwan Campus, Shanghai 200438, China. E-mail: yingchen@fudan.edu.cn
[2]   Institute of Eco-Chongming (IEC), No.3663 Northern Zhongshan Road, Shanghai 200062, China
[3]   Institute of Atmospheric Sciences, Fudan University Jiangwan Campus, Shanghai 200438, China

Nutrient stoichiometry and input of trace metals may profoundly affect the growth and community structure of phytoplankton. A bioassay experiment was designed to explore the key components in atmospheric deposition that affect marine phytoplankton growth by adding aerosols and analogues nutrients and Cu to the surface water of the coastal East China Sea (ECS). Our results showed that atmospheric deposition along with the input of phosphate could largely enhance the chlorophyll a (Chl a) concentrations in this eutrophic water. Phosphorus addition lifted the proportions of Thalassiosira oceanica in Diatoms and Biecheleria brevisulcata in Dinoflagellates. The input of soluble aerosol metals might play vital roles in promoting the phytoplankton growth and controlling the dominant species. Soluble aerosol Cu was found to be conducive to the relative abundance of most dominant class Coscinodiscophyceae, and both soluble aerosol Fe and Cu seemed to be very important for promoting the growth of Skeletonema costatum. The co-selection effect of Fe and Cu was likely to be one of the causes for the succession of dominant Diatom species. Our observation revealed the dynamics of detailed phytoplankton community structure in response to the input of atmospheric aerosols.

(VS5-14917) E-poster

On the relationship between aerosol methanesulfonate and surface phytoplankton biomass in the mid-latitude oceans of the Northern Hemisphere

Shengqian **Zhou**, Ying Chen, Shan Huang, Guipeng Yang, Honghai Zhang, Adina Paytan, Hartmut Herrmann, Alfred Wiedensohler, Laurent Poulain, Haowen Li, Fanghui Wang, Yucheng Zhu and Tianjiao Yang

Department of Environmental Science & Engineering, Fudan University, 2005, Songhu Road, 200438, China, PR. E-mail: sqzhou17@fudan.edu.cn

Marine biogenic dimethyl sulfide (DMS) emissions play a critical role in climate regulation due to the significant contribution of DMS to aerosol formation over remote oceans. Aerosol methanesulfonate (MSA) is an important product of DMS and is often used as an indicator of marine biogenic sources. Nonetheless, the linkage between MSA and marine phytoplankton biomass can be affected by many environmental factors as well as the contribution from other sources. Here we conduct an in-depth study of the relationships between MSA and air mass exposure to chlorophyll a (AEC) in three different oceanic regions in the Northern Hemisphere. The results show that MSA concentrations in aerosols can be significantly correlated with the AEC indices when the movement of air masses is mostly confined within the marine boundary layer. Air masses spending considerable time over land can strongly affect the correlations between MSA and AEC in the coastal East China Sea but not in the Gulf of Aqaba. This suggests that MSA may not be a valid indicator of marine biogenic aerosols in oceanic regions influenced substantially by the contribution of terrestrial MSA sources probably associated with lakes, wetlands and anthropogenic emissions. Based on the empirical relationships between MSA and AEC, the ocean-derived MSA over the eastern China seas and part of Northwest Pacific from 2009 to 2018 was simulated. The surface phytoplankton biomass and the boundary layer height along the air mass transport path are the two main factors controlling the spatial and temporal distributions of MSA. Similar methods may be applied to estimate the distribution of other marine biogenic components in the atmosphere.

(VS5- 14918) E-poster

Extreme sea level rise off the northwest coast of the South China Sea in 2012

Lin **Liu**[1,2], Juan Li[3] and Wei Tan[3]

[1]   Center for Ocean and Climate Research, First Institute of Oceanography, Ministry of Natural Resources, China. E-mail: liul@fio.org.cn
[2]   Laboratory for Regional Oceanography and Numerical Modeling, Qingdao National Laboratory for Marine Science and Technology, China
[3]   Shandong University of Science and Technology, China

Tide gauge data are used to investigate sea level variability off the northwest coast of the South China Sea (SCS) in 2012, and a significant sea level elevation with a magnitude approaching 79 mm is observed. Analysis suggests that an abnormal sea surface heat flux and freshwater flux may have contributed to this abnormal rise in sea level, together with the remote influence of an ENSO event. Further investigation shows that the event was dominated by the positive freshwater flux, where large volumes of water entered the ocean, and a maximum is centered to the south of Guangdong province, China. Simultaneously, a positive anomalous heat flux occurred in the northwestern part of the SCS, which is considered to have made a positive contribution to the high local sea level elevation. In addition to the heat flux, the ENSO event also had a significant effect on the event, where the La Niña-induced northwest Pacific cyclone contributed to sea level rise over the northwestern SCS through dynamic and thermodynamic interactions.

(VS5- 14921) E-poster

Differentially expressed genes of octocoal, *Eleutherobia rubra* against heat stress and the local environment

Nayun **Lee**[1], Seungshic Yum[1] and Seonock Woo[2]

[1]   South Sea Environment Research Department, Korea Ocean Research and Development Institute, Geoje, Republic of Korea.
[2]   Korea Institute of Ocean Science and Technology, Busan, Republic of Korea. E-mail: cwoo@kiost.ac.kr

Recently major impacts of climate change including, uprising seawater temperature and ocean acidification, might have accelerated the process of destruction on coral ecosystem worldwide. Soft coral ecosystem in South Sea of Korea is one of the coral communities affected by global warming strongly because the fast warming Kuroshio Current arrives Korean peninsula from the origin of the northern Philippines. In this research, we studied the physiological aspect and transcriptional responses of the coral, *Eleutherobia rubra* using the heat exposure experiment. We collected corals and extracted RNA after heat stress experiments. For the heat stress experiment, we exposed corals to temperature (26 ^{0}C) for 24h and hybridized those RNAs with that of control group (18^{0}C) on the Oligo chip. As the results, we identified several groups of genes which transcription changed compared with control group. Antioxidant genes, ubiquitin-related genes, calcium ion-responsive genes, genome-related genes, and telomerase-related genes were explored in heat exposed coral groups and we compared those gene expressions in spring and summer and also in different locality with various latitudes.

(VS5-14922) E-poster

Dominant microalgae species in Paris Bay (Peter the Great Bay, Sea of Japan) near the net pens with marine mammals

Olga G. Shevchenko[1] and Kirill O. **Tevs**[2]

[1]   A. V. Zhirmunsky National Scientific Center of Marine Biology, Far Eastern Branch, Russian
[2]   Far Eastern Federal University, Vladivostok, Russia. E-mail: tevs.kirill.95@yandex.ru

Species composition and quantitative characteristics of phytoplankton communities indicate the health of a marine environment, and therefore it is very important to thoroughly study microalgae in marine protected areas or aquaculture sites such as Paris Bay. From June to December 2019 (water t_{max} = 25°C, S = 36‰; water t_{min} = -1,8°C, S = 19‰), 108 species and intraspecific taxa of microalgae from five phyla – Bacillariophyta, Dinophyta, Ochrophyta, Cryptophyta и Euglenophyta – were recorded in Paris Bay. Only members of the phylum Bacillariophyta, namely *Skeletonema dorhnii*, *S. japonicum*, *Cyclotella* spp. and *Thalassiosira* spp., were found to form blooms in the study area. In July (t = 15°C, S = 34‰), the abundance of *Skeletonema dorhnii* reached $4,6x10^6$ cells/L, which accounted for 91,6% of the total microalgae abundance. The next outbreak of phytoplankton was observed in September; there was a rapid increase in the population ($4,4x10^6$ cells/L) of several *Cyclotella* species (72%, t = 22°C, S = 19‰). A peak in abundance of *Skeletonema japonicum* ($2,3x10^6$ cells/L) was also noted in autumn (92%, t = 11,8°C, S = 32,1‰). In December, the plankton was dominated ($1,2x10^6$ cells/L) by *Thalassiosira* species (95,6%, t = -1,8°C, S = 35‰). Comparative analysis of the quantitative data with the results of the phytoplankton study conducted in Paris Bay in 2014-2015 showed no consistent trend in the composition and density of microalgae community in the area.

(VS5-14926) E-poster

Spatial distributions of atmospheric water soluble nitrogen and phosphorus depositions to the Pacific Ocean

Rumi Naoe[1], Shigenobu **Takeda**[1], Kei Tamura[2] and Masataka Doi[3]

[1]   Nagasaki University, Nagasaki, Japan. E-mail: s-takeda@nagasaki-u.ac.jp
[2]   Nagasaki Prefectural Environmental Affairs Department, Nagasaki, Japan
[3]   Nagasaki Prefectural Institute of Environment and Public Health, Omura, Japan

Atmospheric aerosols containing combined nitrogen, ammonium and nitrate are transported from the continents to the North Pacific Ocean. The spatial distributions of atmospheric nitrogen (N) and phosphorus (P) depositions to the Pacific Ocean were examined using aerosol (dry) and rainwater (wet) samples collected on the R/V Hakuho-maru during five cruises from July 2012 to February 2015. High inorganic N (IN) dry depositions were observed at the western North Pacific near the east coast of Japan and the south-east of the Kamchatka Peninsula in summer, with a mean contribution of NO_3^- to IN dry deposition of 62 %. Wet deposition of IN was mainly NH_4^+ (71 % on average over the Pacific Ocean), and NH_4^+ wet deposition was high in the equatorial region, which was affected by airmasses passing over relatively high chlorophyll *a* waters during the summer and winter. Dry depositions of P were at very low levels, but the equatorial region had high P wet deposition, about 30 times higher than average in winter 2014.

(VS5-14932) E-poster

Trans-Pacific transport signals of Asian dust from 1998-2011 in aerosols at Saturna Island, B.C

Mona **Mostafaei** and Ann-Lise Norman

University of Calgary, 2500 University Dr NW, Alberta, T2N 1N4, Canada. E-mail: mona.mostafaei@ucalgary.ca

Asian soil dust is regarded as a major component of tropospheric aerosols in the global atmosphere (Zhao et al., 2005). It mainly originates from arid and semi-arid regions in China and Mongolia, mostly during spring (Chen et al., 1999), and is transported over Asian continents, Pacific Ocean and occasionally to North America (Husar et al., 1997).

Soil dust aerosols are considered to have considerable effects on climate, visibility and health. It impacts the climate by altering the global radiation budget (Sokolik and Toon et al., 1996), affects cycles of atmospheric species through heterogeneous reactions (Dentener et a., 1996), reduce the visibility (Patterson et al., 1976) and present serious risks for human health, associated with respiratory and cardiovascular disorders.

This study is focused on aerosol and gas samples, collected by Canada Air and Precipitation Monitoring Network (CAPMoN) at Saturna Island, B.C, for the period 1998-2011. The goal is to examine Asian dust transport to the west coast of North America, by assessing changes in crustal material in spring 2001 and 2005 at surface level. The ratio of calcium and magnesium will be compared with studies that have investigated Asian and African dust events, to constrain whether the signals in Saturna Island originated locally, from long-range transport of dust storms or a mixture of both.

(VS5-14935) E-poster

Dynamics of the bloom-forming genus Skeletonema from the Peter the Great Bay (Sea of Japan)

A.A. **Ponomareva**[1], O.G. Shevchenko[1] and K.O. Tevs[2]

[1]   A. V. Zhirmunsky National Scientific Center of Marine Biology, Far Eastern Branch, Russia. E-mail: anna_andreeva7@mail.ru
[2]   Far Eastern Federal University, Vladivostok, Russia.

Diatoms of the genus *Skeletonema* are known to form harmful blooms; they are non-toxic but can cause mortality of marine wildlife. Six species, namely *Skeletonema costatum*, *S. dohrnii, S. japonicum, S. marinoi, S. grethae* and *S. menzelii*, have currently been identified in the northwestern Sea of Japan. *S. menzelii* is a new record for Russian seas.

The density of *Skeletonema* species ranged from 87 cells/L to 4.6×10^6 cells/L in the study area in 2012 – 2019. Clonal cultures were isolated for further identification of *Skeletonema* species under light microscopy. Colonies of *S. dohrnii, S. marinoi* and *S. japonicum* were mainly observed in June, September and November, respectively. These species' abundance varied significantly between years. Over the observation period, the highest density of *Skeletonema* species was noted in 2019: *S. dohrnii* formed a bloom in summer (4.6×10^6 cells/L), an excessive growth of *S. japonicum* (2.3×10^6 cells/L) was recorded in fall. In previous years of the study (2012-2018), such significant outbreaks in *Skeletonema* population were not noted: their density remained under 884.2×10^3 cells/L. An exception was *S. dohrnii* that flourished in fall of 2015 (1.8×10^6 cells/L). The other species were at low levels. Single colonies of *S. costatum* were present in the plankton in June; small numbers of *S. grethae* and *S. menzelii* were found in September. *Skeletonema* species are indistinguishable from each other under light microscopy. Since some of them could co-occur in plankton, we used a more accurate method to clarify the species composition and quantitative characteristics.

(VS5-14937) E-poster

Air emissions from shipping stimulate oceanic phytoplankton growth

Chao **Zhang**[1], Zongbo Shi[2], Yan Zhang[3] and Huiwang Gao[1]

[1]   Key Laboratory of Marine Environment and Ecology, Ministry of Education of China, and Frontiers Science Center for Deep Ocean Multispheres and Earth System, Ocean University of China, Qingdao 266100, China. E-mail: hwgao@ouc.edu.cn
[2]   School of Geography, Earth and Environmental Sciences, University of Birmingham, Birmingham B152TT, UK
[3]   Shanghai Key Laboratory of Atmospheric Particle Pollution and Prevention (LAP3), Department of Environmental Science and Engineering, Fudan University, Shanghai 200092, China

With a rapid expansion of maritime traffics, a large increase in air emissions from the combustion sources is expected. As important external inputs, their impacts on marine biogeochemistry are poorly understood. Here we collected ship-emitted particles (SEPs) from the stack of a heavy-oil-powered vessel using an on-board emission test system and explored their impacts on phytoplankton growth over the northwest Pacific Ocean (NWPO). In SEP addition microcosm experiments conducted in oceanic zones with varying trophic statuses, the phytoplankton response indicated by chlorophyll *a* (Chl *a*) increased proportionally with increasing SEP-derived nitrogen (N) relative to N stocks (P_{SN}) in baseline seawaters, suggesting SEPs generally promote phytoplankton growth via N fertilisation. Simulations by the air quality model combined with a ship emission inventory further showed that oxidised N (NO_x) emissions from shipping directly contributed to ~43% of atmospheric N deposition flux. Air emissions from shipping (e.g. NO_x and sulfur dioxide) also indirectly enhanced the deposition of reduced N that has existed in the atmosphere, which contributed to ~15% of atmospheric N deposition flux. These results suggest the impact of ship emissions on atmospheric N deposition has become comparable to that of land-based emissions in the NWPO. Based on the modelling N deposition flux and established quantitative relationship between Chl *a* and P_{SN} from microcosm experiments, we estimated the annual response of surface Chl *a* concentrations due to ship-induced N deposition in the NWPO. This work attempts to establish a direct link between marine productivity and air emissions from shipping.

(VS5-14941) E-poster

Diel, seasonal, and vertical changes in abundance, biomass, and community structure of the pelagic polychaetes down to 1000 m depths in the western subarctic Pacific Ocean

Kanako **Amei**[1], Ryo Dobashi[1], Naoto Jimi[2], Minoru Kitamura[3] and Atsushi Yamaguchi[1]

[1]   Hokkaido University, Hakodate, Japan. Email: kanakoamei@eis.hokudai.ac.jp
[2]   National Institute of Polar Research, Tachikawa, Japan.
[3]   Japan Agency for Marine-Earth Science and Technology, Yokosuka, Japan.

Atmospheric CO_2 is fixed by phytoplankton, then through various zooplankton feeding/egestion processes, they transported and stored to the deep-sea. Within the zooplankton, pelagic polychaetes distribute throughout the water column of the world-wide oceans, but little information is available for their ecology. This study investigated the vertical distribution of abundance, biomass, and community of the pelagic polychaetes at K2 (47°00'N, 160°00'E) in the western subarctic Pacific based on the day-night vertical stratified samples collected from 0–1000 m water column by eight-layered vertical stratified sampling by oblique tow of the Intelligent Operative Net Sampling System (IONESS, equipped 335 µm mesh) during 29 October 2010, 26 February, 22–23 April, and 3–4 July 2011. The polychaete abundance and biomass ranged at 0–757 ind. 1000 m^{-3} and 0–6.1 mg WW m^{-3}, respectively. Through the study, ten pelagic polychaete species belonging to nine genera and six families were identified. From cluster analysis based on abundance, the polychaete community was divided into five communities. Each community occurred at the different depth layers. Two surface groups seen at 0–200 m were dominated by two carnivorous species: *Typhloscolex muelleri* and *Tomopteris septentrionalis*. The deepest group, dominated by the particle feeding *Pelagobia longicirrata*, was seen at 500–1000 m. Two transition groups occurred for the intermediate depths. These vertical distributions of the pelagic polychaete communities were common throughout the season and day. As environmental factors that affect the pelagic polychaete community, water mass, food availability, and dissolved oxygen are argued.

(VS5-14953) E-poster

Concentration distribution of atmospheric particulate nitrogen and phosphorus over the North Pacific Ocean

Gang **Yuan**[1,2] and Jianhua Qi[1,2]

4   [1]Ocean University of China, Qingdao, China. E-mail: qjianhua@ouc.edu.cn
5   [2]Qingdao National Laboratory for Marine Science and Technology, Qingdao, China

Atmospheric deposition of long-range transport of nitrogen and phosphorus from continents to ocean may have profound impact on marine biogeochemistry. 14 atmospheric aerosol samples, including 3 samples affected by dust events, were collected during a round-trip cruise in the December 2019 from the eastern China seas (ECSs: the Yellow Sea and the East China Sea) to the northwestern Pacific Ocean (NWPO). The concentrations of dissolved inorganic nitrogen (DIN), dissolved inorganic phosphorus (DIP), dissolved total nitrogen (DTN), dissolved total phosphorus (DTP), total nitrogen (TN) and total phosphorus (TP) in samples were analyzed. The concentrations of TN over the ECSs and NWPO were 1.55-22.64 and 0.09-3.34 $\mu g \cdot m^{-3}$, respectively, while the TP levels were 4.16-233.50 and 1.29-21.16 $ng \cdot m^{-3}$ over the ECSs and NWPO, respectively. The average concentrations of DIN and DIP during non-dust period were 1.42±0.34 $\mu g \cdot m^{-3}$ and 1.34±0.50 $ng \cdot m^{-3}$ in the ECSs, while they were 0.30±0.20 $\mu g \cdot m^{-3}$ and 0.61±0.69 $ng \cdot m^{-3}$ in the NWPO, respectively. Compared with the non-dust samples, the concentrations of DIN, DTN and TN in aerosols affected by dust events increased by 5.8-8.8, 5.5-8.2 and 5.9-10.9 times, while DIP, DTP and TP increased by 8.8-16.7, 7.2-11.9 and 8.9-41.7 times higher than non-dust samples, respectively. During the dust period, the concentrations of nitrogen and phosphorus species gradually decreased due to the increase of distance from shore, but the contributions of DTN to TN and DTP to TP gradually increased, which meant that dust aerosols could be an important nutrient source in some remote regions.

(VS5-14961) E-poster

Characterization and source apportionment of size-segregated atmospheric particulate matter collected at ground level and from the urban canopy in Tianjin, a coastal city

Jiao **Wang**[1,3], Ming Zhou[1], Bao-shuang Liu[1], Jian-hui Wu[1], Xing Peng[1], Yu-fen Zhang[1], Su-qin Han[1], Yin-chang Feng[1] and Tan Zhu[1]

1   State Environmental Protection Key Laboratory of Urban Ambient Air Particulate Matter Pollution Prevention and Control, College of Environmental Science and Engineering, Nankai University, Tianjin 300071, China. E-mail: wangjiao@ouc.edu.cn
2   Tianjin Institute of Meteorological Science, Tianjin 300074, China
3   Key Laboratory of Marine Environment and Ecology, Ministry of Education of China, Ocean University of China, Qingdao 266100, China

A study was conducted on a 255 m meteorological tower in Tianjin from December 2013 to January 2014, to investigate the size distributions of chemical compositions and sources of particulate matter (PM) at ground level and from the urban canopy in coastal zones. Thirteen sets of 8 size-segregated particles were collected with cascade impactor at 10 m and 220 m. Twelve components of particles, including water-soluble inorganic ions and carbonaceous species, were analyzed and used to apportion the sources of PM with positive matrix factorization. The results indicated that the concentrations, size distributions of chemical compositions and sources of PM at the urban canopy were affected by regional transport due to a stable layer approximately 200 m and higher wind speed at 220 m. The concentrations of PM, Cl^- and elemental carbon (EC) in fine particles at 10 m were higher than that at 220 m, while the reverse was true for NO_3^- and SO_4^{2-}. The size distributions of major primary species, such as Cl^-, Na^+, Ca^{2+}, Mg^{2+} and EC, were similar at two different heights, indicating that there were common and dominant sources. The peaks of SO_4^{2-}, NH_4^+, NO_3^- and organic carbon (OC), which were partly secondary generated species, shifted slightly to the smaller particles at 220 m, indicating that there was a different formation mechanism. Industrial pollution and coal combustion, re-suspended dust and marine salt, traffic emissions and transport, and secondary inorganic aerosols were the major sources of PM at both heights. With the increase in vertical height, the influence of traffic emissions, re-suspended dust and biomass burning on PM weakened, but the characteristics of regional transport from Hebei Province and Beijing gradually become obvious.

(VS5-14964) E-poster

Horizontal scale of chlorophyll *a* variability affected by eddy activities in the midlatitudes of global oceans

Hitoshi **Kaneko** and Shin-ichi Ito

Atmosphere and Ocean Research Institute, The University of Tokyo, Kashiwa, Chiba, Japan. E-mail: h_kaneko@aori.u-tokyo.ac.jp

Horizontal characteristic scale of near surface chlorophyll *a* (CHL) is essential for understanding the ubiquitous structure of biological production, and is an important factor which closely related to biodiversity, biological production, and carbon absorption of ocean. Therefore, CHL variability based on the satellite observations from 2001 to 2019 were analyzed in association with meso-scale eddy activity in mid-latitude regions of the five basins including the North/South Pacific (NP/SP), the North/South Atlantic (NA/SA), and the South Indian Ocean (IO). The horizonal scale showed a basin-scale zonal contrast in the latitude of 30°–50°, showing smaller value in the western region of the basins. The horizontal scale decreased with increase of the eddy kinetic energy (EKE) and converged to 80–100 km in the EKE range of 0.6 $m^2 s^{-2}$. In contrast, in the lower range of EKE, the scale varied from 180–210 km in the NP, the NA, and the IO, to > 280 km in the SP and the SA. Especially higher sensitivity of the scale to EKE was indicated in the SA, showing rapid convergence with increasing of EKE. Similar convergence pattern was shown in the eastern NP where iron limitation and eddy transport of CHL were well known. The ratio of zonal scale to meridional scale of CHL variation also converged to unity with increase of EKE except for the regions where intense mean flows such as the Kuroshio Extension and the Gulf Stream occur.

(VS5-14972) E-poster

Occurrence and cycle of biogenic dimethyl sulfide in the western Pacific Ocean and its contribution to atmospheric sulfate aerosols

Feng **Xu**[1], Xu-Xu Gao[1], Hong-Hai Zhang[1, 2] and Gui-Peng Yang[1, 2]

[1]   Frontiers Science Center for Deep Ocean Multispheres and Earth System, and Key Laboratory of Marine Chemistry Theory and Technology, Ministry of Education, Ocean University of China, Qingdao, China. E-mail: honghaizhang@ouc.edu.cn; gpyang@ouc.edu.cn

[2]   Laboratory for Marine Ecology and Environmental Science, Qingdao National Laboratory for Marine Science and Technology, Qingdao, China

Oceanic production and cycle of dimethyl sulfide (DMS) and its subsequent ventilation to the atmosphere significantly contribute to the biogenic sulfur cycle and impact the global climate. Spatial distributions of DMS, dimethylsulfoniopropionate, and dimethyl sulfoxide, production and removal processes of DMS, and biogenic contribution to atmospheric sulfate aerosols were simultaneously studied in the western Pacific Ocean (WPO). Biogenic sulfides had strong correlations and similar distribution patterns. The DMS photo-degradation efficiency ratio for photosynthetically active radiation (PAR): ultraviolet A radiation (UVA): ultraviolet B radiation (UVB) was 1: 36: 391. However, considering the solar spectral composition, the actual contributions of UVB, UVA, and PAR to DMS photo-degradation in surface seawater were 40.6%, 41.2%, and 18.2%, respectively. The modeled DMS photo-degradation for the entire water column indicated that photo-degradation process primarily occurred in the top 80–110 m. PAR and UVA were the dominant drivers for the entire water column due to the significant attenuation of UVB. Overall, the contributions of microbial consumption, photo-degradation, and sea-to-air exchange to DMS removal were 35.4%, 12.3%, and 52.3%, respectively. With DMS ventilation as the foremost pathway of DMS removal from surface seawater, the WPO was estimated to be a significant net source of atmospheric DMS, that subsequently formed 45.2 ± 25.6% of the atmospheric non-sea-salt sulfate aerosols. Besides, deck incubation experiments were conducted to investigate the effects of environmental changes on DMS release, and the results showed that Asian dust additions and acidified treatment (pH=7.9) significantly promoted the phytoplankton growth and the productions of biogenic sulfides.

(VS5-14976) E-poster

Zinc and lead accumulation by *Fucus distichus* (Fucales) in coastal waters of southeastern Kamchatka and Commander Islands during 2000-2020

Liliya A. **Pozolotina**, Anna V. Klimova and Nina G. Klochkova

Kamchatka State Technical University (KamchatGTU), Petropavlovsk-Kamchatsky, Russian Federation. E-mail: pozolotina@mail.ru

In the Far Eastern seas of Russia, *Fucus distichus* Linnaeus (1767) is widespread and dominant species of macrophytes in the littoral zone. This fucoid can withstand long-term exposure to different contaminants (heavy metals, petroleum hydrocarbons, phenols) and is a biomonitor of environmental pollution. The aim of this study was to determine changes in the content of Zn and Pb in *F. distichus* of Avacha Bay (southeastern Kamchatka) and Bering Island (Commander Islands) for twenty years. Avacha Bay is an anthropogenic impact area, Bering Island is a protected area, where the negative impact of human activity is minimal. Over the entire period, Zn content in *F. distichus* varied in the range of 11.6-140.4 µg/g dw in Avacha Bay and 7.8-21.3 µg/g dw for Bering Is. Over a twenty-year period, there has been an increase in its content in *F. distichus* from all the studied areas. The lead content in *F. distichus* for the entire period of research varied in the range of 0.5-13.2 µg/g dw in Avacha Bay and 0.4-5.1 µg/g dw for Bering Is. During 2000-2020, the accumulation of Pb by *F. distichus* decreased. In the period 2000-2010, the concentration ranges of Zn in *F. distichus* of the Avacha Bay and Bering Is. was comparable. A similar situation was noted for Pb content. In the last decade, significant differences have been observed in the accumulation of these metals by *F. distichus* of Avacha Bay and Bering Is.

(VS5-14978) E-poster

Spatial distributions of methyl halides and influence of nitrate concentration on their production in the western Pacific Ocean (2 °N to 24 °N)

Shan-Shan Liu[1], Zhen He [1,2] and Gui-Peng **Yang** [1,2,3]

[1]   Key Laboratory of Marine Chemistry Theory and Technology / Frontiers Science Center for Deep Ocean Multispheres and Earth System, Ministry of Education, Ocean University of China, Qingdao 266100, China. E-mail: zhenhe@mail.ouc.edu.cn; gpyang@mail.ouc.edu.cn

[2]   Laboratory for Marine Ecology and Environmental Science, Qingdao National Laboratory for Marine Science and Technology, Qingdao 266237, China

[3]   Institute of Marine Chemistry, Ocean University of China, Qingdao 266100, China

Methyl halides are responsible for the majority of the ozone layer depletion and important greenhouse gases. This study investigated atmosphere and seawater methyl halides (CH_3Cl, CH_3Br, and CH_3I) in the western Pacific Ocean between 2°N and 24°N. Increases in methyl halides in the atmosphere are likely to have originated from Southeast Asian regions. The elevated concentrations of CH_3I in atmosphere and surface seawater are mainly derived from photochemical production from dissolved organic carbon. The spatial distributions of methyl halides and chlorophyll a, in the upper water column (0–200 m), were linked to biological activity as well as downwelling and upwelling caused by cold and warm eddy. Ship-based incubation experiments showed that nutrient supplementation promoted methyl halide emissions. The elevated methyl halide production was associated with increases in phytoplankton such as diatoms. The estimated emissions of CH_3Br and CH_3I in the western Pacific Ocean account for 3.6% and 1.1% of global oceanic emissions, respectively, highlighting the importance of the open sea to the reactive bromine and iodine in the atmosphere.

GENERAL E-POSTER SESSION

(GP-14894) E-poster

Rapid detection of aquatic microplastics on filter substrates based on hyperspectral imaging

Chunmao **Zhu**, Yugo Kanaya, Ryota Nakajima, Masashi Tsuchiya, Hidetaka Nomaki, Tomo Kitahashi and Katsunori Fujikura

Research Institute for Global Change, Japan Agency for Marine-Earth Science and Technology, Kanagawa, Japan. E-mail: chmzhu@jamstec.go.jp

Microplastic pollution has become an urgent issue because it adversely affects ecosystems. However, efficient methods to detect and characterize microplastic particles are still in development. By conducting a series of laboratory assessments based on near-infrared hyperspectral imaging in the wavelength range of 900–1700 nm, we report the fundamental spectral features of (i) 11 authentic plastics and (ii) 11 filter substrate materials. We found that different plastic polymers showed distinct spectral features at 1150–1250 nm, 1350–1450 nm and 1600–1700 nm, enabling their automatic recognition and identification with spectral separation algorithms. Using an improved hyperspectral imaging system, we demonstrated the detection of three types of microplastic particles, polyethylene, polypropylene and polystyrene, down to 100 μm in diameter. As a filter substrate, a gold-coated polycarbonate filter (GPC0847-BA) showed constant reflectance over 900–1700 nm and a large radiative contrast against loaded plastic particles. Glass fiber filters (GF10 and GF/F) would also be suitable substrates due to their low cost and easy commercial availability. This study provides key parameters for applying hyperspectral imaging techniques for the detection of microplastics.

(GP-14895) E-poster

The role of environmental indicators in ecosystem-enhanced Bering Sea pollock fishery management

Mikhail A. **Stepanenko** and Elena V. Gritsay

Pacific branch of VNIRO («TINRO»), 4 Shevchenko Alley, Vladivostok, 690091, Russia. E-mail: mikhail.stepanenko@tinro-center.ru, elena.gritsay@tinro-center.ru

Bering Sea pollock distributional inter-annual changes have been determined extensively as climate-induced shift. We have presented pollock migration and distribution in the northwestern Bering Sea and compared the two types of distribution as bottom temperature and zooplankton abundance responses. Pollock demonstrated differences in responses to cold and warm temperatures and zooplankton abundance. The differences in responses are influencing pollock spatial distribution shift from Eastern Bering Sea into northwestern Bering Sea. Scale of pollock migration into northwestern Bering Sea in summer feeding period is much higher in warm temperature conditions, but comparable at different trophic level, in low or high zooplankton abundance in the Bering Sea. At the same time speed of pollock northward migration is lower in years of high abundance of large zooplankton (euphasiids and large copepods), however its duration is longer – summer and first part of autumn. The speed of active northward pollock migration is much higher but its duration is shorter – just summer period in years of low zooplankton abundance. The great annual differences of pollock seasonal migration and spatial distribution are related with variability of temperature and large zooplankton abundance. The climate shift, temperature, large zooplankton abundance are the most valid environmental indicators for ecosystem-enhanced Bering Sea pollock fishery management explore.

(GP-14898) E-poster

Oceanographic and biological conditions ensuring the presence of a high productive bottom community in the Marine feeding area of gray whales near north-eastern Sakhalin Island

V. S. **Labay**[1], G.V, Shevchenko[1], I.V. Motylkova[1], N.V. Konovalova[1], I.A. Atamanova[1], V.N. Chastikov[1], R.V. Turchin[2] and B.A. Dotzenko[2]

[1]   Sakhalin branch of the Federal State Budget Scientific Institution "Russian Federal Research Institute of Fisheries and oceanography", Yuzhno-Sakhalinsk, Russia. E-mail: v.labaj@yandex.ru
[2]   LLC "GAZPROMNEFT-SAKHALIN", Saint-Petersburg, Russia

The main features of hydrological and hydrobiological conditions in the Marine feeding area of gray whales were determined as a result of research on the shelf of North-Eastern Sakhalin in 2019. Well-defined diurnal variations in temperature and salinity, which decreased twice a month during the period of decreasing tides (Equatorial tides) with an displacement of about a day, is marked. It confirmed the hypothesis expressed earlier about the dipping of warmer waters with relatively low salinity at the high-tide phase. This phenomenon is especially clearly defined in the typical warm season two-layer distribution of Oceanological elements with a well-defined layer of jump. It was also shown in vertical distributions of concentration of chlorophyll-*a*.

The structure, composition, and ratio of mass species of microalgae of phytoplankton are also subject to daily fluctuations that depend on the dynamics of the aquatic environment. The deepening of surface phytoplankton communities into the intermediate and bottom layers was observed at the tidal phase. Short-term rise of near bottom communities to the surface is marked at the low tide.

The average zooplankton biomass for the survey periods was significantly higher than the average for the North-Eastern Sakhalin shelf. Most of the zooplankton organisms from the upper horizons do not fall below the thermocline with a small amplitude of a tide and is delayed somewhere in the intermediate layers or redistributed in the surface horizon. The increase of plankton biomass in the lower horizon is clearly expressed with large amplitude of tides. This is due to the deeper penetration of surface water.

Thus, the unique Oceanographic conditions of the area ensure the existence of a specific "natural hydrological pump" that performs periodic vertical transfer of surface water with high temperature and organic matter of plankton to the bottom layers, and bottom water with a high concentration of nutrients – to the surface.

(GP-14905) E-poster

Spatio-temporal variations in the potential habitat of neon flying squid in the Northwest Pacific Ocean

Wei **Yu**, Jian Wen, Zhong Zhang, Xinjun Chen and Yang Zhang

Shanghai Ocean University, Shanghai, China. E-mail: wyu@shou.edu.cn

An integrated habitat suitability index (HSI) model was developed for a pelagic commercial squid *Ommastrephes bartramii* in the Northwest Pacific Ocean based on three crucial environmental variables: sea surface temperature (SST), chlorophyll-a concentration (Chla) and sea surface height (SSH). The model was established by data from 2006-2014 and validated by data in 2015 on the basis of fishing effort and CPUE (catch-per-unit-effort). Results suggested that the HSI model had good capacity to predict habitat suitability for *O. bartramii*. Squid habitat quality showed significant monthly variation, the ranges of suitable habitats in July and August were much larger than those in September. Besides, the latitudinal location of suitable habitats gradually moved northward from July to September. Further, the spatial extents of potential habitat of *O. bartramii* across months were strongly regulated by favorable environmental conditions. The variability trends of monthly CPUE and LATG (latitudinal distribution of fishing efforts) were closely associated and consistent with spatio-temporal habitat variations during 2006-2015. Moreover, climate variability strongly affected habitat variations and squid stocks. Relative to the El Niño event in 2015, the La Niña event in 2007 yielded expanded suitable habitat from July to September, consequently, the CPUE was much higher. And the potential high-quality habitats in 2007 mainly located in northern regions except July comparing to 2015, leading to the higher latitudinal distribution of LATG in August and September 2007. Our findings indicated that *O. bartramii* habitats obviously varied from month to month and were largely affected by environmental changes.

(GP-14920) E-poster

Identification of functional genes in deep-sea corals from seamounts in West Pacific by *de novo* RNA sequencing

Ye Jin **Jo** [1], Seungshic Yum [1] and Seonock Woo [2]

[1]   South Sea Environment Research Department, Korea Ocean Research and Development Institute, Geoje, Republic of Korea. E-mail: cwoo@kiost.ac.kr
[2]   Korea Institute of Ocean Science and Technology, Busan, Republic of Korea

This is a study about investigation the biodiversity of the deep-sea seamount in the West Pacific and discovering the marine biological genetic resources. Coral samples were obtained using epibenthic sledge (EBS) which was one of the collection equipment of Onnuri Research Vessel in Korea Institute of Ocean Science and Technology. To classify the coral species, DNA sequences of CO1 and MSH1 were used together with morphological classification method. RNA was extracted by following the method optimized for the soft coral and *de novo* RNA sequencing (RNA-seq) was carried out to explore the functional genes in three deep-sea coral species, *Iridogoria splendens, Chrysogoria chryseis* and *Calyptrophora wyvillei*. Approximately 193,579 unigenes from *Iridogoria splendens*, 235,513 unigenes from *Chrysogoria chryseis* and 193,796 unigenes from *Calyptrophora wyvillei* were identified and those unigenes were classified their functions using NCBI Nucleotide, Pfam, Gene ontology (GO), EggNOG, and UniProt databases. This study focused on the identification of functional genes in deep sea corals and this genetic information will be used for the various analyses of secure genetic sources of target species and understand their environmental characteristics.

(GP-14923) E-poster

Spatial and temporal dynamics of Pacific capelin (*Mallotus catervarius*) in the Gulf of Alaska: using data synthesis to improve monitoring of small pelagic fishes in the Northeast Pacific

David W. **McGowan**

NOAA Alaska Fisheries Science Center, Seattle, WA, USA. E-mail: david.mcgowan@noaa.gov

To support ecosystem-based fisheries management in the Alaska North Pacific, information on spatial patterns and population dynamics of small pelagic fishes is needed to evaluate how changes in their availability as prey impacts managed predators. Small pelagic fishes are not commercially exploited in U.S. waters off Alaska nor are they directly monitored, therefore variations in their abundances and distributions have been primarily monitored by indices based on predator diets or data from surveys that are designed for other species. The limitations of such individual data series can be compensated for by synthesizing data from multiple sources to monitor fluctuations in distribution and abundance of an ecologically important small pelagic species, Pacific capelin (*Mallotus catervarius*), in the Gulf of Alaska from 2000–2019. Spatial overlap in composite distributions of capelin were used to identify core areas where they consistently occur and concentrate. Coherence among abundance indices showed high abundance during an anomalously cold year (2013), followed by a sharp decline during the 2014–2016 marine heatwave and subsequent recovery. In other years, interannual variations in abundance and spatio-temporal differences in density indicate that the availability of capelin to monitoring surveys and predators is highly variable in the Gulf of Alaska. As a result, we highlight spatial factors necessary for interpreting trends from survey- and predator-based abundance indices. Recent advances in acoustic-trawl sampling and spatiotemporal modeling will also be discussed with regard to anticipated improvements in monitoring efforts for capelin and other small pelagic fishes in this region.

(GP-14939) E-poster

Seasonal dynamics of dominant fish populations in Zhoushan Archipelago Seas: roles of oceanic front and fishing

Yongjiu **Xu**[1], Hongliang Zhang[2], Joji Ishizaka[3], Cungen Yu[1], Huijun Wang[1] and Yali Hu[1]

[1]   College of Fisheries, Zhejiang Ocean University, Zhoushan 316022, China. E-mail: xyj-20012318@hotmail.com
[2]   Marine Fisheries Research Institute of Zhejiang, Zhoushan 316021, China
[3]   Institute for Space-Earth Environmental Research (ISEE), Nagoya University, Japan

The seasonal migration of fish between overwinter grounds to spawning grounds determines the seasonal dynamics of fish population in coastal waters of China. The physical process and human activities may strongly interfere the migration success, as well as the spawning success and later recruitment. The fishing activities are always associated with physical process, such as oceanic front, upwelling and eddies. The contribution of oceanic front and fishing are not well know yet in Zhoushan Archipelago due to lack of time series data.Based on the satellite data and fish CPUE time series, we examined how fishing and oceanic front influence the population dynamics, especially, the migration process. Our results suggested that the oceanic front played an more important role in seasonal migration, probability index was significantly positively correlated with Small yellow croaker abundance, while, significantly negatively correlated with Harpadon nehereus abundance, fishing was the second factor to influence the seasonal migration.

(GP-14955) E-poster

Enhance ecosystem-based approach principles in Marine Policy of Pacific Russia to contribute to fulfilling the Ocean Decade Challenges

Amrtatjuti V. **Sereda**

V.I.Il'ichev Pacific Oceanological Institute, Far Eastern Branch, Russian Academy of Sciences, Vladivostok, Russia. E-mail: amrtatjuti@poi.dvo.ru

For Russia, the importance of the Far Eastern seas is heighten by the role of the opportunities for international cooperation, marine resources and aspects of environmental safety in its economic growth and capacity to maintain geopolitical balance. However, there is a mismatch between unique environment of these marine areas, which has no analogues in Russia in biological diversity, and used marine management types that are so far from the criteria of "sustainable development". Government measures towards the implementation of the ecosystem-based marine management principles should provide the requisite protection and sustainable development of the marine and coastal environment and their resources in Pacific Russia in view of the ever-increasing industrial activities in the coastal and marine zones, including anthropogenic pressures and transboundary transfer of pollutions and other security issues according to the Ocean Decade Challenges, since it would ultimately serve as a stabilizing pillar in the process of region adaptation and enhancing resilience to the climate change and its impacts. This item is intended also as a follow-up to discuss opportunities for enhanced cooperation under strategic platform for development of integrated marine policy based on the ecosystem-based principles within and between partner countries to support coastal and marine ecosystem health, protect ecosystem functions and services, respond together to the maritime challenges and provide for sustainable development across North Pacific region.

(GP-14960) E-poster

Detection of fine-scale internal disturbances generated at the Kuroshio front

Kosei **Komatsu**[1,2], Akira Kuwano-Yoshida[3] and Keisuke Ariyoshi[4]

[1]   Graduate School of Frontier Sciences, University of Tokyo, Kashiwa, Japan. E-mail: kosei@aori.u-tokyo.ac.jp
[2]   Atmosphere and Ocean Research Institute, University of Tokyo, Kashiwa, Japan
[3]   Disaster Prevention Research Institute, Kyoto University, Shirahama, Japan
[4]   Japan Agency for Marine Earth Science and Technology, Yokohama, Japan

The Kuroshio is accompanied by plentiful internal disturbances, which have significant influences on marine productivity through enhancement of both horizontal and vertical mixings. However, generation and development processes of the internal disturbances in the western boundary currents remain to be fully elucidated because of resolution limit of conventional observation methods. Therefore we tried to detect the internal disturbances by using 49 bottom pressure gauges distributed at the sea floor originally for monitoring the hydraulic pressure fluctuations due to submarine earthquakes. In this study, we focused on the region south of Kii Peninsula, Japan, where several oceanic events frequently occur under influences of the Kuroshio and the Dense Ocean floor Network system for Earthquakes and Tsunamis (DONET) has been arranged widely by JAMSTEC. The pressure gauges of DONET can measure fine fluctuations of water pressure at the bottom with an accuracy of 0.01 db, hence in some cases it has a potential to detect signals attributed to disturbances generated in the ocean interior. The trial was conducted in autumn 2018, when the Kuroshio had taken a large meander path. Timeseries of the bottom pressure at 0.1 s intervals presented temporal variation identical within the range of 0.16 db to the barotropic fluctuation of the external tide estimated from an astronomical tide model. Cross-spectral analysis of the bottom pressure fluctuations revealed that oceanic disturbances with the period of one hour propagated northeastward from the front of the Kuroshio to the slope water region southeast of Kii P.

(GP-14980) E-poster

An income pooling system in a Japanese trawl fishery: The case of Muroran, Japan

Yutaro **Sakai**

The University of Tokyo, Tokyo, Japan. E-mail: a-sakai@g.ecc.u-tokyo.ac.jp

This paper examines the function of a unique fishery co-management system for a bottom trawl fishery in Muroran, Hokkaido, Japan. In Muroran, trawl fishers have been using an income pooling system since the 1980s, where vessels operate cooperatively and share the total revenue following a certain rule. In 1997, a total allowable catch (TAC) system was introduced to their main target species, Alaska pollock *Theragra chalcogramma*, which made the system effectively co-management between fishers and the government. As the TAC consumption rate increased over time, trawl fishers in Hokkaido decided to allocate the TAC to each region, including Muroran, in 2008. While each region uses a different management system, Muroran's income pooling system appears to be the most successful one. In this paper, I use both interview surveys and historical documents to describe the history of the trawl fishery in the Muroran area after the World War II, how their income pooling system was introduced, how successful it is, and why it continues to work until now. In particular, I argue that the geographical characteristics of Muroran shaped the current management of the trawl fishery. While income pooling systems are common in the Japanese coastal fisheries, they are rare for offshore fisheries even in Japan. As such, this work shed new lights on how to implement a successful bottom-up fishery management.

(GP-14991) E-poster

Harbor seals (*Phoca Vitulina*) discriminate 3D objects : Effects of brightness and shape

Monica **Ogawa**[1], Ayako Momoi[2], Toshihiko Kushihiki [2] and Yoko Mitani[1]

[1]   Hokkaido University, Hakodate, Japan. E-mail: monicasantapinacolada@gmail.com
[2]   Asamushi Aquarium, Aomori, Japan

Harbor seals (*Phoca vitulina*), which are the only pinniped that lives and breeds in Japan throughout the year, interact with salmon set net fisheries in Hokkaido. To mitigate fishery damages, it is important to understand how they recognize the fishing gears. Previous studies have revealed that seals are very sensitive to brightness difference and can discriminate in objects which have complex shape and brightness, but actual mechanism of how they discriminate in objects is unknown. To investigate that, we conducted experiment at the aquarium, using objects contain various shape and brightness features. In training, seals learned "dark gray circle object" to choose in a two-alternative forced choice task. In the test session, we showed variety of objects, which have either same shape or brightness with the object which they learned in training, and we compared choosing rate of each object. Results revealed that harbor seals may discriminate objects based on shape feature, rather than brightness. This is the first study that revealed visual discrimination process of harbor seals and the knowledge can contribute to mitigate fishery damages.

WORKSHOP 4

How does the Pacific Arctic gateway affect the marine system in the Central Arctic Ocean (CAO)?

(VW4- 15003) Invited-Recorded Talk

The Pacific Arctic Gateway: connecting the marine ecosystems of shelf/slope regions to the Central Arctic Ocean

Jacqueline M. **Grebmeier**

University of Maryland Center for Environmental Science, Solomons, Maryland, USA. E-mail: jgrebmei@umces.edu

The Pacific Arctic Gateway is experiencing reduced seasonal ice cover, warming seawater temperatures, and examples of regional ecosystem restructuring. Our understanding of the Pacific Arctic Gateway shelf/slope regions and Central Arctic Ocean (CAO) are limited, particularly carbon cycling, ecosystem alteration, and associated changes in physical drivers that influence biological and biogeochemical components. Key environmental drivers that influence ecosystem dynamics and response of the CAO and shelf-basin interactions include: decreases in sea ice extent and duration, seasonally warming seawater temperatures, changes in prey concentrations, and northward movement of some species, including commercial fish. The planned international Synoptic Arctic Survey (SAS) in the Pacific Arctic Gateway region (here defined as the Chukchi and Beaufort Seas outer shelf and slope, and the Chukchi Borderlands) and Canadian Basin (i.e., the Makarov and Canada basins) seeks to quantify the present state of the physical, biological, and biogeochemical components during the 2020-2022 period coincident with other pan-Arctic SAS programs. Key goals of the SAS are to establish the present state of these ecosystems, to document temporal changes where possible through comparison with historical data, and to quantify linkages between the adjacent shelves, slopes, and deep basins. In combination with ongoing national research programs and the ICES/PICES/PAME Working Group on the Integrated Ecosystem Assessment of the Central Arctic Ocean (WGICA) assessment, the next few years will provide important synthesis and field data to determine status and trends of the Arctic ecosystem for future forecasting capabilities.

(VW4-14990) Live Talk

The influence of Pacific water on the central Arctic Ocean ecosystem: some productivity considerations

Hein Rune **Skjoldal**

Institute of Marine Research, Bergen, Norway. E-mail: hein.rune.skjoldal@hi.no

The Arctic Ocean (AO) is part of the Arctic Mediterranean Sea (AMS) which represents a northern extension of the North Atlantic. The deep Fram Strait is part of the Atlantic gateway. The Pacific gateway in contrast is a roughly 1,000 km stretch of shallow water (around 50 m) connecting the AO with the Bering Sea basin. The inflow of Atlantic water (AW) and Pacific water (PW) through the two gateways are in about 5:1 ratio (5 Sv versus 1 Sv). The PW has lower salinity (by 1-3 units) and is lighter than the AW, and it spreads as a layer between upper polar water and a layer of intermediate AW. The PW is much richer in nutrients (by a factor of about 3 for nitrate and phosphate). The flow of PW links the Bering Strait and the Beaufort Gyre as a global hotspot and global 'coldspot' respectively, with two orders of magnitude difference in annual primary production (order 500 vs 5 g C m^{-2}). It seems a paradox that the low productive Beaufort Sea is the summer feeding ground for 20,000 bowhead whales and 40,000+ beluga whales. The copepod *Calanus hyperboreus* is the dominant zooplankton species in the AO and assumed to be a main prey for bowheads. Where does the production that supports this multiannual copepod take place and what are the spatial connections?

(VW4-14916) Live Talk

Mechanisms of persistent high primary production during the growing season in the Chukchi Sea

Zijia **Zheng**, Hao Wei, Xiaofan Luo and Wei Zhao

Tianjin University, Tianjin, China. E-mail: xiaofan.luo@tju.edu.cn

Persistent high primary production during the growing season in the Chukchi Sea (Arctic Ocean) plays a key role in maintaining an efficient biological carbon pump and diverse Arctic ecosystem. We used a three-dimensional ocean–sea ice–biogeochemical model to simulate monthly averaged net primary production from 1998 to 2015. The results show that the growing season in the Chukchi Sea lasts more than 150 days, with an annual net primary production of 31.2 Tg C y^{-1}. The mechanisms for maintaining high primary production differ in the southern and northern Chukchi Sea biological hotspots. Nutrient-rich Pacific Winter Water triggers phytoplankton blooms in both hotspots as light intensity increased in spring. After these initial blooms, Bering Summer Water and remnant Pacific Winter Water are the main contributors to nutrient levels and drive primary production during the growing season (May to September) in the southern and northern hotspots, respectively. Nitrate budget estimations in the euphotic zone reveal that after the spring blooms, persistent high primary production in the southern hotspot is mainly fueled by advecting Bering Summer Water through the Bering Strait. In the northern area, vertical mixing plays a critical role in upwelling nutrient-rich Pacific Winter Water from around the Hanna Shoal, where Pacific Winter Water is trapped for a long duration as a result of topography-influenced ocean circulation. Hence, high primary production exists in the northern Chukchi Sea during the summer and early autumn.

(VW4-14965) Recorded Talk

Sensitivity Study on Planetary Boundary Forcing to the Arctic Marine Ecosystems

Takafumi **Hirata**[1], Yoshio Masuda[2], Jorge García Molinos[1], Irene Alabia[1], Keiko Sato[1], Toru Hirawake[1,3], Eiji Watanabe[4], Maki Aita-Noguchi[5] and Sei-Ichi Saitoh[1]

[1]   Arctic Research Center, Hokkaido University, Sapporo, Japan. E-mail: tahi@arc.hokudai.ac.jp
[2]   Faculty of Environmental Earth Science, Hokkaido University, Hakodate, Japan
[3]   Faculty of Fisheries Sciences, Hokkaido University, Hakodate, Japan
[4]   Institute of Arctic Climate and Environment Research, Japan Agency for Marine-Earth Science and Technology, Yokosuka, Japan
[5]   Earth Surface System Research Center, Japan Agency for Marine-Earth Science and Technology, Yokosuka, Japan

Arctic marine environment has been changing all the time over the history of our planet, but its recent drastic changes are unique in that the recent changes include consequence of human activities such as the greenhouse gas emission as well as resource exploitation. As a result, there is an increasing concern regarding a direct or indirect degradation of the present marine ecosystems and their ecological services. Assessment of these environmental changes on marine ecosystem is therefore necessary, preferably in quantitative manner, for clarifying the degradation. In the PICES 2019 meeting, the Authors has presented a preliminary concept and practical example of the potential vulnerability index of the Arctic marine ecosystem designed for the assessment, using the Planetary Boundary concept. The index basically consists of three aspects: environmental forcing on the Arctic marine ecosystem, sensitivity of the Arctic marine ecosystem to the forcing and the resilience of the ecosystem itself. Here we show a result of a sensitivity study on the quantification of environmental forcing by using different indicators for the Planetary Boundary processes as well as using different datasets for the same indicators. Our work here is expected to provide a robustness of the marine ecosystem vulnerability index being developed.

(VW4-14938) Recorded Talk

Life cycles of the two dominant mesopelagic carnivorous copepods (*Paraeuchaeta glacialis* and *Heterorhabdus norvegicus*) in the Arctic Basin: Insights from SHEBA samples

Atsushi **Yamaguchi**[1], Carin J. Ashjian[2] and Robert G. Campbell[3]

[1]   Hokkaido University, Hakodate, Japan. E-mail: a-yama@fish.hokudai.ac.jp
[2]   Woods Hole Oceanographic Institute, Woods Hole, MA, USA
[3]   University of Rhode Island, Kingston, RI, USA

Most of the Central Arctic Ocean (CAO) lies over oceanic basins. In this region, mesozooplankton, especially copepods, are known to have a peak of species diversity at the mesopelagic zone (200-1000 m). In the CAO, the life cycles of the large suspension feeding planktonic copepods such as *Calanus* spp. and *Metridia longa* are fairly well known while little information is available for life cycles of the copepods characterized by the other feeding modes. In this study, we analyzed life cycles of two sympatric mesopelagic carnivorous copepods (*Paraeuchaeta glacialis* and *Heterorhabdus norvegicus*) based on a year-long time-series of vertical stratified net plankton samples collected at an ice-station drifting through the Canada Basin to the Mendeleev Plain (SHEBA project). In the SHEBA samples, population structures of two species showed clear seasonal successions of copepodite stages. Thus, for *P. glacialis*, the abundant season of each stage was observed at February-August (C1 and C2), May-September (C3), August-February (C4), and May-August (C6). For *H. norvegicus*, the abundant season of each stage was seen for August (C3), December-March (C4), January-July (C5 and C6). After combining these seasonal successions in population structure with the dry weight increment at each copepodite stage, it is revealed that the great mass increment of both species occurred during March-April. Since this period corresponded with the biomass peak of their prey (mesozooplankton), food availability is considered to be an important factor in determining the seasonality in life cycles of the mesopelagic carnivorous copepods.

(VW4-14952) Recorded Talk

Predicting changes on zooplankton community in the pacific sector of Arctic Ocean analyzed by generalized dissimilarity modeling

Kohei **Matsuno**[1,2] and Amane Fujiwara[3]

[1]   Faculty of Fisheries Sciences, Hokkaido University, Hakodate, Hokkaido, Japan. Email: k.matsuno@fish.hokudai.ac.jp
[2]   Arctic Research Centre, Hokkaido University, Sapporo, Hokkaido, Japan
[3]   Japan Agency for Marine-Earth Science and Technology, Yokosuka, Kanagawa, Japan

Many zooplankton studies have been conducted for understanding impact of the climate change in the Pacific sector of the Arctic Ocean. However, since ship-observation is usually limited by spatially and temporally, the investigated area was not fully covered to compare the broad sea-ice motion in the Arctic Ocean. Because of this problem, the impact of sea-ice reduction on zooplankton could not be revealed by only ship-observation. To overcome the limitation, we used generalized dissimilarity modeling (GDM) based on field data (including biological and hydrographical) and satellite data (e.g., sea-ice concentration, surface chl. *a*) during autumns from 2008 to 2017, and predicted the effect of sea-ice extent, temperature and chlorophyll *a* on zooplankton community. From the results of GDM, bottom depth, column integrated-mean temperature, column integrated-mean salinity, column integrated chl. *a*, surface chl. *a*, open water period, annual mean SST and annual mean surface chl. *a* were selected as significant-related parameters. Among the satellite-derived parameters, open water period had the strongest effect, which means the change of open water period induce greatly change on zooplankton similarity. From the predicted effect by the satellite-derived parameters, zooplankton in ice-edge region was affected by open water period, but one in the Bering Strait was changed by annual mean SST. This study suggest combination of ship-observation and modeling with satellite observation could resolve the dilemma of spatial-temporal limitation on the ship-observation, and will evaluate the impact of climate change on zooplankton community in the pacific sector of Arctic Ocean.

(VW4-14940) Recorded Talk

Marine biodiversity patterns under warming and sea ice-free Pacific Arctic

Irene D. **Alabia**[1], Jorge Garcia Molinos[1], Sei-Ichi Saitoh[1], Takafumi Hirata[1], Toru Hirawake[2] and Franz J. Mueter[3]

[1]   Arctic Research Center, Hokkaido University, Sapporo, Japan. E-mail: irenealabia@arc.hokudai.ac.jp
[2]   Faculty of Fisheries Sciences, Hokkaido University, Hakodate Japan
[3]   University of Alaska Fairbank, Juneau Alaska

Climate change is triggering a global reorganization of marine life. Biogeographical transition zones are redistribution hotspots that offer a unique opportunity to understand the mechanisms and consequences of climate-driven thermophilization processes in natural communities. In this context, we examined the impacts of climate change projections in the 21st century (2026-2100) on marine biodiversity in the Eastern Bering and Chukchi seas within the Pacific Arctic, a climate-sensitive boreal-to-Arctic transition zone. Overall, projected changes in species distributions, resulted in poleward increases in species richness and functional redundancy, along with pronounced reductions in phylogenetic distances by century's end (2076-2100). Future poleward shifts of boreal species in response to warming and sea ice changes are projected to alter the taxonomic and functional biogeography of present-day Arctic communities as larger, longer-lived and predatory taxa expand their leading distribution margins. Drawing from the existing evidence from other Arctic regions, these changes are anticipated to increase the future susceptibility and vulnerability of the Arctic ecosystems, as trophic connectance between biological components increases, thus decreasing the modularity of Arctic food webs. Our results demonstrate how integrating multiple diversity facets can provide key insights into the relationships between climate change, species composition and ecosystem functioning across marine biogeographic regions.

Key words: Biodiversity; species distributions; climate change; Biogeographic transition zones; Pacific Arctic region

(VW4-14910) E-poster

Occurrence and transport of persistent toxic substances in the North Pacific - Arctic region under climate change

Ruijing **Li**[1], Guangshui Na[1,2], Hui Gao[1] and Shuaichen Jin[1]

[1]   National Marine Environmental Monitoring Center, Dalian, China. E-mail: gsna@nmemc.org.cn.
[2]   Hainan Tropical Ocean University, Key Laboratory of Utilization and Conservation for Tropical Marine Bioresources, Ministry of Education, China

The increase of temperature and the melting of sea ice caused by climate change will not only change the existing state of pollutants in the Arctic environment, but also change the long-distance transport behavior of pollutants from low latitude areas into the Arctic. This study focused on the North Pacific Arctic region to research on the occurrence, long-distance transport behavior of polycyclic aromatic hydrocarbons (PAHs) and organic phosphates (OPEs) in the atmosphere and water of North Pacific Arctic region, and to explore the impact of climate change on these environmental behaviors. The results show that, affected by climate change, the Kongsfjorden water body, which is composed of glacial melt water, West Spitsbergen Current and the Arctic waters, is stratified. The spatial distribution of PAHs in the water body is closely related to the distribution of suspended particles caused by glacial melt water. In addition, it is found that the Bering Strait and the Arctic Ocean may be the gathering places of OPEs in the atmosphere of Asian continent. The correlation analysis shows that temperature is one of the driving factors for the long-distance transmission of OPEs. Therefore, the Pacific Arctic gateway is an important area to monitor the entry of pollutants from low latitude areas into the Arctic. It is recommended to carry out long-term monitoring of persistent toxic substances in these regions.

(VW4-15006) E-poster

Dynamical Importance Triangle: a new model to explain the multi-scale variation of groundfish in Eastern Bering Sea

Peng **Lian**[1], Zelin Chen[2], Jiayue Gu[3], Suwen Ye[4], Xinyu Li[5], Xiaoyue Cui[6], Jiaqian Gao[6] and Meiqi Zhang[7]

[1]   Institute of Oceanography, Chinese Academy of Sciences, Qingdao, China. E-mail: fisheries@foxmail.com
[2]   University of Tasmania, Hobart, Australia
[3]   Monash University, Melbourne, Australia
[4]   College of Marine Sciences, Shanghai Ocean University, Shanghai, China
[5]   College of Physics, Qingdao University, Qingdao, China
[6]   Ocean University of China, Qingdao, China
[7]   The First Institute of Oceanography, Ministry of Natural Resources, Qingdao, China

As we all know, there are many kinds of signals in climate change affect the marine ecosystem. So a trade-off in different drivers is important in fisheries ecosystem. Eastern Bering Sea Shelf, the habitat of a variety of economic fish, is an important area influenced by the arctic climate change. In order to explain the extent of interaction of different factors. A comprehensive fisheries-environment database of Eastern Bering Sea was established. Furthermore, based on multiple regressions and differential equations, a dynamic importance triangle (DIT) is given though the dietary factors, ecological resilience and thermal factors. This model is proposed by adaptive multivariate nonlinear model, based on the 1982-2018 Groundfish Bottom Trawl Survey Data. We also use ocean hydrodynamic modelling data and multi-scale climate time series data to interpret the oceanic and climatic variations. We analyzed the climatic factors with many popular methods in order to compare with DIT model. With the study of the fishery resources of the Bering Sea, we found that the mutations of the importance dynamic index occurred in the three periods, 97/98, 03/04 and 15/16. A trade-off of important factors responded to different factors playing a leading role, while the high frequency of such unstable signals has increased significantly in recent years. DIT model give us a new vision of understanding the long-term ecosystem dynamics.

WORKSHOP 6
Research priorities for understanding the population dynamics of small pelagic fish in the North Pacific

(VW4-14896) Live Talk

Towards a plankton-based predictor of tuna recruitment

Phoebe A. **Woodworth-Jefcoats** and Johanna L. K. Wren

Pacific Islands Fisheries Science Center, NOAA Fisheries, Honolulu, USA. E-mail: phoebe.woodworth-jefcoats@noaa.gov

Bigeye tuna are of global economic importance and are the primary target species of Hawaii's most valuable commercial fishery. Additionally, recent stock assessments have intermittently identified bigeye tuna as experiencing overfishing in the Pacific Ocean, indicating a potential strain on this fishery's ecological sustainability. Yet, modeling stock dynamics and estimating future catch rates remains challenging. These challenges make it difficult to set appropriate annual catch limits. Therefore, we paired ecological theory with bigeye tuna life history parameters to create a skillful forecast of bigeye tuna catch rates. We show that the median size of phytoplankton in the environment of larval and juvenile bigeye tuna is a robust predictor of bigeye tuna catch rates in Hawaii's longline fishery four years hence – when those larval fish have grown enough to be captured by the fishery. We hypothesize that larger phytoplankton are indicative of larger zooplankton, which are higher quality prey for larval and juvenile bigeye tuna, resulting in greater numbers of fish surviving to reach adulthood and recruit to the fishery. Our forecast is a fishery-independent tool with the potential to improve stock assessments, aid dynamic fisheries management, and allow Hawaii's commercial longline fishing industry to better plan for the future.

(VW6-14904) Live Talk

Trans-Pacific "synchrony" in multidecadal change of habitat patterns for *Ommastrephes bartramii* and *Dosidicus gigas*

Wei **Yu**, Jian Wen, Xinjun Chen, Yi Gong and Bilin Liu

Shanghai Ocean University, Shanghai, China. E-mail: wyu@shou.edu.cn

Trans-Pacific "synchrony" in multidecadal change of habitat patterns of *Ommastrephes bartramii* in the Northwest Pacific Ocean and *Dosidicus gigas* in the Southeast Pacific Ocean during 1950-2015 was examined using habitat suitability index (HSI) modeling approach. The HSI model involved with sea surface temperature (SST) and sea surface height anomaly (SSHA) which were the critical environmental drivers for *O. bartramii* and *D. gigas*. Significant seesaw-like patterns of environmental variability and habitat changes, consistent with the regime shift of warm and cool PDO, were observed for the two squid species. In a negative (cool) PDO phase, both SST anomaly and SSHA increased on the fishing ground of *O. bartramii*, however, the suitable SST and SSHA decreased, as a result, the areas of suitable habitat of *O. bartramii* remarkably contracted. On the contrary, on the fishing ground of *D. gigas*, cooling SST and decreasing SSHA led to the formation of more suitable SST and SSHA, resulting in expansive areas of suitable habitat for *D. gigas*. Moreover, due to the most favorable SST for *O. bartramii* and *D. gigas* moved northward in the cool PDO regime, the suitable habitat for both squid species shifted into the northern regions. Correspondingly, when the climate changed into a positive (warm) PDO, the situation was opposite as that in the cold PDO phase. Our findings suggested that "synchrony" in interannual-to-decadal variability of habitat patterns of *O. bartramii* and *D. gigas* can be detected from the climate regime shift in the Pacific Ocean.

(VW6-14934) Live Talk

Some data on biology and distribution of larval capelin (*Mallotus villosus catervarius*) on the west Kamchatka shelf

Tatiana **Naumova**

Kamchatka branch of the Russian Federal Research Institute of Fisheries and Oceanograph (VNIRO) («KamchatNIRO»), Petropavlovsk–Kamchatsky, Russia. E-mail: Naumova.t.n@kamniro.ru

On the western Kamchatka shelf, capelin larvae was first encountered in plankton net in June; the frequency of its occurrence in catches was 3.6%. The highest larvae catches was – 66 individuals (ind.) m^{-2}, mean was – 6 ind. m^{-2}. The standard length (SL) of the capelin larvae ranging from 4.4 to 11.7 mm, mean – 6.3 mm. The highest catches (86 ind. m^{-2}) and the frequency of occurrence (14.5 %) were observed in July. SL of the larvae ranged from 4.1 to 28.2 mm, mean SL – 9.5 mm. In August, mean catch was 13 ind. m^{-2} and the frequency of occurrence was 5.2%. SL ranged from 4.6 to 36.0 mm, mean SL – 12.5 mm. Capelin larvae, remains near the spawning areas, nearshore over the shallow depths after hatching. SL of the larvae increases from June to September, but its SL also fluctuated significantly within one month.

The spatial distribution of capelin larvae differs from year to year in accordance with the main currents pattern of the western Kamchatka shelf. After a "cold" winter, when the southward current expressed on the shelf of western Kamchatka, the larvae stays in a narrow coastal zone, over the shallow depths near spawning areas. After a "warm" winter, when the northerly current prevails on the shelf, the largest number of the capelin larvae developed in a system of anticyclonic and cyclonic eddies, and some larvae, as they grow, were captured and transported northward and to more seaward areas.

(VW6-14963) Live Talk

Evidence of time-varying processes in Pacific sardine stock assessments

Peter **Kuriyama**, Paul Crone, Kevin Hill and Juan Zwolinski

NOAA Southwest Fisheries Science Center, La Jolla, CA, USA. E-mail: peter.kuriyama@noaa.gov

The Pacific sardine (*Sardinops sagax caerulea*) is a commercially and ecologically important fish species, yet drivers of the population's dynamics remain largely unknown. Studies of sediment cores indicate that populations have fluctuated in the absence of large-scale commercial fishing. Evidence for environmental hypotheses have arisen, then found to have little support upon reexamination. Some examples include asynchrony between sardine and anchovy populations related to climatic decadal oscillations and correlation between sea surface temperatures and recruitment.

Here, we utilize nearly 40 years of data in a stock assessment framework to estimate time-varying processes in Pacific sardine. We focus on estimating time-varying somatic growth (estimated to be cohort-specific or year-specific), natural mortality, and selectivity (as a proxy for movement) to evaluate the relative improvements in stock assessment model fits to the data. Preliminary results indicate that inclusion of time-varying cohort growth results in the best model fits, and a possible inference is that the conditions Pacific sardine experience early in their lives influence the dynamics of the population. The benefit of this approach is that we can utilize a comprehensive dataset and assessment framework, typically used to inform Pacific sardine management, to test ecological hypotheses. Future work will focus on relating environmental variables to the time-varying estimates and evaluating the potential benefits of including environmental variables directly in the assessment. Identification of environmental drives may improve assessment forecast and better inform management of Pacific sardine.

(VW6-14982) Recorded Talk

Particle tracking reveals Pelagic Red Crabs as indicators of anomalous conditions in the California Current

Elizabeth **Saraf**[1,2], Stephanie Brodie[2,3], Megan Cimino[2,3], Isaac Schroeder[2,3], Michael Jacox[2,3], Steven Bograd[2,3] and Elliott Hazen[2,3]

[1]   The University of Rhode Island, Kingston, RI, USA. E-mail: elizabeth_saraf@my.uri.edu
[2]   Institute of Marine Sciences, University of California Santa Cruz, Santa Cruz, CA, USA
[3]   Southwest Fisheries Science Center, National Oceanic and Atmospheric Administration, Monterey, CA, USA

The Pelagic Red Crab (PRC; *Pleuroncodes Planipes*), has intermittently exhibited large range expansions north of its central distribution off Baja California, Mexico. These PRC range expansions are potentially an indicator species for anomalous conditions in the California Current. Mass strandings of this species have been reported on the beaches of Central and Southern California and are thought to be driven by anomalously warm water and northward advection with sequential impacts on ecosystem trophodynamics. The California Undercurrent and seasonal coastal currents, which transport water northward off the west coast of the North America, are presumed responsible for the expansion of PRC distribution; we refer to this as the poleward advection hypothesis. Here we used daily sea surface velocity data for 1993 to 2017 and particle tracking simulations to estimate the potential advection of PRCs from Baja California to Monterey Bay. Backward and forward particle tracking simulations indicate that northward transport of PRCs were influenced by seasonal undercurrents rather than surface currents, and were often associated with El Niño. The particle tracking methodology used was capable of identifying the mechanisms driving the northward range expansions of PRCs, highlighting potential application to other coastal pelagic species exhibiting climate-driven range expansions.Quantifying the drivers of PRC transport and strandings will help us better understand the impact of climate-driven variability and change in the California Current Ecosystem.

(VW6-14996) Live Talk

Diel vertical migrant species in structure of epipelagic nekton of Pacific waters off the Kuril Islands in autumn of 2019

Pavel **Emelin**

Russian Federal Research Institute of Fisheries and Oceanography (VNIRO), Moscow, Russia. Email: emelinpavel@gmail.com

In October 2019, the RV «Vladimir Safonov» conducted a fish scouting for Japanese sardine and Chub mackerel aggregations with a trawl survey in the Pacific waters off the Kuril Islands. The estimated abundance and biomass of the nekton in the survey area ($35\ 892.53\ Km^2$) amounted to 10.71 billion individuals and 40.85 thousand tons. The proportion of fish and cephalopods as a component of nekton biomass was approximately equal (42.3 and 44.3%, respectively). A significant part of nekton was diel vertical migrants (DVM) which are small pelagic fishes and cephalopods ascending to the upper epipelagic zone from the underneath biotopes at night. These species were classified by biotopes as bathypelagic, mesopelagic, epimesopelagic, and upper bathyal. The cumulative percentage of DVM species was 63.32% of the biomass and 98.54% of the nekton abundance. Epimesopelagic species were the most abundant among the DVM. Contribution of this group was 46.63% of the biomass and 85.23% of the nekton abundance. Epimesopelagic species were represented by cephalopods only, and the major part was the firefly squid (*Watasenia scintillans*). Almost half of the 32 DVM species were mesopelagic. Mesopelagic species were represented by 13 fish species from 7 families and 2 squid species from the family Gonatidae. Contribution of mesopelagic species was 12.97% of the abundance and 16.59% of the nekton biomass. Lanternfishes *Diaphus theta*, *Stenobrachius leucopsarus*, *Diaphus gigas* and boreopacific gonate squid (*Gonatopsis borealis*) formed the basis of the abundance and biomass of the mesopelagic species.

(VW6-14950) Recorded Talk

Influence of environmental and population factors on herring spawn timing in Prince William Sound

Beatriz S. **Dias**[1], David W. McGowan[2] and Trevor A. Branch[1]

[1]   School of Aquatic and Fishery Sciences, University of Washington, Seattle, WA, USA. E-Mail: biadias@uw.edu
[2]   Alaska Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration (NOAA), Seattle, WA, USA

For temperate forage fish populations, seasonal patterns have a profound effect on the metabolic rates, spawning phenology and location, and consequently condition of the young-of-the-year fish. Once a prominent commercial fishery in Prince William Sound, the Pacific herring (*Clupea pallasii*) population collapsed following the 1989 Exxon Valdez oil spill. After years of no recovery, research has focused on factors impairing overwinter survival of newly hatched individuals. As extreme climate events are more persistent, shifts in spawn timing may impact larval survival, by altering the timing of larval emergence relative to a host of factors including the spring bloom, subsequent peaks in secondary productivity, larval transport, retention to nursery areas, and vulnerability to predators. Therefore, examining drivers of the spawn timing is crucial to understand the interannual variability and how it affects the overwinter condition of herring in their first year of life. To predict which environmental processes and population demographics influence spawn timing, we examined the influence of 15 covariates from 1980-2019 using Generalized Additive Mixed-effect Models (GAMMs). Our goal is to identify how interannual variability in herring spawn timing is influenced by environmental and population-level factors in Prince William Sound, to improve the current stock assessment model.

(VW6-14913) E-poster

Environmental impact assessment of spawning grounds in the Western Guangdong Waters, South China Sea, using RS/GIS

Jing **Yu**

Guangdong Provincial Key Laboratory of Fishery Ecology and Environment, South China Sea Fisheries Research Institute, Chinese Academy of Fishery Sciences, Guangzhou, PR China. E-mail: yujing@scsfri.ac.cn

Spawning grounds occupy an important position in the supplementary population of fishery resources, especially in the Western Guangdong Waters (WGW) in the northern South China Sea (SCS), where fishery resources is depleting. This study investigated environmental effects on the spatiotemporal variability of spawning grounds in the WGW, based on generalized additive models (GAMs) and the central of spawning ground gravity (CoSGG), using satellite and in situ observations. The results showed that 57.2% of the total variation in fish-egg density in the WGW was explained. Based on the stepwise GAMs, the most important factor was Sea Surface Salinity (SSS), with a contribution of 32.1%, followed by Sea Surface Temperature (SST), water Depth, Month and Chlorophyll a concentration (Chl-a), with contributions of 10.7%, 8.8%, 2.6%, and 2.6%, respectively. Offshore distance had a slight influence on the model, explaining approximately 0.4% of the variation in fish-egg density. In summary, fish eggs in WGW were mainly distributed in the area with SSS of 32.0-34.0 PSU, SST of 24-27°C, and Depth of 0-18 m. The CoSGG shifted eastwards by 0.38°N and northwards by 0.26°E from April to June. The distribution of spawning grounds in the WGW was affected by the Western Guangdong Coastal Current (WGCC), cyclonic circulation, the SCS Warm Current (SCSWC), and changes in habitat environment (such as SST). Fishes in the WGW tended to spawned in areas with high seabed slope and steep terrain (near the Qiongzhou Strait).

(VW6-14957) E-poster

Accounting for price responses in economic evaluation of climate impacts for a fishery

Chang K. Seung[1], Juhyun **Yi**[2] and Dohoon Kim[2]

[1]   Alaska Fisheries Science Center, Seattle, WA, USA.
[2]   Pukyong National University, Busan, Rep. of Korea. E-mail: delaware310@pknu.ac.kr

The present study evaluated the economic impacts of fluctuations in anchovy (*Engraulis spp*.) catch in Gyeong-Nam (GN) province in South Korea, arising due to warming seawater, accounting for the effects of the responses of the anchovy price. It combines an inter-regional input-output (IRIO) model of two regions (i.e., GN province and all other provinces combined) with several regression models to make projections of the quantities and prices of raw and processed anchovies based on two greenhouse gas (GHG) concentration scenarios (i.e., representative concentration pathway (RCP) 4.5 and 8.5). The results indicate that price responses to the harvest variations are substantial, and offset to an enormous extent the economic impacts of the harvest changes. The offsetting effects of price responses, averaged across four different periods (years) and the two RCP scenarios, are noticeable with a value of 19.1%. None of the previous IO-based economic impact analyses of fisheries accounted for the price effects induced by a quantity shock. This study fills this critical void by considering such effects.

(VW6-14959) E-poster

Polar cod *(Boreogadus saida)* stock in the Bering Sea

Olga **Maznikova**, Aleksey Somov and Aleksey Baitaliuk

Russian Federal Research Institute of Fisheries and Oceanography, Russia. E-mail: maznikovao@vniro.ru

The Bering Sea is the marginal part of the polar cod range. Despite the fact that polar cod is regularly observed in trawl catches during the complex surveys in the western part of Bering Sea, there is few data of its stock in the Russian scientific literature. According to data for 1972-2017, it has been found that polar cod formed concentrations of different density in the northwestern part of Bering Sea, reaching in some years to Olyutorsky and Karaginsky bays. Maximum concentrations of polar cod are noted in the northwestern part of Anadyr Bay, in Norton Sound, off St. Lawrence Island and Nunivak Island.The results of trawl surveys also showed differences in the spatial distribution of polar cod depending on the "warm" and "cold" years. Despite the fact that the densest aggregations were confined to areas with a low bottom temperature, the observed climate warming is accompanied by a retreat of the polar front and a reduction in the area of ice fields, which leads to a shift in the distribution boundaries of the polar cod and reduction of its abundance and changes in ecosystem. Thus, in the next 5 years, a further decrease in the abundance and biomass of polar cod can be assumed and with further reduction in the area of its range.

(VW6-15001) E-poster

Variability and change of the oceanographic conditions in the feeding migrations and reproduction areas of sardine, mackerels and saury in the Northwest Pacific

Elena **Ustinova,** Viktor Filatov and Yury Sorokin

Pacific branch of Russian Federal Research Institute of Fisheries and Oceanography (TINRO), Vladivostok, Russia. E-mail: elena.ustinova@tinro-center.ru

We analyzed multi-scale variability and changes of the oceanographic conditions in the feeding and reproduction areas of sardine (*Sardinops melanostictus*), mackerels (*Scomber japonicus and Scomber australasicus*) and saury (*Cololabis saira*) using the data collected by TINRO R/Vs, remote sensing data and NEAR-GOOS gridded water temperature. Last 7 years, significant changes in the spatial distribution of these species have occurred in the Northwest Pacific. Since 2014, mackerel and sardine have been observed en masse in the waters available for Russian fishery, and since 2015 the main concentrations of saury have shifted to the east and north. In 2019, saury fishing was carried out east of 170°E. This is the most eastern position of the fishery areas for all years. Changes in the water dynamics contributed to this redistribution: more northerly propagation of subtropical origin waters and weakening of the Oyashio current. The penetration of sardine and mackerels into the northern regions is associated with increase in their abundance, which is formed in the reproduction zone near the Honshu, Shikoku and Kyushu islands. Common feature of the previous and current periods of the sardine high abundance is the predominance of the PDO positive phase when relatively cold conditions are observed in the reproduction zone. However, in the series of relatively cold years were the exceptions. Large Kuroshio meander off south Honshu Island is observed in recent years similar to the previous period of high sardine abundance. The first low-abundance sardine generation was formed after the meander sharp decrease in the 1988 spawning season.

WORKSHOP 9
Building a PICES early career professional network

(VW9-14966) E-poster

Economic feasibility of developing the low-fishmeal feed for Olive Flounder

Juhyun **Yi** and Dohoon Kim

Pukyong National University, Busan, Republic of Korea. E-mail: delaware310@pknu.ac.kr

Oliver flounder (*Paralichthys olivaceus*) aquaculture plays an important role in Korean aquaculture industry. However, the business condition of the olive flounder aquaculture in Korea is getting worse due to the change in market circumstances such as decreasing market price and increasing farming costs. To overcome this situation, the National Institute of Fisheries Science (NIFS) of Korea has been undertaking the projects to develop the low-fishmeal feed for olive flounder to lower the feeding cost. In addition to developing the low-fishmeal feed technically, this study aimed to assess the economic feasibility of the low-fishmeal feed developed by NIFS. In the analysis, NPV, IRR, and BCR were estimated with the economic data from field surveys on 59 olive flounder farms and the experimental data from the NIFS projects. The results showed that all experimental feeds except for FM35 which used fishmeal for the 35% of feed weight would be economically feasible even though they were less profitable compared to the control feed. Among the experimental feeds, FM45 which used fishmeal for the 45% of feed weight was shown to be most profitable (IRR 8.4%). According to the results of sensitivity analyses, the low-fishmeal feed was not profitable if the market price of olive flounder would decrease by 10% or the growth rate of olive flounder would drop by 20%. In addition, the low-fishmeal feed could not be economically feasible when the survival rate of olive flounder reduced under 40% or the feed price would increase by 40%.

(VW9-14971) E-poster

Marine Fishery Policy Adjustment in China since 2011

Meng **Su**, Lingling Wang and Jiahao Xiang

School of Economics, Ocean University of China, No. 238 Songling Rd., Shandong, 266100, China. E-mail: sumengouc@qq.com

Based on an analysis of China's marine fishery management policies since the promulgation of the Fisheries Law in 1986, this paper finds that since 2011, the focus of China's marine fishery resource management has gradually changed from input control to output control. The past decade was a key period in the adjustment of marine fishery policies. This paper reviews the adjustments to China's marine fishery policy since 2011, analyzes the characteristics of these adjustments, and assesses the future challenges confronting China's marine fishery policymaking. Ultimately, China's marine fishery policy aims to realize the sustainable development of the marine fishery industry under the dual goals of focusing on the livelihood of fishermen and repairing offshore fishery resources.