3rd PICES/ICES
Early Career Scientist Conference

Climate, Oceans and Society: Challenges and Opportunities

30 May - 2 June, 2017, Busan, Korea

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Symposium Organizers

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Notes for Guidance

Location

The entire conference will be held at the Commodore Hotel located at 151, Junggu-ro, Jung-gu, Busan, 610-110, Korea (http://www.commodore.co.kr/eng/html/main/index.php).

Registration

The registration desk will be set in Commodore Hotel
The desk will be open from 16:00–18:00 on May 29, from 8:00–18:00 on May 30.

Presentations

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

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

Posters

Posters will be on display in the Grand Ballroom during the entire Conference.

Social activities

Banquet Dinners

May 30 (18:30-21:00)
Commodore Hotel

May 31 (18:30-21:00)
Commodore Hotel

Offsite Excursion

June 1 (14:30)

Off Site Conference Banquet

June 1 (19:00)

Day 0 (Monday, 29 May 2017)	
16:00 18:00	**Conference Welcome Desk Open** (sign in; pick up Conference Program and Name tag)
Day 1 (Tuesday, 30 May 2017)	
7:30	**Breakfast** Commodore Hotel Dining Hall
8:00	**Conference Welcome Desk Open**
9:00	**Plenary Welcome (Grand Ballroom)** Chul Park (PICES), Wojciech Wawrzynski (ICES), Yang su Kim (Deputy Minister, MOF), Young Je Park (Vice president, KIOST), Antje Gimpel (SSC: Icebreaker)

S1-A1 (Grand Ballroom) ***Climate change and the effects on the ocean*** **Conveners:** Maija Viska/Youngji Joh		**S2-B (Heerak Hall)** ***Ecosystem-Based Management – Get the big picture*** **Conveners:** Antje Gimpel/Henrike Rambo	
9:55	*Introduction by Conveners*	9:55	*Introduction by Conveners*
10:00	**Ivan Sudakov** Critical transitions in the changing Arctic system	10:00	**Leigh Michael Howarth** Top-down or bottom-up? Investigating the effects of fishing pressure and primary productivity on benthic size spectra
10:20	**Lev Naumov** Variability of sea ice concentration and sea ice forms in the Kara sea in modern climate	10:20	**Madeline S. Cashion** The who, what, and where of global shark catch: the Mediterranean and Black Seas
10:40	***Coffee Break***	10:40	***Coffee Break***
11:00	**Youngji Joh** Observed and predicted changes in ocean temperatures winter extremes in the Northeast Pacific	11:00	**Zhongxin Wu** Understanding the effects of large scale stock enhancement using quantitative and qualitative modelling approaches
11:20	**Nadezhda Sokolova** Combination of paleoenvironmental reconstructions and satellite derived data modeling for understanding modern climate change	11:20	**James J. Waggitt** Quantifying top-predators' use of hydrodynamic features in coastal regions; applied and ecological consequences
11:40	**Roksana Jahan (CANCELLED)** Effect of climate change and nutrient reduction on phytoplankton in Tolo Harbour	11:40	**Andrew F. Johnson** Fisheries ecology, economics and social wellbeing: Balancing the approach

12:00	**Laura J. Falkenberg** Projecting biological impacts of ocean acidification: Approaches to link physico-chemical changes with organismal response	12:00	**Ou Ling** Offshore wind management in China - Based on ecosystem approach
12:20	**S1-A1 Ends** ***Lunch*** Commodore Hotel Dining Hall	12:20	**S2-B Ends** ***Lunch*** Commodore Hotel Dining Hall

S1-A2 (Grand Ballroom) ***Climate change and the effects on the ocean*** **Conveners:** Haruka Takagi/Lingbo Li		**S2-A (Heerak Hall)** ***Introduction of anthropogenic substances to the ocean and their impacts*** **Conveners:** Tae-Wook Kim/Maximilian Schupp	
13:45	*Introduction by Conveners*	13:45	*Introduction by Conveners*
13:50	**Buntora Pasaribu** The impact of environmental stress on physiology of *Symbiodinium* sp.	13:50	**Tae-Wook Kim** Atmospheric deposition of reactive inorganic nitrogen in Uljin, South Korea
14:10	**Ateeq Ur Rehman** Singlet oxygen dependent photo-inactivation mechanism of Photosystem II in cultured *Symbiodinium* cells and its involvement in coral bleaching	14:10	**Muthukumar Chandrasekaran** Anthropogenic loads of Urea-N along the Ennore Creek, South India and its implications on the adjacent coastal waters
14:30	**Joy N. Smith** Ocean acidification effects on zooplankton communities living in coral reef ecosystems	14:30	**Mangalaa Kameswari Rajasekaran** Impact of land use and seasonal climate on biogeochemical cycle of silicon (macronutrient) in the Indian estuaries
14:50	**Lingbo Li** The distributional responses of groundfish to climate variability along the Northeast Pacific coastal shelf	14:40	**Jelena Mandić** Levels and origin of polycyclic aromatic compounds in Adriatic Sea
15:10	***Coffee Break***	15:10	***Coffee Break***
15:30	**Martina H. Stiasny** Climate change effects on Atlantic Cod recruitment and fisheries	15:30	**Edem Kyere-Yeboah Mahu** The bulk Fluorescein Diacetate Assay (FDA) as a technique for evaluating biotic impacts of crude oil to coastal sediments

15:50	**Patricia Puerta** Non-stationary responses of salmon populations to temperature in the Gulf of Alaska	15:50	**Natalija Suhareva** Differences in variations of heavy metal concentrations in muscle tissues of representative fish species of the Baltic Sea and the Gulf of Riga
16:10	**Eric Hertz** The effects of a shifting ocean environment on consumption and growth rates of juvenile Pacific Salmon	16:10	**Mirjam van der Mheen** The influence of material properties on the transport processes of buoyant marine plastic debris
16:30	**Nerea Lezama-Ochoa** Present and future potential habitat distribution of *Carcharhinus falciformis* and *Canthidermis maculata* by-catch species in the tropical tuna purse-seine fishery under climate change	16:30	**Giuseppe Suaria** Microplastics occurrence and characteristics in Mediterranean surface waters
16:50	**S1-A2 Ends**	16:50	**John S. Woods** Accounting for invasive species impacts within Life Cycle Impact Assessment
		17:10	**S2-A Ends**
17:30	**Pre-dinner Social** POSTER SESSION #1		
18:30	Plenary Keynote Speakers (ICES) **Alejandra Bize and Simon Cooper** Marine science and social media		
19:15	**Banquet Dinner** Commodore Hotel		
20:30	**Conference Day 1 Ends**		

Day 2 (Wednesday, 31 May 2017)			
7:30	**Breakfast** Commodore Hotel Dining Hall		
8:40	Plenary Keynote (PICES) **Suam Kim (Korea)** Fish and fisheries in a changing environment		
S3-B (Grand Ballroom) ***Marine population dynamics and community ecology*** **Conveners**: Daniel van Denderen/Minho Kang		**S2-C (Heerak Hall)** ***Evaluation of best management practices*** **Conveners:** Antje Gimpel/Andrew Johnson	
9:25	*Introduction by Conveners*	9:25	*Introduction by Conveners*
9:30	**Mei Sato** Seasonal shift in hot spots associated with an upwelling front in the California Current System: GLOBEC revisited	9:30	**Ferrario Filippo** The importance of seascape and ecological factors for an effective use of marine artificial structures as habitat for canopy-forming seaweeds
9:50	**Astra Labuce** Effect of variability in environmental conditions on Calanoid Copepod (Crustacea) egg bank and recruitment in the Gulf of Riga, Baltic Sea. Preliminary results	9:50	**C. Gabriela Mayorga Adame** The ANChor project: Appraisal of Network Connectivity between North Sea subsea oil and gas platforms
10:10	**Minho Kang** Multispecies biomass dynamics models with species interactions across multiple domains	10:10	**Nadeem Nazurally** Assessing coral recruitments and biodiversity in and around permeable submerged breakwaters (PSBs) in view for future considerations of active managements in Mauritius
10:30	***Coffee Break***	10:30	***Coffee Break***
10:50	**Marco Torri** Ecological effects of shallow water dynamics on early life stage of *Sardinella aurita* (Pisces, Clupeidae): Application of a Lagrangian transport model in the central Mediterranean Sea	10:50	**Kristin M. Privitera-Johnson** Estimating among-assessment variation based on estimates of overfishing limits
11:10	**Jessica B Jones** Using statolith elemental signatures to resolve movement and connectivity within a loliginid squid population	11:10	**Henrike Rambo** Using spatial Bayesian Modelling to assess the effects of fishing restrictions on demersal fish biodiversity in a marine spatial management context

11:30	**Romain Frelat** Tensor Decomposition reveals spatio-temporal dynamics of fish communities in the Baltic Sea	11:30	**Charlotte Klinting** Reconciling science with stakeholder inclusion: A Q study of the ICES scientific advisory process
11:50	**Alessandro Orio** Historical spatiotemporal dynamics of Baltic cod and flounder as analysed using standardised fishery-independent data	11:50	**Abdulwakil O. Saba** Perceptions on the Impacts of Climate Change on Fishing Communities along Lagos Coast, Nigeria
12:10	**Christine C. Stawitz** How do changing somatic growth rates affect estimation of management quantities in fisheries stock assessments, and can such growth changes be detected?	12:10	**Maximilian Felix Schupp** Climate change and biodiversity: How stakeholder perceptions can shape local adaptation strategies
12:30	***Lunch*** Commodore Hotel Dining Hall	12:30	***Lunch*** Commodore Hotel Dining Hall
13:40	**Marisa Norma Chantal Litz** Energy dynamics and growth of juvenile Chinook salmon reveal the importance of piscivory during early marine residence	13:40	**Antje Gimpel** Tools and methods to support and Ecosystem Approach to Aquaculture (EAA) – A gap analysis
14:00	**Josie South** The functional response of the blenniid *Lipophrys pholis*: effects of prey supply and temperature	14:00	**Nengye Liu** Reforming China's Marine Environmental Protection Law through enhancing the science-law interface and understanding interactions between economic, social and environmental activities
		14:20	**S2-C Ends**

		S1-C, Day 1 (Heerak Hall) ***Coastal dynamics: Changes in sea level, geomorphology and ecosystems*** **Conveners:** Maija Viska/Moritz Wandres	
14:20	**Nataliia Kulatska** What's on cod's menu?	14:20	*Introduction by Convenors*
14:40	**Camilla Sguotti** The failed recovery of Atlantic cod stocks	14:40	**Faisal Amri** A coupled model simulaton of thermal dispersion using cellular automata and numerical hydrodynamic model
15:00	**Daniel van Denderen** Global patterns in the productivity of marine fish along parallel pathways of energy	15:00	**Moritz Wandres** How will sea level rise and changing offshore wave conditions affect the future nearshore wave climate?
15:20	***Coffee Break***	15:20	***Coffee Break***
15:40	**Peng Sun** Fisheries-induced evolution effects on hairtail (*Trichiurus lepturus*) in the East China Sea and its management implications	15:40	**Isa O. Elegbede** GIS analysis of sea level rise; impact on fish resources and sustainable solutions
16:00	**Jin Gao (changed to talk)** Predicting population dynamics via spatial time delay embedding	16:00	**Maija Viska** Long-term variations of simulated sediment flux and deposition of marine litter along the south-eastern Baltic Sea coast as possible indicator of climate change
16:20	**Andrea Bryndum-Buchholz** Climate change impacts on global fish abundance – A multi-model analysis on an ocean basin scale	16:20	**S1-C, Day 1 Ends**
16:40	**S3-B Ends**		
17:00	**Pre-dinner Social** POSTER SESSION #2		
18:30	**Banquet Dinner** Commodore Hotel		
20:30	**Conference Day 2 Ends**		

Day 3 (Thursday, 1 June 2017)

7:30	**Breakfast** Commodore Hotel Dining Hall

S3-C (Grand Ballroom) ***Marine ecosystems and biogeochemical cycles*** **Conveners:** Daniel van Denderen/Tim Dencker		**S1-B (Heerak Hall)** ***Cross-scale interactions and trends of climate change*** **Conveners:** Haruka Takagi/Jen Lewis	
8:35	*Introduction by Conveners*	8:35	*Introduction by Conveners*
8:40	**Espinoza-Morriberon Dante** Biogeochemical impacts of ENSO in the Peruvian Coastal Upwelling System	8:40	**Anastasia Zvereva** Low-frequency wave motions in the Japan/East Sea
9:00	**Helena Cachanhuk Soares** The marine biogeochemical component in the Brazilian Earth System Model (BESM)	9:00	**Fedor Gippius** Black Sea's wave climate during the last three decades
9:20	**Polina Lobanova** Satellite derived chlorophyll-a and modeled primary production in comparison with field observations in the west part of the Japan/East Sea	9:20	**Danielle Su** Monsoonal influence on the upwelling dynamics around the Maldives
9:40	**Haruka Takagi** Individual ecology of tiny protistan zooplankton: Investigation on photosymbiotic ecology of planktic foraminifers	9:40	**Hyung-Gyu Lim** Bio-optical effect of chlorophyll interannual variation to Arctic sea-ice using GFDL Earth System Model
10:00	**Atis Labucis** Phytoplankton community and controlling factors of primary production in the Gulf of Riga (Baltic Sea)	10:00	**Giovanni Liguori** Increasing Pacific decadal variability under greenhouse forcing
10:20	**Soonmi Lee** Long-term trends of spring bloom phytoplankton in the Baltic Sea: A modeling study	10:20	**Cecilia O'Leary** Demonstrating the influence of temperature dependent vital rates on fish abundances through hierarchical Bayesian models
10:40	***Coffee Break***	10:40	***Coffee Break***
11:00	**Zheng-xi Zhou** Factors controlling the phytoplankton community changes in the coastal waters adjacent to the Changjiang River estuary: Statistical analysis and a modeling study	11:00	**Rebecca Selden** The role of warming in current and future piscivore dominance on the Northeast U.S. shelf
11:20	**Kirill Kivva** Nutrient draw-down, ΔSi/ΔN/ΔP-ratios and net community production assessment in the Bering Sea	11:20	**Joyce JL Ong** Boundary current controlled growth of marine fishes across tropical and temperate latitudes

11:40	**Amrit K. Mishra (CANCELLED)** Population dynamics of seagrass *Cymodocea nodosa* in the vicinity of volcanic CO2 seeps of Greece	11:40	**Jen Lewis** You can't swim from the past! Using otolith microchemistry to explore range-expansion in gilthead seabream
12:00	**Zhixuan Feng** Benthic biological hotspots in the Pacific Arctic Region: Distribution and potential drivers	12:00	**Jacob Bedford** Putting a historical plankton dataset to work for marine policy challenges: Identifying drivers of change in pelagic habitats over large temporal scales
12:20	**Marija Sciberras** Sediment type-fishing intensity interactions rather than nutrient enrichment moderate benthic shelf seas nitrogen cycling	12:20	**Travis C. Tai** Ocean acidification and socioeconomic impacts on the future of Canadian fisheries
12:40	**S3-C Ends**	12:40	**S1-B Ends**
13:00	**Lunch** Commodore Hotel Dining Hall		
14:30	**Offsite Excursion** (Bus transportation provided)		
19:00	**Off Site Conference Banquet**		
	Conference Day 3 Ends		

Day 4 (Friday, 2 June 2017)			
7:30	**Breakfast** Commodore Hotel Dining Hall		
8:40	Plenary Keynote (PICES) **Shin-ichi Ito (Japan)** Challenges and advances in understanding marine ecosystems and projecting oceans futures		
S3-A (Grand Ballroom) ***Biodiversity and ecosystem functioning*** **Conveners:** Daniel van Denderen/Christine Stawitz		**S1-C, Day 2 (Heerak Hall) (Continues)** ***Coastal dynamics: Changes in sea level, geomorphology and ecosystems*** **Conveners**: Maija Viska/Moritz Wandres	
9:25	*Introduction by Conveners*	9:25	*Introduction by Conveners*
9:30	**Andrian P. Gajigan** Taxonomic and functional diversity of marine microbes in the Philippine archipelago	9:30	**Menche Lazarte** Looking into the potential role of sediment processes in the productivity of the waters of the harmful algal bloom-infested Murcielagos Bay, Philippines
9:50	**Polina A. Kameneva** Diversity of dinoflagellate sources of phycotoxins found in bivalves in Peter the Great Bay, Sea of Japan (East Sea)	9:50	**Kumar Avinash** Coastline change rate estimation and forecast of Amery ice shelf, Eastern Antarctica: A remote sensing and statistics-based approach
10:10	**Esther Beukhof** Functional traits of fish communities relate to environmental gradients across Europe's continental shelf seas	10:10	**Cyndi S. Ignacio** Influence of tides and coastal morphology on storm impact in Boracay and Bantayan islands: A case study from super typhoon Haiyan (Yolanda)
10:30	***Coffee Break***	10:30	***Coffee Break***
10:50	**Tim Spaanheden Dencker** Matches and mismatches - Patterns and drivers of fish diversity in the North Sea	10:50	**Arseny A. Kubryakov (S1-A1)** The impact of the Black Sea dynamics on the long-term variability of the marine ecosystem
11:10	**Alena Timoshina** Development of a model to study the effects of artificial biotope on biodiversity caused by changes in the hydrodynamic regime of waters	11:10	**S1-C Ends**
11:30	**Jina Oh** A new approach using next generation sequencing to identify massively mixed eggs to species for studying the spawning ecology of marine teleosts		
11:50	**S3-A Ends**		
12:00	**Plenary Closing Remarks** Cornelius Hammer (ICES) and Hal Batchelder (PICES)		
12:30	**Lunch** Commodore Hotel Dining Hall		
14:00	**Conference Ends**		

POSTERS

Session 1A: Climate change and the effects on the ocean	
1A-P1	**Elena Kubryakova** Nutrients and salt transport between continental slope and central part of the Black Sea caused by variability of large-scale circulation
1A-P2 (also talk S1-A1, 10:00 May 30	**Ivan Sudakov** Critical transitions in the changing Arctic system
1A-P3 (cancelled)	**Roksana Jahan** Interannual variation of Cyrptophyceae and small-size flagellates in estuarine waters: Case studies on Gyeonggi Bay, Yellow Sea and Tolo Harbour, South China Sea
1A-P4 (cancelled)	**Roksana Jahan** Interdecadal variation of mixotrophic dinoflagellate species (*Gymnodinium* spp.) response to nutrient reduction and climate change in Tolo Harbour during 1991-2013
1A-P5	**Dmitry I. Frey** Trends in potential temperature of the bottom water flow in the Atlantic influencing climate change
1A-P6	**Dasom Lee** Spatial distribution of Minke whale (*Balaenoptera acutorostrata*) as an indicator of a biological hotspot in the East Sea
1A-P7	**Jianchao LI** Ecological and hydrodynamic effects of Yellow Sea Cold Water Mass (YSCWM) with special reference on Pacific Cod (*Gadus macrocephalus*)
1A-P8	**Christina Eunjin Kong** On the projection of future marine primary productivity in mid-latitudinal marginal seas
1A-P9	**Catalina Aguirre** Projected changes in upwelling-favorable winds at the ocean´s eastern boundaries systems: Relationship between the large scale and synoptic scale

Session 1B: Cross-scale interactions and trends of climate change	
1B-P1	**Kumar Avinash** Recent Antarctic sea ice variability and trends: Nonlinear response to the ocean climate forcings
Session 1C: Coastal dynamics: changes in sea level, geomorphology and ecosystems	
1C-P1	**Marufa Ishaque** Seasonal circulation in the northern Bay of Bengal with special reference to shelf-slope region
1C-P2	**Pavel Kotov** Model for calculation of frozen shores retreat after rising temperatures and thawing
Session 2A: Introduction of anthropogenic substances to the ocean and their impacts	
2A-P1	**Muthukumar Chandrasekaran** Allochthonous inputs of Dissolved Organic Nitrogen (DON) in the Ennore Creek, South India
2A-P2 (cancelled)	**Ana L. Oliva** Polycyclic Aromatic Hydrocarbons in sediments and mussel from a South American coastal environment
2A-P3	**Erwin Don Racasa** Submarine groundwater discharge in Sorsogon Bay, Luzon Island, Philippines
2A-P4	**Jun-Ho Lee** Flux and source assessment of shallow methane (CH4) gas from sediments in the central Yellow Sea, off the southwest of Korea
Session 2B Ecosystem-Based Management – Get the big picture	
2B-P1	**Leigh Michael Howarth** The highs and lows of protection: Measuring multi-species interactions within a community-led temperate marine reserve
2B-P2	**Marija Sciberras** Impacts of bottom fishing on the sediment infaunal community and biogeochemistry of cohesive and non-cohesive sediments
2B-P3	**Sezgin Tunca** SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis of recreational fishing in Foça and Gökova marine protected areas (Eastern Mediterranean, Turkey)
2B-P4	**Jae Ung Choi** Reconstruction of benthic environment change result from the environmental improvement policies executed in Masan Bay since the 1990's: Using the environmental factors and living benthic foraminiferal population

Session 2C: Evaluation of best management practices	
2C-P1	**Yingqiu Zhang** Short-term fidelity, habitat use and vertical movement behavior of the black rockfish Sebastes schlegelii as determined by acoustic telemetry
2C-P2	**Andrew F Johnson** Endangered species, ecosystem integrity, and human livelihoods
2C-P3	**Nadeem Nazurally** Investigation of Trou-aux-Biches as a potential site for marine off-lagoon aquaculture in the republic of Mauritius
2C-P4	**Ou Ling** Potential environment risk of ocean energy development in China
Session 3A: Biodiversity and ecosystem functioning	
3A-P1 (cancelled)	**M. Belal Hossain** Trophic functioning of macrobenthic fauna in a tropical acidified estuary
3A-P2	**Atal Saha** Application of modern genetic tools to assess the consistency between management and biological units in three exploited species from the Northeast Atlantic
Session 3B: Marine population dynamics and community ecology	
3B-P1	**James J.Waggitt** Understanding and predicting spatio-temporal dynamics in marine top-predator communities at regional and decadal scales
3B-P2	**Josie South** The effect of acute and chronic temperature change on the functional response of the lesser spotted dogfish *Scyliorhinus canicula*
3B-P3 (May 31, 16:00)	**Jin Gao (changed to talk)** Predicting population dynamics via spatial time delay embedding
3B-P4 (cancelled)	**Soeon Ahn** Assessment of environmental variables controlling bottlenose dolphin's distribution in Jeju waters
3B-P5	**Hyo-Tae Lee** Analysis of data from the bottom trawl survey in the Korean coastal waters
3B-P6	**Minkyoung Bang** Density-dependent process in biological properties of walleye pollock related with biomass fluctuation in the East Sea during the late 20th century

Session 3C: Marine ecosystems and biogeochemical cycles	
3C-P1 (cancelled)	**Islam Md. Nazrul** Complexity of Integrating Numerical Modeling Results with Mitigation Strategies of Harmful Algae Toxins in Aquatic Ecosystems
3C-P2	**Yeseul Kim** Optical discrimination of harmful *Cochlodinium polykrikoides* blooms in Korean coastal waters
3C-P3 (talk, June 1, 11:20-11:40)	**Kirill Kivva** Nutrient draw-down, ΔSi/ΔN/ΔP-ratios and net community production assessment in the Bering Sea

Session 1-A
Oral Presentations

Climate change and the effects on the ocean

Session 1-A Orals

May 30, 09:20 (1A-11497) (CANCELLED)

Using SMOS salinity observations for a better description of CO2 air-sea fluxes in the tropical Atlantic Ocean

Frédéric Bonou[1,3], Casimir Da-Allada[2,4] and Carlos Noriega[3]

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2 Institut de Recherche Halieutiques et Océanologiques du Benin (IRHOB), Cotonou, Benin
3 Centro de Estudos e Ensaios em Risco e Modelagem Ambiental (CEERMA), Universidade, Federal de Pernambuco (UFPE), Av. Arquiterura s/n, 50740-550, Recife, Brazil
4 Université Polytechnique d'Abomey, Bénin

The global ocean plays a major role in the regulation of atmosphere carbon dioxide (CO2). Indeed, depending on the region, the ocean behaves like an area that takes off CO2 (source) or area that absorbs CO2 from atmospheric(sink). The determination of sinks or sources of CO2 is a difficult task because of the lack and the complexity of CO2 system.

We present a review of the spatio-temporal distribution of CO2 flux (FCO2) at the air-sea interface in the tropical Atlantic. Our goal is to identify the physical parameters that influence the variability of CO2 parameters, by using empirical relationships to quantify their reciprocal influences. Therefore, the products of sea surface salinity (SSS) of the satellite SMOS (Soil Moisture and Ocean Salinity) with 0.25x0.25 of latitude and longitude over the period of 2010 until 2014 are used with other data such the surface temperature of the ocean (SST), the wind, the pressure at the surface level for a better description of the parameters CO2 in the tropical Atlantic. The existing relationships have allowed us to estimate the FCO2 in the the region of the tropical Atlantic, these results are in good agreement and comparable with observations data. From relationships and from surface salinity satellites which provide very suitable observations data, we can build the pCO2 map in any data point and subsequently improve the uncertainties on the FCO2 in the tropical Atlantic.

Keywords: tropical Atlantic, carbon cycle, CO2 flux, climate change.

May 30, 10:00 (1A-11516) (CANCELLED)

Numerical modeling on the effects of pollutants on ecosystem of Kamaishi Bay (Japan) by using MEC model

Md. Nazrul **Islam**[1] and Daisuke Kitazawa[2]

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2 Institute of Industrial Science, The University of Tokyo, Tokyo 1538505, Japan

A three dimensional Marine Environmental Committee (MEC) model was conducted to describe the specific circulation patterns of currents, temperature, and salinity driven by wind and tide forcing in Kamaishi Bay at Miyagi Prefecture in the Great East Japan. The major concern of this study is the diffusion of pollutants caused by 2011 Earthquake and Tsunami disaster impacts on marine ecosystem. In this study, we also simulate the changes of water quality and ecosystems structure from January 2009 to December 2012. The MEC model has been used to predict the distributions of various key water quality indicators and tide flow in the different layer of Kamaishi Bay. High correlation is obtained between simulation derived and measurement derived tidal characteristics. One of the broken marine structures was the breakwater of the Kamaishi Bay, which was completed its construction in 2009 at the Bay mouth where the water depth is over 60 m. We also simulated the effects of breaking water effects on the tide, currents and integrating aquaculture and fisheries. The current variability in shallow areas is influenced by the prevailing winds. The water quality is intensely affected by pollutants and has continually deteriorated due to increased discharges of domestic and industrial waste as well as an increased loading in anthropogenic contamination into the Bay. The results were found that measured and simulated contaminations of pollutants were under the environmental standards in Japan. Observed and simulated DO, T-N and T-P concentrations were not so large different from those before the disaster.

Keywords: Simulation, pollutants, breakwater effects, tsunami, MEC model

May 30, 10:20 (1A-11552)

Variability of sea ice concentration and sea ice forms in the Kara sea in modern climate

L.M. **Naumov** and S.M. Gordeeva

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This article describes variability of the Kara sea ice cover in 1982 to 2015 years in the global warming period. We investigated dynamic of ice cover in the Kara sea and dynamic of three global polynyas in the Kara sea: Novozemelskaya polynya, Ob-Enyseiskaya polynya and Severozemelskaya polynya. Estimated impact on the polynyas of two most important atmosphere factors: ground-level temperature and ground-level wind (zonal and meridional). Describes variability of ice age forms in the Kara sea.

Revealed that ice concentration of the Kara sea in 1982 to 2015 years have an important negative trend and greatly reduced. Most changes are observed in the northern part of the Kara sea. Reduced area of old ice and increased area of younger age forms of ice which indicates that old ice becomes more young in the end of the study period.

Found that polynyas of the Kara sea have trend to expansion. The Novozemelskaya and Severozemelskaya polynyas have expanded the most. The most important influence of these two polynyas has been the increase of the ground-level air temperature. Changes of Ob-Enyseyskaya polynya size is not as great because this polynya is located near the continent. Continental air masses are colder than oceanic air masses. This polynya changes in size due to meridional wind which move ice offshore into the open sea. Wind also has an important influence on size of the Novozemelskyaya polynya.

May 30, 11:00 (1A-11539)

Observed and predicted changes in ocean temperatures winter extremes in the Northeast Pacific

Youngji **Joh** and Emanuele Di Lorenzo

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Ocean temperature extremes and marine heatwaves in the Northeast Pacific have significant impacts on marine ecosystems and regional weather. Using available observations and the Community Earth System Model Large Ensemble (CESM-LENS) dataset we explore how the spatial and temporal statistics of winter temperature extremes change over the period 1920-2100 under the greenhouse forcing scenario RCP8.5. We find that ocean warm extremes (>1ºC) tend to exhibit a preferred spatial pattern resembling the North Pacific Gyre Oscillation (NPGO) with maximum temperatures in the center of the Gulf of Alaska. The variance of these events increases both in the observational datasets and the CESM-LENS, and is linked to a change in the statistics of the Pacific storm tracks, which are an important cooling mechanisms for the Northeast Pacific. As greenhouse radiative forcing progresses, the CESM-LENS warm temperature extremes (>2ºC) increase in amplitude (±0.5ºC) and exhibit a significant southward shift towards the center of the Gulf of Alaska. Cold extremes (<-2ºC) also increase in amplitude (~0.5ºC), however, their pattern resembles the negative phase of the Pacific Decadal Oscillation. Although there is not observational support, in the CESM-LENS the variance of cold extremes is linked to an increase in the frequency of La Niña and the effects of their teleconnections to the North Pacific. Although the robustness of the model results remains uncertain, the observed and predicted increase in amplitude of occurrence in NPGO-like warm events suggests that ecologically-relevant ecosystem threshold will be exceeded more frequently under greenhouse forcing.

May 30, 11:20 (1A-11659)

Combination of paleoenvironmental reconstructions and satellite derived data modeling for understanding modern climate change

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The project focuses on the environmental change and the effect of these change on the ecological functioning of marine ecosystems. In the North Atlantic as one of the most climatically sensitive regions where is heat transport and deep water formation occurs. A better understanding of the mechanisms of North Atlantic environment fluctuations is decisive to examine the climate system's sensitivity in the context of rapidly warming climate. Diatoms are one of the most common algae in marine environment that are usually the best preserved microfossils in marine sediments. As rapidly blooming organisms, they are sensitive to oceanic and atmospheric conditions. Diatom method allows document some of the environmental changes (sea surface temperature, ocean currents, species diversity and productivity) of a particular region. Combination of paleoceanographic reconstruction from key locations of the NA and climate model simulations permits better understand and quantify the factors involved in specific climate events. The main goal of the project was to receive new data and document information about the ocean circulation changes in the North Atlantic during the last climatic cycles based on the diatom assemblages and correlate this data with climate model data. The investigated material consists of three cores which were recovered from the north-east and the north-west part of the AO. During the project the authors performed analysis of diatom assemblages and their change over the last and present interglacial periods. The data was paired with existing datasets of planktonic foraminifera and modern satellite derived data modeling results .

May 30, 11:20 (1A-11444) Moved to June 2, 11:30

The impact of the Black Sea dynamics on the long-term variability of the marine ecosystem

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Satellite altimetry and chlorophyll A data are used to study the long-term dynamics variability of the Black Sea and its impact on the marine ecosystem. It is shown that the Black Sea dynamics is characterised by significant interannual variability, which is driven by the action of the wind curl over the basin. The most distinct feature of the basin dynamics variability is a twofold increase of the current mean kinetic energy (MKE) in 2002-2003 from anomaly weak values in 1998-2001.

We employ an eddy-identification method to show that the weakening of large-scale circulation in response to the decrease of the wind curl leads to the baroclinic instability of the Rim current and enhanced formation of mesoscale anticyclones. Intensification of the large-scale circulation in 2002-2003 suppresses the eddy formation.

Using combined SeaWiFS and MODIS-Aqua measurements we study the interannual variability of the chlorophyll A concentration (Ca) in 1998-2012. It is shown that the eddy-driven cross-shelf exchange plays a major role in the Ca variability of the Black Sea continental slope. The intensification of the Black Sea dynamics in 2002-2003 and following decrease of eddy energy results in the reduction of cross-shelf transport of the nutrient-rich coastal waters to the inner parts of the basin. As a result the Ca decrease by about 25% in 2003-2012 in all seasons compare to 1998-2002. The effect of cross-shelf decline is observed over the continental slope of the Black Sea, where the correlation between MKE and the chlorophyll a concentration reaches (-0.8).

May 30, 11:40 (1A-11557) (CANCELLED)

Effect of climate change and nutrient reduction on phytoplankton in Tolo Harbour

Roksana **Jahan** and Kedong Yin

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Evaluation of a 65-year dataset of climatic parameters and 25-year dataset of nutrients and phytoplankton in Tolo Harbour revealed that climate has become warmer in recent decades associate with positive Pacific Decadal Oscillation, North Pacific Gyre Oscillation and Multivariate ENSO Index values. During 1986-2013, Sea Surface Temperature and Sea Surface Salinity in Tolo Harbour had increased by 0.038^0C yr^{-1} and 0.031 yr^{-1}, respectively. The warming trend (0.046^0C yr^{-1}) is higher in bottom than surface. Nutrient loading reduction had been implemented in 1998 and, consequently, TIN had reduced by ~4 times in 2000s. As a result, phytoplankton biomass decreased dramatically. Diatom abundances were somewhat static because silicate concentrations were same in before and after nutrient treatment. The dominant species were *Skeletonema costatum*, *Thalassiosira* spp., etc. During 1991-98, dinoflagellate blooms were strongly related to lower N:P ratios (r = 0.25) in spring with *Prorocentrum triestinum* and *Gymnodinium mikimotoi*. During 1999-2006, dinoflagellates showed higher abundance (with *Gymnodinium* sp. and *Scrippsiella* sp.) and had relationship with MEI (r = 0.023), SST (r = 0.214) and SSS (r = -0.342). EI-nina induced higher rainfall and lower salinity in spring that create favorable environment (i.e. downwelling) for dinoflagellate blooms in Tolo Harbour. Since 2007, a decreasing trend of dinoflagellates had been detected. Note that, other group of phytoplankton was increasing in 2000s. It hypothesizes that warming and nutrient reduction favor small-sized phytoplankton, especially Cryptophyceae and flagellates. It is assumed that these changes in phytoplankton groups will have large impact on higher trophic level in Tolo Harbour.

May 30, 12:00 (1A-11507) (CANCELLED)

Effect of marine heatwaves on antibacterial defense of two habitat forming macrophytes

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Marine heatwaves (MHWs) have been observed throughout the world and are expected to increase both in frequency and intensity under climate change scenarios causing additional stress to organisms. Macrophytes like the temperate brown seaweed *Fucus vesiculosus* and the seagrass *Zostera marina* are quite widespread in the northern hemisphere providing core ecological services. Understanding the response of such key macrophytes to extreme events will improve our predictions of the responses of coastal marine ecosystems under climate change. Healthy functioning of macrophytes is intimately linked to the structure and composition of epibacterial communities that colonise their surfaces, a process termed epibiosis/fouling. Uncontrolled epibacterial colonisation can be detrimental through fouling-associated fitness costs and increased disease susceptibility. Thus, macrophytes including *Fucus* and *Zostera* produce defence chemicals to 'control' surface epibacteria. While how such fitness associated trait would respond to changing means of abiotic conditions like decreasing light, higher temperature is known, antibacterial defense response of *Fucus* and *Zostera* or any other macrophytes in response to extreme events is unknown. Thus, we tested the defense response of *Fucus* and *Zostera* population to simulated heatwaves in a novel outdoor mesocosm with a multidisciplinary approach. Along with control tanks, two different treatments were applied: treatment experiencing two spring heatwaves followed by a summer heat wave, a treatment experiencing just the summer heat wave. For both the macrophytes, antibacterial defense was not significantly affected among controls and two different treatments. As defense was always high enough to inhibit bacterial settlement, we conclude that the capacity of *Fucus* and *Zostera* for such defense will hardly be weakened by such extreme heat bursts.

May 30, 13:30 (1A-11528)

Projecting biological impacts of ocean acidification: Approaches to link physico-chemical changes with organismal response

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The links between environmental conditions and organism fitness remain largely ambiguous. Understanding these connections, and how they can be modified, is of rapidly growing relevance given the environmental change occurring due to human activities. These associations can be clarified where existing biological theory is invoked as it provides a framework to synthesise otherwise disparate observations. Here, we will review approaches using theory to examine the effects of environmental change on organism fitness, with a focus on ocean acidification. A key theory in this context is Hutchinson's theory of the niche. Of the approaches to incorporate this theory, the most widely discussed is the 'oxygen- and capacity-limited thermal tolerance' (OCLTT) framework in which aerobic scope, and the associated physiological processes, is proposed to reflect whole organism fitness. The ability of OCLTT to reflect the response of the range of processes occurring within whole organisms is, however, increasingly questioned. Here, we highlight evidence to indicate that aerobic scope alone may not be a suitable proxy for whole organism fitness. An alternative emerging approach is that of 'multiple performance-multiple optima' (MPMO), which calls for the niche of many physiological processes to be considered individually. We illustrate the potential utility of such an approach with simulated data. Overall, we emphasize that placing empirical measures within a framework developed based on established theory represents a potentially powerful method to forecast effects of anticipated global change as they scale from physiology to interact at the level of whole organisms.

May 30, 13:50 (1A-11456)

The impact of environmental stress on physiology of *Symbiodinium* sp.

Buntora **Pasaribu** and Jason TC Tzen

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The phenomenon of global climate change has contributed to the decline of coral reef around the world. The coral bleaching is expected to happen more frequently due to the climate change. Environmental factors, such as nutrient levels and temperatures are the major elements in maintaining stable endosymbiotic relationships. The mechanisms and response of cultured *Symbiodinium* cells in the absence of nitrogen, and at various temperatures are still unclear. The present study investigated the influence of different temperatures and nitrogen-deprivation on free-living *Symbiodinium* cultures. The physiological responses of free-living *Symbiodinium* cells cultured at different temperatures during nitrogen deprivation under a 12:12 h light:dark were measured. *Symbiodinium* cell growth was significantly lower in response to lower temperatures. Transmission electron micrographs (TEMs) revealed the formation of lipid droplets induced by nitrogen deprivation under different temperatures. The results of this study will increase our understanding of adaptive responses occurring in *Symbiodinium* under environmental stress.

May 30, 14:10 (1A-11475)

Singlet oxygen dependent photo-inactivation mechanism of Photosystem II in cultured *Symbiodinium* cells and its involvement in coral bleaching

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Coral bleaching involves the expulsion of *Symbiodinium* cells from its host and resulting the breakdown of the coral and algae symbiosis, provides an opportunity to understand the molecular mechanism of this symbiotic association. In this study, we report a precise detection of singlet oxygen ($^1O_2$) production in the *Symbiodinium* cells and in intact coral *Pocillopora damicornis*. Singlet oxygen ($^1O_2$) is one of the most important reactive oxygen species (ROS) in photosynthetic systems. It is produced via interaction of molecular O_2 with ^{3}Chls in the Photosystem II (PSII) reaction center, as well as in the light harvesting antenna. Recently we have developed chemical trapping method for detection of $^1O_2$ in intact cyanobacterial cells. We have also employed chemical trapping method and our data demonstrates the production of $^1O_2$ in intact *Symbiodinium* cells. The data show that $^1O_2$ was enhanced during the heat and light stress conditions. Recently we proposed that the inhibition of the Calvin-Benson cycle by glycolaldehyde and potassium cyanide during thermal stress in *Symbiodinium* cells promotes $^1O_2$ formation. Our study reveals that heat and light stress induce photo-inactivation of PSII and enhance $^1O_2$ production, while histidine provides protection against PSII photo-inactivation and pigment bleaching. Based on our results, $^1O_2$ induced inactivation of *Symbiodinium* cells, may be involved in triggering the expulsion of *Symbiodinium* cells from the coral host, which leads to coral bleaching. I will also report on the latest results obtained in our lab by using fluorescence imaging techniques in *Symbiodinium*.

May 30, 14:30 (1A-11471)

Ocean acidification effects on zooplankton communities living in coral reef ecosystems

Joy N. **Smith**[1,2,3,4], Glenn De'ath[1], Astrid Cornils[2], Jason Hall-Spencer[3], Claudio Richter[2,4], Katharina Fabricius[1]

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Zooplankton are critical to entire marine ecosystems, and yet they may be affected by anthropogenic changes in seawater related to ocean acidification (OA). Here, we examine the effects of ocean acidification on zooplankton that reside in coral reefs by using CO_2 seeps as natural laboratories for examining OA impacts on entire communities. Observations in coral reefs at two separate CO_2 seep sites and over three expeditions reveal that zooplankton abundance was consistently reduced under high-CO_2, although there were no drastic shifts in the community composition. Thus, there is less food available for planktivores, but the food that is available is of similar content. All zooplankton taxa were reduced under OA conditions although to different degrees. The reduction in zooplankton abundance is partly attributable to a change in their habitat. These residential zooplankton live in the substrate of the coral reef, and a shift from structurally complex corals to massive bouldering corals means there is less space available for the zooplankton to reside within. Less zooplankton in coral reefs affected by ocean acidification will have consequences for the fish and corals that feed on them. In an ecosystem already vulnerable to ocean acidification, coral reefs may be even more threatened if the very basis of their food webs is reduced.

May 30, 14:50 (1A-11439) (CANCELLED)

Temperature, oxygen, metabolism and upper thermal niche boundaries of water-breathing ectotherms

Rasmus **Ern** and Andrew J. Esbaugh

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Temperature-induced limitations on the capacity of the cardiorespiratory system to transport oxygen from the environment to the tissues, have long been regarded as the principal determinant of the upper thermal limits of fishes and other water-breathing ectotherms. Consequently, the upper thermal niche boundaries of these species are considered highly sensitive to aquatic hypoxia and other environmental stressors that constrain the performance of their cardiorespiratory system. However, the generality of this dogma has been questioned as some species have been found maintain cardiorespiratory performance at high temperatures. We recently proposed a novel metric for assessing the synergistic effects of environmental stressors on the performance of the cardiorespiratory system, and classifying the oxygen-dependence of the upper thermal limits in water-breathing ectotherms; the oxygen limit for thermal tolerance (PCT_{max}), which is the water oxygen tension (P_wO_2) where an organism's upper thermal limit (CT_{max}) starts to decline. Determining PCT_{max} in a number of tropical, temperate and polar aquatic ectotherms; including black-axil chromis, red drum, lumpfish and antarctic krill, we found that only in the antarctic krill were the upper thermal limits determined by insufficient tissue oxygen supply. In black-axil chromis, red drum and lump fish, the upper thermal limits were maintained over a wide range of water oxygen levels. Aquatic hypoxia should therefore have little impact on the upper thermal niche boundaries of these tropical and temperate species. In light of these findings we propose a framework for characterising the relationship between temperature, oxygen, metabolism and upper thermal niche boundaries of water-breathing ectotherms.

May 30, 14:50 (1A-11698)

The distributional responses of groundfish to climate variability along the Northeast Pacific coastal shelf

Lingbo **Li**[1], Anne Hollowed[1], Steve Barbeaux[1], Jennifer Boldt[2], Edward Cokelet[3], Toby Garfield[4], Stéphane Gauthier[5], Darin Jones[1], Aimee Keller[6], Jackie King[2], Michelle McClure[6], Olav Ormseth[1], Wayne Palsson[1], Patrick Ressler[1], Dale Sweetnam[7], Phyllis Stabeno[3], and Chris Wilson[1]

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Global warming has impacted marine organisms in many different ways, including changes in species distribution. Species have been observed to move to higher latitudes and deeper waters; however, to date, ontogenetic changes have rarely been taken into account. Due to differences in habitat requirements across life stages, changes in species composition likely plays an important role in the distributional shifts reported for species in many studies. Here we present distributional responses of several commercially exploited groundfish across size ranges to climate variability in the Northeast Pacific including the unusual warm event in the Northeast Pacific in 2015. We analyzed a large amount bottom trawl and acoustic survey data from the west coast of US, the west coast of Canada, and the Gulf of Alaska 1996 - 2015. Length bins were chosen through expert opinion to capture ontogenetic differences in distribution for each species. We computed the abundance-weighted centroids of the fish distribution (longitude, latitude, depth and temperature) for each species in each size bin and linked their distributions with potential predictors of environmental changes. Finally, we compared the movement across species, size bins, and regions and summarized their sensitivity and resilience to environmental changes.

May 30, 15:30 (1A-11564)

Climate change effects on Atlantic Cod recruitment and fisheries

Martina H. **Stiasny**[1,2], Felix H. Mittermayer[1], Michael Sswat[1], Martin Hänsel[2], Rüdiger Voss[2], Martin Quaas[2], Thorsten Reusch[1] and Catriona Clemmesen[1]

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Atlantic cod is one of the commercially and also ecologically most important species in the Northern Atlantic with a variety of stocks, most of which are not only under intense fishing pressures, but are also likely affected by other anthropogenic stressors. There has been increasingly concern to include climate change effects into sustainable management strategies, however quantifiable data, which would allow for this, has been lacking. We were able to show experimentally that cod larvae of different stocks, i.e. the Western Baltic stock and the Arcto-Norwegian cod, are highly vulnerable to ocean acidification and that the effect on survival translates into a dramatic effect on recruitment. To additionally include warming effects on the recruitment relationship, we correlated the recruitment success of the past decades with the temperature records. The temperatures of regions and months of the year, which had the highest explanatory power, were extrapolated into the future and the effect of this relationship was added to the effect of acidification. The resulting effect on the stocks and the associated socio-economics, in terms of optimal fishing pressure, spawning stock biomass and profits are explored.

May 30, 15:50 (1A-11597)

Non-stationary responses of salmon populations to temperature in the Gulf of Alaska

Patricia **Puerta**[1], Lorenzo Ciannelli[1], Michael Litzow[2] and Ryan Rykaczewski[3]

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Almost all research on environment-biology links is based on a stationary covariation among these variables (i.e. driver-response relationship is the same throughout the period of observation). Non-stationary relationships are widely recognized in paleoecology, and are predicted as a result of the anthropogenic forcing into new climate states. However, there are very few observational studies that incorporate the changing influence of the environment on population dynamics using non-stationary models. We investigated the variability in the relationships among climatic indices (PDO, NPGO), ocean variables (SST, upwelling, freshwater) and ten salmon populations in the Gulf of Alaska from 1965 to present. Results from statistical modeling showed a non-stationary relationship between salmon population abundances and SST. Populations showed a breakpoint in the response centered in late 1980s with an initial period with high sensitivity to SST variability, followed by apparent insensitive period. Similar results were also observed for PDO. Additional, analyses showed that salmon populations-SST relationships are causative (not spurious correlations) and non-stationarity is not related to intrinsic changes in the population time series. These changes coincided with shift in the dominant large scale climatic modes in the North Pacific that changed from PDO to NPGO in 1988/89 determining variability patterns in SST and other oceanographic variables. We suggest that non-stationarity arises from the climate-SST change and that leads to non-stationary relationships between SST and salmon populations. Incorporating non-stationary relationships is decisive for the understanding of climate regulation, forecasting and management of marine population under novel future climate change scenarios.

May 30, 16:10 (1A-11447)

The effects of a shifting ocean environment on consumption and growth rates of juvenile Pacific Salmon

Eric **Hertz**[1], Strahan Tucker[2], Mary E. Thiess[2], John F.T. Morris[2], Dave Mackas[3], Asit Mazumder[1] and Marc Trudel[1,2]

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Ocean conditions that lead to reduced growth in coastal marine ecosystems are expected to increase mortality rates of Pacific salmon (*Oncorhynchus* spp.) and to reduce adult returns to freshwater ecosystems. We examined the effects of ocean conditions on the food consumption growth rates of Pacific salmon in two contrasting ocean domains: the northern California Current System (CCS) and Alaska Costal Current (ACC). We found that, while plankton productivity and temperatures tend to be higher in the CCS, salmon are generally larger and fatter, and have higher growth in the ACC. The poorer growth and condition of salmon in the northern CCS appears to be related to a calorie-deficient diet rather than to lower rates of food consumption or to higher metabolic rates. This indicates that ocean conditions affect salmon production through changes in prey community composition and quality, which in turn are induced by the effects of climate on ocean circulation, and on the local success of different zooplankton life history strategies (year round activity vs. seasonal dormancy and lipid accumulation).

May 30, 16:30 (1A-11555)

Present and future potential habitat distribution of Carcharhinus falciformis and *Canthidermis maculata* by-catch species in the tropical tuna purse-seine fishery under climate change

Nerea **Lezama-Ochoa**[1], Hilario Murua[2], Guillem Chust[3], Emiel Van Loon[4], Jon Ruiz[5], Martin Hall[6], Pierre Chavance[7], Alicia Delgado de Molina[8] and Ernesto Villarino[9]

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By-catch species from tropical tuna purse seine fishery have been affected by fishery pressures since the last century; however, the habitat distribution and climate change impacts on these species are poorly known. With the objective of predicting the potential suitable habitat for a shark (*Carcharhinus falciformis*) and a teleost (*Canthidermis maculata*) in the Indian, Atlantic and Eastern Pacific Oceans, a MaxEnt species distribution model (SDM) was developed using data collected by observers in tuna purse seiners. The contribution of various environmental variables (depth, sea surface temperature, salinity and primary production) and the potential impact of future climate change on species habitat by the end of the century under the IPCC A2 emission scenario were evaluated. Results from projected future distribution maps indicated that the equatorial region and some coastal upwelling regions were the areas of greatest by-catch of these species in concordance with the main fishing grounds. Sea surface temperature was the environmental variable that contributed most to the habitat distribution of the two species in the three oceans in general. Under climate change scenarios, the largest change in present habitat suitability is observed in the Atlantic Ocean (around 16% of the present habitat suitability area of *Carcharhinus falciformis* and *Canthidermis maculata*). This work presents new information about the present and future habitat distribution under climate change of two by-catch species that contributes to the development of ecosystem-based fishery management and spatially driven management measures.

May 30, 16:50 (1A-11479) (CANCELLED)

Creeping climate constraint: a case study of the north Atlantic's pelagic predators

Camrin D. **Braun**[1,2], Gregory B. Skomal[3] and Simon R. Thorrold[4]

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Climate model predictions reveal regional declines in oceanic dissolved oxygen as one product of global climate change. Evidence suggests ongoing dissolved oxygen depletion and vertical expansion of oxygen minimum zones (OMZs) throughout much of the north Atlantic Ocean. OMZ shoaling may restrict the usable habitat of pelagic fishes to a narrow surface layer and spatially separate these predators from their mesopelagic prey. We use satellite archival tags to record the movements and dive behavior of 11 swordfish (*Xiphias gladius*) and 8 bigeye tuna (*Thunnus obesus*) throughout the north Atlantic and implement generalized additive mixed models (GAMMs) to determine environmental drivers of habitat use. The most parsimonious variables describing habitat use by these species were used to generate habitat suitability predictions under changing climate scenarios. This modeling approach will help inform management of commercially important pelagic fish stocks as further expansion of the Atlantic OMZs, along with overfishing, may threaten the sustainability of these valuable pelagic fisheries and marine ecosystems.

Session 1-B
Oral Presentations

Cross-scale interactions and trends of climate change

June 1, 08:40 (1B-11470)

Low-frequency wave motions in the Japan/East Sea

Anastasia **Zvereva**

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Wavelet analysis of the altimetry measurements from 1992 to 2012 defined main energetic frequencies of the Japan/East sealevel perturbations: the quasi-biennial, annual and semi-annual. The possibility of fluctuations occurrence at the quasi-biennial as a result of parametric resonance caused by the Earth rotation speed fluctuations was described. The directed frequency spectral analysis revealed the presence of waves with an annual period, propagating to the south-west in the north and south regions and to the northeast in the central part of the Japan/East Sea. Based on the results of the complex SVD a "cellular" pattern in the Japan/East Sea level field, which corresponds to the wave theory of low-frequency level oscillations in closed or semi-enclosed basins by (LeBlond, Mysak 1981, Pedlosky, 1984) is observed. A new class of the planetary progressive-standing waves has been suggested. Phenomenological model of a progressive wave propagating mainly westward and modulated by the standing wave is introduced. By applying multivariate statistical analysis to the Japan/East Sea altimetry data a general classification of the low-frequency wave motions, which defines the place for a new planetary waves type is offered. This approach to the dynamics and kinematics of the Japan/East Sea and World Ocean level oscillations explains the position of frontal zones that define the plankton accumulation and fishery regions on a completely new level.

June 1, 09:00 (1B-11626)

Black Sea's wave climate during the last three decades

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This study is focused on the alterations and typical features of the wind wave climate of the Black Sea since 1979 till nowadays. Wind wave parameters were calculated by means of the 3rd-generation numerical spectral wind wave model SWAN, which is widely used on various spatial scales – both coastal waters and open seas. Data on wind speed and direction from the NCEP CFSR reanalysis were used as forcing. The computations were performed on an original unstructured computational grid with cell size depending on the sea depth. The distance between grid points varies from 10—15 km in deep-water offshore regions till 500 m in coastal areas. Modeling results were validated against data of in situ measurements performed by a Datawell wave buoy installed 7 km off the city of Gelendzhik.

Modeling results were applied to evaluate the principal characteristics of wind waves: seasonal and total maximal and average wave parameters, recurrences of wave heights, periods and directions, duration of storms etc. Multiannual trends of wave parameters were also assessed to evaluate the response of wind waves to climate change and to determine periods of high and low storminess.

Special attention is paid to coastal areas, as storm waves may cause severe damage here. Moreover, waves in coastal areas are a possible source of renewable energy.

The reported study was funded by the Russian Foundation for Basic Research (RFBR) within the research project No. 16-35-00488.

June 1, 09:20 (1B-11563)

Monsoonal influence on the upwelling dynamics around the Maldives

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The Maldives are a group of coral islands in the central part of the equatorial Indian Ocean along 73ºE that form a barrier to the seasonally reversing monsoonal currents. This puts the island chain in direct contact with the eastward flowing Southwest monsoon current (SMC) during the Southwest monsoon (SWM) period from June to October and the westward flow from the Northeast monsoon current (NMC) during the Northeast monsoon (NEM) from December to April. The flow topography interaction of these islands with the monsoonal currents enhance primary productivity in the lee of the islands as a result of the Island Mass Effect (IME). Under these conditions, nutrients are upwelled into the photic zone, leading to elevated chlorophyll blooms. SeaWIFs ocean colour imagery reveal a prominent chlorophyll bloom along the Maldivan western coastline during the NEM and a counterpart recirculation feature along the eastern coastline extends as a plume from the Maldives to southern India and then on to Sri Lanka during the SWM. There is increasing recognition that the IME and its associated eddies modulate ocean productivity and that potential changes in the Indian Monsoon may impact the development of these ecosystem generators. Thus, an integrated approach using satellite imagery, field observations and a numerical model derived from the Regional Ocean Model System has been performed to investigate the role of the monsoon on the variability of the island mass effect around the Maldives.

June 1, 09:40 (1B-11548)

Bio-optical effect of chlorophyll interannual variation to Arctic sea-ice using GFDL Earth System Model

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Chlorophyll (CHL) affects penetration of shortwave radiation in global ocean surface layer. To examine the effect of CHL interannual variation in the Arctic, GFDL earth system model (ESM), which oceanic bio-geochemical (BGC) is embedded in coupled general circulation model, is employed to simulate two experiments; fully-coupled experiment (BGC.on), BGC model turns off and prescribes climatological monthly mean CHL obtained from BGC.on experiment (BGC.off). The mean difference between BGC.on and BGC.off experiments show that sea-ice concentration (SIC) increase 8% and shortwave heating in ocean surface over 30m decrease 6 W/m^2 averaged in Eurasian Basin (80º-160ºE,78º-88ºN) in August. To identify effect of interannual variation of CHL, the ideal shortwave heating ratio (α_{sw}) is estimated in two cases that assume climatological CHL and varying CHL at the same conditions of fraction of visible radiation and surface height obtained from BGC.on. In climatological CHL case, α_{sw} of climatological CHL case is constant during 250 years regardless of shortwave flux change. In varying CHL case, however, CHL change is negatively correlated with to shortwave flux increase due to mixing increase. The cases of high (low) α_{sw} associated with CHL is basically low (high) shortwave flux in the ocean surface due to large (small) reflection from sea-ice. Consequently, the varying CHL case absorbs less shortwave flux 0.18 W/m^2 over 30m than climatological CHL case in a July to August. Ice-albedo feedback may amplify this cooling effect. This result suggests that interannual variation of CHL can maintain SIC although CHL existence induce ocean surface heating.

June 1, 10:00 (1B-11443)

Increasing Pacific decadal variability under greenhouse forcing

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Decadal changes in Pacific climate impact long-term transitions in marine ecosystems and influence the statistics of weather including ocean and atmosphere extremes such as strong droughts, hurricanes and marine heatwaves. Using observational analyses of basin-scale sea surface temperatures (SST) we show that the variance of the El Niño-like decadal variability is increasing in the period 1940-2016 by ~30%, along with an intensification of the coupling (e.g. lag correlation) between major climate modes of the Pacific. The significance of these trends, and their link to greenhouse forcing, is confirmed by examining an ensemble of 30 simulations of the Community Earth System Model (CESM-LE) over the period 1920-2100 forced with the RCP8.5 radiative forcing scenario. In the CESM-LE, we find that a significant trend in the strength the winds-evaporation-SST (WES) thermodynamic feedback leads to an intensification of the low-frequency variance of the North Pacific Meridional Mode (NPMM), which in turn energizes the El Niño-like Pacific decadal variability through its El Niño precursor dynamics. The stronger SST anomalies associated with the NPMM also reinforce the coupling with El Niño and the climate coupling between tropics and extra-tropics. This suggests that an important fraction of the observed and modeled trends in ENSO variance under greenhouse forcing may be caused by stronger thermodynamics coupling and meridional modes.

June 1, 10:20 (1B-11535)

Demonstrating the influence of temperature dependent vital rates on fish abundances through hierarchical Bayesian models

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Climate can impact fish population dynamics directly through changes in vital rates or indirectly through changes in connectivity or ecosystem productivity. This project aims to determine how variation in fish population vital rates and fishing pressure across time can account for observed shifts in abundances and productivity, how this variation can be incorporated into a stock assessment framework, and how this impacts management. Using summer flounder (*Paralichthys dentatus*) as the model species, the effect of climate on fish demographic rates was considered as a potential driver of abundance patterns. The influence of temperature was explored through various functional forms of natural mortality and stock-recruitment relationships. Models tested were age structured hierarchical state-space models using Bayesian estimation techniques. Parameterizations included temperature as linear and nonlinear covariate predictor of natural mortality and stock recruitment, vital rates critical to population persistence. These simulations explored the impact of temperature-dependent demographic parameters on biomass reference points (BRPs) estimated by age structured stock assessment methods. The results describe patterns in productivity over time as influenced by temperature-dependent natural mortality and stock recruitment to consider when updating BRPs. This mechanistically-based population model elucidates the relative importance of temperature in observed changes in abundance and this approach can be used when considering various scenarios of climate change in future management.

June 1, 11:00 (1B-11442)

The role of warming in current and future piscivore dominance on the Northeast U.S. shelf

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Asymmetries in individual responses to climate change have the potential to alter overlap between species and thereby impact important predator-prey and competitive interactions. As a result, warming oceans may modify the functional role of species within marine ecosystems. In this study, we evaluate the effect of warming on interactions between two important piscivores (Atlantic cod and spiny dogfish) and their prey in the northeast U.S. shelf. We use species distribution models to predict range size and species overlap under historical and future ocean conditions. Temperature was a significant predictor of species occupancy for both piscivores and their prey and was an important driver of historical range extent. The projected changes in ocean temperatures with a doubling of CO_2 altered suitable habitat for cod, spiny dogfish, and their prey species. As the range for the cold-water predators like cod contracts with warming, its potential for top-down control will diminish for the majority of their prey. In contrast, range expansion for warm-water associated predators like spiny dogfish will enhance its overlap with prey and its importance as a piscivore. As a result, ocean warming may reinforce the shift in piscivore dominance from cod to spiny dogfish in this ecosystem.

June 1, 11:20 (1B-11450)

Boundary current controlled growth of marine fishes across tropical and temperate latitudes

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Predictions of the effects of climate change on the productivity and dynamics of marine fishes are hampered by a lack of historical data on growth patterns. Biochronologies obtained from the otoliths of fishes provide important insights into their growth responses to historical climate variability. Otolith biochronologies from six species of tropical and temperate marine fishes across 23° of latitude and 3000 km of continental shelf in Western Australia showed that the strength of a regional boundary current (Leewin Current?), largely modulated by the El Niño-Southern Oscillation (ENSO), accounted for almost half of the variability in decadal growth patterns of five of the six species. Stronger flow during La Niña years drove increased growth of five of the six species, whereas weaker flow during El Niño years reduced growth. Our work is the first to provide evidence of a link between the growth patterns of adult fishes, flow of a boundary current and ENSO at spatial scales that include multiple climate zones, habitat types and depth ranges. The importance of the boundary current, which is linked to ENSO, has implications for the potential scale, timing and outcomes of climate change impacts along continental shelves.

June 1, 11:40 (1B-11526)

You can't swim from the past! Using otolith microchemistry to explore range-expansion in gilthead seabream

Jen **Lewis**, Frank van Veen, Ewan Hunter, Regan Early, and Audrey Darnaude

Affiliation

The gilthead seabream *Sparus aurata* is highly sought after in Europe both commercially and recreationally, and is currently the most prolifically farmed marine fish in the Mediterranean. Warming sea water temperatures are thought to be responsible for an apparent recent range expansion of *S. aurata* into the English Channel and Celtic Sea. Currently little is known about the UK population, but adult fish are being caught more frequently in the spring/summer months, and juveniles have been observed in recent years. Current climate trends suggest that further northward expansion in the coming decades is likely. In the Mediterranean successful wild populations rely on brackish lagoons as juvenile nursery areas, with some regions being more critical for early life stages than others. Understanding critical habitats for the successful completion of each life-stage will form part of an important evidence base to ensure that healthy local populations are safeguarded for future years. Otolith stable isotope and multiple trace element signatures will be applied to investigate key nursery areas for juveniles in the UK; to identify whether individuals caught in the UK demonstrate broad or fine scale site fidelity over their life span (in the UK or further afield); and whether different individuals exhibit specific freshwater/marine migration strategies. Greater understanding of this target fish will benefit sea-anglers and fishers, the coastal tourism sector and conservationists managing the long term sustainability of inshore fisheries.

Keywords: Otolith microchemistry; Trace elements; Fisheries; Habitat; Climate change; Range expansion

June 1, 12:00 (1B-11536)

Putting a historical plankton dataset to work for marine policy challenges: Identifying drivers of change in pelagic habitats over large temporal scales

Jacob **Bedford**[1], Martin Attrill[1], David Johns[1], and Abigail McQuatters-Gollop[1]

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Plankton make useful ecosystem indicators due to their key position at the bottom of the pelagic food web and their sensitivity to environmental change. Within the European Marine Strategy Framework Directive, plankton are used to monitor pelagic habitats towards the overall vision of 'Good Environmental Status' by 2020. This requires a thorough understanding of natural variability and drivers of change in plankton communities in order to identify signals of direct anthropogenic impact and to set realistic targets. Using historical datasets to establish a baseline state could aid in this contextual understanding by providing insight into how and why this baseline state has changed through time. Two datasets are available to apply this long term perspective on plankton indicators within the North Sea: the Continuous Plankton Recorder dataset collected by the Sir Alister Hardy Foundation for Ocean Science since 1958 , and a recently digitised collection of baseline plankton surveys undertaken by ICES from 1902 to 1914. However, differences in sampling and analysis methodologies between the two datasets results in structural differences hindering their direct comparison. Once integrated, differences in community composition between samples in datasets revealed insights into change in plankton community dynamics during the past century.

June 1, 12:20 (1B-11457)

Ocean acidification and socioeconomic impacts on the future of Canadian fisheries

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Ocean acidification (OA) challenges sustainable development through impacts on marine organisms, ecosystems, and social-ecological interactions. In this study, we projected various future scenarios of the impacts of OA in addition to climate change on Canadian fisheries, estimating changes to species' distributions and abundances, catch potential and landed values. Climate model data was coupled with a dynamic bioclimatic envelope model to predict impacts to fisheries along Canada's three coasts. This model predicts individual species' change in abundance and movement into different areas based on environmental parameters and habitat suitability. Economic impacts were estimated as changes to landed values using historical fish prices. Overall impacts of OA were negative, but differences across Canada's coasts were defined by catch composition (e.g. prominence of shellfish fisheries in the Atlantic) and highest projected changes in pH (i.e. Arctic). Using this data, we can then estimate the relative risk of coastal communities to OA and climate change. Our study will provide novel insights into the future of Canadian fisheries and contribute to the development of policies and management decisions for a sustainable future.

Session 1-C
Oral Presentations

Coastal dynamics: Changes in sea level, geomorphology and ecosystems

May 31, 14:40 (1C-11637)

A coupled model simulaton of thermal dispersion using cellular automata and numerical hydrodynamic model

Faisal **Amri** and Dadang Kurniadi Mihardja

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In this research a coupled model was used to simulate a thermal dispersion phenomenon that caused by a continuous source that came out from an outlet in a 10 km x 1 km-sized tidal channel. The thermal dispersion was simulated by using cellular automata while the hydrodynamic condition in the channel was simulated by numerical model. The hydrodynamic condition in the channel was simulated in these schemes : tidal force in the opened boundary, constant outflow rate from the outlet which was 0,4 m/s, and several wind conditions (westerlies and easterlies) as the current generator. The cellular automata model used Von Neumann neighborhood in the advection process with the cell (main and neighbooring) weighting coefficent (k_{SUA} and k_{STA}) defined as $k_{SUA} = 1 - \frac{|u|}{\Delta x}\Delta t - \frac{|v|}{\Delta y}\Delta t$ and Moore neighborhood in the diffusion procces with the cell weighting coefficent (k_{SUD} and k_{STD}) defined as $k_{SUD} = 1 - \frac{D_x}{\Delta x^2}\Delta t + \frac{D_y}{\Delta y^2}\Delta t$ .The cellular automata model was evaluated and compared with analytical model and numerical model in synthetic opened-water area as the model domain. The evaluation of cellular automata model showed a similar result with relative (absolute) difference belows 9,13 % (0,001^{o}C) compared to analytical model while the relative (absolute) difference belows 43% (0,3^{o}C) compared to numerical model. Comparison of coupled model with weighting coefficient as stated before with numerical model also showed similar result with relative (absolute) difference belows 7% (0,42 ^{o}C).

Keywords : Thermal Dispersion, Cellular Automata, Synthetic Area

May 31, 15:00 (1C-11562)

How will sea level rise and changing offshore wave conditions affect the future nearshore wave climate?

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Nearshore wave energy flux is responsible for coastal mixing, sediment transport, and erosion. Previous studies have evaluated the future wave climate under increased greenhouse gas emission scenarios by forcing global wave models with wind data from global climate models (GCMs). Due to the coarse resolution of these models, the effect of changing offshore wave conditions and sea level rise on the nearshore wave climate is relatively unknown.

We address this gap of knowledge by simulating the southwest Western Australian (SWWA) nearshore wave climate under two representative concentration pathways (RCP4.5 and RCP8.5) with and without mean sea level rise. A high-resolution regional Simulating WAves Nearshore (SWAN) wave model is nested into an ensemble of global wave models and forced with winds from GCMs participating in the Coupled Model Intercomparison Project (CMIP5).

Results indicate that the SWWA shelf and nearshore wave climate is more sensitive to changes in offshore mean wave direction than offshore wave heights. In shallow water (< 30 m), the annual mean wave energy flux increases by up to 20% with sea level rise as a result of decreased wave dissipation. In winter months, the longshore wave energy flux, which is responsible for coastal erosion increases by up to 62% under the RCP8.5 greenhouse gas emission scenario. The study highlights the importance of using high-resolution regional wave models to evaluate future wave climates, since coastal wave climate is more sensitive to changes in wave direction and sea level rise than the offshore wave heights.

May 31, 15:40 (1C-11620)

GIS analysis of sea level rise; impact on fish resources and sustainable solutions

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Sea level rise due to climate change, affects the biophysical and socio-economic aspects of coastal environment. These effects include: coastal flooding and erosion, salinity intrusion, decline in fish resources and socio-cultural impacts. Though, studies have continuously focused on proffering solutions to mitigate these effects, none has provided any sustainable one. Therefore, the aim of the research was to investigate the impact of sea level rise on fisheries resources along the Nigerian coast and proffer sustainable solutions of resilience nature. We considered scenarios base on Intergovernmental Panel on Climate Change (IPCC) for sea level rise, and other extreme scenarios. Also, a Geographic Information System (GIS) model was adopted to show the significant impact of sea level rise on the fish resources along the coast. A sustainable climate change resilient tool was utilised to proffer sustainable solutions. A decline in fish resources along the coast was recorded, due to sea level rise and other pressures, which also affected distribution of fish resources and habitat modification. We also present possible resilient-adaptive measures to the Nigeria coastline. In general, it is difficult to predict the level of biodiversity of fish resources and their distribution along the coast, caused by climate change and other pressures.

Keyword: Climate change resilient; GIS; fish resources; Marine coastal ecosystem; Sea level rise

May 31, 16:00 (1C-11611)

Long-term variations of simulated sediment flux and deposition of marine litter along the south-eastern Baltic Sea coast as possible indicator of climate change

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The south-eastern margin of the Baltic Sea mainly consists of long interconnected segments of sedimentary coasts. These coasts consist primarily of relatively soft and easily erodible sediment and are sensitive to any changes in the hydrodynamic loads. The development of coasts in this area is controlled mainly by waves due to almost non-existing tidal processes. Wave driven alongshore drift includes the direct wave driven relocation of sediment grains and the impact of strong currents that are created in the surf zone by breaking waves. There are several sediment transport divergence and convergence points across the Latvian coast of Baltic Sea. Some points are very stable and some change from year to year. Marine litter along the coast is distributed by the same forces as sediment and might have some similarities with areas of sediment deficit and concentration. Marine litter, like unidentified plastic pieces, polystyrene foam and plastic rope, might end up in similar places where the sediment accumulates along the coastline. Heavier pieces like coal might be thrown on coast by the strongest waves. Sediment and marine litter concentration places might indicate changes in wave patterns along the coast, consequently show some possible tendencies in climate change. Sediment transport along the eastern Baltic Sea coast was evaluated using Coastal Engineering Research Council method and wave data from WAM wave model and adjusted geostrophic winds for 1970–2007. More than 160 beach litter surveys were conducted at Latvian coastline from 2012-2016 according to UNEP/IOC Guidelines on Survey and Monitoring of Marine Litter.

June 2, 09:30 (1C-11660) (CANCELLED)

The role of suspended sediment transport in coastal erosion and recovery

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As sea level rises and storm intensity changes, the world's coastlines are being subject to increasing erosion. Winter storms in 2013-2014 removed extensive amounts of sand from the Southwest coast of England, and recovery is still on going. Recovery from these large storms has traditionally been thought to occur during calm periods, but a new field study will test the hypothesis that storm recovery requires smaller episodic high-energy events. Furthermore, the role of suspended sediment in coastal erosion and recovery remains understudied. Presented here will be initial findings from February-March 2017 field measurements on an exposed sandy coast in Cornwall, United Kingdom. Using turbulence and velocity measurements to understand hydrodynamics causing transport and erosion coupled with measurements of suspended particulate and particle size information, we will describe the response of Perranporth Beach suspended load to winter storms, both small and large, and begin to feed this information into a new conceptual understanding of coastal erosion and recovery.

June 2, 09:30 (1C-11527)

Looking into the potential role of sediment processes in the productivity of the waters of the harmful algal bloom-infested Murcielagos Bay, Philippines

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Murcielagos Bay is a relatively small and shallow bay located in the northwestern part of Mindanao in the Philippines. It has been affected by recurring blooms of *Pyrodinium bahamense* var. *compressum*, resulting in a shellfish ban enforced by the Bureau of Fisheries and Aquatic Resources from 2009-2013. Field data, hydrodynamic, residence time and water quality models show that the small, stratified embayment in the southern part of the bay, called Sapang Dalaga, has a long residence time which may have an impact on the water quality and recurrence of blooms. A 24-hour field monitoring in November 2013 showed higher than usual chlorophyll-a values ranging from 0-40 ug/L and higher nutrient concentrations were observed at the bottom of the water column. Preliminary results from water quality modeling showed increasing chlorophyll-a (proxy for phytoplankton) values with increasing nutrients. While anthropogenic activities in the area have yet to be assessed, it is equally important to note that shallow waters are prone to sediment re-suspension, which affects the nutrient budget. Hence, the close coupling between the sediment bed and water column will be examined and the potential role of sediments in determining the productivity of the bay will be examined through a DELFT-WAQ sediment-water interface water quality model.

June 2, 09:50 (1C-11561)

Coastline change rate estimation and forecast of Amery ice shelf, Eastern Antarctica: A remote sensing and statistics-based approach

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The present study indicates that Amery ice shelf (AIS) morphology is controlled by the physical forcing (mainly sea surface temperature, wind-parameters, and surface pressure) and global human interventions. The changes in ice shelf positions of AIS, Eastern Antarctica, are investigated for a period of 15-years (2001-2016) using multi-dated MODIS satellite images. The study area extends for about 460 km was divided into three sectors and each sector into a number of transects at uniform intervals (i.e, 5 km). Further, past coastline positions have been demarcated and future positions are estimated for 5- and 10-years period. The rate of change in AIS coastline position has been estimated using the statistical methods—end point rate, average of rates and linear regression—and cross-validated with correlation coefficient and root-mean-square error (RMSE) methods. Resultant changes in the AIS coastline have been inferred from the estimated values of the back-calculated errors. About 51% of transects exhibit ±200 m RMSE values, indicating better agreement between the estimated and satellite-based ice-shelf positions, and the transects closer to the sectors boundaries exhibit 47% uncertainties in coastline change rate estimations. Based on the values of correlation coefficient and RMSE, the influence of physical/natural processes and global anthropogenic activities on coastline changes has been calculated. Significant morphological changes in Amery Ice shelf have been recorded at every 5-years and attempted linked with major climatic events. The present study demonstrates that the combined use of satellite imagery and statistical techniques can be very useful in quantifying and predicting the coastline changes.

June 2, 10:10 (1C-11599)

Influence of tides and coastal morphology on storm impact in Boracay and Bantayan islands: A case study from super typhoon Haiyan (Yolanda)

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When super typhoon Haiyan entered central Philippines in 2013, it generated 0.1-7m storm surges that damaged infrastructures, caused casualties and contributed to coastal erosion. Understanding storm-induced coastal erosion is crucial to sound coastal management and vulnerability assessment. This study assessed the morphological impact of Haiyan (12 days to a month after) and the short-term post storm recovery (within five to six months) along the 12 and 6 km beaches of Bantayan and Boracay, respectively. Impact on and recovery of the beaches were measured by using shoreline change analysis, beach profiling and volume change calculation. The islands were assessed as they lie along the typhoon path and because of their economic importance as tourist destinations.

Immediately after super typhoon Haiyan, both islands eroded with lower and narrower profiles losing 6 m3/m and 2 m3/m. Six months after, Bantayan initially recovered with higher and wider beaches gaining 4 m3/m. Boracay beach further lowered, narrowed and eroded roughly 6 m3/m of materials.

Considering the storm's high intensity, the impact on both islands was less intense than anticipated. Wave run-up only reached normal high tide with Haiyan striking at low tide. The fairly straight to convex shape, beach topography, wide reef flat, nearshore bathymetry, parallel orientation to storm path and wave exposure to monsoon winds also limited the damages. During recovery, wind exposure, longshore transport and nearshore topography subjected Boracay to further erosion. Knowledge of contributing factors to storm-induced erosion and its recovery rate is crucial in estimating and mitigating future impact to coastal areas.

June 2, 11:10 (1C-11519) (CANCELLED)

Seasonal fluctuations of the velocity field over the entire Kuroshio region

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The Kuroshio, a strong current that is located in the western boundary of the North Pacific, plays a vital role in marine fisheries and climate variability. Not only does the Kuroshio transport the larvae and fry of numerous fish species, it also supplies significant heat and moisture into the atmosphere in the North Pacific. Therefore, a lot of studies have focused on seasonal and inter-annual variations of the Kuroshio in terms of its velocity, current path and volume transport. As the previous studies have investigated the seasonal features of the Kuroshio in individual regions, the unified seasonal feature over the entire Kuroshio region still remains unclear. By using the data collected by satellites and assimilation model's outputs, we aim to show the seasonal variation of the velocity field over the entire Kuroshio region (from off Luzon Island to south of Japan) and give an insight to its driving mechanism. The result shows that the transport variation reaches maximum coincidently in July from east of Taiwan to south of Japan, while its minimum value occurs differently from place to place. In places where there is a land boundary on the west of the Kuroshio (Taiwan and Japan), the minimum velocity appears in February or March. While in the place without a land boundary (the East China Sea), it turns to November. To clarify the driving mechanism, we are now designing a numerical experiment, considering both remote and local process.

Session 2-A
Oral Presentations

Introduction of anthropogenic substances to the ocean and their impacts

May 30, 13:50 (2A-11549)

Atmospheric deposition of reactive inorganic nitrogen in Uljin, South Korea

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We investigated the amount and effect of wet and dry deposition of reactive inorganic species (N_r, NO_3^- and NH_4^+) to a marginal sea (East Sea) of the East Asia. Total suspended particles (TSP) and precipitation samples were collected in Uljin, a coastal city of eastern South Korea. Sampling periods were from October 2013 for precipitation samples and March 2014 for particulate samples to April 2016. The flux ranges of wet N_r deposition were 0.04−12.79 mmol N m^{-2} $month^{-1}$ with ~56% contribution from NO_3^-. The average concentrations of N_r associated with TSP were 1.93 ± 2.16 μg N m^{-3}, of which NH_4^+-N accounted for about 56%. Wet N_r deposition were highest in summer and lowest in winter, which was mainly due to seasonal variations of precipitation. However, atmospheric particulate N_r were greatest in spring in which Asian dust events frequently occurred. The potential impact of N_r deposition to the East Sea will be presented.

May 30, 14:10 (2A-11575)

Anthropogenic loads of Urea-N along the Ennore Creek, South India and its implications on the adjacent coastal waters.

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Globally, coastal water bodies of urban regions tend to have an enormous pressure of anthropogenic activities and results in excess supply of nitrogen inputs in to the adjacent coastal waters. Ennore creek located in Northern part of Chennai Metropolitan city in the Tamilnadu State, India is one such an example as it receives treated and untreated effluents from various industries along with domestic sewages. Urea is one of the well-known organic forms of nitrogen having wide range of natural and anthropogenic sources and widely considered as it triggers algal blooms in the coastal region. India an agricultural nation has exponentially increased the usage of urea as nitrogen fertilizer in the recent years and ultimately the diffusion of such excess application ends up in the coastal waters. Despite its high importance, studies on the distribution of urea along the coastal waters of India are still sparse.. Considering these factors, a study on the distribution and seasonal variation of urea in the Ennore creek and its adjacent coastal water was carried out from December 2014 to February 2016. The results revealed that, the concentrations of urea in the Ennore creek ranges from 1.76 μM to 50.24 μM, which is found to be higher than the previously reported values from the coastal regions elsewhere. Input of such huge amount of urea in to the adjacent coastal waters, enforcing a significant changes on the phytoplankton assemblages. The present study strongly emphasis the need of regular monitoring of urea on the coastal water of the agricultural based country like India.

May 30, 14:30 (2A-11584)

Impact of land use and seasonal climate on biogeochemical cycle of silicon (macronutrient) in the Indian estuaries

Mangalaa **Kameswari Rajasekaran**[1], D. Cardinal[1], J. Brajard[1], V.V.S.S. Sarma[2], Djouraev Irina[3] and N.S. Sarma[4].

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Seasonal climate and land-use are the major processes that alter nutrient supply in the estuaries, affecting the ecosystem health and biogeochemical cycles. Silicon (Si) is an important nutrient for diatoms and Si:N imbalance can dramatically alter estuarine and coastal ecosystems. In general, the impact of anthropogenic activities might result on increased supply of materials (N, P and other pollutants) but, adverse effects on Si supply based on the different land use (e.g., dam construction, deforestation) patterns. Compared to N, P and C, the Si cycle is less studied in land-ocean continuum, especially in the tropics, though 74% of riverine Si input. We present the first study of biogenic silica (BSi or ASi), dissolved silica (DSi) and lithogenic silica (LSi) distribution and their relationship with other biogeochemical parameters in 26 Indian tropical estuaries during monsoon and non-monsoon periods. In addition, we attempted to report the effect of land use on Si cycle. There is an existence of clear seasonal influence on ASi and DSi variability due to the monsoonal effect and the total ASi, DSi and LSi flux from the Indian estuaries are 2.6, 26 and 144 x 10^6 kmol to the northern Indian Ocean during wet period respectively. The wide plains and increased agricultural activities on the eastern regions are responsible for the Si variability and higher concentration when compared to the western estuaries. Nevertheless, the increasing urbanization, deforestation and agriculture alarms that, Si cycle is possibly getting affected in the future.

May 30, 14:40 (2A-11616)

Levels and origin of polycyclic aromatic compounds in Adriatic Sea

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Polycyclic aromatic compounds (PAC) were investigated in 29 sediment samples from the Eastern Adriatic Sea (Mediterranean Sea). PAC concentrations ranged from 14,98 to 23970,92 μg kg^{-1}. The highest PAC levels were determined in sediments from the Sibenik Bay and the lowest PAC levels were determined in open sea sediments. Unsubstituted PACs predominated in sediments from the Sibenik Bay and the Coastal area, while methyl-substituted PACs were dominant in sediments from the open sea area and the Kastela Bay. Benzofluorantenes were dominant PAC compounds in most of investigated samples. The pyrogenic origin of PACs was determined for each station in the Sibenik Bay and the majority of stations in the Coastal area, while in the open sea area PAC originated from petrogenic sources. Equal contribution of pyrogenic and petrogenic sources was determined in the Kastela Bay. Positive Matrix Factorization (PMF) provided detailed and accurate information on the PACs' origin that can be applied in coastal management purposes. A high level of pollution was determined at K3, P3 and P9, whereas moderate pollution was determined in other investigated stations of the Kastela Bay and the Coastal area. A low level of pollution was determined for each station in the open sea area. Due to a very high level of pollution, determined at each station of the Sibenik Bay, the entire Sibenik Bay can be considered a HOT SPOT area.

May 30, 15:30 (2A-11402)

The bulk Fluorescein Diacetate Assay (FDA) as a technique for evaluating biotic impacts of crude oil to coastal sediments

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This study adapted the bulk fluorescein diacetate (FDA) assay to evaluate the impact of crude oil on biological activity levels in marine sediments. Sediment cores from the Elkhorn Slough, California were incubated with different levels of sweet crude oil (Deepwater Horizon, Macondo Prospect) in the Moss landing Marine Laboratories aquarium facility over a 30 day period. During this period, the amount of fluorescein released, concentration of oxygen in overlying waters, and flux of oxygen into the sediments were monitored. For all treatments a strong negative correlation between added oil and FDA production was observed ($p<0.05$). The concentration of oxygen in the topmost 2mm of sediment cores decreased linearly with addition of crude oil and correlated positively with fluorescein released ($p<0.05$). A linear increase in sediment oxygen flux was also observed upon crude oil addition. The miniaturized bulk FDA assay could be powerful in evaluating oil spill impacts in coastal systems.

Keywords: crude oil impacts, marine sediments, fluorescein diacetate, Macondo Prospect

May 30, 15:50 (2A-11532)

Differences in variations of heavy metal concentrations in muscle tissues of representative fish species of the Baltic Sea and the Gulf of Riga

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During the study concentrations of mercury (Hg), copper (Cu) and zinc (Zn) were measured in muscle tissues of five commercially important fish species (cod, herring, perch, flounder and round goby) of the Gulf of Riga and the Baltic Sea. Later variations of the concentrations were compared with changes in fish size, weight, age, relative and nominal content of lipids, and pollution level of the sampling site for every species. Mercury concentrations were found in ranges from 3.37 to 293.03 $\mu g\ kg^{-1}$, with the highest mean concentration in elder perch individuals (101.16 $\mu g\ kg^{-1}$ wet weight for 6 years old perch). In general, the means of mercury concentrations in every age group of every species were higher than environmental quality standards (20 $\mu g\ kg^{-1}$ wet weight) defined by directive 2000/60/EC of the European Parliament and of the Council. Moreover, increase of mercury concentrations was not gradual for some species. At the same time relative content of lipids was dropping with aging in flounder and round goby, it was increasing in cod and remained relatively constant in perch and herring. More dissimilarities were found for concentrations of Cu and Zn. Rates of the concentration increase were changing according to dietary preferences at different age stages of the fish. The study was aimed to describe the cause and effect relations in contamination process with focus on bio-magnification of the heavy metals in edible fish tissues.

May 30, 16:10 (2A-11642)

The influence of material properties on the transport processes of buoyant marine plastic debris

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Plastic material is the most abundant form of marine debris. Plastics harm marine life through entanglement, ingestion and by the transport of invasive species. The extreme durability of plastic makes it a particularly hazardous pollutant of the marine environment. Its longevity enables buoyant plastic debris to traverse entire ocean basins. As such, plastic contamination of the oceans is a global issue. The transport processes of buoyant debris depend on specific material properties such as size, density, rising speed and windage coefficient (the susceptibility to direct wind forcing). Different transport processes can lead to significantly different spatial and temporal distributions of marine plastic debris. A good understanding of the transport processes is therefore essential to optimize monitoring, mitigation and clean-up strategies. This study determines several material properties of different macroplastic samples. The influence of these properties on the transport of the samples is investigated using both laboratory flume and field experiments. Finally, the effect of the material properties on the distribution of marine plastic debris in the Indian Ocean is considered. This is done by performing a series of sensitivity analyses using numerical particle tracking and ocean current models. The results of this study can be used to determine areas of specific interest to monitor and focus sampling efforts on.

May 30, 16:30 (2A-11452)

Microplastics occurrence and characteristics in Mediterranean surface waters

Giuseppe **Suaria**[1], Carlo G. Avio[2], Francesco Regoli[2] and Stefano Aliani[1]

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Numerical models predict some of the highest concentrations of floating plastic in the world to occur in the Mediterranean Sea. Here we present the results of a large-scale survey of neustonic micro- and mesoplastics in Mediterranean surface waters, providing the first extensive characterization of their polymeric identity, as well as detailed information about their size, abundance and geographical distribution. Plastic particles were found in all 74 samples collected with a mean concentration of 1.25±1.62 particles/m^2 and 703.16±1573.95 g/km^2, confirming the Mediterranean Sea as one of the most heavily impacted regions of the world with regards to plastic pollution. More than half of all collected particles were smaller than 500 μm suggesting very high fragmentation rates. Sixteen different classes of synthetic materials were identified through ATR FT-IR analysis (n = 4050 particles). Polyethylene, polypropylene, polyamides and plastic-based paints were the most abundant polymers, followed by poly(vinyl-chloride), polystyrene, poly(vinyl-alcohol), poly-epoxides, PET, poly-isoprene, poly(vinyl-stearate), ethylene-vinyl acetate and paraffin wax. The first record of polycaprolactone, a biodegradable polyester floating in off-shore waters is also reported. We estimate that during our survey, between 2.2 and 4.0 x 10^{12} synthetic particles and between 933.4 and 2675.4 tonnes of plastic were floating in the Mediterranean basin, providing further evidence about the magnitude of this problem for the entire region. Geographical differences in the relative proportions of these floating polymers were also observed, demonstrating sub-basin scale heterogeneity in plastic composition and likely reflecting a complex interplay between pollution sources, sinks and residence times of different polymers at sea.

May 30, 16:50 (2A-11533)

Accounting for invasive species impacts within Life Cycle Impact Assessment

John S. **Woods** and Francesca Verones

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Oceans facilitate shipping and thus the transport of goods globally. However, shipping (ballast water and hull fouling) is the predominant pathway for the introduction of alien species in the marine environment. Alien species may become invasive and damage marine ecosystems via out-competition of native species for biotic and abiotic resources. Consumption of goods transported by sea is therefore driving marine ecosystem damage due to invasive species. Invasive species are now a widespread problem, with only 16% of marine ecoregions globally having no reported marine invasions.

We developed a model for quantifying the potential impact of invasive species, introduced in association with the transportation of goods via shipping, on marine ecosystems, within the framework of life cycle assessment (LCA). LCA is a widely used tool for assessing potential environmental impacts of a product or process over its entire life cycle.

We model impacts on marine ecosystems based on data pertaining to bilateral trade, shipping trade routes and environmental conditions in source and receptor coastal regions. We account for the distribution, threat and introduction pathways for marine invasive species from different taxonomic groups. Our developed model characterizes i) the pressure placed on receptor coastal regions in terms of the amount of shipping required to satisfy consumption of goods transported by sea to each country (number of ‘average ships’ / tonne of good consumed) and ii) the potential ecosystem damage caused by an increase in ‘average ships’ (potentially disappeared fraction of species / ‘average ship’).

Session 2-B
Oral Presentations

Ecosystem-Based Management – Get the big picture

May 30, 09:20 (2B-11680) (CANCELLED)

Resilience of coral reefs to climate change and anthropogenic disturbances in the Gulf of Mannar

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Coral reefs and atolls are significant submarine features of tropical and subtropical regions formed by the long-term accumulation and compaction of skeletons of lime secreting organisms. Coral ecology interactions occur between coral animal and physical environmental condition, and between coral polyps and other marine organisms. This research paper identifies ecological goods and services of coral reef ecosystems, with special prominence on how they are generated. Goods are divided into renewable resources and reef mining. Services are classified into information services, physical structure services, biogeochemical services, biotic services, and social cultural services. The consequences of human impacts on coral reefs are also discussed, including the loss of hardiness, or buffer capacity, and human economic activities such as deforestation or industrialization that may adversely impact corals in their habitat.

May 30, 10:00 (2B-11126)

Top-down or bottom-up? Investigating the effects of fishing pressure and primary productivity on benthic size spectra

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The importance of top-down (e.g. fishing pressure) and bottom-up (e.g. primary production) processes have on marine ecosystems is strongly debated. This is because marine ecosystems are highly variable. For instance, if you were to sample the seabed in two areas a kilometre apart. One sample may contain thousands of different worms, molluscs and other small organisms, while the other may contain a completely different suite of species, or just as likely, very few organisms at all. Samples that strongly differ from each other can result in "noisy data", which is very difficult to interpret and draw any solid conclusions.

To help simplify ecological research, we can employ a method known as "Size Spectra" which focuses solely on measuring the body size and abundance of populations. In doing so, we can effectively simplify an entire ecosystem to a single graph, able to indicate levels of disturbance, energy flow and production. Despite these benefits, the size spectra of marine ecosystems remains a poorly understood area. Hence, in 2015 and 2016, we spent eight weeks in the Celtic Sea deploying a series of grabs, dredges and trawls which captured the full size spectra of animals ranging in size from the smallest nemertean worm, to the largest fish. As we surveyed sites across a gradient of fishing pressure and primary productivity, we can determine just how important the impacts of fishing are, or whether natural processes such as primary productivity remain the most important factors.

May 30, 10:20 (2B-11464)

The who, what, and where of global shark catch: the Mediterranean and Black Seas

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One in four fishes in the class Chondrichthyes (sharks, skates, rays, and chimaeras) is threatened with extinction, according to the International Union for the Conservation of Nature's Red List. The primary threat to chondrichthyans is overfishing, but the taxonomic resolution of existing catch statistics is often so low that species-level impacts are overlooked; most of the catch is lumped into categories like "sharks" or "sharks, skates, and rays". The Sea Around Us database of global fisheries contains reconstructed catch data from four fishing sectors (industrial, artisanal, subsistence and recreational), two catch types (landed versus discarded catch) and two types of reporting status (reported versus unreported) for the Exclusive Economic Zones (EEZs) of all maritime countries and territories of the world from 1950-present. This research aims to develop a method to taxonomically disaggregate catch statistics to reduce their current ambiguity Using countries in the Mediterranean and Black Seas as a case study, domestic annual species-level catches of will be estimated using species distributions and species-level fisheries data (e.g., catch amount and gear used) from adjacent EEZs. The calculated catches will be allocated spatially within a half degree latitude by half degree longitude grid. This research will uncover catches of species that are typically underrepresented in fisheries data and will also identify regions of the Mediterranean and Black Seas that require attention from fisheries managers and conservation groups. Additionally, we seek to clarify our current understanding of important fisheries issues effecting chondrichthyans including misidentified catch, bycatch, and illegal, unreported, and unregulated fishing.

May 30, 11:00 (2B-11652)

Understanding the effects of large scale stock enhancement using quantitative and qualitative modelling approaches

Zhongxin **Wu**[1,2,3], Xiumei Zhang[1], Hector M. Lozano-Montes[4] and Neil R. Loneragan[2]

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Large-scale release programs of cultured juveniles and massive deployment of artificial reef are being increasingly implemented in recent years along the seacoast of China, aiming at restoring the marine environment and promoting fishery production. However, little is known about these interventions' impacts at the level of ecosystem. This study, concentrating on a representative of restocking reef zone of northern Yellow Sea, used the mass balance model Ecopath with Ecosim (EwE) and qualitative network model to evaluate the effects of the practices of releasing sea cucumber *Apostichopus joponicus* and abalone *Haliotis discus hannai* on ecosystem sustainability. The stock enhancement process was simulated in EwE by linearly increasing the target stock scale from the current biomass to its estimated ecological carrying capacity. Meanwhile, the qualitatively specified community matrix and signed digraphs that covered the variable interactions of released species were constructed to visually represent the community impacts of stock enhancement. The simulated results of quantitative and qualitative models both showed that the practice of enhancing *A. joponicus* within its limit of ecological carrying capacity was likely to strengthen the system stability, as a result of detritus feeding sea cucumber accelerating the recycling efficiency of system detritus pool. In contrast, the simulated releases of *H. discus hannai* beyond its optimal release ranges would rapidly weaken the sustainability of current system, since the large number of introduced *H. discus hannai* through grazing decrease the system energy throughput, and might subsequently affect the system sustainability. This study informed that release programs of grazing invertebrates should consider an ecosystem risk assessment so that it is sustainable.

May 30, 11:20 (2B-11406)

Quantifying top-predators' use of hydrodynamic features in coastal regions; applied and ecological consequences.

JJ **Waggitt**[1], PGH Evans[2], SJ Fraser[3,4], PW Cazenave[5], EA Masden[6], PE Robins[7], AMC Robbins[8], BE Scott[3], R Torres[5], G Veneruso[7], HM Wade[9], BJ Williamson[3] and T Whitton[7]

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The construction of anthropogenic structures within coastal regions, in particular those associated with marine renewable energy installations, will change these environments physically through the alteration of hydrodynamic regimes and the removal of energy. In coastal regions, top-predators (cetaceans and seabirds) often exploit hydrodynamic features (e.g. eddies, divergences/convergences, shear-lines) originating from interactions between tidally-driven currents and bathymetric features for foraging opportunities. These opportunities likely concern the aggregation of exploitable prey items at very predictable and particular times and places, reducing searching and capture costs and therefore increasing foraging efficiency. An increased understanding of precisely how top-predators exploit these hydrodynamic features, including the physical quantification and comparison of the features being used, could allow the impacts of anthropogenic developments to be better predicted and mitigated. Comparisons among species, seasons and sites would also offer insights into the mechanisms driving inter and intraspecific variations in foraging strategies. To improve our understanding, observational surveys have been combined with computational models to quantify relationships between foraging activity and hydrodynamic features in coastal regions characterised by strong tidal currents in northern Scotland and Anglesey. Numerous associations were found between top-predators and hydrodynamic features. Differences in associations among species, and within species across seasons and sites, suggest that foraging strategies were likely determined by a combination of fundamental behaviours and spatiotemporal variations in resource availability and requirements. Further work is concentrating on understanding how hydrodynamic features could directly influence prey behaviour and abundances within coastal regions - knowledge which could help explain the associations detected within these studies. Results indicate that impacts from anthropogenic developments could be species, season and site-dependent. Such knowledge should be used when conceiving mitigation measures aiming to reduce the potential for negative impacts on top-predators.

May 30, 11:20 (2B-11688) - (CANCELLED)

Constraints and opportunities and their effects on catch in the multispecies and multigear fish aggregating device (FAD) fisheries

Edison D. **Macusi**[1,4*] Paul Van Zwieten[1], Ricardo P. Babaran[2] and Wolf M. Mooij[3]

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Constraints in fishers' effort allocation include intrinsic factors to the fishery as time (actual days for fishing, travel time), operational factors (fuel, ice, crew), and strategic investments (boat and gears). Also, extrinsic factors that limit or enhance fishing effort such as landing sites, infrastructures and management regulations for the fishing fleet. This paper investigates how various constraints on the tuna FAD fisheries affects catch and revenue. Catch could be potentially affected by operational, time constraints, and the distance that fishers traverse to fish. Our data was derived from interviews with fishers from Mati City, Lupon, Governor Generoso and General Santos City (n=229). Constraining factors related to catch were chosen based on exploratory factor analysis. Catch and revenue were standardized and related to fuel trip, crew, species, distance travelled by using regression. Results show that operational factors: fuel trip (40%), crew (21%) and time constraint, gear soak time (17%) are main constraints. Catch was explained mainly by fuel trip and crew (r^2=42%; P<0.0001) and further analysis with gear types show that fuel trip, crew, gear types and crew x gear types interaction were significant (r^2=81%; P<0.0001). Handlines showed positive relationship between increasing number of crews, while for ringnets and purse seines, increasing number of crews did not increase catch. Direct comparison of catch of different gears show that purse seine catch rate was highest 1448kg/100hp/day followed by handlines catch rate 267kg/100hp/day, ringnet 246kg/100hp/day and then the 'small lines'79kg/100hp/day (r^2=42%; P<0.0001). A direct comparison of revenues of the different gear types show that purse seines have the highest revenue Php 51,558/100hp/day, followed by handlines Php 13,441/100hp/day, ringnets Php 5,506/100hp/day and 'small lines' Php 2,039/100hp/day (r^2=27.35%; P<0.0001). The examined overall catch rates and revenue increase with distance.

May 30, 11:40 (2B-11583)

Fisheries ecology, economics and social wellbeing: balancing the approach.

Andrew Frederick **Johnson**[1], Andrés M. Cisneros-Montemayor[2], Catalina López-Sagástegui[3], Edward H. Allison[4] and Octavio Aburto-Oropeza[1]

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Marine fishery scientists are primarily charged with describing current problems, future outcomes and likely solutions for marine fisheries before stocks collapse, habitats are irreversibly damaged and food security reduced to dangerous levels. One important question, however, will always remain no matter how much rigorous scientific output is produced: Is this dedicated scientific community focusing its efforts in the right direction? Here we use an extensive bibliographic search and found that although research output is increasing, our results challenge the direction in which it is developing. A common bias towards ecological followed by economic and social wellbeing studies needs to be reversed, and conclusions must be drawn across generally smaller spatial scales more relevant to real-world management applications. In order to examine these patterns on a case-specific level and corroborate our findings, a detailed examination for three contrasting fisheries management interventions was undertaken: 1) the Newfoundland Cod moratorium, 2) the North Sea Plaice box formation and 3) the recent Upper Gulf of California gillnet ban. We also suggest that a potential disconnect between research effort and management application can be remedied if more multi-disciplinary approaches are taken in which studies combine ecology, economy and social wellbeing in fisheries rather than leaving the latter two as secondary remarks or foot-note comments. In order for this change to take place, however, it may also be necessary to look further into other potential drivers of the research biases such as funding agencies, data availability and career pressures focused heavily on impact factors.

May 30, 12:00 (2B-11647)

Offshore wind management in China - Based on ecosystem approach

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As the first large scale commercialized ocean energy in China, offshore wind management has been put on the schedule of marine management. The basis way of offshore wind management approach in China is Marine Function Zoning (MFZ). By considering about the offshore wind resources and demands, sea use compatibility, marine protected areas etc., there are 22 offshore wind zones in 7 provinces that have been defined in provincial MFZ. As the priority zones for offshore wind siting by developers and project permitting by management departments, offshore wind zones play an important role in realizing the sustainable development of regional sea areas. Besides, there are 2 management rules of offshore wind zones published in recent years to keep the offshore wind development activities more eco-friendly. The rules set management items such as the site extent should keep certain distance away from the coastline, the EIA document should be submitted to certain department, and what kinds of marine environment protection rules should be followed. For the ecosystem-based offshore wind management, the published rules do make a significance progress, not only because offshore wind management is a new subject to management departments, but also the items require agreement by many stakeholders that have little experience about offshore wind to base a decision.

Session 2-C
Oral Presentations

Evaluation of best management practices

May 31, 09:30 (2C-11696)

The importance of seascape and ecological factors for an effective use of marine artificial structures as habitat for canopy-forming seaweeds

Filippo **Ferrario**[1,5], Thew Suskiewicz[1], Ljiljana Ivesa[2], Elizabeth Strain[3], Shimrit Perkol-Finkel[4], Ladd E. Johnson[1] and Laura Airoldi[5]

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Man-made structures are sprawling in marine seascapes because of increasing coastal populations; pressing development, energy demand and greater risk of coastal hazards from climate change. Moreover, artificial reefs are being used in coastal areas in attempts to offset habitat loss and mitigate coastal development impacts. Interest is growing in designing marine developments that maintain vital ecosystems and critical services as well as in implementing sustainable offsetting strategies having a low risk of failure. Unfortunately, progress has been hindered by poor understanding of the ecology of these artificial habitats and their integration in marine seascapes. In particular, overlooking the effect of strong ecological interactions adds a high level of uncertainty to the expected evolution of benthic communities and habitat formation on artificial structures. Here we present field-based research conducted in two different temperate regions – Mediterranean Sea and Atlantic Canada – to assess the performance of artificial structures as habitats for valuable canopy-forming large brown seaweeds (i.e. Fucales and Laminariales). We demonstrated that grazer driven top-down control can seriously compromise the growth potential of canopy seaweeds on artificial structures compared to natural rocky reefs. Importantly, the impact of grazers is influenced by the bottom composition and habitat heterogeneity, suggesting that seascape could modulate the biotic control. This knowledge is fundamental to ensure the persistence of key ecosystem functions when designing artificial marine structures, and planning restoration/development projects. We thus advocate for an urgent need of habitat mapping of coastal subtidal areas and research on the ecology of potential grazers.

May 31, 09:50 (2C-11576)

The ANChor project: Appraisal of Network Connectivity between North Sea subsea oil and gas platforms

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Installations of oil and gas platforms across the North Sea have introduced hard substrate to the seafloor which has been colonized by hard-bottom marine organisms: algae, mussels, tube-building worms, hydroids, anemones and reef-building corals. Platforms have been thought to function as "artificial reefs" in the North Sea for decades. Whether the platforms work as an inter-connected reef network is not known.

As the North Sea enters the decommissioning era, it becomes crucial to understand how platform removal will affect the overall structure and functioning of North Sea ecosystems. To evaluate whether the removal of decommissioned platforms will have more than a local effect on the marine ecosystems of the North Sea, we study the connectivity among subsea platforms. We aim to determine the temporal and spatial scales at which the populations of benthic marine organisms established on the platforms are linked through larval connectivity, and the sensitivity of regional networks to re-configuration. To this end we carried out a series of particle tracking simulations using an Individual Based Model capable of simulating planktonic larvae with different life history characteristics (i.e. Pelagic Larval Duration (PLD), depth preference, timing of release) coupled to a high horizontal resolution (~1.8 km) ocean circulation model of the Northwest European Shelf.

Regional differences in connectivity are expected due to the different oceanographic regimes in the different regions of the North Sea and the geographical distribution of the platforms. Larval characteristics, particularly PLD, are expected to drive differences in the connectivity patterns of the different species modelled.

.May 31, 10:10 (2C-11591)

Assessing coral recruitments and biodiversity in and around permeable submerged breakwaters (PSBs) in view for future considerations of active managements in Mauritius

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Mauritius has seen rapid developments and the tourism sector has been one of the main pillars for the flourishing economy. Considering the size of the island and the little space available along the shore, hotels are now being constructed in areas with previously no sandy beaches and thus provisions had to be made for beach improvement work and lagoon rehabilitation in terms of placement of Permeable Submerged Breakwaters (PSBs). In addition, these PSBs are found most appropriate as substrate for coral recruitment and coral transplant. This research investigated the colonization of various species in 3 stations and the PSBs in the north-west region. These structures have created habitats not only for corals but fishes and other marine organisms whether natural reef structures were present or absent. Biodiversity around the PSBs have increased rapidly with different coral species. Coral recruitment (<2mm) were 2.0 ± 1 recruits/m^2 (mean ± SD) on Station 1 (Control), 3.0 ± 1 recruits/m^2 (mean ± SD) on Station 2 and 3 ± 1 recruits/m^2 (mean ± SD) for Station 3. The number of coral recruits over the PSBs, 3.0 ± 1 recruits/m^2 (mean ± SD) and 40% survival rates over a 10-month period clearly showed that corals are adapting to the environment but a lack of proper substratum may be the cause for reduced recruitments in certain reefs. These results are indicative that there is a need for active management of the current environment and habitat degradation has been the main cause for coral depletion and biodiversity lost.

Keywords: marine environment, rapid development, coral recruitments, permeable submerged breakwaters and lagoon rehabilitation.

May 31, 10:50 (2C-11692)

Estimating among-assessment variation based on estimates of overfishing limits

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Fishing has an important role as a source of income, nutrition, culture, and tradition. Successful fishery science and management practices are contingent upon a good understanding of the inherent uncertainties that accompany data collection, using data and assessment models to determine stock biomass in absolute terms and relative to reference points, and the efficacy of management measures to achieve desired goals. Uncertainties can be broadly categorized as either scientific uncertainty, the uncertainty inherent in data collection and analysis methods, or management uncertainty, the uncertainty associated with the implementation of management regulations. Fishery scientists and managers aim to reduce scientific uncertainty by investing in new data sources and improving modeling and assessment tools. This study involves synthesizing completed stock assessments to identify and quantify the influence of uncertainty on the outcomes of assessments. The buffer between the overfishing limit and the acceptable biological catch for US west coast groundfish and coastal pelagic species is based on a measure of between-assessment variance in biomass estimates from a retrospective analysis, but ignores uncertainty in productivity and target fishing mortality rates. However, this latter uncertainty can be substantial for some assessments. A revised retrospective analysis is therefore undertaken to quantify the total uncertainty associated with estimating overfishing limits using assessment outputs for US west coast groundfish and coastal pelagic species and species in Australia's Southeast Shark and Scalefish Fishery. This uncertainty could be utilized to inform acceptable biological catches for U.S. west coast fisheries.

May 31, 11:10 (2C-11695)

Using spatial Bayesian Modelling to assess the effects of fishing restrictions on demersal fish biodiversity in a marine spatial management context

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Marine spatial planning (MSP) is implemented world-wide as cross-cutting tool to achieve sustainable development and harmonize competing uses and interests. However, the environmental effects of implementing MSP are largely unknown and require spatial environmental risk assessments to inform decision making. Bayesian belief networks (BN) are a very useful tool for such assessments as they provide a transparent way of depicting uncertainty in the system while handling a range of input data including expert knowledge. If coupled with a GIS spatial predictions of environmental risks of management failure can be produced. We applied this approach to examine effects of planned bottom trawling restrictions in German waters of the North Sea. Specifically, we examine how fishing displacement scenarios based on different levels of area closures would affect the demersal fish biodiversity to provide advice for the German MSP process. We compared the status quo with a future scenario in which we simulated planned implementation of marine protected areas and an increase in offshore wind farm developments which are closed to fishing. We also accounted for the influence of natural disturbance on marine biodiversity and included elements of management effectiveness and propose a measure of quantifying spatial management compliance. The BN was able to predict the proportion of the area in which biodiversity would be likely to decrease. In conclusion, MSP processes should incorporate spatial management assessments based on BNs which allow for the integration and the quantification of related risks as well as uncertainties at a common spatial scale.

May 31, 11:30 (2C-11658)

Reconciling science with stakeholder inclusion: A Q study of the ICES scientific advisory process

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This study takes place within the context of the EU Marine Strategy Framework Directive (MSFD), which aims to achieve 'Good Environmental Status' in European marine waters. Due to the lack of existing guidance on how to operationalise MSFD Descriptor 6 on 'Seafloor Integrity', various pressure mapping models of fishing intensity are being developed by the different European Regional Seas Commissions (RSCs). As a key provider of marine scientific data and advice, ICES has been requested by the EU to provide guidance on how these pressure maps contribute to an overall assessment of the state of seabed habitats. Because any discussion of fishing intensity in European waters will also encompass various political, environmental and commercial interests too, the MSFD requires that relevant stakeholders be properly included. To ensure transparency, ICES hosted a workshop on fisheries benthic impacts in May 2016, open to policy makers, marine conservation scientists, and fishery representatives alike. However, valuable stakeholder inclusion such as this is complicated by both the technical nature of ICES' work and because, as a scientific body, it cannot make policy recommendations. Furthermore, there is a perceived risk that by including non-scientist participants any actual scientific input will be delegitimized. In order to reconcile the tensions that emerge in this type of "participatory science", this paper evaluates the role of stakeholders in the ICES advisory process using Q Methodology, which analyses quantitative and qualitative data to generate salient social perspectives. These revealed areas of existing concern as well as common interests that centered on the role of science; improved inclusion of stakeholders; conflicting interpretations of the precautionary principle, and a general reticence in the use of visualisation for fear of misinterpretation.

May 31, 11:50 (2C-11445)

Perceptions on the Impacts of Climate Change on Fishing Communities along Lagos Coast, Nigeria

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The study examined some impacts of climate change and adaptation strategies on three coastal fishing communities (Itun-Agan, Sakpo and Eleko Beach) in the Lagos, Nigeria. To get the perceptions of different stakeholders including residents, community leaders and experts on the impact of climate change and adaptation, data were collected with the aid of structured questionnaires which were purposively administered to respondents. A total of 233 respondents consisting of 33 community leaders, 144 residents and 56 experts were interviewed. Data were analyzed using descriptive and inferential statistics. According to the study using Friedman Test statistics, chi-square value ($p < 0.001$) was 113.253, 89.310 and 58.803 at 10, 3 and 4 degrees of freedom respectively, indicating significant relationships between flooding and household welfare, human activities and climate change impact as well as institutional response versus climate change mitigation and adaptation in coastal fishing communities. Fishing communities in Itun-Agan, Sakpo and Eleko Beach are subject not only to sea-level rise, but also flooding and increased typhoons, having negative impact on their livelihoods and survival options. Finally, this study, amongst others, foregrounds on possible strategies that culminate to increasing knowledge and local awareness including indigenous options for achieving adaptation to climate induced risks and capacity of coastal communities to effectively adapt to such risks.

May 31, 12:10 (2C-11686)

Climate change and biodiversity: How stakeholder perceptions can shape local adaptation strategies

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Global climate change has a wide range of effects on marine ecosystems. One of the most apparent consequences is the shift in local biodiversity induced by e.g. altering temperatures and changes in species range. The biodiversity and economy in the North Sea are especially affected by those shifts in the distribution and abundance of native and non-native species as well as extreme weather events. These pressures can have cumulative effects on entire food webs as well as the goods and services we draw from the stability and productivity of these ecosystems. Despite the major challenges this problem poses on a global scale we will have to combat its causes and adapt to the coming changes on a local scale, requiring local adaptation strategies and involving all relevant stakeholders. Two workshops were conducted to assess perceived threats and opportunities and highlight the areas stakeholders perceive to be the most important in adapting to the coming changes. The first workshops target group consisted of stakeholders ranging from fisheries, fish processing, local government and tourism associations to NGOs, while the second workshops target audience was early stage marine researchers. Perceptions about the importance of certain shifts and trends differ widely between the groups. Local directly affected stakeholders have differing priorities from scientists and envision different approaches to adaptation. This highlights the need for improved communication between all parties to enable the creation of effective adaptation strategies.

May 31, 13:40 (2C-11486)

Tools and methods to support and Ecosystem Approach to Aquaculture (EAA) – A gap analysis

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8 Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER), Port en Bessin, France
9 Dalhousie University (DAL), Silver Spring, USA
10 Marine Scotland Science (MSS), Aberdeen, Uk
11 Christian Michelsen Research (CMR), Bergen, Norway
12 The National Agricultural Research and Innovation Center (NARIC), Szarvas, Hungary
13 Yellow Sea Fisheries Research Institute (YSFRI), Qingdao, China
14 The James Hutton Institute (JHI), Aberdeen, Uk
15 The University of Crete (UOC), Crete, Greece
16 University of Western Australia (UWA), Crawley, Western Australia

The EU funded project AquaSpace aims to highlight the key issues and practical challenges when integrating aquaculture management in the wider context of marine spatial planning (MSP) processes. Accounting for emerging conflicts and synergies with other sectors or combined impacts in a multi-use environment a science based evaluation of aquaculture planning options is needed which allow for a spatial representation of costs (e.g. risks) and benefits (e.g. food security) of a proposed aquaculture activity at a specific location.

This study outlines a targeted review on existing spatial analysis of costs and benefits and a stakeholder consultation process on required assessments to enhance spatial planning with aquaculture. Informed by the real world of the AquaSpace case studies, a gap analysis on desired tools to facilitate the aquaculture planning process was conducted.

Results revealed that there are multiple tools assessing environmental factors describing the suitability of a site for aquaculture ventures. Meanwhile a lack of tools assessing costs and benefits related to socio-economic issues was conceivable. Further it can be said that although nearly all functions have been applied in a GIS framework, no practical tools were found which were designed to fully implement environmental, social and economic functions.

Nevertheless, developed further, these tools could fill identified gaps and deliver decision support by providing a holistic view on environmental costs and benefits. Some methodology is taken forward to be part of a GIS add-in which allows such an environmental capture based aquaculture. Such a toolkit would support the licensing process and facilitate investments.

May 31, 14:00 (2C-11531)

Reforming China's Marine Environmental Protection Law through enhancing the science-law interface and understanding interactions between economic, social and environmental activities

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China's marine environment has been seriously affected by the country's rapid economic growth. Sustainable management of China's marine ecosystems requires approaches at the science-law interface which appreciate the complex human-environment dynamics that have led to the current ecological catastrophe and the corresponding impacts on human health and well-being. China's Marine Environmental Protection Law (MEPL), adopted in 1999 three years after China's ratification of the United Nations Convention on the Law of the Sea, takes, however, a largely sectoral approach to ocean management.

The effectiveness of the MEPL to protect the marine environment has been questioned following recent accidents, such as the "2011 Bohai Bay Oil Spill", the largest offshore oil spill disaster in China's history. At the same time, unsustainable fishing practices and the failure to curb land-based marine pollution has devastated fish stocks, with those that remain largely unfit for human consumption. Marine pollution and destruction of coastal ecosystems has stunted development of the coastal tourism industry and created grave safety concerns for coastal inhabitants.

The MEPL is currently being revised. This provides an opportunity to rethink current approaches to regulating China's marine environment. This paper evaluates Chinese legal and institutional approaches to date and the extent to which scientific knowledge and concepts have been incorporated into their design and implementation. Conceptual mapping of interactions between key social, economic and environmental issues is combined with legal and institutional analysis to set out pathways to incorporate more integrated and ecosystem-based management of China's marine environment.

Session 3-A
Oral Presentations

Biodiversity and ecosystem functioning

June 2, 09:30 (3A-11496)

Taxonomic and functional diversity of marine microbes in the Philippine archipelago

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Diversity studies in the Philippines, which is known as the center of marine biodiversity, have mainly focused on macroorganisms. Whether microorganisms exhibit similar megadiversity remains a question of interest. We implemented 16S rRNA and whole metagenomics sequencing to uncover the taxonomic and functional diversity of marine microbes in two Philippine biogeographic regions, the Benham Rise (BR) and West Palawan Shelf (WPS). These regions are characterized by remarkable geologic histories governed by different oceanographic regimes. The major bacterial phyla in both regions are *Proteobacteria, Cyanobacteria*, *Actinobacteria*, and *Bacteroidetes*, while *Thaumarchaeota* and *Crenarchaeota* are the major archaeal phyla. Vertical zonation of the microbial community is evident and may be attributed to the stratification of physicochemical parameters acting as a dispersal barrier. *Synechococcus* and *Prochlorococcus* are abundant in the surface to deep-chlorophyll maximum layers, while archaeal taxa are enriched in the mesopelagic layer. Based on comparable 16S rRNA surveys using V4 primers, the richness and diversity of BR surface waters is similar to that of the Indian Ocean and South China Sea but is greater than that of the polar regions. This supports the idea of a latitudinal gradient of microbial biodiversity, which increases towards the equator. More microbial phyla were detected in WPS samples using 16S rRNA V3V4 primers, which have greater resolving power. Functional analysis revealed the diversity of genes associated with bioelement cycling, photosynthesis and organic matter processing. Further exploration of internal seas and extreme marine environments around the archipelago may yet reveal hidden pockets of biodiversity.

June 2, 09:50 (3A-11798)

Diversity of dinoflagellate sources of phycotoxins found in bivalves in Peter the Great Bay, Sea of Japan (East Sea)

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More than 30 years of study of phytoplankton biodiversity in the Western Part of the Sea of Japan revealed presence of dinoflagellates, which are or can be potentially the sources of several phycotoxins, including paralytic shellfish toxins and lipophylic toxins. The study includes investigation of planktonic and epiphytic species of microalgae. About 30 species were revealed within the families Prorocentraceae, Dinophysiaceae, Gymnodiniaceae, and Gonyaulacaceae. The majority of microalgae have seasonal patterns of increasing in abundance, but multiyear dynamics shows influence of temperature, salinity, nutrient inflow and other environmental factors on their development.

Several phycotoxins from dinoflagellates were found in tissues of filter-feeding bivalves. One of the most wide-spread mussels, *Crenomytilus grayanus,* in the Peter the Great Bay may contain toxins of okadaic acid group, yessotoxins, pectenotoxins and azaspiracides. There is seasonality in the concentration of toxins with the maximum in late spring for okadaic acid toxins, middle summer for azaspiracides and winter for pectenotoxins. For azaspiracides the microalgae source has not been identified yet, but we can assume its presence, due to the presence of the toxin. Moreover, it was shown that *Prorocentrum foraminosum* is a new toxin-producing species. It is similar to *Prorocentrum lima* (one of the major sources of okadaic acid toxins in Western Europe) in terms of ecological niche; its ability to transfer toxins to bivalves is being tested *in vitro*.

June 2, 10:10 (3A-11609)

Functional traits of fish communities relate to environmental gradients across Europe's continental shelf seas

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Functional diversity has been shown to promote ecosystem functioning and to increase ecosystem's resilience against disturbances from either natural or anthropogenic origin. However, it is not yet understood for marine ecosystems what the natural drivers are of functional traits that make up functional diversity. In this study, we used a unique dataset containing the spatial occurrence of over 300 marine fish species across Europe's continental shelf seas – ranging from Iceland and southern Greenland to the Mediterranean with a high spatial resolution of ¼ degree. Three-matrix approaches (RLQ and fourth-corner analysis) were used to investigate the relationships between species traits and environmental variables through the information on species occurrences. We compared our results with spatial patterns of community weighted mean traits. The analysis revealed that areas with greater seasonal differences in temperature and primary production, e.g. southern North Sea, Baltic Sea and western Mediterranean, favour small and short-lived species. Waters around Greenland and Iceland that have low water temperatures and little differences between seasons tend to be dominated by larger and longer-lived species with relatively large offspring. We demonstrated that the RLQ and fourth-corner analysis combined with community weighted mean traits were able to reveal relationships between functional traits of fish and their environment. Our results are useful for future studies aiming to relate functional traits to ecosystem functions, e.g. fisheries yield, and to predict changes in fish species distribution and ecosystem functioning in the light of climate change and other stressors on marine ecosystems.

June 2, 10:50 (3A-11623)

Matches and mismatches - Patterns and drivers of fish diversity in the North Sea

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Biodiversity has traditionally been equated to species richness and abundances. However, biodiversity's effect on ecosystems and its response to pressures, such as climate change and fishing, is not linked to the species itself, but rather its functional characteristics in the form of response and effect traits. Defining and analyzing these traits across time and space in relation to environmental changes give us the tools to predict the consequences of observed rapid and drastic changes (e.g. climate change). In this study, we have analyzed three decades of taxonomic and functional trait diversity to contrast two important facets of biodiversity. Covering three decades, 78 demersal teleost and cartilaginous fish species and more than 8500 samples in the North Sea, this study shows distinct spatial and temporal matches and mismatches in biodiversity measures, incorporating a select set of both life history and morphometric fish traits.

Using generalized additive models, we modelled the relationship between five biodiversity measures and environmental and anthropogenic variables. The best explanatory variables varied between different facets of biodiversity, however, temperature, salinity and fishing pressure consistently explained a high degree of the variation. The study highlights three main results: In order to investigate the effect of biodiversity on ecosystem functioning we need to incorporate functional traits, including life history traits; different facets of biodiversity show spatial and temporal incongruences complicating management and conservation; and different environmental and anthropogenic drivers do not affect biodiversity uniformly across space.

June 2, 11:10 (3A-11570)

Development of a model to study the effects of artificial biotope on biodiversity caused by changes in the hydrodynamic regime of waters

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The current significance of artificial reefs employment is known around all over the world. Several characteristics of seabed constructions (such as height, length, shape of artificial reefs etc.) impact the turbulence, salinity, temperature, chemical composition and turbidity of water near the reef. These factors influence the biodiversity and abundance of organisms. Size and shape affect the value of the total weight of fouling organisms, the composition of the bio community and the intensity of the functioning of benthos and fish. Preliminary modeling of the shape and type of artificial biotopes, as well as modeling of their best location on sea bottom allows to create reef designs that satisfy the most important indicators necessary for increasing biodiversity. The purpose of the model developed here is to identify features of the hydrodynamic regime for various designs of artificial reefs on the seabed. Present model is not hydrostatic, enabling small scale detail on the processes of vertical movements. The developed model use deterministic differential Reynolds's equations of averaged turbulent flow. Complete parameterization of Smagorinsky is used to describe the coefficient of turbulent exchange. Closure is achieved using the continuity equation. Finite difference method and as a time numerical scheme – explicitly-implicit scheme are used as a numerical solution of the model. Our research would contribute to increase the effectiveness of the installation of artificial reefs in the coastal zone.

June 2, 11:30 (3A-11926)

A new approach using next generation sequencing to identify massively mixed eggs to species for studying the spawning ecology of marine teleosts

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Many species of marine teleost for breeding lay a mass of buoyant eggs with a sphere shape. These eggs are the key elements for identifying the fish spawning grounds and periods. However, this information has not been widely used in spawning ecology studies because morphological identification of eggs is difficult. To overcome this and meet the needs of mass analysis, we introduced next generation sequencing (NGS) analysis to the species identification of mixed fish eggs. As compared with the Sanger sequencing, the average detection rate of species in the NGS analysis was 71.4±6.07 (SD) %. Regression analysis was conducted between the individual composition of eggs and the species-specific proportion of reads obtained from NGS, including samples in which the proportion of anchovy eggs was known (r^2=0.80, $p<0.05$). This result means that anchovy eggs could be used as a quantitative indicator of the NGS analysis. By applying NGS, 28 species were detected from 6,500 eggs among the unknown 53,475 eggs collected from the southern coast of South Korea. Total number of eggs were 107,155, or which 53,680 eggs were identified as anchovy by morphology. As a result, the species-specific spawning properties of fish were found based on the information of the egg abundance and emergence time. The use of NGS with morphological identification will be very powerful for the species-specific ecological studies of fish spawning in waters where multiple species spawn simultaneously.

Session 3-B
Oral Presentations

Marine population dynamics and community ecology

May 31, 09:30 (3B-11542)

Seasonal shift in hot spots associated with an upwelling front in the California Current System: GLOBEC revisited

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Biological features associated with upwelling fronts, often recognized as "hot spots", serve as important foraging grounds for fish and marine mammals. Simultaneous measurements of biological and physical properties in the Northeast Pacific achieved by the Global Ocean Ecosystem Dynamics (GLOBEC) project provided unique data sets to examine biological-physical interactions in coastal upwelling regions. We explored hot spots associated with the summer-time upwelling fronts in the California Current System, using concurrently towed multifrequency echosounders and undulating vehicle equipped with hydrographic and optical sensors. Based on the frequency response characteristics of active acoustic measurements, we identified three biological features: zooplankton, Pacific hake (*Merluccius productus*), and a feature located at upper 50 m. During the early upwelling season, all hot spots were located offshore of the front with the peak biomass of zooplankton and surface feature at ~50 km offshore, and hake at ~70 km offshore. Later in the upwelling season, the zooplankton and surface features moved closer to the front at ~30 km offshore, while hake appeared at 20 – 40 km inshore of the front. Movement of the hot spots toward or across the front was associated with weakening of the front sharpness characterized by longitudinal gradient of geopotential anomaly. Instead of the traditional view of an upwelling front as a location of increased biomass, the upwelling front acts as a barrier for animal distributions potentially impacting predator-prey interactions in higher trophic levels.

May 31, 09:50 (3B-11607)

Effect of variability in environmental conditions on Calanoid Copepod (Crustacea) egg bank and recruitment in the Gulf of Riga, Baltic Sea. Preliminary results

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The aim of this study is to determine and compare the contribution of two strategies – egg production in the water column and hatching from eggs deposited in the sediments, known as the "egg bank" – to population recruitment of key calanoid copepod species (*Acartia* spp. and *Eurytemora affinis*) in the Gulf of Riga, Baltic Sea. The analysis of long term (20 years) abundance data showed that the amount of *E. affinis* nauplii follows the abundance of females, but *Acartia* spp. nauplii are always in the water column, regardless of female presence or absence and independently of season. These results led to a hypothesis that recruitment of A*cartia* spp. is based mainly on the eggs stored in the sediments, but the main recruitment of *E. affinis* population in the Gulf of Riga comes from egg production. The hypothesis is partly confirmed so far by sediment incubation experiments that resulted in the highest hatching activity and response to environmental conditions of *Acartia* nauplii; the amount of *E. affinis* hatching from sediments did not vary significantly under different treatments and was two orders of magnitude less than *Acartia*. Also seasonal and spatial variations in amount of egg bank and differences in egg production between both species have been observed. This study is ongoing and more experimental and field work is planned.

May 31, 10:10 (3B-11977)

Multispecies biomass dynamics models with species interactions across multiple domains

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Multispecies interactions (predation and competition) are known to have important consequences for the dynamics of marine fish populations. These interactions depend on the spatial overlap among fish species in the community. Multi-species biomass dynamics models were extended to account for food-web interactions in multiple spatial areas (Gulf of Maine, Southern New England, and Georges Bank). A total of 15 fish species collected from the areas were aggregated into four trophic groups: non-migrating benthivores, non-migrating piscivores, migrating piscivores, and migrating planktivores. The spatial distribution of each species group was determined from trawl-survey data, taking into account distributional shifts. A hierarchical model fitting procedure was used to estimate the production parameters (r and k) and interaction coefficients among migrating and non-migrating species groups. In our study, migrating groups played a spatially essential role in species interactions across multiple areas, indicating that the three spatial areas are functionally connected through the high degree of connectivity and direct linkages between migrating groups and non-migrating groups. Our results demonstrated that accounting for trophic interactions improves the model fit and that the strength and direction of these interactions vary among spatial areas.

May 31, 10:50 (3B-11681) (CANCELLED)

Modeling the connectivity of early-life stages for exploited species: A new approach for the delimitation of fisheries assessment units in the Mediterranean Sea

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A good description of larval connectivity is of paramount importance for understanding the dynamics and complexity of marine populations. Indeed, there is growing evidence that the spatial and demographic structures of marine populations are often more complex than currently accounted for in assessment and management frameworks. In this study, large-scale larval dispersal by ocean currents is assessed and used to gain insights into the spatial distribution of subpopulations and to help manage marine species whose biogeographic patterns rarely coincide with political boundaries. Our target-species, the European hake, is one of the most commercially and ecologically important demersal species in the Mediterranean Sea. We introduce an original approach that integrates realistic connectivity processes in the delimitation of fisheries assessment units. The Lagrangian flow network (LFN) methodology simulates the dispersal of free-swimming hake larvae by ocean currents. We combine estimated spawning areas, large ensemble of connectivity matrices informing on dispersal and predicted settlement grounds of juveniles. Identification of self-coherent regions associated to relatively stable circulation and environmental properties are obtained with a state-of-art community detection algorithm (*Infomap*). Communities reveal how demographic connectivity shapes the subpopulations of hake in the entire Mediterranean Sea, providing efficient seascape separation that is compared with established stock-assessment units. By incorporating concepts and tools from fisheries sciences, oceanography, population dynamics and network-theory, our modeling framework allows identifying spatial mismatches between hake´s connectivity patterns and management areas at the scale of the Mediterranean basin, opening future perspectives for other commercial species.

May 31, 10:50 (3B-11578)

Ecological effects of shallow water dynamics on early life stage of *Sardinella aurita* (Pisces, Clupeidae): Application of a Lagrangian transport model in the central Mediterranean Sea

Marco **Torri**[1,2], Raffaele Corrado[3], Federico Falcini[4], Angela Cuttitta[1], Luigi Palatella[3], Guglielmo Lacorata[3], Bernardo Patti[1], Marco Arculeo[2], Biagio De Luca[1], Grazia Maria Armeri[1], Francesca Mangiaracina[1], Salvatore Mazzola[1] and Rosalia Santoleri[4]

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Multidisciplinary studies are recently seeking to define diagnostic tools for fishery sustainability by coupling ichthyoplanktonic datasets, physical and bio-geochemical oceanographic measurements, and ocean modelling. The main goal of these efforts is to understand the processes that control the fate and dispersion of fish early life stages and thus tune the inter-annual variability of biomass of fish species. We analyzed spatial patterns of eggs and larvae of *Sardinella aurita* collected during 2010 and 2011 summer cruises in the central Mediterranean Sea. We considered satellite sea surface temperature (SST), chlorophyll (CHL) and wind data to recognize the main oceanographic patterns that determine egg and larvae transport processes, and we paired these data with Lagrangian simulations. We provide a mechanistic explanation of the observed transport process by using a potential vorticity model that considers the role of wind stress in generating cold filaments. Thereafter, applying otolith microstructure analyses on larvae collected in 2013, we wonder about the ecological effect of circulation patterns. We back-tracked the trajectories of larvae from the known sampling point to the presumed spawning location. Lastly, we implemented a generalized additive model to explain daily growth performance (i.e. width of otolith micro-increments) in relation to daily SST and CHL (i.e. food availability) encountered during the advection pathway, larval size and site factor. Our study contributes to an improved understanding of the spatial and temporal dynamics affecting planktonic stages of fish, providing essential information in the framework of an ecosystem approach addressed to a sustainable management of the fishery resources.

May 31, 11:10 (3B-11537)

Using statolith elemental signatures to resolve movement and connectivity within a loliginid squid population.

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Understanding patterns in migration and the degree of connectivity within a population is necessary for stock assessment and management. Cephalopods are characterised by short lifespan, high fecundity and rapid growth resulting in high interannual variability, thus making abundance and biomass difficult to predict. Ontogenetic variation of element:Ca ratios for 13 trace elements (Na, Sr, Mg, B, Li, Ba, Al, Mn, Fe, Zn, Cu, Cd and Pb) were quantified in statoliths of the commercial squid *Doryteuthis gahi* using laser ablation inductively coupled mass spectrometry (LA ICP-MS). Statoliths were aged to produce high resolution time-delimited elemental fingerprints, reflecting the chemical and physical properties of the surrounding water mass at the time of incorporation. Generalised additive models were applied to each element to assess inter and intraspecific variation in the chemical signature and make inferences about movements. Multivariate analysis was applied to the natal signature to determine the degree of mixing between geographically distinct groups on spawning grounds. Ba/Ca and Sr/Ca ratios showed significant ontogenetic variation, indicating that squid migrate into deeper cooler water as they mature. Multivariate analysis indicated that geographically separate populations mix on spawning grounds, maintaining geographical connectivity. Potential applications are discussed.

May 31, 11:30 (3B-11474)

Tensor Decomposition reveals spatio-temporal dynamics of fish communities in the Baltic Sea

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Marine ecosystem-based fisheries management requires a holistic understanding of the dynamics of fish communities and their responses to external pressures such as fisheries exploitation and climate change. However, characterizing multi-species community dynamics in heavily exploited large marine ecosystems over time and space is difficult and requires novel statistical approaches. We applied Tensor Decomposition (TD), a mathematical framework that allows the synchronized study of multiple ecological variables (in our case abundances of fish populations) measured repeatedly through time and space. We used this comprehensive approach to investigate spatial and temporal changes of more than 45 fish species in the eight roundfish areas of the Baltic Sea for the period of 1999 to 2015. The TD approach revealed strong spatial patterns, that explained up to 40% of the total variability, while the temporal patterns accounted for around 5% of the total variability. Our analysis identified five major groups of species sharing similar spatio-temporal variability in abundances. These groups were found to be quite homogeneous in terms of traits, related to size, trophic level, biogeography and habitat preference, supporting the theory that organisms sharing similar traits exhibit similar dynamics. Furthermore, we conducted correlation analyses relating hydro-climatic drivers and fishing pressure to the temporal dynamics of the identified groups. Using an innovative statistical approach, our study contributes to a better understanding of the patterns and drivers of the diverse Baltic Sea fish communities, information that is key to inform a sustainable management of the ocean.

May 31, 11:50 (3B-11520)

Historical spatiotemporal dynamics of Baltic cod and flounder as analysed using standardised fishery-independent data

Alessandro **Orio** and Michele Casini

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Understanding the spatiotemporal dynamics of marine species is essential for an ecosystem-based management. The distribution of marine species is the result of the connections between the intrinsic characteristics of the populations, trophic interactions, climate and anthropogenic factors. Because of all these interdependencies, the distribution of a species in a determined area is likely changing over time.

In the Baltic Sea, cod (*Gadus morhua*) and flounder (*Platichthys flesus*) are commercially important species dominating the demersal community. Cod has experienced a dramatic change in abundance and distribution throughout the last century. Much less is known of the spatiotemporal dynamics of flounder. Furthermore the Baltic Sea has experienced throughout the years relevant changes in salinity, temperature and oxygen conditions. We analysed the changes in spatial distribution of cod and flounder in the Baltic Sea between 1979 and 2014 using standardised trawl surveys and hydrographic data and employing Delta-Generalized Additive Models. We also analysed the changes in the depth distribution and in the area occupied by the two species.

Our results show a contraction of distribution areas and changes in depth distribution of cod and flounder, likely due to the increased hypoxia that have made extensive areas of the Baltic seafloor unavailable for the two species. This new spatial arrangement in turn could have caused increasing competition for resources and spatial mismatch between predators and preys.

May 31, 12:10 (3B-11672)

How do changing somatic growth rates affect estimation of management quantities in fisheries stock assessments, and can such growth changes be detected?

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A substantial body of work suggests that somatic growth in marine fish is plastic, and thus growth rates may change substantially in response to both extrinsic (i.e. climate) and intrinsic (i.e. competition) factors. Additionally, changes in somatic growth rate may substantially affect population dynamics of marine fish. However, these changes in growth rate are not incorporated into many fisheries stock assessment models and, consequently, management advice. Growth rate changes are difficult to incorporate in management models, since such models are already highly parameterized and often contain temporal variation in observational parameters which are confounded with somatic growth parameters, such as fisheries selectivity. In this analysis, we evaluate the detectability of temporal changes in somatic growth and how such changes may impact fisheries management quantities. We examine these questions using a simulation framework, employing an operating and estimation model closely modeled on stock assessment models for North Pacific groundfish and the Stock Synthesis 3 (SS3) program. Simulated variation in population processes, including growth, recruitment, and fishing, is derived directly from empirical estimates. We test, first, if regime-like growth shifts can be mistaken for differing fisheries' selectivity across time periods. Regime-like patterns in growth rates are not easily detectable in population models, even when long time series of size-at-age data are available. Secondly, we find such changes, while difficult to detect, can impact management reference points. This suggests more work is needed to increase estimability of temporal growth changes and incorporate them into fisheries stock assessment models.

May 31, 13:40 (3B-11691)

Energy dynamics and growth of juvenile Chinook salmon reveal the importance of piscivory during early marine residence

Marisa N. C. **Litz**[1], Jessica A. Miller[1], Richard D. Brodeur[1], Elizabeth A. Daly[1], Laurie A. Weitkamp[1] and Adam G. Hansen[2]

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Climate change impacts on living marine resources have been documented across many terrestrial and marine habitats and frequently involve changes in the timing of important life events, such as reproduction or migration, which may influence predator-prey interactions. In this study, we used the Wisconsin bioenergetics model to explore potential climate effects, such as variation in temperature and the availability of an important prey item, Northern Anchovy ("anchovy" *Engraulis mordax*), on growth of juvenile Chinook salmon (*Oncorhynchus tshawytscha*). We validated the bioenergetics model under laboratory conditions by comparing observed and predicted growth and consumption during the first three months in seawater. We then used the model to estimate consumption based on measurements of growth, diet, prey availability, prey quality, and temperature collected from the field. We found that growth rate variability was associated most with variability in anchovy consumption and less with variation in diet energy density and ocean temperatures. Highest growth and consumption rates occurred in months when anchovy biomass was highest, but the timing of peak anchovy biomass varied by year. Piscivorous salmon consumed up to twice as much and grew up to three times faster than salmon feeding on invertebrates. We conclude that climate-mediated changes that impact the availability of marine fish prey by altering prey phenology may have the largest impact on salmon growth during early marine residence, a critical period in their life history.

May 31, 14:00 (3B-11455)

The functional response of the blenniid *Lipophrys pholis*: Effects of prey supply and temperature

Josie **South**, Jaimie Dick, David Welsh and Daniel Barrios-O'Neill

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Predation is a key factor affecting community structure and ecosystem function. Predatory behaviour can be mediated by a variety of abiotic conditions. The influence of predation on prey populations can be investigated by comparing the type and magnitude of functional response under different abiotic scenarios. Robust impact prediction can be developed through the use of comparative functional response analysis, which can give valuable insights into how predator-prey systems may fluctuate within different environmental contexts. Here, we use a predator-prey system of the blenniid *Lipophrys pholis* feeding on *Echinogammarus marinus* to investigate the effect of three temperatures; 15°C, 17°C, 19°C, chosen to represent predicted future summer temperatures. Furthermore, we compared the results of two different prey supply models: replacement—in which prey were replaced after consumption, and non-replacement—in which prey density was allowed to deplete. In both designs the functional response type changed with temperature increase from Holling Type II to density dependent Type III. 19°C had the lowest attack rate and maximum feeding estimate for non-replacement and replacement. However, the non-replacement method underestimated attack rates and maximum feeding estimates. This illustrates how predation may change with acute summer warming and shows merits and disadvantages of the differing prey supply systems.

May 31, 14:20 (3B-11560)

What's on cod's menu?

Nataliia **Kulatska**[1], Valerio Bartolino[1], Håkan Wennhage[1], Bjarki Elvarsson[2] and Gunnar Stefansson[3]

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Ecosystem modelling is emerging as an important part of integrated assessments for Ecosystem-Based Fisheries Management (EBFM). It provides more realistic information about the effect of fisheries and fisheries management on the ecosystem, as a whole and for separate components of it, than single-species models do. Species do not live in isolation. They interact, which adds value to taking an ecosystem perspective into account. The key species of the central Baltic Sea ecosystem are cod, herring and sprat. These species were under high pressure during the last decades, facing environmental changes, eutrophication and fishing exploitation. As a consequence, their abundance, distribution and the strength of their predator-prey interactions has changed. In our model the dynamics of these three species are linked by both trophic and technical interactions. Cod feeds on herring and sprat, and a pelagic fishery harvests both herring and sprat. We investigate fisheries effects on interactions between species as well as on their population dynamics and size structure. Central information for our model is cod stomach data, which allow us to quantify predation of cod on herring and sprat, as well as to relate predation rates to prey availability in the sea. Results of our model provide valuable information for stock assessments and for implementation of EBFM.

May 31, 14:40 (3B-11487)

The failed recovery of Atlantic cod stocks

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Atlantic cod populations have been exploited for centuries and have experienced dramatic collapses over the last decades. In order to facilitate the recovery of this ecologically and economically important species, drastic and unpopular management measures have been implemented. Here we conducted a meta-analysis on cod recovery based on assessment data of 19 stocks over its distribution area in the North Atlantic. Based on a set of recovery criteria, such as achievement of management targets, restoration of former population structures and levels of fishing mortality, we classified only 3 stocks out of the 19 as recovering. We further investigated the reasons for the lack of recovery applying regime shift theory. We conducted multiple analyses to detect the presence of stable states (i.e. trend analyses, detection of hysteresis), and also examined the relationship between spawning stock biomass, environmental conditions (sea surface temperature) and fishing pressure to highlight the drivers that could have played a fundamental role in the decline of these stocks. Our analyses revealed that cod recovery is hindered especially by weak management measures (i.e. still too high fishing pressure) in particular in Eastern Atlantic stocks, and by the presence of alternative stable states and hysteresis, in Western Atlantic stocks. These two conditions delay the recovery process or in the worst cases make it even impossible. Our results are relevant because they show how additive human and natural drivers, resulting in discontinuous systems´ responses, can prevent the recovery of such an iconic species such as cod.

May 31, 15:00 (3B-11477)

Global patterns in the productivity of marine fish along parallel pathways of energy

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Global fisheries support about 16% of human protein consumption. Fisheries production is driven by energy from both the pelagic and the benthic (bottom) zone of the ocean. The contribution of energy through the two pathways to fish and fisheries varies largely across the globe. Yet, it is unclear how this variability in the strength of the parallel pathways of energy affects the fish productive capacity across ecosystems on a global scale. Here we study the distributional patterns of two general feeding strategies in marine fish around the globe. We distinguish between fish that feed exclusively on the pelagic pathway (pelagic specialist) and fish that (partly) rely on the benthic pathway for feeding. We observe clear latitudinal patterns, especially for large predatory species (maximum length > 90 cm). These show how large pelagic specialist are the dominant group of fish in (semi-)tropical areas, while large demersal fish (feeding on both energy pathways) are dominant in temperate regions and the exclusive group at the poles. The patterns concur with predicted variation in the proportion of primary production exported to the seabed; highest at the poles and lowest in the tropics. Using a size-based fish community model, we argue that the observed patterns correspond to a classical generalist-specialist interaction, where a poor benthic pathway favors pelagic specialist, while this group is excluded by generalist when pathways are more equal in productivity. The findings can be used to characterize food web structure and energy flux across marine ecosystems on a global scale.

May 31, 15:40 (3B-11644)

Fisheries-induced evolution effects on hairtail (*Trichiurus lepturus*) in the East China Sea and its management implications

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In recent years, increasing evidence has demonstrated that fish phenotypic traits have changed in many exploited fish populations. Typical examples of the fish phenotypic traits are smaller size-at-age and an earlier age-at-maturation. In the East China Sea, one of the more over-exploited ecosystems in the world, most of the fish populations, such as hairtail (*Trichiurus lepturus*) are overfished. Fishing selectivity has great potential to change the biological characters of exploited fish populations. Long-term sustained fishing pressure induces changes in fish phenotypic traits, and eventually fisheries-induced evolution. Simulation and experimental methods are used to evaluate fisheries-induced evolution effects on commercially-important fish populations in the East China Sea and to explore the differences of the phenotypic plasticity and irreversibility when fishing pressure is relaxed. Our results contribute to basic theory on the study of fisheries-induced evolution, and also suggest important implications for fishery management.

May 31, 16:20 (3B-11518) (CANCELLED)

The relationship between observational scale and explained variance in biological communities

A.M. **Flanagan**[1], R.D. Flood[1], M.G. Frisk[1], C.D. Garza[2], G.R. Lopez[1], N.P. Maher[3] and R.M. Cerrato[1]

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This paper addresses objectives concerning the impact of spatial scale on explaining variance in biological communities. In the present application, the analysis focused on quantifying the fraction of infaunal community variation that is below the observational scale of a data set. Observational scale simply refers to the distance between *in situ* samples collected from a study area in geographic space. Data sets used in the analysis consisted of environmental data (water depth, grain size, and surficial percent cover), infaunal community data sets, and sonar treated as a proxy for habitat. Redundancy analysis (RDA) was coupled with spatial statistics generated by multiscale ordination. The RDA-variogram combination was used to partition, visualize, and quantify the variance explained by RDA at different distances as well as within and between sonar-defined habitats (provinces). Although little variance was explained at finer spatial scales (e.g., 0 – 100m), the variance explained between acoustic provinces (>100m) was ≥72.9% for all data sets analyzed after removing the small-scale variation. Results are consistent with hierarchy theory, ameliorate the problem of scale arbitrariness, and highlight the utility of sonar-based habitat classification and spatial analysis for explaining community structure in oceanographic systems.

May 31, 16:20 (3B-11508)

Climate change impacts on global fish abundance – A multi-model analysis on an ocean basin scale

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Major biological changes in marine ecosystems have been associated with anthropogenic climate change in the past and are projected for the future. The impacts of climate change on marine ecosystems include global and regional changes in primary production, species distribution and abundance, with significant consequences for marine ecosystem structure and functioning, as well as the support of fisheries. Anthropogenic climate change is expected to affect resource availability, fishing operations, fisheries profits as well as fisheries management. How these changes may play out on an ocean-basin scale is largely unknown. Here, we use an ensemble of multiple marine ecosystem models to examine global variability of fish abundance in response to past and projected future climate scenarios based on output from selected global climate models. We then compare spatial and temporal patterns of fish abundance on an ocean-basin scale. This study aims at improving our understanding of climate change impacts on marine ecosystems and can help to inform adaptation and mitigation policies in the context of effective future marine resource management.

Session 3-C
Oral Presentations

Marine ecosystems and biogeochemical cycles

June 1, 08:40 (3C-11568)

Biogeochemical impacts of ENSO in the Peruvian Coastal Upwelling System

Espinoza-Morriberón **Dante**[1,2], V. Echevin[1], F. Colas[1] and J. Ledesma[2]

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Every 2 to 7 years, ENSO events profoundly alter the environmental landscape of the Peruvian Coastal Upwelling System for several months. The ENSO warm phase, El Niño, is characterized by high sea surface temperature and low nutrient and chlorophyll concentration. A regional coupled physical-biogeochemical model is used to describe and understand the physical-biogeochemical coupled processes involved in the decrease of phytoplankton during El Niño, with a particular focus on the strong events that occurred between 1958 and 2008. Comparison of observational data from surveys and satellites with model outputs show that our model configuration is able to reproduce the interannual dynamic variability off the Peruvian coast and the impacts of El Niño events. Temperature and sea level anomalies increase, while chlorophyll and nutrient concentrations decrease. Passages of strong coastal-trapped waves during El Niño deepen the thermocline, the oxygen minimum zone, the nutricline and chlorophyll concentrations decrease. The upwelling intensity weakens because of a zonal geostrophic current flowing toward the coast. We show that the depth of upwelled waters does not change considerably, however their nitrate concentration decreases dramatically limiting the phytoplankton growth. We also illustrate that eddies also play an important role in nitrate loss during El Niño by increasing the offshore subduction.

Keywords: Peruvian Coastal Upwelling System, El Niño event, phytoplankton, biogeochemical model, Coastal Trapped Wave

June 1, 09:00 (3C-11595)

The marine biogeochemical component in the Brazilian Earth System Model (BESM)

Helena Cachanhuk **Soares** and Paulo Nobre

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This work presents the developments of the biogeochemical marine component in the Brazilian Earth System Model (BESM), a fully coupled global ocean-atmosphere-biosphere model described in Nobre et al (2013). The ocean component in the BESM is reproduced by the Modular Ocean Model (MOM) developed by Geophysical Fluid Dynamics Laboratory/National Oceanic and Atmospheric Administration (GFDL/NOAA) and the CPTEC/INPE Atmospheric General Circulation Model represents the atmospheric dynamics. The marine biogeochemical model that integrates BESM is the Tracers of Ocean Phytoplankton with Allometric Zooplankton (TOPAZ). This model has three different phytoplankton groups and reproduces the cycle of carbon, nitrogen, phosphorus, oxygen, silicon, iron, lithogenic material and surface sediment calcite. The global biogeochemistry patterns generated by BESM-TOPAZ are contrasted to observational data, as the World Ocean Atlas data and Global Ocean Data Analysis Project (GLODAP). The chlorophyll concentration patterns produced by the model will be compared with the satellite data. It was found that BESM with the marine biogeochemical component simulates the main global patterns of dissolved inorganic carbon (DIC), alkalinity, nitrate and phosphate concentrations. Also, the effects of changes in the river discharges on the ocean biogeochemical dynamics will be discussed.

June 1, 09:20 (3C-11631)

Satellite derived chlorophyll-a and modeled primary production in comparison with field observations in the west part of the Japan/East Sea

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Remote sensing of ocean colour allows to analyze spatial and temporal variability of chlorophyll-a concentration (Chl) in a subsurface layer and estimate primary production of phytoplankton (PP) at regional and global scales. However, the improvement of remote sensing algorithms requires systematical validation of satellite derived data with *in situ* observations. In this work, we compare field and satellite derived estimates of Chl and PP estimated using the Vertically Generalized Production Model (VGPM) in the west part of the Japan/East Sea (35-44°N, 130-137°E) in spring 2004 and autumn 2005 and 2011. PP is calculated based on *in situ* observations of Chl, an assimilation number, a diffuse attenuation coefficient, and sea surface temperature using two models: semi-analytical model developed in V.I. Il'ichev Pacific Oceanological Institute and empirical VGPM. The results of the comparison show fair correlation (r = 0.56 – 0.63) between field and satellite derived data of Chl and modeled PP. Their averaged estimates for all stations of observation have small difference, which, however, may be about 1.5-1.7 times in some periods. In average, satellite Chl overestimate *in situ* observations, while satellite estimates of PP are less than PP calculated using the model developed in V.I. Il'ichev Pacific Oceanological Institute but higher than PP calculated using VGPM. The differences between the satellite and field PP estimates in the layer of photosynthesis is due to the features of the vertical distribution of Chl in the euphotic zone and to the difference in the assimilation numbers used in the models.

June 1, 09:40 (3C-11521) (CANCELLED) Replaced with Takagi (p. 84)

Insights on the microbial carbon pump in the global ocean with spectroscopic techniques

Teresa S. **Catalá**[1,2], Isabel Reche[1], Marta Álvarez[3], Cristina Romera-Castillo[4,5], Mar Nieto-Cid[2], Antonio Fuentes-Lema[6], Eva Ortega-Retuerta[4], Cèlia Marrasé[4], Colin A. Stedmon[7] and Xosé Antón Álvarez-Salgado[2]

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Marine dissolved organic matter (DOM) is one of the largest reservoirs of reduced carbon on Earth. In the dark ocean (> 200 m), most of this carbon is refractory DOM (RDOM). The chromophoric (CDOM) and fluorescent (FDOM) fractions of DOM were used as tracers for RDOM microbial production, namely the 'microbial carbon pump' (MCP). The global span of the Malaspina 2010 circumnavigation allowed the estimation of the net production rate and turnover time of the colored fraction of RDOM (referenced at 325 nm) across the global thermohaline circulation: $3.3 \pm 0.5 \times 10^{-5}$ m^{-1} $year^{-1}$ and 634 ± 120 years, respectively. Furthermore, a distinct chromophore at 415 nm (attributed to cytochrome c), was found with a net production rate and turnover time of $3.1 \pm 0.4 \times 10^{-5}$ m^{-1} $year^{-1}$ and 356 ± 74 years. Concerning the fluorescent fraction of RDOM, four ubiquitous fluorophores were identified: two of humic-like and two of protein-like (tryptophan-like, tyrosine-like) nature. Net production of the humic-like components was observed at $2.3 \pm 0.2 \times 10^{-5}$ and $1.2 \pm 0.1 \times 10^{-5}$ RU $year^{-1}$ (RU = Raman Units), respectively, and the corresponding turnover times were 529 ± 49 and 742 ± 67 years. Ergo, we demonstrated the *in situ* production of both CDOM and FDOM and its relevant role for carbon sequestration in the dark ocean at centennial timescales.

June 1, 10:00 (3C-11588) (CANCELLED)

Amino acid nitrogen stable isotope signatures identify surface diazotroph and deep chemoautotroph based nitrogen inputs into the ambient food webs

Elvita **Eglite**, Dirk Wodarg, Iris Liskow, Detlef Schulz-Bull and Natalie Loick-Wilde

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Changes in plankton biogeochemical functions due to increasing cyanobacteria blooms might affect the secondary production and therefore higher trophic levels throughout the water column to yet unknown degrees. Here we used the central Baltic Sea as a model for an ecosystem characterized by intense N_2 fixation in surface waters and intense nitrification and denitrification processes in the associated oxygen minimum zone (OMZ) in the deep waters below during two summertime cyanobacteria blooms in July of 2014 and 2015. We applied an amino acid nitrogen stable isotope approach to first identify the trophic interactions and nitrogen sources of particulate organic matter (POM) and mesozooplankton from surface, intermediate, and deep waters. Second we identified and quantified diazotrophic N inputs into autotrophs, mixotrophs, omnivores, and carnivores from different depths using bulk-^{15}N isotope mixing model. Diazotrophic N contributed on average 52±4% and 10% to POM, and 39±7% and 29±8% to mesozooplankton in surface and intermediate water depths along all trophic levels. Interestingly, the depth profile of δ^{15}N-Phe, used as a proxy for different N sources, showed congruent values for POM and mesozooplankton in the upper water column indicating incorporation of the same N sources, while mesozooplankton in deep waters had enriched δ^{15}N-Phe values. These results indicate that the planktonic food web in surface and intermediate waters was fueled by diazotrophic N from photoautotrophs while at deep waters in close proximity to the OMZ, the mesozooplankton covered their nitrogen demand through a chemoautotroph based food web utilizing the high DIN concentrations in deep waters.

June 1, 10:00 (3C-11556)

Phytoplankton community and controlling factors of primary production in the Gulf of Riga (Baltic Sea)

Atis **Labucis**, Iveta Jurgensone, Ieva Bārda and Anda Ikauniece

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The annual dynamics of phytoplankton community in the Gulf of Riga, located in the northeastern part of the Baltic Sea, is fairly well investigated while levels of primary production have been estimated just episodically. The productivity was measured after atypically mild winters without ice-cover on the Gulf and missing spring floods. During two years of regular measurements we have tried to get more precise values of primary production. Annual gross primary production as separate measurements has been estimated from 200 to 350 gCm^{-2} while the relation of these results to phytoplankton functional groups is mostly not known. Our attempt has been to find linkage of primary production to phytoplankton groups and gradually changing enviromental factors, like nutrient concentrations, dissolved organic matter and turbidity. Therefore we hypothesize that a large share of primary production in the Gulf of Riga is generated by other parties than autotrophic phytoplankton and attention has been paid to the mixotrophic ciliate *Mesodinium rubrum*. Our first results indicate that this ciliate has been dominating the spring production (20-30%) and it contributes mostly to the "new" production (net primary production). In summer phytoplankton *M. rubrum* is present as small size (less than 27 μm) cells and also contributes mostly to the "new" production.

June 1, 10:20 (3C-11632)

Long-term trends of spring bloom phytoplankton in the Baltic Sea: A modeling study

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During the past decades, the composition of the spring bloom community has changed in the Baltic Sea. Generally, diatoms are the major player in the spring blooms, but recently cold-water dinoflagellates have become dominant in several regions of the Baltic Sea such as the Gulf of Finland. The causes for this change are not well understood but the size of the inoculum and life history strategies are assumed to play an important role. Indirect effects through changes in biogeochemical conditions under the influence of cyanobacterial nitrogen fixation cannot be ruled out, too. We address this issue by using a water column model (GOTM), a modified version of a Baltic Sea ecosystem model in which the life cycle of the three main Baltic Sea phytoplankton groups (diatoms, dinoflagellates and cyanobacteria) are included. First model results represent an alternating dominance of diatoms and dinoflagellates similar to observations. The effect of cyanobacteria on the composition of the spring bloom phytoplankton is rather small. The most important factors that are controlling the dominance of these two spring bloom species are the size of the inoculum of diatoms or dinoflagellates from previous years as well as the winter-spring physical conditions.

June 1, 11:00 (3C-11762)

Factors controlling the phytoplankton community changes in the coastal waters adjacent to the Changjiang River estuary: Statistical analysis and a modeling study

Zheng-xi **Zhou**[1,2], Ren-cheng Yu[1,3] and Ming-jiang Zhou[1]

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Affected by the riverine discharge of the Changjiang River and currents from the open ocean (Taiwan Warm Current, branches of Kuroshio), the hydrodynamic conditions in the coastal waters of the East China Sea adjacent to the Changjiang River estuary are quite complex. In recent years, instead of diatoms (*Skeletonema costotum*), dinoflagellates (e.g.,. *Prorocentrum donghaiense*) dominated in this area during harmful algal blooms (HABs). To obtain a better understanding on the mechanisms of HABs in this region, analyses based on field investigation data from the National Basic Research Priority Program were performed using PCA, MRA and PA to reveal the relationship between HABs and environmental factors. And scenario analysis was done using a one-dimensional model to evaluate the effects of environmental factors on driving the succession processes. The results indicated that temperature changes and nutrient limitations had significant influences. Phosphorous stress was the major factor controlling the succession timing, and nitrate limitations played an important role in restricting the scale of algal blooms in the target area. The intrusion of open seawater characterized as phosphate-rich supported the bloom of dinoflagellate, and the long-term changes in the Changjiang riverine discharge played a significant role on the phytoplankton community changes. This research will help to elucidate the formation mechanisms of HABs in the East China Sea and to predict the occurrence of HABs in this region.

June 1, 9:40 (3C-11573) (time changed)

Individual ecology of tiny protistan zooplankton: Investigation on photosymbiotic ecology of planktic foraminifers

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In oligotrophic and well-lit environments, endosymbiotic association with photosynthesizing algae (photosymbiosis) is regarded as an adaptive ecological strategy for protistan zooplankton like foraminifers and radiolarians. However, basic knowledge on host-symbiont association at the individual scale is poorly understood. In this study, in order to understand trophic interaction within photosymbiotic consortia, culture experiments were conducted by assessing "vitality" of the host and the symbionts. Assuming two pathways of nutrients for symbiont photosynthesis (from the host's metabolites and from the ambient seawater), symbiont-bearing planktic foraminifers were cultured for two weeks under controlled feeding regime (fed *Artemia* or unfed) and controlled seawater nutrient concentration (low- or high-nutrient). Growth of the host and the symbionts, and photosynthetic activity of the symbionts were measured daily.

During the culture period, fed foraminiferal specimens and their symbionts both grew well. In contrast, regardless of the nutrient concentration in seawater, unfed specimens gradually decreased their cytoplasmic volume with keeping their symbiont population. Despite such apparent "weight-loss" of the unfed foraminifers, photosynthetic activity of the symbionts was kept as high as that of the fed specimens. Considering the fact that the unfed foraminifers could survive, it can be said that the symbionts within foraminifers photosynthesized actively which might support the life of the starved host. Although further study is needed to understand the mechanism of this system, if this relationship is true in natural oligotrophic environment, photosymbiosis certainly helps foraminifers to survive for a certain period of starvation.

June 1, 11:40 (3C-11577) (CANCELLED)

Population dynamics of seagrass *Cymodocea nodosa* in the vicinity of volcanic CO_2 seeps of Greece

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Rising carbon dioxide (CO_2) concentrations in the atmosphere will increase the average pCO_2 level in the world oceans, which will have a knock on effect on the marine ecosystem. Coastal seagrass communities, one of the most productive marine ecosystems, are predicted to benefit from the increase in CO_2 levels, but long term effects of elevated CO_2 on seagrass communities are less understood. This study investigated the population dynamics of seagrass *Cymodocea nodosa* meadows, exposed to long term elevated CO_2 at shallow volcanic vents of Milos and Paleochori islands of Greece, using population reconstruction techniques. Elevated CO_2 had effects on growth, morphometry, density, biomass and age structure of *C. nodosa*. The plastochrome interval at both CO_2 vent sites were similar. Density, total biomass and above to below ground biomass ratio of *C. nodosa* were higher at the CO_2 vents than at control sites in both locations. The shoot age and shoot longevity of plants were lower at the vent than at control sites. The present recruitment (sampled year) of the seagrass was higher the long term average recruitment of the communities near the vents. Carbon to nitrogen ratios (%DW) of *C. nodosa* were higher in leaves at CO_2 vents and lower at control sites. This study suggests increased production of *C. nodosa* under elevated CO_2, but other co-factors such as nutrients, trace metal toxicity must also be taken into consideration while predicting effects of future CO_2 concentrations.

Keywords: Seagrass, *C. nodosa*, population dynamics, natural vents, reconstruction technique

June 1, 12:00 (3C-11506)

Benthic biological hotspots in the Pacific Arctic Region: Distribution and potential drivers

Zhixuan **Feng**[1], Rubao Ji[1], Carin J. Ashjian[1], Jinlun Zhang[2], Robert G. Campbell[3] and Jacqueline M. Grebmeier[4]

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The Pacific Arctic Region is experiencing dramatic changes in atmospheric forcing, sea ice, hydrography, and the marine ecosystem. Despite these changes, persistently high macrofaunal benthic biomass has been observed in four major benthic hotspot sites on the shallow continental shelves of the northern Bering and Chukchi Seas: St. Lawrence Island Polynya (SLIP), Chirikov Basin between St. Lawrence Island and Bering Strait (Chirikov), Southeast Chukchi Sea (SECS), and Northeast Chukchi Sea (NECS). We seek to understand what physical and biological processes contribute to the formation and persistence of each of the four benthic hotspots. Extensive field observations and ice-ocean-biogeochemical model outcomes are synthesized to elucidate the hydrographic and pelagic-benthic coupling processes from a bottom-up perspective. The synthesis results suggest that different hotspot sites are governed by different biophysical interactions and degrees of pelagic-benthic coupling. In the SLIP hotspot, high productivity is only found in the springtime, driven by the interactions between local winds, sea ice, and ice algal and pelagic phytoplankton production. The Chirikov and SECS hotspots are mainly supplied by the nutrient rich and very productive Bering Shelf-Anadyr water masses that converge in the vicinity of Bering Strait. In the NECS hotspot, concentrations of organic matter are relatively high in upper Barrow Canyon and shelfbreak regions. The analyses of bottom-up forcing and overall carbon supply to the benthic communities will facilitate the prediction of persistence and relocation of benthic hotspots and also the development of management strategies to mitigate negative effects from climate change in the Pacific Arctic.

June 1, 12:20 (3C-11138)

Sediment type-fishing intensity interactions rather than nutrient enrichment moderate benthic shelf seas nitrogen cycling

Marija **Sciberras**[1], Karen Tait[2], Guillaume Brochain[2], Rachel Hale[3], Jan Geert Hiddink[1], Jasmin A Godbold[3] and Martin Solan[3]

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Bottom fishing and phytoplankton blooms due to eutrophication can have significant impacts on benthic communities and sediment biogeochemical processes in shelf seas, either through physical changes in sediment resuspension and the burial or mixing of organic matter, changes to bioturbating and bioirrigating fauna or alteration to bacterial biomass and activity under different oxygen regimes. To examine the interacting effects of fishing and nutrient enrichment on benthic infauna and microbial activity within the sediment, sediment cores were collected from lightly and heavily fished areas in the Irish Sea in sand and mud and transferred to the lab where a concentrated microalgal solution was added to half of the cores from each of the different fishing intensity areas and sediment type. The abundance and activity of all N cycling bacteria and archaea were higher in mud, with data suggesting a switch from coupled nitrification/denitrification activity within the low fishing intensity sediments to anammox activity in the high fishing intensity sediments. We observed a higher water nitrite and nitrate concentration in sand that had been fished intensively. Infaunal community composition differed significantly between low and high fishing intensity. In general, there was no effect of organic enrichment on microbial and infaunal community and nutrient concentrations, suggesting that bottom fishing has a larger effect on benthic ecosystem processes than organic enrichment. Results demonstrate that intensive trawling disturbance could cause large fluctuations in benthic chemical fluxes and storage through changes in microbial activity and hence may create considerable instability in benthic functions.

Session 1-A
Poster Presentations

Climate change and the effects on the ocean

1A-P1

Nutrients and salt transport between continental slope and central part of the Black Sea caused by variability of large-scale circulation

Elena **Kubryakova**

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The Black Sea is a land-locked marine basin with restricted seawater-exchange through the Bosporus. This is a classic 2-layer density stratified system. This study is dedicated to investigation of impact of large-scale Black Sea dynamics on seasonal variability nutrients and salt transport. In winter, there is divergence in the sea center due to an increase of cyclonic wind vorticity and outflow of salt water from the center to the periphery of the basin is observed. In summer, desalinated water rich in nutrients flows back from periphery. The box physical-biogeochemical model has been constructed to study the horizontal exchange. The model describes the biogeochemical processes of upper 410-meter layer of the deep part of the basin and continental slope. The model includes physical, biological and redox processes, taking into account the seasonal variability of atmospheric parameters and parameterized vertical water movements. Based on the model calculations nutrient and salt exchange in the basin were carried out. It is shown that in the surface water layer Ekman divergence contributes significantly to the outflow of salt from the sea center. In the deep layers the effects of vertical circulation cells results in transport of the continental slope waters to the sea central part. Particular attention is paid to study of the distribution of nitrogen compounds and their cycling as the main factor which determines the functioning of the ecosystem. Contributions of different terms in the transport equation of nitrates, nitrites and ammonium are investigated. Horizontal and vertical nitrogen fluxes were estimated and compared.

1A-P2, Also talk (May 30, S1-A1, 10:00)

Critical transitions in the changing Arctic system

Ivan **Sudakov**

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Elements of Earth's cryosphere, such as the summer Arctic sea ice pack, are melting at precipitous rates that have far outpaced the projections of large scale climate models. Understanding key processes, such as the evolution of melt ponds that form atop Arctic sea ice and control its optical properties, is crucial to improving climate projections. These types of critical phenomena in the cryosphere are of increasing interest as the climate system warms, and are crucial for predicting its stability. In this talk I will give examples of how models from nonlinear and statistical physics are providing powerful tools that we can use to address such questions. Investigating critical behavior as a natural aspect of the Arctic sea ice evolution will shed light on key questions such as critical transitions in the Arctic ecosystem under the changing environment.

1A-P3 (CANCELLED)

Interannual variation of Cyrptophyceae and small-size flagellates in estuarine waters: Case studies on Gyeonggi Bay, Yellow Sea and Tolo Harbour, South China Sea

Roksana **Jahan**[1], Joong Ki Choi[2] and Kedong Yin[1]

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The purpose of the study is to describe the comparative features of small-size phytoplankton, especially Cryptophyceae and flagellates, between Gyeonggi Bay and Tolo Harbour. GB is the largest estuary on the west coast of the Korean peninsula and a typical shallow coast plain estuary with large tidal flats exposed by a macrotidal amplitude of >8m. On the other hand, Tolo Harbour consists of a shallow inner Bay, with a mean depth of 6-7m and a narrow tidal channel which opens in the Mirs Bay. In recent decades, the abundances of Cryptophyceae are increasing in GB and TH. It is remarkable that *Cryptomonas* spp. was the dominating species in GB during 2000s, whereas it was dominant in TH during 1990s and *Plagioselmis prolonga* had an increasing trend since 2001. On average, higher SST in GB ($0.02^0C\ yr^{-1}$) and TH ($0.037^0C\ yr^{-1}$) has large influence on Cryptophyceae abundance. It is anticipated that species fluctuation pattern might be related to regional factors. However, small flagellates had detected to increase in recent decades, especially during summer in GB and all seasons in TH. During summer, GB received huge river discharge which create a buoyant surface layer that traps solar radiation and enhance vertical stability; all of these factors oscillate flagellates. Moreover, it has strong relationship with climatic parameters (r^2=0.347 NPGO, r^2=0.219 MEI) in TH. Therefore, this result shows that recent global warming appears to reduce cell-size of phytoplankton in the Northwest Pacific coastal regions.

1A-P4 (CANCELLED)

Interdecadal variation of mixotrophic dinoflagellate species (*Gymnodinium* spp.) response to nutrient reduction and climate change in Tolo Harbour during 1991-2013

Roksana **Jahan** and Kedong Yin

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The *Gymnodinium* group of species is the most harmful in Hong Kong waters and it has caused the majority of fish kill incidents. In Tolo Harbour, the nutrient reduction strategies had been implemented since 1998 and algal blooms were also decreased. The purpose of this research is to examine how mixotrophic *Gymnodinium* species response to nutrient reduction and climate change by using a 65-year dataset of climatic parameters and 25-year dataset of nutrients and phytoplankton in Tolo Harbour. Three species (*Gymnodinium mikimotoi*, *Gymnodinium* sp. and *Gymnodinium vestifici*) were the most dominant species among 12 species of *Gymnodinium*. *G. mikimotoi* shown strong positive response to nutrient loading in spring during 1991-1998, whereas there was no *G. mikimotoi* after nutrient reduction. Moreover, higher N:P ratios had strong impact on *Gymnodinium vestifici* (r = 0.293) in winter during 1996-2000. Whereas, moderate abundance of *G. vestifici* in spring during 2003-2007 had positive relationship with temperature and MEI (r = 0.28), respectively. The possible mechanism is that the EI-nina phase induced comparatively higher rainfall and lower salinity in spring and created favorable environment for dinoflagellate blooms in Tolo Harbour. Higher abundance of *Gymnodinium* sp. had been detected since 1998, that had positive and negative relationship with temperature (r = 0.279) and Multivariate ENSO Index (r = -0.225), respectively. It is, therefore, said that increased temperature and MEI associated with nutrient ratios play an important role in determining mixotrophic dinoflagellates species abundance in Tolo Harbour.

1A-P5

Trends in potential temperature of the bottom water flow in the Atlantic influencing climate change

Dmitry I. **Frey**[1], E.G. Morozov[1] and N.I. Makarenko[2]

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Antarctic Bottom Water (AABW, potential temperature $\theta<2°C$) represents the coldest and deepest layer in the Atlantic Ocean. This water is formed mainly in the Weddell Sea near the Antarctic slope as a result of cooling and ice formation. When AABW reaches the ocean floor, it propagates to the north, flowing from one basin to another. The strongest flow of bottom water is observed in the Vema Channel in the Southwest Atlantic. This channel connects the Argentine and Brazil basins and provides propagation of the coldest part of AABW.

Measurements of thermohaline properties in the Vema Channel since 1972 show decadal warming of AABW. The goal of this work is to report about our latest hydrological measurements carried out onboard research vessels "Akademik Sergey Vavilov" and "Akademik Ioffe" of the Institute of Oceanology (RAS). Detection of very small changes in potential temperature requires equipment with the highest accuracy and stability. Our experimental instrumentation and data processing are presented in detail. We also discuss velocity measurements of the AABW flow and distribution of potential temperature in a section across the Vema Channel. Hydrodynamic features of the near-bottom current in the channel are studied by numerical simulation using climatic models of global ocean circulation.

This research was supported by the Russian Foundation for Basic Research (project 16-35-50158) and the Russian Science Foundation (project 16-17-10149).

1A-P6

Spatial distribution of Minke whale (*Balaenoptera acutorostrata*) as an indicator of a biological hotspot in the East Sea

Dasom **Lee**[1], Yong Rock An[2], Kyum Joon Park[2], Hyun Woo Kim[2], Dabin Lee[1], Hui Tae Joo[1], Young Geun Oh[1], Su Min Kim[1], Chang Keun Kang[3] and Sang Heon Lee[1]

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The minke whale (*Balaenoptera acutorostrata*) is the most common baleen whale observed in Korea water. Since a high concentrated condition of prey to whales can be obtained by physical structures, the foraging whale distribution can be an indicator of biological hotspot. Our main objective is verifying the coastal upwelling-southwestern East Sea as a productive biological hotspot based on the geographical distribution of minke whales. Among the cetacean research surveys of the National Fisheries Research and Development Institute, recent 9 years data for the minke whales were used available in the East Sea. The regional primary productivity derived from Moderate-Resolution Imaging Spectroradiometer (MODIS). Minke whales observed were mostly concentrated in May and mostly (approximately 70 %) in the southwestern coastal areas (< 300 m) where high chlorophyll concentrations and primary productivity were generally detected. Based on MODIS-derived primary productivity algorithm, the annual primary production (320 g C m^{-2} y^{-1}) estimated in the southwestern coastal region of the East Sea belongs to the highly productive coastal upwelling regions in the world. A change in the main spatial distribution of minke whales was appeared in recent years indicate that the major habitats of mink whales might have been shifted into the north of the common coastal upwelling regions which is consistent with the recently reported unprecedented coastal upwelling in the mid-eastern coast of Korea. These regions are important for ecosystem dynamics and the population biology of top marine predators, especially whales and needed to be carefully managed from a resource management perspective.

1A-P7

Ecological and hydrodynamic effects of Yellow Sea Cold Water Mass (YSCWM) with special reference on Pacific Cod (*Gadus macrocephalus*)

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The Yellow Sea Cold Water Mass (YSCWM) is an important component of the marine system in the Yellow Sea (YS), with an intense thermocline covering a wide range of the YS at a water depth of about 10-20m during its maturity stage in summer. With temperature lower than 10ºC and difference with SST larger than 15ºC, YSCWM becomes an appropriate habitat for oversummering of cold-water species such as Anchovy and Herring, therefore it has crucial ecological significance. Based on seabed-mounted ADCP observation and survey hydrological data, we acquired the basic background temporal-spatial variations of YSCWM and accompanied near-inertial oscillations (NIOs) with speed about 20 $cm \cdot s^{-1}$ and opposite directions up and down the thermocline. Besides, plankton in summer showed a clearly diurnal vertical motion with descent in the daytime and rising at night. In addition, fine suspended particle matter tends to stick to flocs by biochemical process to make it easier to precipitate. Taking Pacific Cod (*Gadus Macrocephalus*) as an example, these ecological and hydrodynamic processes above would associate largely to the oversummering of this typically cold-water and commercially-important groundfish species in YS with increasing trend in catches in recent years. The NIOs provide considerable DO and nutrient into the YSCWM by mixing around the thermocline to avoid being a thoroughly anoxic environment. The vertical motion of plankton and flocs both supply adequate food in the bottom water column for Pacific Cod. The discussion above indicates that local ocean environment contribute to the recruitment, distribution and furthermore the lifecycle of Pacific Cod.

1A-P8

On the projection of future marine primary productivity in mid-latitudinal marginal seas

Christina Eunjin **Kong**[1], Sinjae Yoo[2], Chanjoo Jang[2] and Jisoo Park[3]

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The magnitude of marine primary production (PP) is projected to change in response to future climate variability and the changes in PP will also influence the structure and dynamic of the marine ecosystem and food web interaction. Studies have shown that the global PP appears to have decreased over the past several decades, the PP is expected to decrease in the mid-latitudinal marginal seas. However, the challenges in understanding and predicting PP in response to climate variability is quite complex, particularly the change of PP in the SCM is not well addressed. In this study, we examined characteristics (thickness, depth, and peak) of SCM in the mid-latitudinal marginal seas which include East Seas, East China Sea, and Yellow Sea. We also analyzed how the physical factors (temperature, salinity, sigma-t, etc.) affect the SCM variability using the in-situ data collected from CTD profiler. Our results showed that the depth of SCM layers highly correlates with MLD, as SCM being formed at or above the base of the thermocline. As global warming continues, stratification will be strengthened which will alter the depth and density gradient of the thermocline. This, in turn, will change the formation and depth of SCM and subsequently primary productivity of the upper mixed layer ocean. In this context, we will also discuss the further implication of such potential changes in SCM dynamics in the mid-latitudinal marginal seas and how the fishery production will alter in the study regions.

1A-P9

Projected changes in upwelling-favorable winds at the ocean´s eastern boundaries systems: Relationship between the large scale and synoptic scale.

Catalina **Aguirre**, Maisa Rojas and Rene Garreaud

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CMIP5 simulations under the rcp85 scenario have shown a poleward displacement of coastal upwelling-favorable winds in the ocean's eastern boundaries associated with poleward migration of the subtropical atmospheric high-pressure cells. In this work we analyze historical and future simulations of 17 models to investigate the relationship between the large-scale response of the upwelling-favorable winds (through a geostrophic adjustment) with the synoptic scale variability associated to the coastal atmospheric low-level jets during the upwelling season. Results show that the spatial pattern of the alongshore winds trends is highly consistent with that obtained from the geostrophic alongshore winds (calculated from the surface pressure field), indicating the importance of the large-scale signal of change related to the poleward relocation of the subtropical anticyclones. On the other hand, Kolmogorov-Smirnov test were applied to assess the statistical significance of differences in the empirical cumulative distributions between the present and future alongshore winds at different latitudes in the upwelling systems. At higher latitudes most of the models show a significant different cumulative distribution. In particular, the alongshore wind speed values that in the present day data are in the upper quartile, which are typically associated to mid-latitude synoptic perturbations, increases (decreases) its probability 10%-15% (0%-10%) at higher (lower) latitudes to the end of the century. These results suggest that the poleward migration of the subtropical anticyclones is related with a poleward displacement of the mid-latitude atmospheric perturbation that originates coastal low-level jets in the upwelling systems.

Session 1-B
Poster Presentation

Cross-scale interactions and trends of climate change

1B-P1

Recent Antarctic sea ice variability and trends: Nonlinear response to the ocean climate forcings

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The spatiotemporal variation of Antarctic sea ice extent (SIE) and trends are examined for five Antarctic sectors - the Weddell Sea, Indian Ocean, western Pacific Ocean, Ross Sea, and Bellingshausen and Amundsen Seas (BAS) using satellite-derived observations over 1979–2013. The multidecadal SIE trends has varied less during the satellite record, while the magnitude of trends has undergone substantial weakening over past decade. The long-term SIE records show positive trends in most of the sectors of Antarctica (ranging from 2.3±1.7 to 11.7±3.2 $\times 10^3$ km^2yr^{-1}) except negative trend is observed in the BAS (-5.5±-2.1$\times 10^3$ km^2yr^{-1}). Analysis show weakening in SIE trends in Ross and BAS Seas during 1979-2013 period. In contrast, the sea ice expansion in the Ross Sea is less influenced by short-term variability, with trends more consistent at decadal timescales and beyond. To understand the sea ice variability and changes for the last four decades, different climate indices such as Multivariate El Niño Southern Oscillation (ENSO), Southern Oscillation Index (SOI), Southern Annular Mode (SAM) and Tripole Index for the Interdecadal Pacific Oscillation (TPI-IOP) were correlated and identify dominant forcing mechanisms. In this study, we identify the teleconnection between ENSO, SOI, SAM and TPI-IOP *verses* SIE of the southern hemisphere, and further lead-lag relationships between sea ice and climate indices were established by using wavelet coherency analysis as well as the phase analysis. The study demonstrates that the sea ice variability is linked to warming-cooling processes, and supplemented by the cumulative effect of ocean currents, winds and other atmospheric parameters.

Session 1-C
Poster Presentations

Coastal dynamics: Changes in sea level, geomorphology and ecosystems

1C-P1

Seasonal circulation in the northern Bay of Bengal with special reference to shelf-slope region

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The Bay of Bengal is very dynamic. One of the reasons is the huge quantities of fresh water and sediment that Bay receives annually from its adjoining river systems. Also the coastal as well as open Bay bathymetry is different and complex. The seasonal monsoonal rains and the seasonal cyclones are important attributes of this region which adds to the complexities of the regional oceanography. Though there are a large body of research work on the basin-wide hydrographic characteristics in the Bay of Bengal, especially on the seasonal time-scale, the several aspects of circulation is largely unexplored. The most explored circulation in the Bay of Bengal is the East India Coastal Current (EICC). In this study, to determine the current pattern, remote sensing data of 1999-2014 from different sources have been used. The data has been analysed using a variety of tools including band-pass filtering, chi-square test, mean, standard deviation and linear trend analysis. In addition, to infer the circulation pattern geostrophic current and Ekman currents were computed. Also, sea surface temperature and salinity were examined in conjuncture with current pattern. The domain-averaged monthly mean sea surface height anomaly (SSHA) for the study period showed large inter-annual variability. The monthly mean climatology showed a distinct seasonality. However, the shelf-slope circulation in the northern Bay of Bengal remains largely unknown. It is in this context that the present study investigates the seasonal cycle of circulation with special focus on shelf-slope region in the northern Bay of Bengal.

1C-P2

Model for calculation of frozen shores retreat after rising temperatures and thawing

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Coastal retreat of the Arctic coasts composed by fine-grained frozen soil is a large problem for some countries. Regional-level variations in the coastal retreat rate in the Arctic depend on climate change dynamics and its consequences. Dynamics of typical coasts, in general, are determined by the combination and interaction of two factors: the thermal factor and the wave energy factor. Both factors change under the conditions of global climate warming which will in its turn cause changes in temperature of frozen soil and increasedimpact of the wave action. Coastal retreat in the Arctic is caused by thermomechanical thawing – the thawing by layers and removal of ground affected by the thermal energy of air or water masses and mechanical energy of terrestrial gravity or moving water. So soil deformation and stability during thawing is forecast by solving two types of problems: a temperature problem and a mechanical problem. The influence of the thermomechanical process parameters on the stress-strain state evolution is related to the ice content and soil type, temperature and salinity, heat transfer, and heat boundary conditions. A model of the value of thermomechanical thawing allows an estimate of coastal retreat. This method can be used to estimate the intensity of two types of processes. An example of the first type process is the coastal periodic stormy erosion. Among the second type processes are thermoabrasion and thermodenudation. This study considers a local-scale region on the western shore of the Bering Sea (Chukotka, Russia).

Session 2-A
Poster Presentations

Introduction of anthropogenic substances to the ocean and their impacts

2A-P1

Allochthonous inputs of Dissolved Organic Nitrogen (DON) in the Ennore Creek, South India

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In the last decade several studies torched at the invisible hand of dissolve organic nitrogen (DON) in the primary production relative to the dissolved inorganic nitrogen (DIN). Often in the coastal waters DON is found to be largest contributor, can comprise up to 75- 90% of the total dissolved nitrogen pool. Rivers and coastal water bodies are the major source of allochthonous DON. Composition of DON determines the bioavailability of N and has the potential to enhance eutrophication. Ennore creek located in the Northern part of Chennai Metropolitan city in the Tamilnadu State, India acts as a drain for the river Kosasthalaiyar. Ennore creek is known for its excess dumping of nitrogen as it receives treated and untreated disposal from various industries as well as domestic sewage. This present study is intended to quantify the DON and its seasonal variation on the creek and its adjacent coastal waters. Sampling was performed seasonally from December 2014 to February 2016. From the results, DON values were found to be in the range of 30-1100 µM and it contributes 34% - 75% to the total dissolved nitrogen throughout the study period, the higher concentrations were attributed to the 2015 monsoonal flood on the Kosasthalaiyar River. Allochthonous inputs of such high DON plays a significant role on the regional nitrogen cycle. Uptake experiments with isotopic labelled DIN & DON are under process to understand the role of DON in coastal production even in the high availability of DIN in the study regions. The results from this study emphasize the importance and necessity of the DON, while developing the robust N budget and models.

2A-P2 (CANCELLED)

Polycyclic Aromatic Hydrocarbons in sediments and mussel from a South American coastal environment

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Polycyclic aromatic hydrocarbons (PAHs) are a widely distributed group of persistent environmental contaminants which are able to enter to the marine trophic web, bioaccumulate, biomagnificate and exert biological effects on wildlife and humans. Anthropogenic activities are generally considered the major source of PAHs release into the environment, even though they may have natural origins. Then, the aim of the present study was to monitor PAHs levels, sources apportionment and biota/sediment bioaccumulation. Following the mentioned objective surface sediment samples and native bivalves (Mussel, *Brachidontes rodriguezii*) were collected at different sites from the Bahía Blanca Estuary, Argentina and the presences of 17 PAHs, including the 16 compounds prioritized by US-EPA, were analyzed. Results showed that PAHs accumulates in both sediments and bivalves within the study area, with the highest levels in sediments. The maximum levels of PAHs were found in the vicinity of the port-industrial area and concentrations of PAHs appeared to decrease as the distance from the urban/industrial core increased. The concentrations found allowed to classify the area as with moderate levels of contamination by PAHs. Finally, source apportionment determined mixed PAHs sources, with a slight imposition of pyrolytic inputs in sediments, while petrogenic PAHs were predominant in mussels.

2A-P3

Submarine groundwater discharge in Sorsogon Bay, Luzon Island, Philippines

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Submarine groundwater discharge (SGD) is an important but little recognized pathway of nutrients and other materials from the land to the sea. In tropical Southeast Asia where there is expectedly high SGD and high anthropogenic pressure, there is a dearth of information on SGD and its impacts. In this study, groundwater discharge was studied in volcanic Sorsogon Bay, Luzon Island which has experienced repeated harmful algal bloom events in the past. Twelve manual Lee-type seepage meters were laid out in four transects that extended 150 m into the bay. Periodical seepage waters were collected continuously for 36 hours, from which nutrient samples were subsampled in the first 24 hours. The integrated seepage flux of the transects range from 10.8 to 25.0 L m-1 min-1 with an average of 17.0 L m-1 min-1 or 8930 m^3 m^{-1} a^{-1}, comparable to other tropical island studies and higher than most SGD sites elsewhere. High nutrient concentrations were determined from the seepage meters with average values of 175 µM, 2.38 µM, and 13.5 µM for dissolved silica, phosphate and dissolved inorganic nitrogen, respectively. Overall results suggest agreement with other observations of the relative importance of SGD in tropical islands.

2A-P4

Flux and source assessment of shallow methane (CH_4) gas from sediments in the central Yellow Sea, off the southwest of Korea

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Methane (CH_4) among the gases is the most abundant hydrocarbon in the atmosphere, plays an important role in regulating the Earth's radiation balance and atmospheric chemistry in the troposphere. CH_4 in the headspace gas were determined in surface and core sediments in order to understand the carbon and hydrogen isotopes signatures collected in the Gunsan Basin of the central Yellow Sea from 2013 to 2015. The surface sediments contain 0.2 to 16.9 (μM) CH_4 that are mostly produced, as indicated by the light values of $\delta^{13}C_{CH4}$ range in –70.2~-50.7 (‰) VPDB (Vienna Pee Dee Belemnite). The geochemical characteristics values of $\delta^{13}C_{CH4}$ range in –62.0~-18.0 (‰) VPDB (δ^2D_{CH4} range in –296.0~-144.0 (‰) VSMOW (Vienna Standard Mean Ocean Water)), that is, strongly mixed CH_4 of thermogenic and biogenic origins through the core sediments. The CH_4 flux at the Sediment-Water Interface using Fick's first law of diffusion was calculated 2~29 ($\mu M \cdot m^{-2} \cdot day^{-1}$) within the uppermost 10 cm sediment layer of box corer in 2015. However, more detailed study is needed to reveal clearly the migration pathways and more measurements on the methane emission rates during different seasons in this area required assessment the annual CH_4 distribution and flux in detail.

Session 2-B
Poster Presentations

Ecosystem-Based Management – Get the big picture

2B-P1

The highs and lows of protection: Measuring multi-species interactions within a community-led temperate marine reserve

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Despite recent efforts to increase the global coverage of marine protected areas (MPAs), studies investigating the effectiveness of marine protected areas within temperate waters remain scarce. Furthermore, out of the few studies published on MPAs in temperate waters, the majority focus on specific ecological or fishery components rather than investigating the ecosystem as a whole. This study therefore investigated the dynamics of both benthic communities and fish populations within a recently established, fully protected marine reserve in Lamlash Bay, Isle of Arran, United Kingdom, over a five year period. A combination of diver, camera and potting surveys revealed seafloor habitats within the reserve were recovering, which in turn, was increasing the recruitment of scallops, cod and other commercially valuable species. The marine reserve also promoted the density, size, age structure and reproductive output of commercially exploited scallops and lobster to return to higher, more natural levels. Furthermore, evidence of spillover was observed, meaning these benefits were being transferred to neighbouring fishing grounds. Then again, the higher densities of large lobsters appeared to be having negative consequences for other species, as lobster catch rates were inversely correlated with those of juvenile lobsters, and brown and velvet crabs, likely to be evidence of competitive displacement. Overall, our findings provide evidence that temperate marine reserves can deliver fisheries and conservation benefits, but that ecological recovery can be incredibly complex due to species interactions.

2B-P2

Impacts of bottom fishing on the sediment infaunal community and biogeochemistry of cohesive and non-cohesive sediments

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Bottom-trawl fisheries are wide-spread and have large effects on benthic ecosystems. We investigate the effect of scallop dredging on sand and otter trawling on mud by measuring changes in the infaunal community and the biogeochemical processes. We hypothesize that changes in biogeochemistry due to fishing will be larger in mud where macrofauna-mediated processes are expected to play a greater role, than in sand where hydrodynamics mediate the redox system. We sampled benthic infauna, sediment pore-water nutrients, oxygen, chlorophyll-*a*, apparent redox potential discontinuity layer, organic carbon and nitrogen content over a gradient of fishing intensity in sand and mud. The effects of fishing on biogeochemistry were stronger on mud than on sand, where biogeochemistry appeared to be more strongly influenced by tidal currents and waves. On mud, trawling increased sediment-surface chlorophyll-*a* and ammonium concentration beyond 5 cm depth, but decreased ammonium and silicate concentration in the upper sediment layers. The effects of fauna and bioturbation potential on biogeochemistry were very limited in both mud and sand habitats. Our results suggests that otter trawling may be affecting organic-matter remineralization and nutrient cycling through sediment resuspension and burial of organic matter to depth rather than through the loss of bioturbation potential of the benthic community. In conclusion, our hypothesis that the effects of trawling on biogeochemistry are larger in mud is supported, but the hypothesis that these effects are mediated by changes in the infauna is not supported. These results imply that management of trawling on muddy sediments should have higher priority.

2B-P3

SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis of recreational fishing in Foça and Gökova marine protected areas (Eastern Mediterranean, Turkey)

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This study analysed the strengths, weaknesses, opportunities and threats of Recreational Fishing (RF) modalities in two noteworthy Marine Protected Areas (MPAs) of Turkey, Foça and Gökova. At each study site, Foça and Gökova MPAs, a fixed number of 130 fishers were randomly interviewed from December 2012 to March 2013. In addition to 130 fishers in each site, face-to-face interviews were conducted with 37 RF charter operators, charter cooperative heads, commercial fishermen, owners of RF equipment shops, and local people. According to the results, the existence of shore and boat based RF activities including charter vessels constitutes one of the most important strength in the two marine protected areas. The lack of cooperation under an organization, and low membership rates was one of the major weakness for the two MPAs. Mainly, it is necessary to increase the effectiveness of RF organizations through sustainable management schemes. This kind of cooperation will help to enhance knowledge flow and problem solution between recreational fishers and other stakeholders. Subsidies can also be useful to encourage sustainable RF activities by also attracting local small scale fishermen to organize RF tours within the two MPAs. Monitoring, control and surveillance are one of the key points to achieve sustainable recreational use of resources within the MPAs, and certification programs for recreational fishers should be put into practice to eradicate problems arising from marine area use, illegal fishing, species and lengths. In conclusion, this study is supposed to serve key points through management of RF in two MPAs.

2B-P4

Reconstruction of benthic environment change result from the environmental improvement policies executed in Masan Bay since the 1990's: Using the environmental factors and living benthic foraminiferal population

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Reconstruction of environmental changes over the past 15 years was attempted by using the environmental and the living benthic foraminiferal population data. In the reconstruction using PCA and biological indices, the dredging of the polluted sediments was effective in removing the pollutant however it had a negative impact on the survival of foraminiferal population. In addition, it was revealed that accumulation of pollutants due to the failure to discharge the sewage out into the open sea through underwater discharging seriously aggravates the polluting of the benthic environment. Although the direct efforts such as dredging and discharging of wastewater were revealed very well in the reconstruction of the pollution history, definitive symptoms of the indirect efforts of regulating the quantity of pollutants entering the wastewaters from the land were not revealed. Long term and periodic research efforts are needed in order to quantitatively assess the effect of these indirect environmental improvement policies.

Session 2-C
Poster Presentations

Evaluation of best management practices

2C-P1

Short-term fidelity, habitat use and vertical movement behavior of the black rockfish Sebastes schlegelii as determined by acoustic telemetry

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The spatial and temporal dimensions of fish behavior are particularly relevant for sustainable management of rockfishes (*Sebastes* spp.) resources because most rockfish species are long lived and have high site fidelity, increasing their vulnerability to overexploitation. The 46 day spatial behavior of the black rockfish *Sebastes schlegelii*, a species subject to overexploitation in the Yellow Sea of China, was studied through acoustic telemetry tracking. The average residence index (the ratio of detected days to the total period from release to the last detection) in the study area was 0.92 ± 0.13, and most of the tagged fish were detected by only one region of the acoustic receiver array, suggesting relatively high site fidelity to the study area. Acoustic tracking also suggested that this species is more frequently detected during the day than at night in our study area. However, the diel detection periodicity (24 h) was only evident for certain periods of the tracking time, as revealed by a continuous wavelet transform. The habitat selection index of tagged *S. schlegelii* suggested that *S. schlegelii* preferred natural reefs, mixed sand/artificial reef bottoms and mixed bottoms of boulder, cobble, gravel and artificial reefs. The vertical movement of tagged *S. schlegelii* was mostly characterized by bottom dwelling behavior, with a high individual variability in migration vertical pattern. Our results have important implications for *S. schlegelii* catchability, the implementation of marine protected areas, the identification of key species habitats, and sustainable management of marine resources in eastern China.

2C-P2

Endangered species, ecosystem integrity, and human livelihoods

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If efforts to conserve endangered species lack long-term visions and neglect the human dimensions, conservation success will be questionable. Exclusion of stakeholders in decisions can lead to mistrust and polarization of groups. The story of the vaquita marina (*Phocoena sinus*), a porpoise endemic to the Northern part of the Gulf of California provides a unique opportunity to discuss this paradigm. A proposed gear-switch in the local fisheries addresses the bycatch that threatens the vaquita but neglects local livelihoods, the traditions and heritage of the community, the ecological integrity of the area and increases dependence on fishing subsidies. We estimate it will cost an additional US $8.5 million (2/3 of the net revenue produced by gillnets and 30% more in fuel consumption) if local revenues are to be maintained at pre-gear-switch levels. Additionally, suggested new trawl gears caught 2.7 times more unusable (therefore discarded) bycatch than gillnets, which included invertebrates and small juvenile fishes of economically valuable species. Our results show that the proposed gear switch intervention can be considered another “quick-fix” intervention in the history of the vaquita conservation agenda that urgently needs long-term goals that incorporate ecological, economic and human wellbeing.

2C-P3

Investigation of Trou-aux-Biches as a potential site for marine off-lagoon aquaculture in the republic of Mauritius

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Government of Mauritius has recently embarked on a new sector for the economy, namely the ocean. Aquaculture is key among the various activities identified for future development. Not only will it represent a new income and employment generating activity, it will also contribute to national food security. Aquaculture is an activity that is highly sensitive to the surrounding environment, and, there is an imperative need to perform an in-depth investigation of the abundance and distribution patterns of the various species present and physico-chemical parameters over the selected sites to ensure long-term sustainable aquaculture development. Trou-aux-Biches located in the north of Mauritius is among the sites identified in the Master Plan. Given its importance as a highly touristic area, it is necessary to be cautious about any aquaculture investment in this region. In this study, the lagoon and the open sea outside the reefs, including shipwrecks, were ecologically assessed using established methodologies, such as the line intercept transect. Three transects with 5 stations each for the shallow lagoon, as well as the shipwrecks around Trou-aux-Biches, were assessed for their species composition, distribution and structure. The benthic surveys within the lagoon revealed a high percentage of living benthic cover of 51%, but very few fishes, while the off-lagoon area was rich in its benthic cover as well as fish populations. The shipwrecks surveyed along with surrounding environment were heavily colonized by different species of corals and fishes. Trou-aux-Biches being rich in diversity of marine organisms needs a more complex integrated marine aquaculture exploitation.

Keywords: Aquaculture, ocean economy, lagoon, shipwrecks, impacts, ecosystems, fish species, coral species.

2C-P4

Potential environment risk of ocean energy development in China

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Ocean renewable energy, such as tidal range, tidal current, wave energy, as a strategical energy resources, has been developed by many countries. China is going to develop three test sites to support the sea trial of ocean energy, which respectively distributed in north, east and south of Chinese sea area. According to the characteristics of construction, operation and decommission period analyis, combined with the research results from published literature, several kinds of environmental problems are defined in this study, which mainly include hydrodynamic, physical, chemical, and biological effects. Besides, the marine species, current sea use status and marine environment pressure factors are different in the three test site. After the data analysis of sea use activities, marine key species and migrating species, key local environment contamination, and vulnerable ecosystems, this study presents the key potential environment risks of the individual test sites. Moreover, as a new kinds of sea use activity, ocean energy management is a new subject to the marine management department. The results would contribute to the ocean energy test site management, and the ocean energy management legislation.

Session 3-A
Poster Presentations

Biodiversity and ecosystem functioning

3A-P1 (CANCELLED)

Trophic functioning of macrobenthic fauna in a tropical acidified estuary

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Ocean acidification (OA), is one of the major drivers of ongoing global environmental change which cause a global scale disturbance to marine ecosystems damaging biodiversity and hampering proper ecosystem functioning. Here, the trophic structure of benthic in- and epifaunal communities in the acidified Brunei Estuary (Borneo, SE Asia) were characterized, and their distribution along the estuarine pH gradient was analyzed using univariate and multivariate techniques. The result revealed that surface deposit feeders represented by polychaetes were numerically dominant within the infaunal communities, while for the epifaunal communities filter feeders represented by bivalves were highly abundant. Species richness for almost all trophic groups increased toward the lower estuary, except for omnivores in the epifaunal communities, which decreased markedly.BIO-ENV and CCA showed that trophic shifts within infaunal communities were associated with environmental gradients. Surface-deposit feeders and omnivores were the most abundant macrobenthos of the upper estuary characterized by low salinity, low pH, and higher organic matter in the sediment. The proportion of filter feeders and carnivores increased with salinity/pH and sand. A more uniform distribution of trophic structure was found at lower estuary stations with high salinity and pH over sandy habitat. On the contrary, within epifaunal trophic groups, the percentage of surface deposit feeders and omnivores declined, but filter feeders remarkably increased toward the sea; however, carnivores remained almost similar in all stations. nMDS ordination for epifaunal trophic groups clearly demarcated higher salinity/pH stations from lower salinity/pH stations, suggesting different trophic compositions along the estuarine pH gradient.

3A-P2

Application of modern genetic tools to assess the consistency between management and biological units in three exploited species from the Northeast Atlantic

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Sustainable management of exploited marine species can be promoted by establishing management unit boundaries that are biologically meaningful. Unfortunately, the identification of isolated populations in widely distributed marine species is complicated by low levels of genetic differentiation. Modern genetic approaches now allow for the isolation of hundreds of genetic markers, therefore improving the power to identify biologically meaningful management units. Saithe (*Pollachius virens*), Greenland halibut (*Reinhardthius hippoglossoides*), and beaked redfish (*Sebastes mentella*) are migratory and commercially important fish species in the North Atlantic. The species' geographical ranges are divided into several management units throughout the distribution ranges, although the genetic population structure is not completely resolved. The question of consistency between management units and genetic population structure remains. The present study is aimed at testing for genetic structure of the species within the Northeast Atlantic. We apply genome wide sequencing technologies to identify markers (Single Nucleotide Polymorphisms, SNPs) that are most discriminatory between sites across the species geographical range. Different SNP panels are used for detailed analyses of population structure and to assess the consistency between management and biological units in three exploited species from the Northeast Atlantic.

Session 3-B
Poster Presentations

Marine population dynamics and community ecology

3B-P1

Understanding and predicting spatio-temporal dynamics in marine top-predator communities at regional and decadal scales

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The rapid increase in anthropogenic industries and activities in coastal and offshore habitats places a range of threats on marine top-predator (marine mammal and seabird) populations that inhabit these areas. Threats range from direct impacts such as displacement and collisions, to indirect ones such as changes in prey abundance and availability driven by modified hydrodynamic regimes. To manage industrial development in a manner which reduces the possibility of negative impacts on top-predator communities, a detailed knowledge of species distributions is needed to minimise spatial and temporal overlap between populations and industries/activities. However, risk assessment processes must also understand the processes governing species distributions, to account for community responses to ongoing environmental change. The NERC funded Marine Ecosystems Research Programme (MERP) aims to investigate the processes governing the distributions of marine top-predators across north-western Europe, and over the previous four decades. Around 2.1 million kilometres of vessel and aerial surveys have been assembled, representing one of the largest ever collations of its kind. At-sea vessel and aerial survey datasets have been combined with those quantifying physical processes and prey characteristics. Results from the initial analysis of this data are presented here, in particular: (1) identifying the physical properties of habitats characterised by particularly diverse and abundant communities of top-predators; and (2) the processes likely to explain shifts in prominent species distributions across the study area and period. These insights into the processes governing the distributions of top-predators at a regional and decadal scale can assist those tasked with ensuring the environmentally sustainable growth of industries by identifying habitats which consistently support large numbers of species and animals, and also by understanding the dynamics of species which may be of particular conservation concern.

3B-P2

The effect of acute and chronic temperature change on the functional response of the lesser spotted dogfish *Scyliorhinus canicula*

Josie **South** and Jaimie Dick

Predation is a strong driver of community structure and population dynamics. It is essential, in a changing thermal landscape, to reliably predict and quantify predation impact on prey populations under different abiotic contexts. Poikilotherms are especially susceptible to the effects of increasing temperature. Both gradual warming and acute, daily variation in temperature have been demonstrated to have adverse physiological consequences. We used comparative functional response analysis to assess how predator-prey interactions change under different warming scenarios. The functional response shape, attack, and handling parameters, and maximum consumption were calculated for *Scyliorhinus canicula* feeding upon the isopod, *Echinogammarus marinus* under ambient summer temperature of 12°C and a predicted future (daily summer maximum) temperature of 16.5°C. A 2 by 2 design of predator acclimated, prey acclimated, both acclimated, and both non-acclimated was implemented to test differential responses to temperature rise in both predator and prey. We found that the functional response changes from Holling Type II to Type III with an increase in temperature, except when only the predator was acclimated. Maximum feeding rate and attack rate were significantly higher, and handling time was significantly lower when both species were acclimated to higher temperatures. There was no significant difference in attack rate between treatments at high temperature. Significant differences in handling time and maximum feeding estimates between treatments suggest that physiological processes that act upon both predator and prey mediate the handling time and therefore the impact. Temperature increase causes a higher predation impact but is mitigated by differing thermal optima.

3B-P2 (Moved to Oral Section, May 31, 16:20)

Predicting population dynamics via spatial time delay embedding

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Many fish stocks are known to display nonlinear dynamic behavior. In a nonlinear forecasting framework, the ability to make useful predictions depends on the nature of time series. However, ecological time series are usually short and noisy while repeated measurements in spatially replicated sites are common. In this study, we developed a spatial time delay embedding method via Gaussian process modeling to evaluate whether information on spatial structure would improve prediction skill. The method was tested against simulated data as well as the larvae survey dataset from the CalCOFI database to forecast recruitment. We found that spatial information greatly improves the forecast skill of sardine recruitment. This is particularly important when spatial time series are available but each of the time series is not long enough to make meaningful predictions. Our method also provides the ability to incorporate habitat variables in space and time.

3B-P4 (CANCELLED)

Assessment of environmental variables controlling bottlenose dolphin's distribution in Jeju waters

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Habitat and spatial patterns of the Indo-Pacific bottlenose dolphin, *Trusiops aduncus*, in Jeju waters was investigated as part of a larger effort to understand its individual identification and seasonal distribution patterns. The photographs of 104 identified dolphins belonging to one population showed that they are perennial residents in the region. The urgent challenge is to understand their habitat range and habitat preference well enough in planning the conservation of this endangered species in the face of the pressures resulting from human population growth and environmental changes. A Species Distribution Model is a statistical model of the abiotic and biotic factors controlling species distribution linking species occurrence temporally and spatially to the environmental predictors. This study investigates the environmental parameters that control bottlenose dolphin distributions in relation to foraging traits (strategies). It is hypothesized that the topography of habitat and distribution of prey will be potential factors controlling the distribution patterns. We analyze the sighting data (presence-only) conducted by the Cetacean Research Institute between 2007 and 2015. We then use statistical models to test how the environmental factors (bathymetric gradient, water depth and distance from the nearest coastline for physiographic variables and SST, Salinity and Chlorophyll-a concentration for prey distribution data) influence the dolphin's distribution patterns.

3B-P5

Analysis of data from the bottom trawl survey in the Korean coastal waters

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The Korean National Institute of Fisheries Science (NIFS) has biannually (spring and fall, respectively) deployed a bottom trawl survey along the coastal areas for the last 10 years. Their survey design seems to be a systematic sampling because their trawling takes place on a regular basis: i.e., one trawling per unit bottom area, which is a square of 2 331 km^2. Using the survey data, NIFS has not yet reported their estimates of the groundfish population sizes, and also they have not evaluated the uncertainty of the estimates. Our objectives are to infer the groundfish population sizes, and to examine the temporal and spatial change in species compositions in relation to ocean conditions.

3B-P6

Density-dependent process in biological properties of walleye pollock related with biomass fluctuation in the East Sea during the late 20th century

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Walleye pollock (*Gadus chalcogrammus*, pollock hereafter) was one of the most dominant fisheries species in Korean waters during the 1970s-1980s. However, the stock biomass has considerably decreased resulting in the pollock stock collapse after 2008. Although it was expected that the biological characteristics of pollock would be adjusted in accordance with the biomass fluctuation, the systematic investigation of pollock resources in South Korean waters has been difficult because the major spawning ground is located in North Korean waters. The National Institute of Fisheries Science has collected information on pollock in the East Sea since the mid-1960s. Using these data, we tried to investigate biological characteristics of pollock during high (1976-1985) and low (1991-2000) biomass periods. Density-dependent growth of pollock was evident in Korean waters with dominance of larger size classes, larger condition factor, and larger length of maturation in the low biomass period. Concurrently, a monthly variation of GSI (gonado-somatic index) indicated that there was a density-dependent process in reproductive property of pollock stock in Korean waters. On the other hand, the pollock population abundance seems to be affected by ocean surface warming after the late 1980s. Our findings suggest that the biomass fluctuation associated with the environmental change in early life stage was thought to be responsible for the changes in the biological properties of pollock.

Session 3-C
Poster Presentations

Marine ecosystems and biogeochemical cycles

3C-P1 (CANCELLED)

Complexity of Integrating Numerical Modeling Results with Mitigation Strategies of Harmful Algae Toxins in Aquatic Ecosystems

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A three dimensional hydrodynamic ecosystem and IMPACT mitigation coupled model was employed to simulate algae transition and toxin produced ability under the nutrients limited conditions and their mitigation strategies. Numerical simulation was carried out for the four years of the period 2005–2009. Algae have shifted seasonally and annually between 2005 and 2009, between three major algal: *Microcystis* spp., *Planktothrix* spp., and *Cyclotella* spp. The model reproduced well the transitions of dominant algae in the four years by calibrating ecological parameters. The biomass of *Planktothrix* spp. suddenly increased in the summer of 2008, and *Planktothrix* spp. became the dominant species. Longer periods of stratification, lower concentration of dissolved oxygen, and higher concentration of dissolved nitrogen were observed in 2008, while the sudden increase in *Planktothrix* spp. biomass in 2008. We also found that the toxin production is made by *Microcystis* spp., and is proportional to the growth of algae, while it depends on whether phosphorus or nitrogen limits the algal growth. The toxin remains in the cell for respiration. Harmful algae toxin is released with extracellular release and mortality, and advects and diffuses with the surrounding current and turbulence. The degradation of toxin was taken into account by the decay coefficient which reduces the concentration of toxin. Numerical simulation was also tried under the assumption that phosphorus or nitrogen always limits the algal growth. This study examined the IMPACT (Integrating Mitigation Policies for Aquatic Cyanobacteria Toxin) model for diminution strategies of harmful algal blooms and their toxins.

Keywords: Societal complexity, simulation, algae, transition, toxin, mitigation, eutrophic lake

3C-P2

Optical discrimination of harmful *Cochlodinium polykrikoides* blooms in Korean coastal waters

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Harmful algal blooms (HABs) have occurred and caused large damages to the fishery industry in the coastal waters of Korean peninsula since the late 1980s. To effectively detect and monitor the spatial and temporal distributions of widespread HABs, *in-situ* optical measurements and/or satellite remote sensing can be used. In this study, we investigated the possibility of optically discriminating HABs focusing on *C. polykrikoides*, the major HAB causative dinoflagellate species in Korean waters. We estimated the apparent optical properties (AOPs) from the inherent optical properties (IOPs) of *C. polykrikoides* blooms based on forward calculation to use the distinctive optical characteristics for discriminating *C. polykrikoides* blooms from non-HABs in the visible wavelength. We produced a large dataset of simulated remote sensing reflectance (R_{rs}) spectra in a wide range of bio-optical conditions using Hydrolight software and bio-optical data provided by the International Ocean-Color Coordinating Group (IOCCG). The two R_{rs} band ratios (R_1: $R_{rs}(555)/R_{rs}(531)$, R_2: $R_{rs}(488)/R_{rs}(443)$) were determined to be effective in discriminating high-density *C. polykrikoides* blooms. Even under optically complex water conditions, the distribution of *C. polykrikoides* blooms in the space of R_1-R_2 was separated clearly from that of non-HABs. The results were consistent with *in-situ* observations and seem applicable to diverse coastal environments. Our findings provide theoretical and quantitative criteria upon which in-water HAB detecting algorithms can be developed.

3C-P3 (changed to a talk, June 1, 11:20-11:40)

Nutrient draw-down, ΔSi/ΔN/ΔP-ratios and net community production assessment in the Bering Sea

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Nutrient draw-downs in the marine environment reflect net community production (NCP) rates and present indirect information on phytoplankton community structure (e.g. relative abundance of diatoms). Time-series data for the Bering Sea is quite rare, thus spatial averaging of multiannual data is required to investigate nutrient dynamics in the area. Present work is dedicated to analyze station data available for the Bering Sea including datasets of NODC (USA), BEST-BSIERP (USA), JAMSTEC (Japan), as well as data of TINRO-Center (Russia). Silica, nitrogen, and phosphorus draw-downs were assessed as integral difference between early summer and late summer profiles. NCP was assessed based on total inorganic nitrogen. The results revealed high rates of annual NCP along the Bering Sea "Green Belt" (50-60 g C m^{-2} yr^{-1}). High rates of NCP were obtained along the eastern (53 g C m^{-2} yr^{-1}) and western coast of the sea (81 g C m^{-2} yr^{-1}) as well. The lowest NCP rates (25-30 g C m-2 yr-1) were found in the northern and central regions of the eastern shelf and in the oceanic domain of the sea. This behavior is caused by apparent nitrogen limitation of primary producers as well as possible iron limitation within the oceanic domain. The molar ΔSi/ΔN-ratios equal to 1.0-3.6, and ΔSi/ΔP-ratios were in range of 17-32. The following results reflect high relative abundance of diatoms in the area. However, apparent nitrogen and possible iron limitation of diatoms may have caused relatively high ΔSi/ΔN-ratio in the area. The study is supported by RFBR, research project No. 16-35-00388 мол_а.

Senior Scientists Presentations

June 2, 08:40

Fish and fisheries in a changing environment

Suam **Kim** (Plenary Keynote, PICES)

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Since the pioneering work by the Norwegian scientist J. Hjort (1914), the issue on the changes of the year-class strength of marine fish population became an important research topic in fishery science. The interannual fluctuation of fish abundance and biomass was explained partially by the strength of fishing activity and/or environmental variability of ocean. Aside from the overfishing impacts, the predation, starvation, and transport process by current during the early life history of fish were regarded as the main hypotheses for the controlling recruitment processes. Furthermore, changes in ocean environment such as warming, hypoxia, and acidification of seawater caused by climate change in recent years have completely altered the aquatic ecosystems. Productivity, distribution, and phenology of marine fishes were seriously changed compare to the past, which called for the urgent attention to the fisheries society for the sustainable development. In the lecture, the brief introduction of marine fish and fisheries focusing on food security will be introduced. The past history of scientific activity in fisheries oceanography and some scientific investigations currently on-going in world's ocean will be also included. Especially, the climate change effects on marine ecosystems and fisheries and the emerging theme on 'fish and people in a changing world' will be briefly introduced with the future direction and the trend of fishery science.

June 2, 8:40, Plenary Keynote

Challenges and advances in understanding marine ecosystems and projecting oceans futures

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The ocean is covering approximately 70 % of the earth's surface and providing huge amount of ecosystem services. The marine ecosystems are composed by numerus species from microscale bacteria to the largest livings blue whale. However, it is speculated that 91 % of marine livings have not yet been discovered. Also the marine ecosystem is still a frontier region for scientists and human beings. To sustainably receive the ecosystem services from the ocean, it is essential to understand the structure and functioning of marine ecosystems. Humans affect the ocean in a variety of ways including physical modification, pollution, ocean acidification and global climate change.

Data obtained by global observing networks, international and regional scientific programs and improved fidelity of climate models have advanced our understanding of both climate change and climate model evaluation. In addition, Coupled Model Intercomparison Projects (CMIPs) have contributed to improving climate model ability to reproduce past climates as well as climate variability through the use of ensemble modeling approaches. Nevertheless, typical model resolution is a half to one degree in latitude/longitude in the ocean model component, which makes it difficult to represent many ocean structures and phenomena important to marine ecosystems (e.g. upwelling, western boundary currents, eddies). Coastal areas are some of the most productive and biodiverse regions, and are dominated by mesoscale phenomena, which cannot be properly resolved by the climate models. One approach that is being used to achieve regional high-resolution climate-scale simulations is by nesting of a high-resolution limited-area model within a lower resolution large-scale model. Typically, information is downscaled from the coarse- to the fine-resolution region through an overlap in the domains. The high-resolution nest can explicitly resolve features missing from the large-scale model. However, when making a future projection, regional changes may also possibly affect the global climate (i.e. upscaling effects). Furthermore, model requirements are often different when considering ecosystems. For example, phenology is one of the most important items for marine ecosystems; a slight difference in the start of the spring stratification may result in a quite different marine ecosystem response.

Earth system models (ESMs), which include the carbon cycle, couple physics to lower-trophic-level marine ecosystem models. A common major weakness of ESMs lower-trophic-level models is the coarse functional group representation of zooplankton and lack of calibration with zooplankton abundances. This is partly because of the lack of a global database for zooplankton and partly because ESMs lower-trophic-level models have been designed to obtain accurate simulations of nutrient cycling and primary production but not necessarily for zooplankton dynamics. Nevertheless, zooplankton is a key component of marine ecosystems and it is our challenge to improve their representation, as well as the full marine ecosystem in climate models. This presentation will 1) show an example of international collaboration to build up an integrated ecosystem model (NEMURO.FISH) and 2) discuss our challenges for full food web modelling and future projections.

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