International Symposium

Understanding Changes in Transitional Areas of the Pacific

Program and Abstracts

La Paz, Baja California Sur, Mexico
April 24-26, 2018

www.pices.int/2018-Pacific-TA

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Program

Abstracts

Plenary, Invited, and Contributed Presentations

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Abstracts in this collection are not edited and are printed in the condition they were received.

Front cover:
Pez volador (Cheilopogon xenopterus), a flying fish commonly seen in the entrance of the Gulf of California; mixed media (acrylic, alcohol, and paper on wood), 40x30 cm, 2018, an original piece by an amateur local artist (Salvador Emilio Lluch-Cota).

Prepared by PICES Secretariat

Symposium Organizers

Symposium Convenors

Sachihiko Itoh (PICES/AORI, University of Tokyo, Japan)

Salvador Lluch-Cota (CIBNOR, Mexico)

Phoebe Woodworth-Jefcoats (PICES/PIFSC, NOAA-Fisheries, USA)

Evan Howell (PICES/PIFSC, NOAA-Fisheries, USA)

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Session Convenors

Session 1: *Effects of climate variability and change on the physics, biology, and fisheries in Pacific transitional areas*

Gerard DiNardo (ISC, Southwest Fisheries Science Center, NOAA-Fisheries, USA)

Evan Howell (Pacific Islands Fisheries Science Center, NOAA-Fisheries, USA)

Shinya Kouketsu (JAMSTEC, Japan)

Phoebe Woodworth-Jefcoats (Pacific Islands Fisheries Science Center, NOAA-Fisheries, USA)

Session 2: *Challenges in managing highly migratory and transboundary resources in Pacific transitional areas*

Nicolás Gutiérrez (Food and Agriculture Organization of the United Nations)

Salvador Lluch-Cota (CIBNOR, Mexico)

Minling Pan (Pacific Islands Fisheries Science Center, NOAA-Fisheries, USA)

Session 3: *Challenges in observing and modeling Pacific transitional areas*

Enrique Curchitser (Rutgers University, USA)

Sachihiko Itoh (AORI, University of Tokyo, Japan)

Session 4: *Advances in understanding Pacific shelf-offshore transitional areas*

François Colas (Institut de Recherche pour le Développement, France)

Hiroshi Kuroda (Hokkaido National Fisheries Research Institute, FRA, Japan)

Angelica Peña (Department of Fisheries and Oceans, Canada)

Session 5: *Biodiversity changes in Pacific transitional areas*

Xianshi Jin (Yellow Sea Fisheries Research Institute, CAFS, China)

Rubén Rodriguez Sánchez (CICIMAR-IPN, Mexico)

Thomas Therriault (Department of Fisheries and Oceans, Canada)

Session 6: *Transition zones in coastal habitats*

Francisco Arreguín-Sánchez (CICIMAR-IPN, Mexico)

Jingmei Li (Ocean University of China, China)

Welcome

Welcome to the international symposium on "*Understanding Changes in Transitional Areas of the Pacific*". Transitional areas span from basin-wide structures, such as the boundaries between gyres, to meso- and local-scale features. The scope of the symposium captures the expectation that systems within transitional areas will reflect the impacts of climate variability and change more dramatically and sooner than other more homogeneous areas, making them regions of particular concern.

With deep satisfaction, we acknowledge that about 150 scientists from 15 countries and 6 international and regional fisheries management organizations are attending the symposium and that more than 140 abstracts have been submitted by experts in physical and biological oceanography, fisheries sciences, climate and ecosystems modelling, plankton research, marine ecology, and socio-economic sciences. We anticipate that many of these presentations will be published in a special issue of *Deep-Sea Research II* a year after the symposium.

We thank PICES for promoting this initiative, all the sponsors for their trust in us when we asked for support for the symposium, and the local hosting institutions, CIBNOR, CICIMAR, and CICESE, for their hard work in preparing this event. We also express our gratitude to the Scientific Steering Committee, session convenors and invited speakers for their commitments.

The goal of this symposium is to expand our understanding of Pacific transitional areas and to provide an update on the scientific progress achieved since April 2002, when the first PICES international symposium on "*North Pacific Transitional Areas*" was held also in La Paz. Participants of the 2002 symposium may recall the great occasion we had to contrast concepts, compare systems and methods, and bridge different views and understandings of what transitional systems reveal, and the scientific challenge they represent. We expect to repeat that experience.

This symposium will also allow to increase interactions between the PICES community and scientists from other regions of the Pacific Rim, and to integrate the interests of Latin American scientists into PICES programs and research. Furthermore, by supporting 20 students and early career scientists, this symposium should lead to much future research on transitional areas.

We are sure this 2018 Pacific transitional areas symposium will be memorable as an opportunity not only to learn, discuss and debate science, but also to meet old friends and make new ones, and to enjoy the food, sights, and hospitality of beautiful La Paz, Mexico.

Sachihiko Itoh, Salvador Lluch-Cota, Phoebe Woodworth-Jefcoats, Evan Howell and Alexander Bychkov
Symposium Convenors and Coordinator

Notes for Guidance

The symposium will be held April 24–26 at the Centro de Investigaciones Biológicas del Noroeste (CIBNOR; http://www3.cibnor.mx/icibnor.php), located at Km. 1 Carretera a San Juan de La Costa "EL COMITAN", La Paz, B.C.S., 23205. All sessions will take place in building "S", just after the main entrance to the facilities: plenary sessions in the "Dr. Felix Córdoba Alva" Auditorium at the ground level, and concurrent topic sessions in the meeting rooms on the first floor. Posters will be on display at the CIBNOR Central Plaza.

The PICES-Mexico special session on April 23 will be convened at the "Dr. Héctor Mayagoitia Domínguez" Auditorium, CICIMAR (Centro Interdisciplinario de Ciencias Marinas; www.cicimar.ipn.mx), located at Av. Instituto Politécnico Nacional s/n Col. Playa Palo de Santa Rita.

Registration

The registration desk will be set at CICIMAR during the PICES-Mexico special session from 14:00–18:00 on April 23, and at the main auditorium entrance at CIBNOR from 8:00–18:00 on April 24 to April 26.

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 presenters should designate at least 5 minutes for questions. Authors can download their presentations directly to the computers in the rooms where the sessions will be held.

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

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

Posters

Posters will be on display at the CIBNOR Central Plaza from noon of April 24 until noon of April 26. Poster presenters are expected to be available at their posters for at least one hour to answer questions during the two Poster Sessions/Receptions to be held from 18:00–19:30 on April 24 and April 25. To facilitate planning of poster viewing, presenters should leave a note with their posters to notify participants on the times when they will be available.

Presenters are requested to bring their posters to the registration desk before 11:00 on April 24.

Internet access

Wireless internet access will be available at CIBNOR. In addition, a few computers with Internet access will be available for participants in the room above the main auditorium.

Social activities

Symposium icebreaker

April 23(18:00-19:30)
CICIMAR (Centro Interdisciplinario de Ciencias Marinas; www.cicimar.ipn.mx)

The icebreaker, combined with viewing of program posters from PICES and Mexico, will provide an opportunity for participants of the symposium and the PICES-Mexico special session to interact while enjoying cold beer, appetizers and a beautiful sunset at the "El Conchalito" beach.

Beer & Fish Poster Sessions / Receptions

April 24 & April 25 (18:00-19:30)
CIBNOR (Centro de Investigaciones Biológicas del Noroeste)

These Poster Sessions/Receptions will be designed to allow participants to wander around the poster displays and chat with presenters while sipping beverage, and nibbling on hot and cold Mexican snacks.

Symposium Dinner

April 26(19:00-22:00)
Restaurante La Marea (Frente de Playa area)

Bus transportation during the symposium

Bus transportation will be arranged between downtown hotels and the venues (see map).

April 23:
Route 1: Stop 1/Jardín Velázco (Hotel Catedral) – Stop 2/Seven Crown Hotel – Stop 3/Hotel Zar – CICIMAR
Route 2: Stop 1/Hotel Blue - CICIMAR
Departure to CICIMAR for the PICES-Mexico special session at 13:00
Departure to CICIMAR for the Symposium Icebreaker at 17:00
Departure from CICIMAR to downtown hotels at 19:30

April 24 to April 26:
Route 1: Stop 1/Jardín Velázco (Hotel Catedral) – Stop 2/Seven Crown Hotel – Stop 3/Hotel Zar – CIBNOR
Route 2: Stop 1/Hotel Blue - CIBNOR
Departure to CIBNOR for the symposium at 8:00
Departure from CIBNOR to downtown hotels at 19:30 on April 24 and April 25
Departure from CIBNOR to downtown hotels and dinner venue at 17:30 on April 26

Program at a Glance

Monday, April 23 [CICIMAR]			
14:00 18:00	**PICES-Mexico Special Session**		
18:00 19:30	**Symposium Icebreaker**		
Tuesday, April 24 [CIBNOR]			
09:00 12:10	**Opening Ceremony, Plenary Session**		
13:30 17:50	**Session 1 (Day 1)**	**Session 2 (Day 1)**	**Session 5 (Day 1)**
18:00 19:30	**Poster Session/Reception**		
Wednesday, April 25 [CIBNOR]			
09:00 10:40	**Plenary Session**		
11:10 12:50	**Session 1 (Day 2)**	**Session 2 (Day 2)**	**Session 5 (Day 2)**
14:00 17:40		**Session 4 (Day 1)**	**Session 3**
18:00 19:30	**Poster Session / Reception**		
Thursday, April 26 [CIBNOR]			
09:00 10:20	**Plenary Session**		
10:50 12:50	**Session 1 (Day 3)**	**Session 4 (Day 2)**	**Session 6**
14:00 15:40			
16:00 17:30	**Summary Plenary Session, Closing Ceremony**		
19:00 22:00	**Symposium Dinner** [Restaurante La Marea (Frente de Playa area)]		

All events on April 23 will be held at CICIMAR (Centro Interdisciplinario de Ciencias Marinas)
All events on April 24-26 will be held at CIBNOR (Centro de Investigaciones Biológicas del Noroeste)

Coffee/Tea Breaks will take place every day in the morning (~ at 10:30) and afternoon (~ at 15:30).
Lunch breaks are scheduled approximately from 12:30-14:00; lunches are covered by the registration fee.

List of Sessions and Workshops

S1	Apr. 24-26	Effects of climate variability and change on the physics, biology, and fisheries in Pacific transitional areas
S2	Apr. 24-25	Challenges in managing highly migratory and transboundary resources in Pacific transitional areas
S3	Apr. 25	Challenges in observing and modeling Pacific transitional areas
S4	Apr. 25-26	Advances in understanding Pacific shelf-offshore transitional areas
S5	Apr. 24-25	Biodiversity changes in Pacific transitional areas
S6	Apr. 26	Transition zones in coastal habitats

Schedule at a Glance, April 24

Plenary

9:30 **Jeffrey Polovina (General Plenary)**
The North Pacific Transitional Zone: A research and management retrospective

10:00 **Satoshi Osafune (Plenary S1)**
Decadal-scale temperature variability in the subarctic-subtropical gyre boundary region in the North Pacific

10:25 ***Coffee Break***

10:55 **Francisco Werner (Plenary S1)**
Secular and paroxysmic shifts of transitional areas: Science and management challenges

11:20 **Nicolas Gutierrez (Plenary S2)**
Considerations of transitional and transboundary processes when assessing and managing highly migratory tuna species

11:45 **Paul Snelgrove (Plenary S5)**
Transitional habitats as an opportunity to understand drivers of ecosystem functioning

12:10 **Lunch**

S1-Day1 *Effects of climate variability and change on the physics, biology, and fisheries in Pacific transitional areas*		**S2-Day1** *Challenges in managing highly migratory and transboundary resources in Pacific transitional areas*		**S5-Day1** *Biodiversity changes in Pacific transitional areas*	
13:30	***Introduction by Convenors***	13:30	***Introduction by Convenors***	13:30	***Introduction by Convenors***
13:35	**Sayaka Yasunaka (Invited)** Large nutrient variation in the North Pacific Transitional Area	13:35	**James Ianelli (Invited)** Status of science-based fisheries management in the South Pacific Regional Fisheries Management Organization (SPRFMO) area	13:35	**Xinzheng Li (Invited)** Long time change of macrobenthos from the Yellow Sea and East China Sea, Northwestern Pacific
14:00	**Hitoshi Kaneko** Decadal salinity variation in the western North Pacific correlated with the North Pacific Gyre Oscillation	14:00	**Dale Squires** High-seas fisheries management	14:00	**Víctor Aramayo** OMZ-influenced benthic responses along bathymetric gradients reflects coherent transitional ecological changes
14:20	**Ruben Rodriguez-Sanchez** Interannual spatial dynamic of frontal activity along the southern part of the California Current (1985-2015)	14:20	**Minling Pan** Challenges in managing highly migratory and transboundary resources in Hawaii longline fisheries	14:20	**Cherisse Du Preez** Submarine islands of benthic biodiversity within and adjacent to an offshore transitional area
14:40	**Tim R. Baumgartner** The nature of the transition in the California Current Ecosystem during the 1997-1998 El Niño event	14:40	**Yoshinori Aoki** Reviews of Albacore biology and fisheries around transition areas in the North Pacific Ocean	14:40	**Jeffrey Crooks** Biological invasions at the land-sea-freshwater interface in the Tijuana River National Estuarine Research Reserve, a Marine Protected Area in a binational watershed
15:00	**Luz de Lourdes Aurora Coronado-Álvarez** Estimates of anthropogenic carbon in waters off Mexico north and south of the Cabo San Lucas front	15:00	**Jose Augusto Valencia-Gasti** Distribution of Pacific sardine spawning between U.S. and Mexico from 2000 to 2013	15:00	**Tammy Norgard (presented by Cherisse Du Preez)** Understanding the Pelagic waters and Coastal Transition Zone within Canada largest Area of Interest for Protection on the Pacific Coast

Schedule at a Glance, April 24

S1-Day1		S2-Day1		S5-Day1	
15:20		15:20	**Ricardo Oliveros-Ramos** Dynamics of the transition zones between distribution sub-areas of jack mackerel (*Trachurus murphyi*) in the South Pacific	15:20	**Romeo Saldívar-Lucio** Restructuring reef-fish functional groups: No-fishing consequences into a transitional area
15:40	***Coffee Break***	15:40	***Coffee Break***	15:40	***Coffee Break***
16:00	**Ruben Lara-Lara** Phytoplankton biomass and production rates, pCO2 and carbon fluxes time series (2006-2016) in the southern California Current Region	16:00	**Toshihide Iwasaki (Invited)** Stock assessment for Pacific saury, considering some marine environmental factors	16:00	**Sonia Batten (Invited)** Lower trophic level transitions determined from Continuous Plankton Recorder surveys
16:20	**Laura Lilly** Is every El Niño the same? ENSO-related zooplankton community shifts in the southern California Current System	16:25	**Hidetada Kiyofuji (Invited)** Distribution and behavior of highly migratory species in transition areas in the western Pacific Ocean - Tracking of Marine Animals (ToMAs) Project	16:25	**Bertha Lavaniegos (Invited)** Changes euphausiid species composition in the transition zone of the California Current during the period 1998-2016
16:40	**David Rivas** Physical and biological effects of the 2014-2015 northeastern Pacific's climatic anomaly on northern Baja California Peninsula, diagnosed by a numerical NPZD model	16:50	**Leanne Duffy** Using long-term catch trends and habitat preferences of bycatch species to improve ecosystem-based management in transition areas within the eastern Pacific Ocean	16:50	**Sylvia P. A. Jiménez-Rosenberg** Bahía Vizcaíno as a transitional area for fish larvae communities in the Southern California Current
17:00	**Saúl Álvarez-Borrego** Spatial and temporal variations of satellite-derived SST, and phytoplankton biomass and production in the transition zone at the southernmost CCS in 2002-2017	17:10	**Shane Griffiths** A flexible spatially-explicit ecological risk assessment approach for quantifying the cumulative impact of tuna fisheries on data-poor bycatch species caught in eastern Pacific Ocean transition areas	17:10	**Kazuaki Tadokoro** Seasonal variation of plankton community and biodiversity in the Kuroshio-Oyashio Transition waters
17:20	**María C. Jiménez-Quiroz** Impact of the Blob and El Niño warming phenomena in the SW Baja California peninsula: Study case of Bahia Magdalena	17:30	**Dale Squires** Bycatch-saving technological change	17:30	**Susana Cabrera-Núñez** Community structure and spatial distribution of zooplankton in the Mexican Transitional Pacific (April 2015)
17:40	**S1, Day1 Ends**	17:50	**S2, Day1 Ends**	17:50	**S5, Day 1 Ends**

Schedule at a Glance, April 25

Plenary

9:00 **Dimitri Gutierrez (Plenary S4)**
Recent trends on temperature, productivity and oxygenation across the Peruvian upwelling system

9:25 **John Barth (Plenary S3)**
On the edge: Observing and modeling intensified physical and biogeochemical interactions in the Pacific's ever-shifting transition zones

9:50 **Toshio Suga (Plenary S3)**
North Pacific subtropical-subpolar transitional areas as ventilation windows of the both gyres

10:15 **Kenneth Johnson (Plenary S3)**
Observing biogeochemical variability in transitional areas of the South Pacific/Southern Ocean with the SOCCOM profiling float array

10:40 ***Coffee Break***

S1-Day2 *Effects of climate variability and change on the physics, biology, and fisheries in Pacific transitional areas*		**S2-Day2** *Challenges in managing highly migratory and transboundary resources in Pacific transitional areas*		**S5-Day2** *Biodiversity changes in Pacific transitional areas*	
11:10	**Ryan Rykaczewski** Variability in the transport and latitude of the North Pacific Current: Consequences for northeastern Pacific ecosystems	11:10	**David Demer** Continuous differentiation of sardine stocks in the Ensenada Front transitional area	11:10	**Giancarlo Moron** Identifying biogeographical transition zones and nekton assemblages in the northern Humboldt Current System
11:30	**Evan Howell** Variation in phytoplankton composition between two North Pacific frontal zones along 158°W during winter-spring 2008–2015	11:30	**Stefan Koenigstein** Impacts of climatic and ecological variations on human user groups and implications for marine ecosystem-based management in Northern Peru	11:30	**Ruslan Pastor (presented by Carmen Yamashiro)** Spatial-temporary distribution of biodiversity on the northern border of the Peruvian maritime domain (2014-2015)
11:50	**Johanna Wren** Evaluation of fleet dynamics and oceanography as factors accounting for variations in black-footed albatross interactions in the Hawai'i-based deep-set longline fishery 2006-2017	11:50	**Chin-Hwa Jenny Sun (Invited) (presented by Minling Pan)** Economic and conservation: Biological and economic tradeoffs between longline and purse-seine fishing in the Eastern Pacific Ocean	11:50	**Ruslan Pastor (presented by Carmen Yamashiro)** The coastal El Niño 2017 and its effect on the space-time distribution of some fishes and invertebrates off the coast of Peru
12:10	**Elliott Hazen (presented by Steven Bograd)** Mesoscale ocean features lead to increased energy gain for Elephant Seals in the North Pacific Transition Zone	12:15	**Simon Bush (Invited)** Only one path to sustainability? Understanding the role of MSC certification in regional fisheries management organizations	12:10	**David Petatán-Ramírez** Habitat suitability index of Pacific sardine (*Sardinops sagax*) in the Mexican Pacific Ocean under climate change scenarios
12:30	**Ellen Yasumiishi (presented by Keith Criddle)** Climate related changes in abundance and range shifts of pelagic fishes and jellyfish in the eastern Bering Sea during late summer, 2002-2016	12:40	**S2 Ends**	12:30	**Julio Lorda** Species range shifts, long term variability of temperature on coastal systems, and insights into the future
12:50	***Lunch***			12:50	**S5 Ends, *Lunch***

Schedule at a Glance, April 25

S1-Day2		**S4-Day1** *Advances in understanding Pacific shelf-offshore transitional areas*		**S3** *Challenges in observing and modeling Pacific transitional areas*	
14:00	**Xianshi Jin** Effects of environmental changes in inshore waters on community structure and population dynamics of exploited marine species	14:00	***Introduction by Convenors***	14:00	***Introduction by Convenors***
14:20	**Xiujuan Shan** Biological responses of small yellow croaker (*Larimichthys polyactis*) to multiple stressors: A case study in the Yellow Sea, China	14:05	**Xinyu Guo (Invited)** Cross-shelf transports of water and nutrients in the East China Sea and their impacts on the primary production	14:05	**Charles Stock (Invited)** Predicting and adapting to biome-scale marine resource changes in the North Pacific
14:40	**Tatsuya Sakamoto** Reproducing migration history of Japanese sardine using otolith $\delta^{18}O$ and a data assimilation model	14:30	**Tatsuro Karaki** Buoyancy shutdown process for the development of the baroclinic jet structure of the Soya Warm Current during summer	14:30	**Masao Kurogi (Invited)** Development of a high resolution coastal ocean model
15:00	**Keith Criddle** Durable entitlements and resilience in fishery social ecological systems subject to environmental forcing	14:50	**Hiroaki Saito** Nutrient front across the Kuroshio	14:55	**Daisuke Hasegawa (Invited)** Mixing processes of the Oyashio and Tsugaru Warm Current in the Northwestern Pacific Ocean
15:20	**Barbara Muhling** North Pacific albacore distribution and migrations along transition zones	15:10	**Hiroshi Kuroda** Numerical experiments based on a coupled physical–biochemical ocean model to study the Kuroshio-induced nutrient supply on the shelf-slope region south of Japan	15:20	**Enrique Curchitser** Projected coastal hypoxia in a coupled bio-physical model of the California Current System
15:40	***Coffee Break***	15:30	***Coffee Break***	15:40	***Coffee Break***
16:00	**Gerardo Aceves-Medina** Interannual variability tendences of the fish larvae abundance of dominant species at the Transition Zone of Bahia Vizcaino (1997-2014)	15:55	**Michael Jacox (Invited)** Wind and nutrient controls on phytoplankton biomass in the coastal, offshore, and transitional areas of the California Current System	16:00	**Sergey Prants** Lagrangian analysis of mesoscale eddies in the Kuroshio-Oyashio frontal zone
16:20	**Ana Gabriela Uribe-Prado** Fish larvae associations off the west coast of the Baja California peninsula during climate anomalies of 2014 and 2015	16:20	**Steven Bograd** Cross-shelf variation in California Current Water mass structure	16:20	**Cristhian Asto** Spatio-temporal variability of the Equatorial Front in the Eastern Pacific

Schedule at a Glance, April 25

S1-Day2 *Effects of climate variability and change on the physics, biology, and fisheries in Pacific transitional areas*		**S4-Day1** *Advances in understanding Pacific shelf-offshore transitional areas*		**S3** *Challenges in observing and modeling Pacific transitional areas*	
16:40	**Timothy Frawley** Impacts of a transition to tropical oceanic conditions in the Gulf of California on pelagic fisheries (2010-2015)	16:40	**William Crawford** Variations in subsurface oxygen concentration in the Pacific Canadian transition zone	16:40	**Isabel Ramirez** The effect of Ojo de Liebre Lagoon on the hydrodynamics of Bahia Vizcaino
17:00	**Diane Gendron** Recent decline in body condition of individual blue whales in the Gulf of California	17:00	**Angelica Peña** Interannual variability of biogeochemical conditions along the British Columbia continental shelf and slope	17:00	**Hitomi Oyaizu** Temperature and growth cause the recruitment variability of Pacific saury (*Cololabis saira*): Modeling survival processes in early life stages
17:20	**Elan Portner** Differential response of midwater, midtrophic communities to ENSO and tropicalization in the Gulf of California	17:20	**Shinichiro Kida** A Lagrangian view of spring blooms and river-ocean dynamics	17:20	**Sachihiko Itoh** Fine-scale variability of isopycnal salinity in the California Current System
17:40	**S1, Day2 Ends**	17:40	**S4, Day1 Ends**	17:40	**S3 Ends**

Schedule at a Glance, April 26

Plenary

9:00 **Francisco Arreguín-Sánchez (Plenary S6)**
Climate change, the challenge of fisheries management and the need of a change of paradigm: Ecosystem reference levels for sustainable fisheries

9:25 **Thomas Therriault (Plenary S6)**
Coastal Aquatic Ecosystems Under Stress: PICES experiences

9:50 **Emanuele Di Lorenzo (General Plenary)**
Multi-scale impacts of climate on Pacific Transitional Areas

10:20 ***Coffee Break***

S1-Day3 *Effects of climate variability and change on the physics, biology, and fisheries in Pacific transitional areas*		**S4-Day2** *Advances in understanding Pacific shelf-offshore transitional areas*		**S6** *Transition zones in coastal habitats*	
10:50	**Daniel Grados** Changes in the oxycline depth and their impacts on fish distribution	10:50	**Vera Oerder** Frontal activity and characteristics in an area of seasonal coastal upwelling near Punta Lavapié, Humboldt Current System	10:50	***Introduction by Convenors***
				10:55	**Zengjie Jiang (Invited)** Potential impacts of coastal mariculture on marine ecosystems and sustainable approaches
11:10	**Rodolfo Cornejo** Acoustic and bio-ecological observations of mesopelagic fishes (*Vinciguerria lucetia* and myctophids) in Peruvian Humboldt Current	11:10	**François Colas** The impact of El Niño events on the fine-scale dynamics off Peru coasts: In-situ measurements and regional model analysis	11:20	**Jon Chamberlain (Invited)** A review of the use of models to simulate environmental interactions of marine finfish aquaculture in BC and their potential application to other coastal zone management challenges
11:30	**Carmen Yamashiro** Distribution of jumbo flying squid (*Dosidicus gigas*) and the environmental conditions in Peruvian waters	11:30	**Criscely Luján-Paredes** Ecological characterization of the pelagic habitat in the Peruvian Upwelling Ecosystem: Insights from the dynamics of the coastal shelf-open ocean transitional areas	11:45	**Arturo Aguirre-Velarde** Marine aquaculture vulnerability in the northern limit of the Peruvian upwelling system
11:50	**Luis Mariátegui (presented by Carmen Yamashiro)** Biological and fishing aspects of the jumbo flying squid (Dosidicus gigas) in the main fishing areas of the Peruvian sea between July 2015 to June 2017	11:50	**Michelle I. Graco** Connections between the Peruvian coastal upwelling and open ocean biogeochemistry with the plankton variability	12:05	**Jingmei Li (Invited)** Valuing the loss of ecological benefits of wetland reclamation in Jiaozhou Bay based on choice experiments
12:10	**Miguel Ñiquen** Impact of climatic variability on the distribution of dominant species in coastal and oceanic regions off Peru	12:10	**Dante Espinoza-Morriberón** Interannual variability of the chlorophyll-*a* transitional zone in the Peruvian Upwelling System: Local and remote forcings		

Schedule at a Glance, April 26

S1-Day3 *Effects of climate variability and change on the physics, biology, and fisheries in Pacific transitional areas*		**S4-Day2** *Advances in understanding Pacific shelf-offshore transitional areas*		**S6** *Transition zones in coastal habitats*	
12:30	**Patricia Ayón** Spatio-temporal variability of the early life stages of anchovy (*Engraulis ringens*) and Panama lightfish (*Vinciguerria lucetia*) in the Northern Humboldt Current System (1964-2016)	12:30	**Avy Bernales** Impact of oceanographic variability in the nano- and microphytoplankton dynamics off the central coast of Peru – 12° S (2013-2016)	12:30	**Meng Su (CANCELLED)** Preliminary analysis of the Jimo coastal ecosystem with the Ecopath model
12:50	***Lunch***	12:50	***Lunch***	12:50	***Lunch***
14:00	**David Correa** Peruvian North as a transition area during coastal El Niño 2017 and its impact on the marine environment: A review oceanographic, meteorological and artisanal fishery	14:00	**Roberto Quesquén** Answer of zooplankton indicator species to oceanographic variability in the transition zone off the central coast of Peru (2013-2017)	14:00	**Steve Kasperski** Understanding social vulnerability and resource dependence in Alaska fishing communities
14:20	**Betsy Buitrón** Reproduction of Jack mackerel *Trachurus murphyi* in Peru	14:20	**Katia Aronés** Zooplankton biomass in the Northern Humboldt Current System and its variability associated with areas of transition	14:20	**Miguel Angel Ojeda Ruiz** Fisheries in Bahia Magdalena-Almejas: Evolution and the need to explore new policies and management paradigms
14:40	**Luis Usca Cornejo (presented by Miguel Ñiquen)** Dynamics of the artisanal fishery of the flying fish roe in southern Peru	14:40	**Graciela Pérez-Mora** Surface temperature and chlorophyll-a satellite, in coastal transition zones: Effect on the anchovy fishery (*Engraulis ringens*) of northern Chile	14:40	**Lander Merma** Physical variability associated to the formation of water stratification events and emergence of anoxia in Paracas Bay (14º S) downstream the main Peruvian coastal upwelling cell
15:00	**Josymar Torrejón–Magallanes** Spatio-temporal distribution modeling and abundance index of perico (*Coryphaena hippurus*) in the Pacific Ocean off Peru	15:00	**Wencheng Lau-Medrano** The Peruvian anchovy and oceanographic fronts: Description of association and using as a proxy of presence	15:00	**Ursula Mendoza** Sulfidic events in a bay of the Central Peruvian upwelling system
15:20	**Wilbert Marin (presented by Miguel Ñiquen)** Billfish fisheries and environmental variability in Peru during 1997-2016	15:20	**Ioanna Bouloubassi** Imprints of physical, chemical and biological conditions in sedimentary proxies across the Peruvian shelf	15:20	**Juan A. Payan Alcacio** Analysis of the community structure of the mangrove fish in the American Continent
15:40	**S1 Ends**	15:40	**S4 Ends**	15:40	**S6 Ends**

POSTERS

S1: Effects of climate variability and change on the physics, biology, and fisheries in Pacific transitional areas

S1-P-1 **Erick D. Ruvalcaba-Aroche**
"El Niño" 2015-2016 in northeastern tropical-subtropical convergence: Implications on squid paralarvae distribution

S1-P-2 **Raquel Toste**
Changes on the transport of North Pacific Current system based on CMIP5 projections to the end of the century

S1-P-3 **Carina Stefoni Böck**
Spatiotemporal variability of the oceanic fronts at the Kuroshio-Oyashio Confluence region and its relationship with ENSO

S1-P-4 **Nestor Rey-Villiers**
Biogenic silica as an indication of change in primary productivity in the last 5 thousand years

S1-P-5 **Shinya Kouketsu**
Decadal salinity changes on the isopycnal surfaces revealed by the Argo float array around the subarctic front in the North Pacific

S1-P-6 **Toshimasa Doi**
Representation of multi-decadal changes in dissolved inorganic substances in the Estimated Ocean State for Climate Research (ESTOC)

S1-P-7 **Shigeki Hosoda**
Spatial and temporal variability of oxygen minimum zone in the North Pacific detected by biogeochemical Argo floats

S1-P-8 **John J. Selvaraj**
Decadal changes in the Colombian Pacific thermal frontal zones as revealed by satellite observations

S1-P-9 **Pavel A. Munshi**
Case study of upwelling at Baja California waters

S1-P-10 **Erick J. Rodriguez-Aamador**
Larval fish habitats in the shallow oxygen minimum zone in the Tropical Pacific off Mexico before and during "El Niño Godzilla 2015-2016"

S1-P-11 **Eleuterio Yáñez**
Environmental conditions associated with swordfish Chilean coast

S1-P-12 **Deivis Cueva**
Is there genetic fluctuation in northern population of *Engraulis ringens* over timescales? An approach with mitochondrial markers

S1-P-13 **Hiroaki Tatebe**
Atmospheric responses and feedback to the meridional ocean heat transport in the North Pacific

S2: Challenges in managing highly migratory and transboundary resources in Pacific transitional area

S2-P-1 **Aleksandr Zavolokin**
Management of fisheries resources in the Convention Area of the North Pacific Fisheries Commission: Progress and challenges

S3: Challenges in observing and modeling Pacific transitional areas

S3-P-1 **Yukio Masumoto**
Eastern Indian Ocean Upwelling Research Initiative (EIOURI)

S4: Challenges in managing highly migratory and transboundary resources in Pacific transitional areas

S4-P-1 **Ximena Orosco**
Paralarvae of *Argonauta* spp. (Class: *Cephalopoda*) as indicators of ocean fronts in the NHCS

S4-P-2 **Kazuo Ishikawa**
Transport and recruitment of age-0 jack mackerel (*Trachurus japonicus*) from the East China Sea to coastal areas along the Kuroshio

S4-P-3 **Ramiro Castillo**
Behavior of schools of anchoveta (*Engraulis ringens*) on the fronts of coastal and oceanic water masses between 2015 and 2017

S4-P-4 **Elda Pinedo**
Spatial characterization offshore-inshore of euphausiids in the Northern Humboldt Current System

S4-P-5 **Amaru Márquez**
Persistence of a sub-surface fluorescence maximum within the Oxygen Minimum Zone in the Pacific off Mexico

S5: Biodiversity changes in Pacific transitional areas

S5-P-1 **Adriana Gomez-Leon**
Spatio-temporal variability in the relative abundance of benthic foraminifera in La Paz lagoon, Gulf of California

S5-P-2 **David Torres**
Changes in marine zooplankton diversity during El Niño 2015-2016 in a convergence area in northern Peru

S5-P-3 **Natalia Arakaki**
Distributional patterns of macroalgae from northern Peru

S5-P-4 **Victoria Díaz-Castañeda**
Macrobenthic colonization of an artificial reef located in the west coast of Baja California, Mexico

S6: Transition zones in coastal habitats

S6-P-1 **Ricardo Palomares-García**
Seasonal cycle of the copepod community in an anti estuarine lagoon

S6-P-2 **Sonia Sánchez**
Seasonal variability in the distribution of phytoplankton in Paracas Bay/Peru, as a response to environmental conditions

S6-P-3 **Jesus Roberto Oyervides-Figueroa**
Genetic characterization of *Artemia franciscana* by isoenzymes

Session Descriptions

S1: Effects of climate variability and change on the physics, biology, and fisheries in Pacific transitional areas

Co-Convenors:
Gerard DiNardo (Southwest Fisheries Science Center, NOAA-Fisheries, USA)
Evan Howell (Pacific Islands Fisheries Science Center, NOAA-Fisheries, USA)
Shinya Kouketsu (JAMSTEC, Japan)
Phoebe Woodworth-Jefcoats (Pacific Islands Fisheries Science Center, NOAA-Fisheries, USA)

Plenary Speakers:
Satoshi Osafune (JAMSTEC, Japan)
Cisco Werner (NOAA-Fisheries, USA)

Invited Speaker:
Sayaka Yasunaka (JAMSTEC, Japan)

Pacific Transitional Areas (PTAs) are impacted by climate variability and change at seasonal to century time scales. Climate fluctuations can affect both the geographical and vertical locations of PTAs, as well as their three-dimensional structure and phenology. All of these changes have the potential to impact biological systems, including fisheries.This session aims to address questions surrounding any of these aspects of climate variability and change. We invite submissions discussing both observed climate effects as well as projections for future change. Presentations on biophysical connections are also encouraged. We are particularly interested in talks that include discussion of the societal implications of climate variability and change in PTAs.

S2: Challenges in managing highly migratory and transboundary resources in Pacific transitional areas

Co-Convenors:
Nicolás Gutiérrez (Food and Agriculture Organization of the United Nations)
Salvador Lluch-Cota (CIBNOR, Mexico)
Minling Pan (Pacific Islands Fisheries Science Center, NOAA-Fisheries, USA)

Plenary Speaker:
Nicolás Gutiérrez (Food and Agriculture Organization of the United Nations)

Invited Speakers:
Simon Bush (Wageningen University, Netherlands)
James Ianelli (South Pacific Regional Fisheries Management Organization/Alaska Fisheries Science Center, NOAA-Fisheries, USA)
Toshihide Iwasaki (North Pacific Fisheries Commission)
Hidetada Kiyofuji (International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean/National Research Institute of Far Seas Fisheries, FRA, Japan)
Jenny Sun (National Taiwan Ocean University, Chinese-Taipei)

Management of marine fisheries is always difficult due to the large number of factors, actors, and uncertainties involved. Dealing with highly migratory and transboundary resources inhabiting transitional areas is even more complex because one has to (1) consider a wider range of environmental and ecological factors and diverse ecosystems often used by populations for different processes during the life stages (reproduction, nursing, feeding), (2) deal with very large geographical distributions and their changes at different time scales, and (3) understand that more than one political, legal and technical framework may be involved in the stocks assessment, exploitation and management. This session welcomes contributions dealing with theoretical and practical examples of assessment, management, stocks identification, and other management tools (i.e., market incentives) of marine transitional areas and their fish resources. Case studies on successful implementation of solutions to deal with the complexities of highly migratory resources are particularly encouraged.

S3: Challenges in observing and modeling Pacific transitional areas

Co-Convenors:
Enrique Curchitser (Rutgers University, USA)
Sachihiko Itoh (AORI, University of Tokyo, Japan)

Plenary Speakers:
Jack Barth (Oregon State University, USA)
Kenneth Johnson (Monterey Bay Aquarium Research Institute, USA)
Toshio Suga (Tohoku University/JAMSTEC, Japan)

Invited Speakers:
Daisuke Hasegawa (Tohoku National Fisheries Research Institute, FRA, Japan)
Masao Kurogi (JAMSTEC, Japan)
Charles Stock (Geophysical Fluid Dynamics Laboratory, NOAA, USA)

Understanding of marine physical and ecological processes has progressed considerably in recent decades with development of advanced observational instruments, analysis techniques and coupled bio-physical numerical models. Nevertheless, observing and modeling transition zones remains a challenge due to the multi-scale variability and complex trophic interactions associated with these regions. The strong gradient of physical properties gives rise to fine-scale disturbances, which impacts biological production in multiple trophic levels and are not necessarily resolved in observations or models. In this session, we invite presentations that explore physical, chemical and biological processes in the Pacific transitional areas through advanced techniques of observation, modeling, rearing and laboratory analyses.

S4: Advances in understanding Pacific shelf-offshore transitional areas

Co-Convenors:
François Colas (Institut de Recherche pour le Développement, France)
Hiroshi Kuroda (Hokkaido National Fisheries Research Institute, FRA, Japan)
Angelica Peña (Department of Fisheries and Oceans, Canada)

Plenary Speaker:
Dimitri Gutiérrez (IMARPE, Peru)

Invited Speakers:
Xinyu Guo (Ehime University, Japan)
Michael Jacox (Southwest Fisheries Science Center, NOAA-Fisheries, USA)

Transitional areas between coastal shelf and offshore regions produce strong physical, chemical, and biological gradients influencing a wide variety of processes, including biogeochemical cycling, phytoplankton size and production, plankton and fish community structure, and biodiversity. These transitional areas are characterized by variable mesoscale currents, fronts, rings, filaments and eddies that impact nutrient fluxes, acidification, deoxygenation and plankton transport. A better understanding of the processes controlling the exchange is necessary in order to predict responses to climate change. In this session, we welcome presentations on observational, theoretical, and/or numerical studies that advance our understanding of environmental and ecological responses—from phytoplankton to top-predators—to climate variability and change in coastal shelf-open ocean transitional areas.

S5: **Biodiversity changes in Pacific transitional areas**

Co-Convenors:
Xianshi Jin (Yellow Sea Fisheries Research Institute, CAFS, China)
Rubén Rodriguez Sánchez (CICIMAR-IPN, Mexico)
Thomas Therriault (Department of Fisheries and Oceans, Canada)

Plenary Speaker:
Paul Snelgrove (Memorial University of Newfoundland, Canada)

Invited Speakers:
Sonia Batten (SAHFOS, UK)
Bertha Lavaniegos (CICESE, Mexico)
Xinzheng Li (Institute of Oceanology, Chinese Academy of Sciences, China)

Characterized by strong environmental gradients, Transitional Areas (TAs) can occur both offshore or nearshore where fresh and marine waters collide. TAs may have increased habitat heterogeneity that promotes ecosystem structure, function, and biodiversity that maintains ecosystem goods and services for coastal communities (e.g., shoreline protection, fisheries resources). Alternatively, extreme environmental fluctuations may limit biodiversity and resulting ecosystem goods and services. Many countries are implementing conservation measures to protect areas of higher biodiversity and, to ensure longer term conservation objectives are realized, it becomes imperative to understand the specific characteristics of each TA. Further, like other marine ecosystems, TAs are under increasing stress due to climate change and other human-mediated activities (e.g., fisheries, shipping, resource extraction). This is especially true in the coastal zone where habitat loss/degradation, over-exploitation, invasive species, pollution, etc. are prevalent and expected to interact negatively with climate change. Thus, it is expected that species' distributions will be altered resulting in changes in community composition, biodiversity, and ecosystem structure, function, and services. Additionally, this may lead to a mis-match between existing conservation areas and the biodiversity they were designed to protect. Conservation management need to consider dynamic measures for features such as TAs that are known to have greater spatial and temporal variability. To better understand possible biodiversity changes in TAs this session invites contributions related to: 1) characterization and identification of biodiversity trends in TAs or comparisons to non-TAs; 2) identification of major drivers of biodiversity change in TAs, including mechanistic and experimental approaches; 3) forecasts of change in TAs, including species distribution models or adaptive variation; and 4) potential implications related to conservation management or policy development.

S6: **Transition zones in coastal habitats**

Co-Convenors:
Francisco Arreguín-Sánchez (CICIMAR-IPN, Mexico)
Jingmei Li (Ocean University of China, China)

Plenary Speakers:
Francisco Arreguín-Sánchez (CICIMAR-IPN, Mexico)
Thomas Therriault (Department of Fisheries and Oceans, Canada)

Invited Speakers:
Jon Chamberlain (Department of Fisheries and Oceans, Canada)
Jingmei Li (Ocean University of China, China)
Zengjie Jiang (Yellow Sea Fisheries Research Institute, Chinese Academy of Fishery Sciences, China)

Coastal habitats represent the transition between the open oceans and terrestrial ecosystems. These are typically highly productive systems, where many types of both marine and terrestrial organisms, spanning multiple trophic levels reproduce, nurse, and feed. Coastal ecosystems support multiple physical and biological processes, support regulation of hydrology and climate, and provide food and coastal protection from storms and sea level rise. As the boundary between terrestrial and ocean ecosystems, they face multiple challenges from human presence and their activities in recreation, tourism, habitat modification, resource extraction, and waste disposal. All of these are important stressors and are increasingly and potentially interacting in ways not yet known. In essence, coastal systems are dominated by both major commercial interests and ecological concern about the sustained integrity, biodiversity and quality of an important interface that is increasingly threatened by human behavior. Issues of concern are changes in nutrient dynamics/availability, possibly leading to nearshore eutrophication and/or hypoxia, changes in species composition and/or productivity, and more frequent or persistent HAB events. This session welcomes contributions dealing with the role of coastal systems in terms of 1) their use by oceanic species for refuge, reproduction and feeding, 2) carbon and energy dynamics, 3) the impact of stressors in altering coastal habitats and their suitability to provided needed ecosystem functions, and 4) ecosystem services including fisheries and tourism.

Plenary, Invited and Contributed Talks

April 24

Plenary

April 24, 9:30 (General Plenary)

The North Pacific Transitional Zone: A research and management retrospective

Jeffrey **Polovina**

Scientist Emeritus, Pacific Islands Fisheries Science Center, NOAA, Daniel K. Inouye Regional Center, Honolulu, HI, USA
E-mail: Jeffrey.Polovina@noaa.gov

I'll discuss some key events and themes from three decades of research and management in the North Pacific Transition Zone (NPTZ). Beginning in the late 1980s there was an increase in research focusing on the transition zone in response to concerns over increased high seas driftnet fishing. However before the research could progress very far, the United Nations in 1992 issued a moratorium banning high seas driftnet fishing. However, by the early 2000s there was a renewal of research in the NPTZ as new tools including electronic tags and satellite remotely-sensed oceanographic data allowed researchers to investigate the spatial and temporal dynamics of the region and how it was used by pelagic animals. In 2002 PICES held a symposium on transitional areas that explored among other things the differences and similarities in oceanography and ecology between the west, central, and east NPTZ. The early 2000s was also a time when bycatch of seabirds and sea turtles in pelagic longline fisheries of the region was a management concern and this time researcher identified ways to substantially reduce this bycatch. A topic of ongoing research is the impact of climate change on both the physics and fisheries of the region and also the region's role as a carbon sink. Going forward, developing ecosystem approaches for the resource management of the region will be a challenge of the International Scientific Committee.

April 24, 10:00 (S1 Plenary)

Decadal-scale temperature variability in the subarctic-subtropical gyre boundary region in the North Pacific

Satoshi **Osafune**

Japan Agency for Marine-Earth Science and Technology, Yokosuka, Kanagawa, Japan. E-mail: osafune@jamstec.go.jp

The subarctic-subtropical gyre boundary region in the North Pacific, a basin-scale Pacific Transitional Area (PTA) with a relatively strong temperature gradient, is one of the regions with the highest variance of sea surface temperature (SST) anomaly in the world. A large part of the variance is related to the decadal-scale major climate modes known as the Pacific Decadal Oscillation (PDO) and North Pacific Gyre Oscillation (NPGO). It is shown that the SST anomaly patterns related to those climate modes are largely explained by anomalous advection of the strong mean temperature gradient via anomalous surface current forced by the local wind stress. SST in this region, however, is also influenced by other various processes, including those related to ocean internal variability, such as entrainment of subsurface temperature anomaly, advection of temperature anomaly from upstream regions, and wave propagation. Thus, it is important to evaluate the impact of the internal variability, in order to better understand the mechanism controlling the decadal-scale SST anomaly related to climate variability. In this talk, I will present my works on decadal-scale temperature variations in this gyre boundary region focusing on the ocean internal variability. The main topic is about the impact of the 18.6-year modulation of tide-induced vertical mixing in relation to the precession of the Moon's ascending node.

April 24, 10:55 (S1 Plenary)

Secular and paroxysmic shifts of transitional areas: Science and management challenges

Francisco E. **Werner**

NOAA Fisheries, Silver Spring, MD, USA. E-mail: cisco.werner@noaa.gov

Oceanic transitional areas (TAs) can be defined as regions characterized by strong gradients in the physical and biogeochemical environments that challenge biological communities, many of which are already exposed to their physiological limits. Oceanic TAs delimit biogeographic regions, they have been used to define boundaries between Large Marine Ecosystems, and they are also associated with basin-scale boundaries between oceanic gyres and related biological provinces. Under stable environmental conditions, such provinces can be monitored and studied using conventional methods and management advice can be "relatively" straightforward. However, over the past decades, we have witnessed sustained (secular) as well as abrupt/short-term (paroxysmic) environmental changes that have impacted oceanic TAs, and the targeted species and ecosystems – from microbiomes to upper trophic levels – within the regions they bound. While the magnitude and the rates of change of shifts in oceanic TAs cannot yet be quantitatively anticipated, there is evidence supporting their continued occurrence. In this presentation, implications in the differences of the nature of the oceanic TA shifts and needed responses will be discussed. Scientific approaches will require a balance between sustained time-series (well-suited for secular changes) versus flexible, novel and adaptive sampling methods (better suited for abrupt changes). In turn, management advice may result in a shorter time-horizon of forward projections and greater uncertainties. Similarly, since transitional areas also straddle geopolitical boundaries, greater communication will be needed between affected parties, as adaptation of human communities will depend on decisions from broader international management bodies.

April 24, 11:20 (S2 Plenary)

Considerations of transitional and transboundary processes when assessing and managing highly migratory tuna species

Nicolas **Gutierrez**

Food and Agricultural Organization of the United Nations, Rome, Italy. E-mail: nicolas.gutierrez@fao.org

Managing highly migratory tuna resources presents several challenges, including the need to view fisheries from multiple spatial and temporal scales, which usually involves populations and processes spanning ecological and socio-political boundaries. Therefore, tuna Regional Fisheries Management Organizations (tRFMOs) share the mandate of developing formal mechanisms to better integrate environmental and ecosystem science into management advice. Despite this mandate, limitations on the development and implementation of research and monitoring programs of these tansboundaries tuna resources remain. In particular, reducing large-scale uncertainties often requires data from disparate sources across multiple jurisdictional management boundaries. Here, I will review recent research focused on elucidating large-scale dynamics for tuna management within tRFMOs. Particularly, I will discuss how these tRFMOs are addressing assessment and management challenges related to migration patterns, stock structures across regions, and reproductive and other areas of critical biological importance.

April 24, 11:45 (S5 Plenary)

Transitional habitats as an opportunity to understand drivers of ecosystem functioning

Paul V.R. **Snelgrove**

Memorial University, St. John's, NL, Canada. E-mail: psnelgro@mun.ca

Transitional habitats, by definition, encompass ecotones that typically vary in ecosystem functioning, species composition, and diversity. Increasing interest by ecologists in links between ecosystem functioning and living organisms, and biodiversity in particular, has produced a wide range of experimental studies, particularly in terrestrial environments. However, the open nature of ocean ecosystems complicates such experiments, resulting in studies that either greatly simplify natural systems (testing small subsets of species from a given environment in small containers) or focus on naturally simple (low diversity) systems with unknown utility for understanding more complex systems. Using examples from the NSERC Canadian Healthy Oceans Network and beyond spanning the last decade, and habitats from sediments to eelgrass to deep-water corals, I will consider how experiments along natural gradients such as those in transitional habitats offer an opportunity to test biodiversity-ecosystem functioning relationships in situ under real-world conditions, and thus advance ecological theory and understanding of the potential ramifications of ocean change. Studies of transitional habitats can therefore not only advance understanding of those habitats but also provide a model system to understand functioning of other habitats.

S1: Effects of climate variability and change on the physics, biology, and fisheries in Pacific transitional areas

April 24, 13:35 (S1-12369) Invited

Large nutrient variation in the North Pacific Transitional Area

Sayaka **Yasunaka**[1], Yukihiro Nojiri[2], Tsuneo Ono[3], Frank A. Whitney[4], Shin-ichiro Nakaoka[5]

1 Japan Agency for Marine-Earth Science and Technology (JAMSTEC), FRA, Yokosuka, Japan. E-mail: yasunaka@jamstec.go.jp
2 Hirosaki University, Japan
3 Fisheries Research Agency, Japan
4 Institute of Ocean Sciences, Canada
5 National Institute for Environmental Studies, Japan

We present the surface nutrient variability in the North Pacific by using nutrient samples collected by volunteer ships and research vessels. Seasonal variation in sea surface nutrient is large in the North Pacific transitional area. Nutrients reach maximum concentrations in March, and minimum concentrations in August. In summer, substantial amounts of nutrient remained in the northern part, while nutrients almost deplete in the southern part. Large seasonal drawdown indicates large biological production, which would relate the nutrient rich water transported southward from the Bering Sea by the Oyashio Current and the enrichment of iron from the Sea of Okhotsk. Interannual variation in sea surface nutrient is also large in the North Pacific transitional area. When the Pacific Decadal Oscillation is in positive phase, stronger westerly winds force high nutrient water southward from the subarctic, and therefore surface nutrient is significantly higher than the climatological means. Robust spatial distributions of the trends of nutrient concentrations are not obtained in the present study. Further observations over a wide area and for a long period of time should be encouraged to enhance our understanding.

April 24, 14:00 (S1-12384)

Decadal salinity variation in the western North Pacific correlated with the North Pacific Gyre Oscillation

Hitoshi **Kaneko**[1], Takeshi Okunishi[1], Shinya Kouketsu[2], Sachihiko Itoh[3], Takashi Setou[4], Hiroshi Kuroda[5] and Yugo Shimizu[4]

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2 Japan Agency for Marine-Earth Science and Technology, Yokosuka, Kanagawa, Japan
3 Atmosphere and Ocean Research Institute, The University of Tokyo, Kashiwa, Chiba, Japan
4 National Research Institute of Fisheries Science, Japan Fisheries Research and Education Agency, Yokohama, Kanagawa, Japan
5 Hokkaido National Fisheries Research Institute (Kushiro Laboratory), Japan Fisheries Research and Education Agency, Kushiro, Hokkaido, Japan

Decadal changes in salinity at the densities of 25.4–26.8 σ_v around the Kuroshio Extension (KE), from the core density from the Subtropical Mode Water (STMW) to North Pacific Intermediate Water (NPIW) were investigated, based on the long-term-data-sets provided from numerical reanalysis and shipboard observations. Examination using the ~30-years-reanalysis data indicated negative correlation between salinity changes in the area from the Oyashio to KE and North Pacific Gyre Oscillation Index (NPGO; that is closely related with the decadal stability of KE with ~2-years-lag). Salinity at the STMW (25.4 σ_v) core generally decreased when NPGO was positive, and salinity at the NPIW (26.8 σ_v) core tended to decrease when KE modulated from stable to unstable phase. Similar negative correlations between salinity changes and NPGO were recognized in the northern region of KE in the layers from the just below STWM (26.0 σ_v; lag ~2-years) to NPIW (26.8 σ_v; ~4-years). The negative relationships between salinity changes around NPIW core and NPGO with 2-years-lag in the north of KE were also obtained from the long-term monitoring of the coastal Oyashio, which were upstream regions of the northern region of KE. The relationships at the greater density suggested enhancement of influence of low-salinity-nutrient-rich subarctic water around KE under its decadal modulations from stable to unstable. That would be important for changes in biological activities in the areas of the Oyashio, KE, and the transition areas.

April 24, 14:20 (S1-12496) ***Talk changed to Poster***

Atmospheric responses and feedback to the meridional ocean heat transport in the North Pacific

Hiroaki **Tatebe**[1], Masao Kurogi[1] and Hiroyasu Hasumi[2]

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[2] Atmosphere and Ocean Research Institute, University of Tokyo, Kashiwa, Japan

Atmospheric responses and feedback to meridional ocean heat transport (OHT) have been investigated using a global climate model that is interactively connected with a high-resolution regional ocean model embedded in the western North Pacific. Compared with a global climate model without the regional model, the net heat supply into the Kuroshio–Oyashio Extension (KOE) region is increased as a result of the increase of the mean northward ocean heat transport (OHT) by the western boundary currents and mesoscale eddies. Resultant sea surface temperature (SST) rise sharpens the meridional SST gradient and reinforces the crossfrontal difference of the surface heat flux and thereby enhances lower-tropospheric baroclinicity. These changes cause northward deflection and strengthening of the wintertime storm track over the North Pacific, which leads to the Pacific–North American (PNA)-like pattern anticyclonic response of the mean westerly jet. The increase of the eddy northward atmospheric heat flux (AHF) associated with the enhanced storm-track activity is compensated by the decrease of the mean northward AHF. The changes of the atmospheric circulations reduce the mean northward OHT in the eastern North Pacific that compensates the increase of the mean northward OHT in the KOE region. The atmospheric responses, which have once been excited by the SST fronts in the KOE region, stabilize the trans–North Pacific OHT. The modeling results herein suggest that basinwide Bjerknes-like compensation works in air–sea coupled processes for the formation of the climatic mean state in the North Pacific.

April 24, 14:40 (S1-12389)

The nature of the transition in the California Current Ecosystem during the 1997-1998 El Niño event

Tim R. **Baumgartner**[1] and Reginaldo Durazo[2]

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[2] Facultad de Ciencias Marinas, UABC, Ensenada, Baja California, México

We describe the nature of the transition zone in the California Current that occurred from roughly 26° to 30°N. The data were collected on seven quarterly cruises in the IMECOCAL survey area off Baja California from October 1997 to August 1999. *T-S* diagrams are presented to demonstrate the abnormally warm and salty conditions. Dynamic heights indicate the direction and intensity of flows at the surface and 200 m depth. Sections of temperature and salinity along with their anomalies along line 120 (just north of Punta Eugenia, 27°N) show the structure of the water column down to 600 meters. Distribution of spiciness on the σ_t *25* surface shows a distinct boundary between relatively warm, salty water with properties approaching that of Subtropical Surface Water flowing poleward along the coast and the equatorward flow of fresh, cold waters of Subarctic Water offshore. The California undercurrent (CU) is a well-defined subsurface poleward flow along the coast that brings warm and salty water Equatorial Subsurface Water from the Eastern Tropical Pacific. The core of the CU at 250 m depth roughly coincides with σ_t *26.4* surface. The flow of the CU was most intense in January 1998 at the same time that water originating from Subtropical Surface Water was present along the coast. The well-defined near surface and deep poleward flows during the peak phase of the El Niño appear to originate from a large scale cyclonic circulation affecting the flow in the southeastern region of the North Pacific subtropical gyre.

Key words: California Current, Transition Zone, El Niño

April 24, 15:00 (S1-12405)

Estimates of anthropogenic carbon in waters off Mexico north and south of the Cabo San Lucas front

Luz de Lourdes Aurora **Coronado-Álvarez**, Saúl Álvarez-Borrego and J. Rubén Lara-Lara

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The aim of this work was to estimate the anthropogenic dissolved inorganic carbon (C_{ANT}) in the southern California Current System (CCS) and in the tropical region off Mexico to test the hypothesis of a significant difference between them. The Tracer combining Oxygen, Carbon, and total Alkalinity (TrOCA) was used to calculate C_{ANT}. We used the NACP, and CCHDO databases. The CCS had a C_{ANT} average (±standard error) of 69.0±2 μmol kg^{-1} in the 0-100 m depth interval, decreasing to cero at 800 m; with an average C_{ANT} integrated with depth (ΣC_{ANT}, 0-800 m) of 20.9±1.8 moles m^{-2}. While in the tropical region C_{ANT} had an average of 69.1±2.5 μmol kg^{-1} also in the 0-100 m depth interval, and also decreasing to near cero at 800 m; with an average ΣC_{ANT} of 20.0±1.2 moles m^{-2}. In the CCS, the coastal stations average ΣC_{ANT} was 11.69±2.31 moles m^{-2}; and the CCS oceanic stations had an average ΣC_{ANT} of 24.92±1.64 moles m^{-2}. The tropical coastal stations had an average ΣC_{ANT} of 19.39±1.26 moles m^{-2}; and the oceanic stations had an average ΣC_{ANT} of 21.06±1.60 moles m^{-2}. A Bayesian t test to compare the average ΣC_{ANT} in both regions resulted in a low probability of a significant difference (95% credibility interval) between regions. There were significant differences between coastal and oceanic stations within each region.

April 24, 14:20 (S1-12404) ***Time changed from 15:20 to 14:20***

Interannual spatial dynamic of frontal activity along the southern part of the California Current (1985-2015)

Ruben **Rodriguez-Sanchez**[1], Marlenne Manzano-Sarabia[2] and Hector Villalobos [1]

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The California Current is a highly dynamic pelagic system with complex circulation and elevated mesoscale variability that results from eddies, meander, up- and down-welling, and others ocean-atmospheric process. Although there are differences in the underlying physical mechanisms that influence the formation and persistence of these mesoscale oceanic processes, fronts are the common surface expression of all of them. Different hypothesis suggests that these ocean structures engender significant pattern in the habitats of marine pelagic species. Fronts may offer opportunities for foraging and breeding aggregations. This research address the interannual frontal activity along the southern part of the California Current, under the supposition that the spatial dynamics of these mesoscale processes could help to elucidate a significate underlying mechanism affecting latitudinal shifts in species distribution observed in recent decades. The frontal activity was analyzed for a 30-year period (1985-2015), by developing monthly time-series of SST fronts in different areas along the California-Baja California coast, using the Single-Image Edge-Detection (SIED) method applied to monthly satellite data from the AVHRR Pathfinder v5. The mapped location of the fronts showed a progressive northward shift in frontal activity during the period between 1985 and late 1990s, followed later by a progressive change towards south. Superimposed over both long-period trends, north-south short-term interannual changes were also recorded in response to ENSO events. Time-series of frontal activity for the whole southern part of the California Current showed significate statistical relationships with other large-scale indices, like the SOI, MEI, NOI and PDO.

April 24, 16:00 (S1-12528)

Phytoplankton biomass and production rates, pCO_2 and carbon fluxes time series (2006-2016) in the southern California Current Region

J. Rubén **Lara-Lara**, Lourdes Coronado-Álvarez, Carmen Bazán-Guzmán, Martin Dela Cruz-Orozco and Uriel Mirabal-Gómez

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The FLUCAR program has aimed to understand the primary production rates that determine the temporal variability of the CO_2 partial pressure (pCO_2) and carbon fluxes (FCO_2) (ocean-atmosphere) in a coastal station in the California Current. Therefore, temperature time series, phytoplankton biomass (Cl*a* proxy, by fluorimetry), *in situ* primary production rates (^{14}C), pCO_2 and FCO_2 were generated from 2006 to 2016. To expand the spatial scale, time series of temperature, chlorophyll and satellite primary production were generated. Both, the temperature and salinity series showed the two events of the ENSO phenomenon (El Niño and La Niña). El Niño showed temperaturas >20ºC and salinities up to 34, on the contrary, during La Niña, sea surface temperature fell to 14ºC and salinity to 33.4. On the other hand, both pCO_2 and FCO_2 increased during La Niña and decrease during El Niño. The chlorophyll *in situ* series (Chl *a*) and primary production (PP), due to not having the appropriate monitoring frequency, only showed the seasonal variability, P/B ratios (mgC mg Cla^{-1} hr^{-1}) during winter-spring (ratios 1 to 9) and lower during summer-autumn (ratios from 0.5 to 3.) were shown. In summary, the coastal station showed the daily and interanual variablility of variables and processes, which determine the fertility and health of the ocean.

April 24, 16:20 (S1-12478)

Is every El Niño the same? ENSO-related zooplankton community shifts in the southern California Current System

Laura E. **Lilly** and Mark D. Ohman

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El Niño is a coupled atmosphere-ocean phenomenon that occurs in the Equatorial Pacific Ocean and impacts the mid-latitude California Current System (CCS). Southern CCS zooplankton assemblages are influenced by Subarctic Pacific, subtropical, and offshore waters and species intrusions, and can change dramatically during El Niño. Inter-El Niño variability and influences on CCS ecosystems are not well understood, so determining zooplankton differential responses to individual events can elucidate forcing mechanisms and improve response predictions. Here we analyze CalCOFI zooplankton taxon and species spring biomass (1951-2016) to examine: (1) how southern CCS zooplankton assemblages vary across seven El Niño events and the 2014-15 Warm Anomaly; and (2) resilience and recovery of endemic CCS vs. non-endemic species following El Niño. Total zooplankton and dominant taxa (copepods, euphausiids) decrease in biomass and increase in subtropical species during most El Niño events. Euphausiid and copepod community shifts roughly categorize as: major Eastern Pacific (EP) El Niños increase significantly in subtropical, non-endemic species; Central Pacific (CP) El Niños increase moderately in non-endemic species; some El Niños show mixed CP-EP species shifts; and some El Niños resemble neutral-year assemblages. The 2014-15 Warm Anomaly resembles the 1992-93 CP El Niño, while the 2015-16 El Niño resembles EP and mixed events. Resident cool-water species return to mean levels 1-2 years after most El Niños, while some subtropical species show multi-year cyclical presence. These patterns suggest that mid-latitude expressions of El Niño may be associated with multiple forcing mechanisms, which vary by event and in their effects on zooplankton.

April 24, 16:40 (S1-12462)

Physical and biological effects of the 2014-2015 northeastern Pacific's climatic anomaly on northern Baja California Peninsula, diagnosed by a numerical NPZD model

David **Rivas** and Mariana Dorantes-Gilardi

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A physical-biological Nitrate-Phytoplankton-Zooplankton-Detritus (NPZD) numerical model is used to analyze the effects of the climatic anomaly that occurred in the northeastern Pacific during 2014-2015 on the shelf dynamics off northern Baja California Peninsula. These effects include persistently positive sea surface temperature anomalies, reaching a maximum >3°C in October 2015, and consistently negative anomalies of phytoplankton concentration. These effects, which have been corroborated by satellite-derived observations, are results of remarkable anomalies of the depth of both thermocline and nutricline associated with variations of the meridional flows. The analysis of the along-shelf transports and its relation to the regional larger-scale patterns, diagnosed by climatic teleconnection indices, provides information about the origin and timing of the water masses prevalent in the study area.

April 24, 17:00 (S1-12372)

Spatial and temporal variations of satellite-derived SST, and phytoplankton biomass and production in the transition zone at the southernmost CCS, in 2002-2017

Saúl **Álvarez-Borrego**, Uriel Mirabal-Gómez, José C. Ortiz-Ahumada, and José R. Lara-Lara

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The California Current System (CCS) has high phytoplankton productivity because of coastal upwelling with high nutrient input, but off the southernmost part of the Baja California peninsula phytoplankton biomass (Chl_{sat}) decreases significantly. Our objective was to characterize the spatial and temporal variations of satellite-derived SST, and Chl_{sat} and primary production (PP), in 2002-2017, for transects off the southern Baja California peninsula: off Cabo San Lazaro (TCSLA) and off Cabo San Lucas (TCSLU). Comparing these two areas an inference may be made on the different impacts on Chl_{sat} and PP north and south of the boundary between the CCS and the tropical region. We used Aqua-MODIS monthly composites of SST and Chl_{sat}, and those of PP calculated based on the former two, for 2002–2017. Each transect was 300 km long. In general, the coastal zone of TCSLA had higher Chl_{sat} values than on TCSLU. There were seasonal and interannual variations at both transects, but the seasonal variance was largest which indicates the strong influence of seasonal upwelling. The "blob" of 2014 and the 2015-2016 eastern Pacific (EP) type El Niño had much stronger effects on TCSLU than on TCSLA. The 2003 and 2010 central Pacific type (CP) El Niño had also strong impacts. The 2005 CP El Niño event had a strong impact on the biology of TCSLU, similar to those of the 2014, and 2015-2016 events, but not on TCSLA. During 2017 there was a clear recovery of Chl_{sat} on TCSLU after the very low values of 2014-2016.

April 24, 17:20 (S1-12413)

Impact of the Blob and El Niño warming phenomena in the SW Baja California peninsula: Study case of Bahia Magdalena

María C. **Jiménez--Quiroz**[1], Rafael Cervantes-D.[2], René Funes-R.[2], Sofía Barón-C.[1], Felipe J García-R.[3], Sergio Hernández-T.[2], David U. Hernández-B.[4], Rogelio González-A.[2], Raúl Martell-D.[5], Sergio Cerdeira-E.[5], José I. Fernández-M.[1], Luis V. González-A.[1], Mario Vásquez-O.[1] and Francisco J. Barrón-B.[3]

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Bahia Magdalena is a coastal lagoon located in the Pacific coast of Baja California, a transitional zone between tropical and temperate regions. Its biological and fishing richness is enormous, however recently certain fishing resources diminished in coincidence with the unusual warming event known as The Blob (TB2013-2015) and the warm phase of ENSO (El Niño 2015-2016). The objective of this work was to determine the impact of those phenomena on the ecosystem productivity. This study included monthly analyses of climatic indices and environmental and biological variables measured *in situ* and with MODIS-Aqua satellite images, since January 2015 until December 2017. In 2015, the upwelling strength decreased and water types showed the tropical influence, additionally abundance and seasonal patterns of nutrients and chla were altered. By April 2015, the chain-forming diatom *Eucampia zodiacus* bloomed and the highest BZ was recorded, although it was lower than during ENSO-neutral years. In 2016, when El Niño finished and ENSO cold phase (La Niña) started, upwelling was enhanced, and also were nutrients and chla abundance. Blooms of the diatoms *Guinardia/Rhizosolenia* were detected by September, whereas the ZB remained low. “La Niña” finished in 2017, and in contrast to previous years, the strength of upwelling increased by June and its rich-nutrients water input caused harmful algal blooms, whereas ZB was scarce. The changes observed strongly suggest that the warming caused by the TB2013-2015 and “El Niño” did affect the resilience and productivity in a greater extent than other “El Niño” events.

S2: Challenges in managing highly migratory and transboundary resources in Pacific transitional areas

April 24, 13:35 (S2-12516) Invited

Status of science-based fisheries management in the South Pacific Regional Fisheries Management Organization (SPRFMO) area

James **Ianelli**[1] and Niels Hintzen[2]

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The South Pacific Regional Fisheries Management Organization (SPRFMO) came into force in 2013 after a 6-year development process. During this period 11 science working group meetings established enough data and consensus to have effective conservation and management measures accepted at this first meeting. The primary fishery resources covered by the Commission in this large area spanning the south Pacific includes Jack mackerel, squid, and a number of valuable deepwater species. Based on the recently concluded Scientific Committee meetings, we review the status of fisheries and management issues related to: a) jumbo squid, b) deepwater groundfish (namely orange roughy), and c) jack mackerel (*Trachurus murphyi*) resources. Spatial demographic characteristics for these stocks are contrasted. In particular, alternative hypotheses on jack mackerel stock structure suggest a potential relationship to transition areas.

April 24, 14:00 (S2-12475)

High-seas fisheries management

Ross Shotten[1,2] and Dale **Squires**[3,4,5,6]

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High Seas fisheries administered by RFMOs provide challenges that have been solved in many national jurisdictions. The international nature of RFMOs and high seas fisheries raises issues of national sovereignty, international law, and RFMO governance RFMOs plus conservation and management policy measures. Allocation of permanent or long duration rights, such as transferable rights to catch, effort, capacity, or access, pose particularly thorny challenges due to the sovereignty of States, the self-enforcing voluntary nature of RFMO decision-making and enforcement, RFMO super-majority or consensus requirements, development aspirations of coastal and small island developing States, stocks within Exclusive Economic Zones and the Area Beyond National Jurisdiction (ABNJ), and Law of the Sea allowance for entry into a high seas fishery. Tuna and deep-water fishery RFMOs and the Parties to the Nauru Agreement have varying experience allocating TACs, TAEs, and rights to catch, effort, capacity, and access. Considerable attention has been devoted to developing the concept of rights-based management for these fisheries. Nonetheless, substantive resistance to allocating rights requires additional approaches to management of target catch, bycatch, and living habitat such as coldwater corals. This presentation reviews these issues and credit-based options for target catch, bycatch, effort, capacity, and living habitat, an incentive-based policy instrument, with cap-and-trade potential. Credit systems provide many benefits of rights-based management but without the permanence or long duration of allocating rights. Credit systems are used in control of pollution and greenhouse gasses and have great potential for high seas fisheries.

April 24, 14:20 (S2-12366)

Challenges in managing highly migratory and transboundary resources in Hawaii longline fisheries

Minling **Pan**[1] and HingLing Chan[2]

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The Hawaii longline fleet fishes both inside and outside the US EEZ. The main targeted species (bigeye and swordfish) are pelagic and transboundary species harvested by multiple gear types and many nations. In addition, these fisheries interact with several protected species, some of which are also transboundary species. This presentation provides a review of recent trends in the Hawaii longline fisheries as related to the dependency on local (EEZ) resources versus high sea resources and an overview of transboundary management issues facing the fishery. A few recent studies, including time-area closure analysis and spillover assessment, have been conducted to address these challenges in the fisheries. This presentation will provide a review of recent studies and a discussion on future research needs related to management of transboundary fishery resources in the Pacific.

April 24, 14:40 (S2-12570)

Reviews of Albacore biology and fisheries around transition areas in the north Pacific Ocean

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Albacore tuna, *Thunnus alalunga,* of the north Pacific is one of the most important species for Japanese fisheries. The fish's wide distribution exposes them to multiple Japanese fisheries such as longline and pole-and-line fisheries. Understanding their biology including distribution through their life history is essential to set proper oceanic division in the stock assessment, hence we could achieve optimal conservation of their stock. In the north Pacific Ocean (NPO), life history of albacore has been unveiled by larval sampling, conventional and archival tag research, and fishery information. Here, we review their biology from egg to adult and focus on the behavior in the transitional areas known as highly exploitable areas for this species. At some moment in their lifetime, they migrate from spawning area toward north where is the transitional area in the NPO. According to the data of tagged tuna, they exhibit significant depth change in their distribution through the northward migration; staying in deep depth in the southern area of Japan and in shallow depth in the transitional area. Spontaneous measurement of the water temperature with their behavior suggested that they cannot stay for long at temperature colder than 14°C, and strong thermocline in the transitional area forces them to stay at the warmer surface. These physiological constraints may be linked to the fishery efficiency as it changes interaction depth of the fish and fisheries; longline and pole-and-line fisheries are operated in the southern area near Japanese water while only pole-and-line fishery is operated in the transitional area.

April 24, 15:00 (S2-12396)

Distribution of Pacific sardine spawning between U.S. and Mexico from 2000 to 2013

Jose Augusto **Valencia-Gasti**[1] and Timothy Baumgartner[2]

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The distribution and transboundary movements of sardine stocks in the California Current system (CCS) poses the question whether or not the U.S. and Mexico are fishing on the same stock. We examine the distribution of Pacific sardine spawning during the months of April and May from years 2000 through 2013. The spring spawning of the northern sardine stock extends from northern California down to Central Baja California. The results of this study indicate that the U.S. and Mexico are indeed fishing on the northern as well as the southern stock. It is important to recognize that interannual and decadal climate variability shifts the distribution and abundance of the sardine eggs resulting in the changing geography of recruitment of juveniles into the adult population. This may, in turn, influence the relative abundance of fish available to both the U.S. and Mexican fishing fleets. We focus on the ocean conditions between April 2002 when roughly 10% of the northern stock was found in waters off Baja California and April 2003 when 6% was found there. This is explained by the difference in equatorward flow of the California Current determined by shifts in the regional wind field that also influenced the strength of Ekman transport.

April 24, 15:20 (S2-12536)

Dynamics of the transition zones between distribution sub-areas of jack mackerel (*Trachurus murphyi*) in the South Pacific

Ricardo **Oliveros-Ramos**[1,2], Enrique Ramos-Vasquez[1], Arnaud Bertrand[3] and Jorge Csirke[1]

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[3] Institut de Recherche pour le Développement (IRD), France

South pacific Jack mackerel (*Trachurus murphyi*) has an ocean-scale distribution range, from the equator to the austral region of Chile along the South American coastline, and from the coast of South America to New Zealand and Tasmania. South Pacific Fisheries Management Organisation (SPRFMO) is concerned to the conservation and management of Jack mackerel in the high seas, relying on estimates of biomass and fishing pressure based on the assumptions on population dynamics, including population structure. Several hypotheses have been proposed for jack mackerel population structure, from a single population up to several discrete populations; while recent studies show a pelagic metapopulation structure is the more likely. However, still no definitive answer has been given and the uncertainty associated to its population structure still hampers management. In this work we model the spatial distribution of Jack mackerel in the South Pacific in order to analyze the spatio-temporal variability of the habitat suitability and use it to dynamically classify stable habitats and transition zones. This classification uses metrics of the stability of the habitat (mean habitat quality, interannual stability, seasonal stability, strength of the seasonality and impact of extreme events) to identify similar areas by cluster analysis. We identified three stable sub-areas of distribution: one main sub-area with high habitat suitability and high seasonal and interannual stability off the Chilean coast (25ºS-41ºS) extending through the "jack mackerel belt" up to 134ºW; and two sub-areas with high habitat suitability but low seasonal and interannual stability off Peru and New Zealand coasts. The dynamics of the transition zones between these three sub-areas may be related to migration exchanges and periods of partial isolation, supporting the metapopulation hypothesis. The implications of these results for the stock assessment and management are discussed.

April 24, 16:00 (S2-12399) Invited

Stock assessment for Pacific saury, considering some marine environmental factors

Toshihide **Iwasaki**

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Pacific saury, *Cololabis saira*, is a small pelagic fish widely inhabit as a single stock in the North Pacific. Its longevity is two years. All Age-1 fish are sexually mature and a certain part of age-0 fish attains sexual maturity. Spawning season is long (autumn-spring) and spawning grounds are wide (Kuroshio region to Kuroshio extension region). Biomass estimates are annually available from the Japanese trawl surveys since 2003, which is independent from the commercial fishery operation. The biomass has decreased during the research period (around five million metric tons in 2003 and around one million in 2017). China, Chinese Taipei, Japan, Korea, Russia and Vanuatu are the fishing members of North Pacific Fisheries Commission (NPFC). The dominant type of fishery is stick-held dipnet. Total annual catch fluctuated in the range of 124-629 thousand metric tons during 1950-2016. NPFC completed its provisional stock assessment for Pacific saury in 2017 applying data until 2015 to the surplus production models. Stock status was likely to be "not overfished" and "not overfishing". As the next step, NPFC is improving the stock assessment for Pacific saury. One approach is just data update and another is to establish new and appropriate stock assessment model for Pacific saury. For the second approach, NPFC will consider the impacts by spatially and temporally different catch and the impacts of various marine environmental factors on the dynamics of Pacific saury. Contribution from PICES research accomplishment on marine environmental factors affecting the dynamics of small pelagic fish will be highly welcomed.

April 24, 16:25 (S2-12695) Invited

Distribution and behavior of highly migratory species in transition areas in the western Pacific Ocean - Tracking of Marine Animals (ToMAs) Project

Hidetada **Kiyofuji**, Yoshinori Aoki and Ko Fujioka

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The northwestern North Pacific Ocean is an important forage and migration habitat for various highly migratory species such as skipjack tuna, albacore tuna, pacific bluefin tuna, blue sharks, loggerhead turtles and etc. The major oceanographic feature in this area is the Kuroshio Extension, which lies in the latitude range from approximately 35°N to 37°N. One specific biological feature in the North Pacific Ocean is the transition zone chlorophyll front (TZCF) which is used as a forage and migration pathway by several highly migratory species, yet the effects of the TZCF and Kuroshio Extension system on their habitat changes have not been fully analyzed and described due to the historical absence of the appropriate synaptic data fields. In the present study, we will overview the project, "tracking of marine animals (ToMAs)", that is mainly based on electronic tags to describe and improve our understanding of highly migratory species habitat in the western Pacific Ocean.

April 24, 16:50 (S2-12427)

Using long-term catch trends and habitat preferences of bycatch species to improve ecosystem-based management in transition areas within the eastern Pacific Ocean

Leanne **Duffy**, Shane Griffiths and Cleridy Lennert-Cody

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Ecological Risk Assessment (ERA) has been increasingly used to assess the sustainability of data-limited non-target species impacted by resource-limited fisheries. ERA methods such as Productivity-Susceptibility Analysis (PSA), rank a number of attributes related to a species' susceptibility to being captured and its resilience to depletion. These methods are generally not spatially-explicit, and thus the effects of availability to a fishery based on habitat changes cannot be detected. In the eastern Pacific Ocean (EPO) preliminary PSAs have been produced for the large-vessel tuna purse-seine fishery and the high-seas tuna longline fishery, both of which interact with speciose assemblages. Results from those PSAs identified some elasmobranchs, common to both fisheries, as vulnerable under the current levels of fishery removals. We analyzed catch trends of these species for the purse-seine fishery operating within EPO transition areas in relation to changes in environmental variables over the past two decades. We discuss implications of identified spatial and temporal changes in habitat on the vulnerability of these species when assessed using a new spatially-explicit ERA. Such ERAs will allow managers to make better-informed decisions about monitoring and/or assessing key vulnerable species in response to oceanographic changes and localized impacts of fishing.

April 24, 17:10 (S2-12428)

A flexible spatially-explicit ecological risk assessment approach for quantifying the cumulative impact of tuna fisheries on data-poor bycatch species caught in eastern Pacific Ocean transition areas

Shane **Griffiths**, Leanne Duffy, and Cleridy Lennert-Cody

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The eastern Pacific Ocean (EPO) supports some of the largest and most valuable tuna fisheries in the world. Some EPO fisheries, such as longline and purse seine sets on floating objects, have a significant bycatch comprising species with diverse life histories from sea turtles, seabirds, elasmobranchs to large mesopelagic fishes. The Inter-American Tropical Tuna Commission (IATTC) has adopted an ecosystem-based management approach for EPO tuna fisheries through its Antigua Convention to account for fishing impacts on non-target species. However, demonstrating the sustainability of all impacted species – many having little catch or biological data – is a significant challenge. Ecological Risk Assessment (ERA) approaches, such as the widely-used semi-quantitative attribute-based Productivity-Susceptibility Analysis (PSA), have been a major advancement for fishery managers to identify potentially vulnerable species in data-limited settings. Unfortunately, PSA produces only a relative measure of risk, it cannot assess the cumulative impact of co-occurring fisheries, and doesn't easily account for changes in habitat changes with respect to fishing effort. Using an example of pelagic fisheries operating within transition areas in the EPO, this paper introduces a new spatially explicit ecological risk assessment approach designed for data-poor species and fisheries that can assess the cumulative impact of multiple fisheries by producing a quantitative estimate of fishing mortality using a flexible susceptibility analysis. Fishing mortality is then compared against conventional biological reference points (e.g. F_{msy}, $F_{0.1}$) derived from a length-based per-recruit model to determine a species' status. Our approach allows fisheries managers to adapt analyses to changing species habitats and fishing effort patterns under a changing climate to more confidently identify vulnerable species in which to direct resources to either implement mitigation measures, or collect further data for more formal stock assessment.

April 24, 17:30 (S2-12476)

Bycatch-saving technological change

Kathleen Segerson[1], Dale **Squires**[2] and Niels Vestergaard[3]

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Bycatch of protected species, such as sea turtles, vaquita, and dolphins, poses a perennial issue to fish harvesting. Technological change that reduces the proportion of bycatch to target catch presents one of the most important ways to reduce bycatch. Examples include circle hooks and mackerel-type bait for swordfish to reduce sea turtle bycatch and eco-FADs to reduce bycatch of ocean sharks and bigeye for skipjack purse seine vessels setting on FADs. An important issue for policymakers seeking to reduce bycatch is understanding the process by which bycatch-reducing technological change occurs, the factors that influence it, and its implications for management of target and bycatch stocks. We present a bioeconomic model of technical change directed at reducing bycatch. We develop the maximum economic yield of the target catch under technological change while accounting for bycatch with: (1) all research and development (R&D) devoted to technical change for the target species; (2) all R&D devoted to bycatch reducing technology; (3) R&D devoted to both. Besides technology policies directing R&D, we also consider how policies and market forces affect incentives to reduce bycatch through induced technological innovation and the resulting implications for resource management. The focus is on endogenous (induced or directed) technical change that responds to market and policy-induced incentives. We also define output biases or the way that technological change favoring relative bycatch reduction differs from technological change favoring relative target catch.

S5: Biodiversity changes in Pacific transitional areas

April 24, 13:35 (S5-12375) Invited

Long time change of macrobenthos from the Yellow Sea and East China Sea, Northwestern Pacific

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The main aims of this research are exploring the temporal and spatial variations of macrobenthic diversity among seasons, periods, and regions in the southern Yellow Sea, mainly discussing the influence of anthropogenic activities to the macrobenthos, and studying the temporal and spatial variations of macrobenthic diversity among months, seasons, and regions in the East China Sea, mainly discussing the influence of Kuroshio Current to the macrobenthos.

The results show that, the long term variations of macrobenthos in the southern Yellow Sea was mainly influenced by anthropogenic activities; the evolution orientations of macrobenthos were different in the regions with different anthropogenic stress, such as the downsizing and simplification in the coastal region and the invariance in the offshore region; the macrobenthos in the East China Sea could reflect the influence of Nearshore Kuroshio Branch Current, especially for the distribution pattern of the demersal fish; some rare species (such as *Neobythites sivicola*) could act as the indicator species of the intrusion of Kuroshio Current.

Key words: Macrobenthos; Macrofauna; Biodiversity; Community Structure; Temporal and Spatial Variation; Kuroshio Current; Southern Yellow Sea; East China Sea

April 24, 14:00 (S5-12489)

OMZ-influenced benthic responses along bathymetric gradients reflects coherent transitional ecological changes

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Oxygen minimum zones (OMZ) are prominent stressors for marine life affecting both pelagic and benthic habitats. One of the most intense and shallow OMZ appears along the Peruvian coast and intercept a large fraction of the continental shelf with a key role in the benthic ecology. By analyzing the most abundant benthic (<63µm) organisms responses along a spatial (inshore-offshore) gradient in five stations (35-178m depth) during the CRIO1504 expedition, we explore the main OMZ-induced changes both on the benthic biota and their associated habitat conditions off central Peru (12°S). The oxygen conditions underlying the sediment can be variable. Shallow stations at continental shelf (35-90 m) can be under oxic, hypoxic or anoxic conditions, whereas hypoxia is dominant at the external shelf and slope. While geochemical results across depth gradient showed a proportional and progressive increase of surface sediment richness (especially for total carbon and nitrogen percentages), surface sediment chlorophyll-a concentration tends to be relatively homogeneous. By contrast, a highly-adapted, Nematoda-dominated benthic community was identified inhabiting along the depth gradient in inverse proportion, and exhibiting an astonishing diversity in spite of reduced conditions persistence across stations as a consequence of a remarkable OMZ influence. We discuss the transitional ecological changes and their closely-related benthic diversity responses, particularly pointing out the meaning of spatial gradients as modulators of some key ecological roles.

April 24, 14:20 (S5-12530)

Submarine islands of benthic biodiversity within and adjacent to an offshore transitional area

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Surrounded by the abyss, submarine volcanic mountains (seamounts) rise steeply from the deep, creating relatively isolated, shallow benthic ecosystems far from the coast. In general, seamounts are regarded as biodiversity hotspots, as well as important refuge habitats and feeding grounds for resident and transient species that are ecologically, commercially, and culturally significant. As Canada works towards meeting its 2020 national and international conservation targets, Fisheries and Oceans Canada (DFO) Science has identified seamounts as Ecologically and Biologically Significant Areas and in need of protection. An unprecedented initiative to collect information on Canada's network of offshore Pacific seamounts has DFO scientists uniquely positioned to start answering questions regarding island biogeography and benthic biodiversity trends on seamounts within and adjacent to the offshore transitional area (*i.e.*, the bifurcation of the Subarctic and North Pacific currents). We used a global seamount classification system, informed by ROV surveys, fisheries data, and large-scale oceanographic models, to differentiate biologically meaningful classes among the 46 Canadian seamounts. The resulting five classes are largely defined by fundamental oceanographic properties, such as dissolved oxygen concentration and proximity to a deep-scattering layer. In July 2017, we embarked on an expedition to collect baseline data on several of the previously unexplored seamounts, to ground-truth our classification system. Our preliminary findings support the hypothesis that there is variability in the distribution, composition, and biodiversity of benthic species among the different classes of seamounts; for example, variability in ecologically significant Vulnerable Marine Ecosystem indicator species, such as habitat-creating deep-sea corals and sponges.

April 24, 14:40 (S5-12458)

Biological invasions at the land-sea-freshwater interface in the Tijuana River National Estuarine Research Reserve, a Marine Protected Area in a binational watershed

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Estuarine systems represent the one place on earth where the three major habitat types, - land, sea, and freshwater - all come together. Because of this, these transitional areas are characterized by rich sets of abiotic and biotic interactions. However, management issues from these three different habitat types tend to converge here as well. One particularly problematic issue in estuaries is invasive species, with non-natives from a variety of habitats being found in these systems. Biological invasions compromise the natural integrity of ecosystems, and can be viewed as both causes and consequences of ecological change. The ecology and management of invasive species has been a focus of work at the Tijuana River National Estuarine Research Reserve, which lies at the terminus of a large, binational watershed immediately north of the US / Mexico Border. Marine, freshwater, and terrestrial invaders into the Reserve highlight the many management challenges associated with invasive species, but also offer opportunities to learn more about the sometimes unexpected dynamics of biological invasions.

April 24, 15:00 (S5-12411)

Understanding the Pelagic waters and Coastal Transition Zone within Canada largest Area of Interest for Protection on the Pacific Coast

Tammy **Norgard**[1], Rick Thomson[2], Tetjana Ross[2], Debby Ianson[2], Cherisse DuPreez[2], Joy Hillier[1] and Miriam O[2] (*presented by Cherisse Du Preez*)

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International and domestic targets call for the conservation of 10% of Canada's Oceans by 2020. In May 2017, a large area of Canada's Pacific offshore region was approved as an Area of Interest (AOI) for the potential establishment of a Marine Protected Area. This AOI is approximately 140,000 km^2, and encompasses hydrothermal vents, bathyal and abyssal zones and the overlying pelagic zones. The AOI hosts vulnerable marine ecosystems (VMEs), such as dense cold-water coral and sponge gardens, unique geological features, as well as species that are unique, threatened, and/or are ecologically, commercially, and culturally significant. As this AOI is developed into a full scale Marine Protected Area, a plan to monitor the pelagic waters as well as the benthic habitats will be developed. Recently, a report on the Biophysical and Ecological Overview of the Offshore AOI was completed which documented many of the oceanographic features. One of these oceanographic features is the Coastal Transition Zone (CTZ), an area where two major currents (the Subarctic and North Pacific currents) bifurcate, resulting in variable currents. These currents are farther north during summer months and centered over the AOI during winter months. The report highlights a need for the establishment of monitoring baselines for conservation efforts. The question of how we effectively monitor the pelagic waters of this large area in the face of climate change and other stressors is going to be a focus of our future research initiatives.

April 24, 15:20 (S5-12408)

Restructuring reef-fish functional groups: No-fishing consequences into a transitional area

Romeo **Saldívar-Lucio**[1], Héctor Reyes-Bonilla[2], Gustavo Dela Cruz-Agüero[3], Salvador E. Lluch-Cota[4], Damien Olivier[2], Arturo Ayala-Bocos[2] and Daniel B. Lluch-Cota[1]

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The Cabo Pulmo reef (CP) is part of a Marine Protected Area (MPA) that is located into the transitional area formed at the southern portion of the Gulf of California (Eastern Pacific). In this area we can observe the confluence of waters from the Tropical Pacific, the California Current and the Central Pacific. Because of the non-fishing regime and its good conservation status, CP sustains high levels of primary and secondary productivity that have led to the increase in size and abundance of different groups of fish, including resident carnivores (*e.g.*, jacks, snappers). The objective of the present study was: 1) to analyze the structural changes in the fish community within functional groups (1987-2016); 2) evaluate the predictive performance of climate signals on community attributes, considering that the fishing pressure factor has been removed. We worked with 6 functional groups which were obtained by means of multivariate classification techniques and based on relevant ecological characteristics (*e.g.* trophic level). To study the possible structural changes, community indices (*e.g.* diversity, dominance) were computed. Among the changes detected, it has been observed the regulation of competition interactions through the intensification of predation events, as well as the decreasing dominance within functional groups. The ecological effects derived from protection suggest the effectiveness that a MPA can achieve to reinforce the resilience of marine ecosystems in transitional areas.

April 24, 16:00 (S5-12352) Invited

Lower trophic level transitions determined from Continuous Plankton Recorder surveys

Sonia **Batten**[1] and Sanae Chiba[2]

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The Continuous Plankton Recorder Survey of the North Pacific has been sampling the lower trophic levels at ocean basin scales with high taxonomic resolution since 2000. The distribution of plankton community structure is known to follow latitudinal temperature gradients, for example higher diversity at lower latitudes and generally larger species in cooler, higher latitudinal regions. The CPR is towed behind commercial ships along standard transects which fortuitously cross physical transitional regions (such as shelf to open ocean), large scale temperature gradients and also mesoscale features such as frontal zones and eddies.

This presentation will review some of the outputs from this program that are relevant to the focus of the Symposium, including; northwards shifts in plankton communities (both composition and seasonal timing) in response to warming events, east-west differences in the response of zooplankton size structure to warming, and along-transect transitions between communities associated with eddies and currents. The length of the CPR time series, together with the recent apparent increased variability in ocean climate, allows some measure of understanding of how plankton communities will respond to further climate change.

April 24, 16:25 (S5-12418) Invited

Changes euphausiid species composition in the transition zone of the California Current during the period 1998-2016

Bertha E. **Lavaniegos**

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Interannual changes in the assemblages of euphausiids during the period 1998 to 2016 are analyzed in the southern region of the California Current. Diverse climatic events occurred during this 20 years period, such as two strong El Niño (1997-1998 and 2015-2016), several weak El Niño events, two strong La Niña (1998-2000 and 2010-2012), and also local phenomena as the subarctic water intrusion in 2002-2003 and the anomalous warming in 2014-2015 named the blob. It is well known that euphausiids are good indicators of El Niño due to experienced changes in distribution. El Niño 1997-1998 was not the exception with subarctic species (*Euphausia pacifica*, *Thysanoessa spinifera*) retreating and the subtropical species *Nyctiphanes simplex* or the equatorial *Euphasia eximia* advancing toward the north. However, in other El Niño events the response of indicator species was not so clear. El Niño 2015-2016 also considered strong, showed evidences of tropical species increasing off Baja California but questions remain about if this obeyed to El Niño impact or to the prolonged warming since 2014. Other open question is how much warm will bear the transition-zone species, characteristic of the California Current ecosystem, before to be definitively displaced by tropical species, and consequences for planktivorous predators.

April 24, 16:50 (S5-12402)

Bahía Vizcaíno as a transitional area for fish larvae communities in the Southern California Current

Sylvia P. A. **Jiménez-Rosenberg** and Gerardo Aceves-Medina

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In 20 years of continuous sampling by the IMECOCAL Program, fish larvae communities in the Southern California Current have been widely studied regarding to species composition and community structure on seasonal and inter-annual scales. According to this, the region can be divided in three mayor zones: Ensenada, Bahía Vizcaíno, and South Punta Eugenia. Larvae of coastal pelagics *Engraulis mordax*, *Sardinops sagax* and *Scomber japonicus* rank among the seven most abundant. Variability in their trends of abundance in the last 20 years, seem to be related whit long term periods of both, rise and decay of the average sea surface temperature. Along with coastal pelagic larvae, those of mesopelagic are dominant year round in Bahía Vizcaíno and three species rank in the first four by their abundance: *Vinciguerria lucetia*, *Triphoturus mexicanus* and *Diogenichthus laternatus*. These larvae maintain their dominance despite the seasonality and the high variability observed in the Southern California System. Although, response to this environmental forcing is different among species and zones. *Synodus lucioceps* is the only demersal species which larval abundances rank between the first seven. High abundances of these larvae have been associated to El Niño Events in the transitional zones of the California Current. Data series of fish larvae abundances, as well as registers of environmental variables such as temperature, Chl-*a* concentration and zooplankton abundance, have highlighted the importance of Bahía Vizcaíno as a center of high diversity and as a transitional zone between the northern and southern fauna.

April 24, 17:10 (S5-12461)

Seasonal variation of plankton community and biodiversity in the Kuroshio-Oyashio Transition waters

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In the Kuroshio-Oyashio transition waters, complex ocean environment is formed because of influenced by the Kuroshio and Oyashio currents. As the results, a distinctive plankton ecosystem is expected to be formed in the waters. Although seasonal variation of the plankton community is a fundamental finding to understand its ecosystem, there are few studies in the waters. Therefore we studied seasonal variation of plankton community and biodiversity in the Kuroshio-Oyashio waters. We used the data of species composition of diatom collected by Japan Meteorological Agency from 1951 to 1990 and data of mesozooplankton collected at an A-line monitoring transect by Fisheries Research and Education Agency of Japan. In the diatom community, cold waters species e.g. *Chaetoceros debilis* dominated during winter, and then warm species e.g. *Skeletonema costatum* dominated during spring. From summer to autumn, subtropical and tropical species dominated in the community. Mesozooplankton community also represented the similar seasonal change. Cold water species e.g. *Neocalanus* spp. dominated from winter to spring. From summer to autumn, the subtropical species e.g. *Ctenocalanus vanus* dominated. This study revealed that community structure of the phyto-mesozooplankton represented dynamic seasonal change in the Kuroshio-Oyashio waters.

April 24, 17:30 (S5-12443)

Community structure and spatial distribution of zooplankton in the Mexican Transitional Pacific (April 2015)

Susana **Cabrera-Núñez** and Sergio Hernández-Trujillo

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The transitional Pacific of Mexico, is consider a convergence zone, due to the presence of California Current, Gulf of California and tropical water of Mexican Costal current, suggesting high complexity of intra and interspecific interactions and high zooplankton diversity zone. Therefore, the structure of the zooplankton community, latitudinal distribution, and their relationship with environmental variables from Cabo Corrientes to Acapulco Bay were analyzed. The samples were obtained in april 2015, the zooplankton was quantified, identified and the attribute of the community was assessed. Water column temperature between 0-20 m was 26±1°C, and higher chlorophyll-a concentration went between 20-60 m. 27 taxa were identified, and both copepods and cladocerans constitutes 78% abundance, and reminders groups 22%. Trophic structure of the community was mainly characterized by herbivores (81%). Latitudinal differences in taxonomic group number as well as diversity copepod species were non-significant. 60 species of copepods were identified, the most abundant species in the community were *Subeucalanus subcrassus* and *Centropages furcatus*, with 28 and 16%, respectively. In this community, 12.5% of copepod species had been reported as member of Tropical Eastern Pacific Copepoda.

Plenary, Invited and Contributed Talks

April 25

Plenary

April 25, 09:00 (S4 Plenary)

Recent trends on temperature, productivity and oxygenation across the Peruvian upwelling system

Dimitri **Gutiérrez**[1,2]

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The interplay between upwelled cold and oxygen-unsaturated waters onshore, with warmer, stratified waters offshore plays a key role for structuring the biological productivity off Peru. Here we review the current knowledge and highlight some findings regarding trends that affect this interplay. In the annual cycle, productivity usually peaks during summer, when upwelling events are weaker and less frequent, allowing onshore pulses of stratified waters that promote phytoplankton blooms. Remote forcing (*e.g.* by Kelvin waves) can modulate the thermocline and oxycline depths, affecting the physical and chemical features of the upwelling source waters and the cross-shore gradients. In addition, mesoscale and submesoscale activities influence on the size and intensity of the physical fronts and cross-shore transfer of properties. A significant cooling trend of coastal surface waters has occurred since the late 1970's to the early 2000's off Central and Southern Peru, which was accompanied by a positive trend in the surface chlorophyll-*a* concentrations. For the last decade, the coastal cooling trend has slowed down or even reversed, whereas there is a shoreward retreat of the thermal front. As well, satellite data show a reduction of surface chlorophyll-*a* concentrations offshore, but an increase onshore, whereas the coastal oxycline depth exhibits a slight deepening trend. Remarkably, no significant spatiotemporal changes in the alongshore wind forcing has been determined for the last decades with the available data. Instead, remote forcing, driven by changes in El Niño flavours and associated Kelvin wave upwelling/downwelling signature, and larger-scale stratification are factors that likely have contributed to the observed trends. A better understanding of the mechanisms certainly will improve the projection of the future physical and biogeochemical responses of the Peruvian upwelling to climate change.

April 25, 09:25 (S3 Plenary)

On the edge: Observing and modeling intensified physical and biogeochemical interactions in the Pacific's ever-shifting transition zones

John A. **Barth**

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Gradients in physical and biogeochemical properties concentrate and drive ocean productivity and marine animal distributions. The Pacific features long open-ocean, east-west transitions between equatorial, subtropical and subarctic environments. Their great expanse and distance from shore makes them best studied with satellites and autonomous floats and drifters. One example, the bifurcation of the North Pacific Current into the southward flowing California Current and the northward flowing Alaska Current, influences ocean variability downstream and is amenable to monitoring with satellites and Argo floats. Ringing the Pacific, coastal transition zones separate productive coastal waters from less productive waters offshore. Examples include the offshore edges of the California and Humboldt Currents and the fronts between buoyancy-driven currents at high latitudes and offshore waters. These coastal transition zones and the productive boundary current ecosystems they delineate are studied using ship-based methods and, more recently, with autonomous vehicles equipped with multi-parameter sensors. Both sharp, cross-margin gradients in ocean properties and 1000-km scale along-margin propagation of climate variability are measured using a network of underwater gliders. Transition areas in the Pacific are modeled using regional-scale, coupled physical biogeochemical models driven by basin and global scale models. One recent example examines seasonal-to-decadal scale variability in dissolved oxygen along the west coast of the United States and classifies that variability based on the intensity of upwelling forcing and undercurrent strength. These examples and others from around the Pacific are used to review the potential for future observation and modeling of these critical, yet changing, ocean transition zones.

April 25, 09:50 (S3 Plenary)

North Pacific subtropical-subpolar transitional areas as ventilation windows of the both gyres

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Transitional areas between the subtropical/subpolar gyres of the North Pacific are characterized by strong density-compensating meridional gradients of temperature and salinity and associated low vertical gradients of subsurface potential density known as "stability gaps." Wintertime mixed layer of the transitional areas is relatively deep and dense due to the stability gaps, forming a tongue of denser water extending eastward. Because of this density distribution, the western and central parts of the transitional areas serve as ventilation windows of the both subtropical and subpolar gyres. The profiling float network Argo has greatly improved our capability to monitor the transitional areas even during severe winter conditions and our understanding of seasonally evolving upper stratification, ventilation processes and their interannual to decadal variability. This talk will exemplify progresses in our understanding in such domains since the international PICES symposium on "North Pacific Transitional Areas" in 2002, which would be a useful basis for further studies of various aspects of the North Pacific subtropical-subpolar transitional areas.

April 25, 10:15 (S3 Plenary)

Observing biogeochemical variability in transitional areas of the South Pacific/Southern Ocean with the SOCCOM profiling float array

Kenneth S. **Johnson**[1], Lynne D. Talley[2], Stephen C. Riser[3], Joellen L. Russell[4], Emmanuel Boss[5] and Jorge L. Sarmiento[6]

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The Southern Ocean Carbon and Climate Observations and Modeling (SOCCOM) program is a 6-year project funded by NSF Polar Programs (with additional support from NOAA and NASA) to deploy ~200 profiling floats equipped with oxygen, nitrate, pH, chlorophyll, and particle sensors. 102 profiling floats have been deployed, 91 are currently operating, with a relatively high density in the Pacific sector up to 30°S. The floats are operated as part of the Argo array and all of the data is in the public domain. The overarching focus of the SOCCOM program is to understand variability in the carbon cycle, the physical and biological processes that drive this variability, and to incorporate these observations and underlying knowledge in state estimate models and in coupled ocean-atmosphere climate models (see http://soccom.princeton.edu, which includes data access). The profiling floats collect data year-round, and provide a seasonal, geographic, and vertically resolved perspective on biogeochemical processes. Analyses of this data by SOCCOM PI's reveal a variety of biogeochemical regimes and transitional zones across the Southern Ocean and into the South Pacific. Distinct zonation in net community production (Johnson et al., 2017, JGR Oceans, doi: 10.1002/2017JC012839) and air-sea oxygen flux (Bushinsky et al., 2017, JGR Oceans, doi: 10.1002/2017JC012923) is seen. Bio-optical sensors on the floats suggest there is no Southern Ocean bias in chlorophyll derived by remote sensing (Haëntjens et al., 2017, JGR Oceans, doi: 10.1002/2017JC012844). SOCCOM associates find distinct zonation in transport of carbon into the mesopelagic zone (Dall'Olmo et al., 2016, Nature Geosci., doi: 10.1038/ngeo2818).

S1: Effects of climate variability and change on the physics, biology, and fisheries in Pacific transitional areas

April 25, 11:10 (S1-12495)

Variability in the transport and latitude of the North Pacific Current: Consequences for northeastern Pacific ecosystems

Ryan R. **Rykaczewski**[1], Jasmin G. John[2], Charles A. Stock[2], John P. Dunne[2] and William T. Peterson[3]

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Decadal variability in ecosystems of the northeastern Pacific has been attributed to changes in the wintertime intensity of the Aleutian low-pressure system and shifts in the latitude and transport of the North Pacific Current. Periods of more intense low pressure are associated with increased catches of salmon in the Gulf of Alaska. However, in the California Current, such periods are associated with decreased salmon catches, zooplankton biomasses, and productivities of seabirds and demersal fishes. Here, we explore the hypothesis that an intensified Aleutian low-pressure system is associated with equatorward displacement of the North Pacific Current and decreased advective transport of nutrients and/or zooplankton from the subarctic gyre to the California Current. We use a large-scale biogeochemical model forced by atmospheric fluxes over the historical period to: 1) explore how the position of the North Pacific Current and intensity of the Aleutian low have varied in relation to well-known modes of variability in the region (PDO, ENSO, and NPGO), 2) investigate how the latitude of the current and its bifurcation influences nutrient flux to the California Current and coastal Gulf of Alaska, and 3) consider the relationship between the latitude of the North Pacific Current and other influential ecosystem processes (e.g., upwelling and alongshore transport). Preliminary results indicate that nutrient supply to northeastern Pacific ecosystems is associated with changes in transport of the North Pacific Current, but distinguishing the relative influence of horizontal and vertical transport processes remains challenging.

April 25, 11:30 (S1-12457)

Variation in phytoplankton composition between two North Pacific frontal zones along 158°W during winter-spring 2008–2015

Evan A. **Howell**, Michael P. Seki, Phoebe Woodworth-Jefcoats, and Jeffrey J. Polovina

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Data from research cruises along the 158°W meridian through the North Pacific Subtropical Frontal Zone (STF) during spring 2008, 2009, 2011, and 2015 were used to estimate phytoplankton functional types and size classes. These groups were used to describe phytoplankton composition at the North Pacific Subtropical (STF) and Transition Zone Chlorophyll (TZCF) Fronts, which represent ecologically important large-scale features in the central North Pacific. Phytoplankton class composition was consistent at each front through time, yet significantly different between fronts. The STF contained lower integrated chlorophyll-*a* concentrations, with surface waters dominated by picophytoplankton and a deep chlorophyll maximum equally comprised of pico- and nanophytoplankton. The TZCF contained significantly higher concentrations of nanophytoplankton through the water column, specifically the prymnesiophyte group. Integrated chlorophyll-a concentrations at the TZCF were 30–90% higher than at the STF, with the dominant increase in the signal from the nanophytoplanktonic prymnesiophyte group. The meridional position of the STF was consistently located near 32°N through these three years, with the more spatially variable TZCF ranging from 2° to 4° further north of the STF. This variability in the frontal position of the TZCF in relation to ecological impacts though the food web will be discussed.

April 25, 11:50 (S1-12441)

Evaluation of fleet dynamics and oceanography as factors accounting for variations in black-footed albatross interactions in the Hawai‘i-based deep-set longline fishery 2006-2017

Johanna L.K. **Wren**[1] and Jeffrey J. Polovina[2]

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The Hawaii-based deep-set longline fishery targets bigeye tuna *(Thunnus obesus)* but occasionally seabirds go after baited hooks, get hooked, and are drown as the gear sinks. While mitigation efforts have proven successful, black-footed albatross *(Phoebastria nigripes)* interactions are increasing. In an effort to better understand when and where these interactions take place, we explore the relationship between black-footed albatross sightings in the Hawai‘i-based deep-set longline fishery and fleet dynamics, oceanographic factors, and biological drivers. Oceanographic factors we investigated include both large scale climate variability due to the Pacific Decadal Oscillation (PDO) and El Niño – Southern Oscillation as well as local oceanographic, and biological drivers, such as sea surface temperature, surface chlorophyll, and wind patterns. Using generalized additive models we found that factors driving black-footed albatross sightings include both large scale and local climate variables, namely positive PDO, strong westerly winds, high chlorophyll, and cooler temperatures. The majority of black-footed albatross interactions take place in an area north of the Hawaiian Islands, spanning 23-30°N and 150-165°W. Black-footed albatross nest in the Northwestern Hawaiian Islands and their main foraging habitat during nesting are the productive fronts to the north of the Hawaiian Islands. During positive PDO a strong Aleutian Low shifts these frons to the south, increasing the overlap of the albatross foraging grounds and the deep-set fishing grounds. We found that BFAL interactions are primarily driven by PDO patterns influencing local oceanography. Therefore, the high levels of sightings and interactions may persist for many years rather than being a short episodic event.

April 25, 12:10 (S1-12543)

Mesoscale ocean features lead to increased energy gain for Elephant Seals in the North Pacific Transition Zone

Briana Abrahms[1,2], Kylie Scales[3], Elliott **Hazen**[1,2], Steven Bograd[1,2], Robert Schick[4], Patrick Robinson[2] and Dan Costa[2]
(*presented by Steven Bograd*)

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Electronic tags provide insight into how foraging animals select resources, and thereby how does the distribution of resources structure animal distributions and trophic interactions? The mechanistic linkages between habitat use, foraging ecology, and fitness consequences are limited because the outcomes of individual resource selection decisions, such as energy intake, are rarely measured. In the open ocean, convergent mesoscale features (~10-100 km) have been shown to aggregate prey, increasing foraging opportunities for marine vertebrates through bottom-up processes, yet the energy transfer to top predators remains unquantified. We investigated the selection of mesoscale features by deep-diving northern elephant seals (*Mirounga angustirostris*) in the Pacific Ocean, and quantified the corresponding energetic gains from the seals' resource selection patterns. We assembled a suite of bio-logging and oceanographic datasets, including satellite tracking data (N=142 adult females), time-depth dive recorders, daily body fat estimates, and time-matched ocean circulation measurements. To identify convergent mesoscale features, we computed Finite-Size Lyapunov Exponents (FSLE) at 4-day intervals, which measure the backward-in-time separation of initially nearby water parcels. We found that northern elephant seals selected areas with higher FSLE activity and greater mesoscale structural complexity during post-molting migrations. While absolute FSLE did not influence daily energy gain, energy gain increased significantly with increasing FSLE spatial standard deviation, suggesting that areas of mesoscale complexity may concentrate prey fields, even at depth where northern elephant seals forage. Our results show that areas of physical structure not only attract foraging top predators, but also lead to increased trophic transfer.

April 25, 12:30 (S1-12341)

Climate related changes in abundance and range shifts of pelagic fishes and jellyfish in the eastern Bering Sea during late summer, 2002-2016

Ellen M. **Yasumiishi** and Kristin Cieciel
(*presented by Keith Criddle*)

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Climate change is expected to alter the abundance and distribution of marine species in the Arctic. We use new standardized geostatistical delta-generalized linear mixed models from Thorson (2015) to estimate annual abundance and center of gravity of pelagic fish and jellyfish in the eastern Bering Sea during late summer for a 15 year period (2002-2016). Next, we examine whether changes in abundance and distribution are correlated with variability in sea ice and temperatures in the eastern Bering Sea. Sea ice is important in determining ecosystem structure in the eastern Bering Sea, therefore understanding how species relate to past environmental conditions during periods of variable sea ice and temperature will help us understand how marine species will respond to future climate change.

April 25, 14:00 (S1-12463)

Effects of environmental changes in inshore waters on community structure and population dynamics of exploited marine species

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The inshore waters are the critical habitat of many commercial fishery species and excellent fishing grounds. In China, the inshore fishery provides more than 90% of marine catch, and is an important source of high quality protein. With the extensive and in-depth development of human activities (*e.g.* large-scale reclamation, land sourced pollution and mariculture, *etc.*), the problems on environment and resources in inshore waters are becoming increasingly severe. The fragmentation and defunctionalization of the spawning and nursery grounds caused by the loss of wetlands, seriously destroyed the recruitment and sustainable production of inshore fishery resources. Environmental changes in coastal waters and its effects on marine fishery resources is a fundamental and advanced subject in the succession of marine ecosystem and sustainable yield of marine fisheries. In this presentation, the three bays (Laizhou Bay, Bohai Bay and Liaodong Bay) and one estuary (the Yellow River Estuary) have been taken as the case studies, the important commercial fishery species (small yellow croaker, Japanese flounder, fleshy shrimp and blue crab, *etc.*) were as the target species. The research mainly focuses on two key scientific problems, including "the formation, transition process and mechanism of fishery species habitat during early developmental stage" and "driving-foundation of fishery species recruitment and their adaptive mechanism to environmental changes". The results clarified the scientific mechanism on formation and evolution characters of the habitat of key fishery species during early life stage, analyzed the effects of environmental changes on community structure and population dynamics of marine fishery species.

April 25, 14:20 (S1-12477)

Biological responses of small yellow croaker (*Larimichthys polyactis*) to multiple stressors: A case study in the Yellow Sea, China

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Temporal changes in biological traits of small yellow croaker *Larimichthys polyactis* in the Yellow Sea were examined for the period of 1960–2008. The body size and age of *L. polyactis* population decreased substantially, in particular, average length of fish in 2008 was reduced by ~50% than those occurring in 1960, and at that time ~93% of the total catch was dominated by one-year-old individuals. Moreover, a bimodal length-frequency distribution of fish was observed in 1960, but this changed to unimodal structure from 1985 onwards. Correspondingly, growth parameters also varied significantly over the years, *i.e. k* (growth coefficient) and t_0 (initial age of fish) gradually increased from 0.26 and -0.58 yr in 1960 to 0.56 and -0.25 yr in 2008, respectively. Although, L_∞ (body length) sharply decreased from 34.21 cm in 1960 to 24.06 cm in 2008, and t_r decreased from 3.78 yr in 1960 to 1.61 yr in 2008. There was no significant difference (P>0.05) between natural mortality coefficient and fishing mortality coefficient. However, according to the gray correlation analysis, changes in the biological characteristics of small yellow croaker were induced by different stressors ranked as: fishing vessel power> feeding grade> sea-surface-temperature. This study suggests that the active fishery management measures for biological characters of fish populations should be considered.

April 25, 14:40 (S1-12447)

Reproducing migration history of Japanese sardine using otolith $\delta^{18}O$ and a data assimilation model

Tatsuya **Sakamoto**[1], Kosei Komatsu[2,1], Kotaro Shirai[1], Tomihiko Higuchi[1], Toyoho Ishimura[3], Yasuhiro Kamimura[4], Chikako Watanabe[4], Atsushi Kawabata[5], Michio Yoneda[6] and Takashi Setou[4]

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Although tracking the movement and understanding the migration of fish is a key for fisheries science, it has been technically difficult especially for small sized fish that cannot be tagged. In this study, a new scheme was developed to estimate migration history of a captured fish using high resolution otolith $\delta^{18}O$ analysis and a data assimilated ocean model. $\delta^{18}O$ in otolith is affected by both $\delta^{18}O$ and temperature of ambient water. $\delta^{18}O$ in seawater is correlated with salinity. Using salinity and temperature distribution of an ocean model, therefore, it is possible to estimate the area that the fish located from otolith $\delta^{18}O$ profile. The estimated areas can further be narrowed by filtering out areas that are impossible to reach by passive transport and active swimming. This new scheme was tested for immature Japanese sardine. High precision micro-milling system Geomill 326 and ultra-micro-volume carbonate analyzing system MICAL3c were used to extract otolith $\delta^{18}O$ profile, which resulted in temporal resolution of 10-30 days through whole life. The relationship between seawater $\delta^{18}O$ and salinity in the Kuroshio-Oyashio system was updated through numbers of water sampling: $\delta_{seawater} = 0.56*S - 19.06$ ($r^2 = 0.86$, $p < 0.01$). Because the estimated migration histories expressed northward migration, consistently with previous sampling surveys, and closely approached the actual captured location in the end, we concluded that the scheme successfully worked for the Japanese sardine. The scheme can be applied to other species without large modification and would be helpful to understand its migration.

April 25, 15:00 (S1-12429)

Durable entitlements and resilience in fishery social ecological systems subject to environmental forcing

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Sustainability of fisheries and fishery dependent communities depends on intrinsic characteristics of ecological and environmental systems that govern the response of fish stocks to environmental forcing and exploitation and intrinsic characteristics of social, economic, and legal systems that determine who may fish and how fishing may occur. Some fisheries and fishery dependent communities have proven resilient to changes in fish abundance and distribution; others have not. Since 1995, Alaska's halibut fishery has operated under a system of perennial Individual Fishing Quotas. While viewed as successful from the perspective of increased economic value, increased management precision, and improved safety. The fishery is struggling to deal with a precipitous decline in size-at-age that seems to be associated with environmental changes that appear to affect prey quality and availability. The decline in stock productivity affects current earnings and the value of the durable entitlements. In Alaska's salmon fisheries, similar declines in the value of limited entry permits led to high numbers of bankruptcies, economic contraction in fishery-dependent communities, and an out-migration of limited entry permits. The possibilities of a similar outcome in the halibut fishery are examined in an empirically-based simulation.

April 25, 15:20 (S1-12424)

North Pacific albacore distribution and migrations along transition zones

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North Pacific albacore (*Thunnus alalunga*) migrate throughout much of the North Pacific, including the California Current Ecosystem (CCE). Their abundance in the CCE, and local availability to fishing fleets, has varied strongly historically, at both interannual and decadal-scales. In this study, we use fishery-dependent catch data and tracks of tagged animals to show how albacore use migration corridors across the North Pacific, and link these to spatial availability of favorable metabolic and foraging habitats. We also relate albacore distribution to abundance of primary prey species in CCE foraging areas, and investigate how varying availability of forage fishes has driven "prey switching" behavior in time and space. Our results are relevant to the development of ecosystem models for the CCE, and for the assessment of future climate change impacts on the stock, and associated fisheries.

April 25, 16:00 (S1-12390)

Interannual variability tendences of the fish larvae abundance of dominant species at the Transition Zone of Bahia Vizcaino (1997-2014)

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Ichthyoplankton of the southern region of the California Current off the peninsula of Baja California has been widely studied regarding to species composition and community structure on seasonal and interannual scales, generally associated to the presence El Niño and La Niña events. Continuous sampling of this area by the IMECOCAL program has allowed the formation of a data series since 1997 to date, which includes the abundance of fish larvae and other zooplankton groups, as well as registers of environmental variables such as temperature, Chl-*a* concentration and zooplankton abundance between others. These data have highlighted the dominance of species as *Vinciguerria lucetia, Diogenichthys laternatus* y *Sardinops sagax* among others, and have allowed to identify the importance of the transitional region of Bahía Vizcaíno as a center of high diversity in the western coast of Baja California. In this work, we present the main findings on the interannual variation trends of the dominant fish larvae species in the Bahía Vizcaíno region and highlight the importance of *V. lucetia, D. laternatus* y *S. sagax* as indicative species of the environmental trends in the study area.

April 25, 16:20 (S1-12438)

Fish larvae associations off the west coast of the Baja California peninsula during climate anomalies of 2014 and 2015

Ana Gabriela **Uribe-Prado**, Gerardo Aceves-Medina, Ricardo J. Saldierna-Martínez, Silvia P.A. Jiménez-Rosenberg and Alejandro T. Hinojosa-Medina

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During 2013 to 2016, a series of climatic events developed in the northern hemisphere of the Pacific Ocean that affected the dynamics of the California Current System (SCC). The oceanic region off the western coast of the Baja California Peninsula (WCBCP) was affected in 2015-2016 by one of the most intense El Niño events recorded (comparable with those of 1982-1983 and 1997-1998), which was preceded by the warm water mass that originated in the Gulf of Alaska in 2013, and by a short-lived El Niño event in 2014. Although the effect of those processes on different faunal groups from the north and center of the SCC has been studied, there is still discussion about the effect they had on the southern portion. This work provides evidence of the influence of environmental variables on the distribution of fish larvae associations of the WCBCP during the summers of 2014 and 2015. Based on techniques of classification and ordination using environmental and ichthyoplanktonic data, four associations related to values of high larval abundance of mesopelagic species were found during 2014, where the species richness was contributed by demersal populations in a community dominated by tropical-subtropical species. In 2015 there were five associations related to low values of abundance and species richness in a community that registered an increase of coastal species with a wide faunal affinity.

Key Words: Southern California Current, fish larvae associations, 2013-2016 climate anomalies

April 25, 16:40 (S1-12492)

Impacts of a transition to tropical oceanic conditions in the Gulf of California on pelagic fisheries (2010-2015)

Timothy H. **Frawley**[1], Dana K. Briscoe[1], Patrick C. Daniel[1,2], Elan Portner[1], Unai Markaida[3], Larry B. Crowder[1,4], Carlos J. Robinson[5] and William F. Gilly[1]

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Interannual oceanic oscillations and ongoing climatic variability present an increasingly complex challenge for the management of pelagic marine fisheries. Although fisheries oceanography has advanced our understanding of the interactions between pelagic populations and oceanographic variation, unexplained fishery declines still occur, even in comparatively well-studied systems like the Northeast Pacific. Here we discuss sustained declines in landings of California sardines (*Sardinops sagax*) and Humboldt squid (*Dosidicus gigas*) across the central Gulf of California (GOC) in the context of changing oceanographic conditions. Following the 2009-10 El Niño event, productivity declined across the central GOC while water temperatures in the region increased, most significantly at depths of 50-75 m. Sardine and squid fisheries crashed, and squid began maturing at an extremely small-size, a phenotype characteristic of this species in the equatorial portion of its range. Industrial sardine vessels transitioned to target anchovies and thread herring, and many squid fishermen abandoned the sector. In 2015-16, El Niño conditions returned to the region, disrupting a nascent recovery of the squid fishery and reducing squid size at maturity to the smallest levels ever observed. Spatially explicit oceanographic analyses reveal that recovery of both fisheries was likely inhibited by the progressive intrusion of tropical water into the GOC during the years between these two officially recognized El Niño events. Such phenomena, if they increase in frequency or persistence, could restructure the region's pelagic marine food webs and lead to a long-term collapse of embedded fisheries, threatening employment opportunities and economic benefits across Northwest Mexico.

April 25, 17:00 (S1-12448)

Recent decline in body condition of individual blue whales in the Gulf of California

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Whales are effective indicators of changes in the ecosystem. The Gulf of California is used as a winter nursing and feeding ground by the eastern North Pacific blue whale population. This has facilitated the monitoring of blue whale individuals in the southwestern region for over 25 years. In recent years the physical fitness of the whales appears to be declining. To monitor the individual whales' physical condition, a body condition index was developed and applied to the individual identification database. This index uses digital photographs (2006-2017) to examine the degree of visibility of an individual's vertebral column, post-cranial depression and ribs/flanks, on which basis the whale is then assigned an overall body condition of good, compromised or poor. Results show that overall body conditions in the years 2015 [p=0.005], 2016 [p=0.000], and 2017 [p=0.012] were significantly different from those in previous years. Body conditions were not biased to sex [p=0.193]. These results imply a worsening physical condition of the population, considering that prior to 2015 whales were mostly in good condition. These outcomes are most likely the consequence of depletion of food sources, potentially due to increased surface temperatures and decrease in zooplankton biomass in the eastern North Pacific Ocean. While this population is considered the most recovered worldwide, our results show the individual physical condition is declining and highlight the urgency to monitor individual health more closely using other biological parameters.

April 25, 17:20 (S1-12544)

Differential response of midwater, midtrophic communities to ENSO and tropicalization in the Gulf of California

Elan **Portner**[1], Kelly Benoit-Bird[2], Chad Waluk[2], Carlos Robinson[3] and William Gilly[1]

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Over the past five years, the Gulf of California (GOC) has experienced tropicalization, observed as increased sea surface temperature (SST), sea surface height (SSH), subsurface warming, and a redistribution of primary productivity during summer (July-October). Concurrently, there has been a drastic reduction in size of mature Humboldt squid (from 75cm to 20cm) to a phenotype typical of this squid in the tropical portion of its range. However, it is unclear how these oceanographic changes affected the midwater organisms that squid feed on, limiting our ability to assess the relative effects of temperature and food availability on the phenotypic response of Humboldt squid to the tropicalization of the GOC. We demonstrate that squid diet composition did not drastically change during 2010-2017, but that variability in prey availability during this same period may help explain the observed diminution of squid size. Using acoustic data collected 2005-2017, we define acoustic proxies of squid food availability in the GOC (e.g. density, depth distribution) and describe the response of nighttime acoustic scattering in the upper 200m of the water column to ENSO and subsurface warming. Mean volume backscattering in the central GOC varied significantly in both basin and shelf habitats with respect to climatic conditions, and was sensitive to the subsurface warming observed 2014-2017. This work provides a unique glimpse into the response of midwater forage communities in the GOC to oceanographic variability.

S2: Challenges in managing highly migratory and transboundary resources in Pacific transitional areas

April 25, 11:10 (S2-12533)

Continuous differentiation of sardine stocks in the Ensenada Front transitional area

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Two stocks of Pacific sardine (*Sardinops sagax*) migrate seasonally and synchronously off the west coasts of Mexico and the United States (US), each within their respective seawater habitats. In the Ensenada Front transitional area, roughly coincident with the Mexico-US border, measures of potential habitat may be used to attribute survey samples and fishery landings to the "northern" or "southern" stock. Sardine potential habitats are characterized predominantly by different ranges of sea-surface temperature (SST). Although SST may be sensed with satellite-based measures, these are often blocked by cloud cover and it may take multiple weeks to create a useful image. Meanwhile, the environmental conditions in the area may change, fish may migrate, and fishing may occur. To better characterize and more continuously monitor the conditions in which sardine may reside, and the presence of migrating coastal pelagic fishes (CPS) within the two habitats, a multi-instrumented mooring was placed for a year near the border of the Mexico and US Exclusive Economic Zones (EEZs). Concurrently, a second instrumented mooring was placed off Del Mar, California. Data collected from these two moorings provide information about the Ensenada Front transitional area and which stock is present in the US EEZ and potentially landed at San Pedro, southern California at any given deployment date.

April 25, 11:30 (S2-12430)

Impacts of climatic and ecological variations on human user groups and implications for marine ecosystem-based management in Northern Peru

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The Piura region in Northern Peru is located in a transitional area between the Peruvian upwelling system and equatorial waters. The strong oceanographic gradient and variability driven by the El Niño Southern Oscillation (ENSO) have pronounced impacts on marine ecosystems and human user groups in the region.

We conducted a series of personal interviews with users of marine ecosystems in Piura, among them artisanal and coastal fisheries, ecotourism operators, aquaculture, as well as governmental bodies and environmental organizations. We identified uses, interactions among users, perceptions about and adaptations to climatic and environmental variability, and potential impacts of shifts in marine ecosystems under climate change scenarios.

Ecological effects of ENSO play an important role in users' perceptions. Fishers are affected by distributional shifts of finfish and cephalopod species. The tourism sector is impacted by infrastructure damage and pollution of marine waters during strong EN events. Mass mortality events in benthic species and top-level predators such as sea lions and marine birds affect aquaculture and tourism. User groups have developed a range of adaptation measures to these changes, including adjustments of target species, economic diversification and migration to other localities. The marine ecosystem in the Piura region is expected to change towards a more tropical system in the coming decades.

This scoping study demonstrates the diversity of links from environmental variability to marine resource users in Pacific transitional areas, identifying knowledge gaps and adaptation options relevant for the undergoing development of an ecosystem-based management approach for marine areas in the Piura region.

April 25, 11:50 (S2-12449) Invited

Economic and conservation: Biological and economic tradeoffs between longline and purse-seine fishing in the Eastern Pacific Ocean

Chin-Hwa J. **Sun**[1], Mark N. Maunder[2], Alexandre Aires-da-Silva[2], Minling Pan[3], William H. Bayliff[2] and Guillermo A. Compeán[2]
(*presented by Minling Pan*)

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The purse-seine fleets targeting yellowfin and bigeye tuna in the eastern Pacific Ocean (EPO) are not managed optimally with respect to economic value. Both tuna species are caught at sizes too small to take advantage of their individual growth and the higher prices obtained for large fish in the sashimi market. This paper evaluates the economic and biological trade-offs of managing the fishery so that the economic value could increase while the spawning biomass of both species is maintained at target levels.

Three analyses are conducted to evaluate the economic and biological tradeoffs at four extreme combinations of purse-seine and longline fishing effort. The first evaluates different effort that could produce the target biomass level. The second evaluates the corresponding optimize equilibrium (long- term) catch and economic value. The third evaluates the dynamic (short-term) effect. Our results show that economics and conservation are not incompatible. In one scenario, we show that reducing purse-seine effort by 26.3%, via a per-ton compensation system between the purse-seine and long line fleets, leads to net economic increase by16.5% or $93 million. To extend our results, three possible methods of implementing such a management strategy are discussed, such as a tradeable right based management scheme.

April 25, 12:15 (S2-12571) Invited

Only one path to sustainability? Understanding the role of MSC certification in regional fisheries management organizations

Agnes Yeeting and Simon R. **Bush**

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Regional Fisheries Management Organizations (RFMOs) facilitate international cooperation for the management of shared transboundary fish resources like tuna. However, RFMOs are challenged with dynamic interests which have slowed progress towards collective decisions on establishing key management measures such as harvest control rules (HCRs) and target and limit reference points. The introduction of market institutions like the Marine Stewardship Council (MSC), a third-party certification standard, have been introduced to incentivize the adoption of these and more measures. The role of MSC as a market institution is thought to work in a linear way – providing economic incentives for meeting its standards. However, based on a comparison of three RFMOs in the Indian, Pacific and Atlantic Ocean, this paper shows how the MSC influences decision making in very different ways. In doing so we demonstrate different 'pathways' through which MSC has been applied to create change at the RMFO level. The findings hold relevance for a wider understanding of how third party certification contributes to change beyond market incentives alone.

S3: Challenges in observing and modeling Pacific transitional areas

April 25, 14:05 (S3-12456) Invited

Predicting and adapting to biome-scale marine resource changes in the North Pacific

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The North Pacific Ocean includes diverse ocean biomes, ranging from oligotrophic "ocean deserts" to prolific upwelling systems fueled by the richest stores of subsurface nutrients in the global ocean. Earth system models project significant changes in the size, location, and physical/biogeochemical properties of these biomes under climate change. Furthermore, trophodynamic mechanisms are expected to amplify physical and lower trophic level trends, generating stark regional marine resource changes that will challenge current management approaches. CO_2 mitigation may ameliorate these impacts, but will not prevent a transition to non-analog ocean states. This talk will critically assess the mechanisms underlying projected biome-scale changes in the North Pacific and their uncertainties. Recent advances in seasonal to multi-annual climate and earth system prediction will then be discussed as a potential pathway for long-term ecosystem and socioeconomic resilience in changing and variable ocean.

April 25, 14:30 (S3-12393) Invited

Development of a high resolution coastal ocean model

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We are developing an ocean general circulation model (OGCM) with 500 m horizontal mesh on K computer, which is to be used as the basis for a forecast system of the entire coastal waters around Japan. The model is composed of interactively coupled four models from an eddy-permitting global model to a 500 m mesh regional model around Japan. The model is integrated for one month and results are compared with observational data. It exhibits various fine scale features which have not been captured by conventional models. Eddies with diameter greater than about 2 km can be represented in the model. Many eddies are generated behind the headlands and islands along strong currents such as the Kuroshio. Similar eddies are detected in sea surface temperature data of the geostationary weather satellite Himawari-8 around the East China Sea and the Tokara Strait along the Kuroshio. Interaction between strong currents and steep bottom topography is also represented in the model. For example, the simulated surface current converges and subsurface density surface undulates over the shallow topographies offshore of the Capes Ashizuri and Muroto where part of the Kuroshio flows over them. Signals of such surface current convergence appear in the images of Synthetic Aperture Radar of the Advanced Land Observing Satellite-2 (ALOS-2).

April 25, 14:55 (S3-12370) Invited

Mixing processes of the Oyashio and Tsugaru Warm Current in the Northwestern Pacific Ocean

Daisuke **Hasegawa**, Takahiro Tanaka, Takeshi Okunishi and Hitoshi Kaneko

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A transition zone between the Oyashio Front and the Kuroshio Extension in the Northwestern Pacific is a world famous fishing ground supported by the outstanding high biological production. Three major water masses from the Oyashio, Kuroshio, and Tsugaru Warm Current merge in the area, resulting in highly variable and complicated oceanographic conditions. Although fishing grounds are mostly formed near frontal zones in this region, detailed physical mechanisms of fishing ground formation in the area are still unclear. Therefore, we have been putting our main study effort on the frontal processes in the area. In this study, we report preliminary results of our 2017 summer field campaign focusing on mixing processes at the front between the Oyashio and the Tsugaru Warm Current (OT) by using the R/V *Wakataka-maru* (692t equipped with a shipboard 38 kHz ADCP, a turbulence profiler with a nitrate sensor attached, and Underway-CTD system) and Slocum G2 Glider (equipped with a turbulence sensor, ADCP, CTD and bio-optical sensors). We conducted zigzag surveys with the both platforms crossing the OT front from the merging point: off the Cape Erimo to the downstream: off Sanriku to reveal the detailed and continuous degenerative processes and nutrient exchange of/between the two water masses.

April 25, 15:20 (S3-12538)

Projected coastal hypoxia in a coupled bio-physical model of the California Current System

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Recent observations have shown an increase of the hypoxic area on the shelf in the California upwelling system. Climate projections suggest this increase would continue over the 21st century. Unfortunately, the low-resolution ocean component of today's climate models in this region are hampered by an inadequate representation of upwelling and other coastal processes. In order to better represent the biogeochemistry (BGC) on the shelf in numerical models, we ported the NOAA-GFDL biogeochemical model COBALT into the regional ocean model ROMS, permitting a seamless representation from global to coastal scales. We present results from a suite of downscaled sensitivity experiments using a 7km California Current implementation for projected future changes in bio-physical drivers of coastal hypoxia, which include oxygen and nutrients in source waters, solubility and upwelling-favorable wind. In this presentation, we will describe and assess the relative impacts of the various drivers of coastal hypoxia.

April 25, 16:00 (S3-12357)

Lagrangian analysis of mesoscale eddies in the Kuroshio-Oyashio frontal zone

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A Lagrangian methodology is elaborated to analyze eddies in the Kuroshio-Oyashio frontal zone. It allows to track evolution of mesoscale eddies and to document how they gain, retain and release water masses of different origin. The methodology is applied to study warm-core mesoscale anticyclones propagating along the Japan and Kuril trenches which have been observed from January 1, 1993 to the present time in the altimetry-based velocity field. A Hokkaido eddy, sampled by profiling floats and in a few cruises in 2003 and 2004, is analyzed in detail in order to compare simulated Lagrangian results with observations.

April 25, 16:20 (S3-12518)

Spatio-temporal variability of the Equatorial Front in the Eastern Pacific

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In the Eastern Pacific, the Equatorial Front (EF) separates the Equatorial Surface Waters to the south from the Surface Tropical Waters to the north. It is also associated with intense horizontal gradients of properties (physical and biogeochemical) between these two water masses. Previous studies described the EF succinctly, identifying it as a permanent superficial formation; however, little is known about its spatial pattern and temporal variability beyond seasonality. Since 2010, the SMOS satellite has been collecting the sea surface salinity (SSS) in a synoptic and continuous manner. We used 6 years (2010-2015) of SSS data which were validated with in-situ data acquired simultaneously. An algorithm was developed for the detection of the EF based on maximum gradients of SSS and with that we determined its spatial and temporal variations. Seasonally, west of Galapagos the EF is centered at ~2°N and did not show significant southern migrations. On the contrary, to the east, it showed greater displacements, reaching ~4°S in spring and ~2°N in autumn which was related to the large-scale superficial winds. Intraseasonally, the EF had slight meridional fluctuations, oscillating between ±1.25° from the mean. This was related to the propagation of Kelvin Waves, mesoscale structures and other high-frequency variability events (*e.g.* Tropical Instability Waves).

Keywords: Equatorial Front, SMOS, Sea Surface Salinity, Variability, Eastern Pacific

April 25, 16:40 (S3-12523)

The effect of Ojo de Liebre Lagoon on the hydrodynamics of Bahia Vizcaino

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Vizcaino Bay (BVC) is an unusual productivity spot in the Pacific Coast of Mexico leading to an overexploitation of the fisheries in the zone. Speak about Vizcaino must be done with the influence of the biggest salt producer in the world as it is Guerrero Negro and the Ojo de Liebre Lagoon.

Only a few studies have been done on the area and in order to reestablish the fisheries or to slow down the deterioration of the productivity for the bay we initialized the simulation of the hydrodynamics of BVC. We utilized the model AEM3d from Chris Dallimore and Hydronumerics, in Melbourne, Australia, with a data set from a Research Cruise performed in august 2017 to stablish the simulation.

From CTD profiles we found interesting and unusual hydrographic signals that motived us to explain those using hydrodynamics simulation.

We used the bathymetry data set from GEBCO08 from DELF database model, and we created a rectangular grid with dx=dy=800 m. The vertical resolution was variable with a minimum of 2 m near the surface and 10 mts near the bottom. We selected a maximum depth of 200 m to make efficient the time and space for the running simulation. The model was forced with meteorological data form Isla de Cedros, and the sea level measured for the days of the campaign at the open boundaries. Temperature and salinity profiles measured during the campaign were used to initialize the simulation. For the temperature and salinity profiles inside the lagoon, we selected profiles from an earlier campaign where the average salinity and temperature were set along the main axis of the lagoon.

The results of the simulation shown clearly how the dynamic is moving the high salinities from the lagoon to the center of the bay, however this movement are not going in an estuarine inverse circulation but rather they are moving along the coastline by the winds to enter to the center of the bay around san Andres point. The average velocity show a circulation with eddy patterns described before for other authors.

April 25, 17:00 (S3-12497)

Temperature and growth cause the recruitment variability of Pacific saury (*Cololabis saira*): Modeling survival processes in early life stages

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Pacific saury (*Cololabis saira*) is a commercially and ecologically important pelagic fish in the North Pacific. Total catch by countries along the western North Pacific is recently increasing. However, the stock variability is not solely explained by fisheries catch. The recruitment rate shows marked interannual fluctuations and many studies indicated influence of environmental variability in the spawning and feeding areas to the stock fluctuation. In this study, we examine the recruitment variability of Pacific saury using an individual-based model combining a bioenergetics, migration and mortality model. We parameterize the mortality rate of seasonal spawning cohort (autumn-, winter- and spring-spawned cohort) with the weight, instantaneous growth rate and temperature, and test the performance of each parameterization by comparing the model and observational results. The interannual variability of the growth-rate frequency distribution in the model is generally consistent with those estimated from the observations. The annual survival rates (recruitment per spawning biomass: RPS) in the model (mRPS) are calculated from the number of survived fish at age-1, and compared with RPS derived from the stock assessment for 2003–2012. The interannual variability in RPS is well reproduced in the model, especially in cases parameterizing the mortality using the weight and temperature with higher weighting on the spring-spawned cohort. The importance of the spring–spawned cohort regarding on the annual RPS is consistent with the hypothesis derived from observations during 1990–1998.

April 25, 17:20 (S3-12394)

Fine-scale variability of isopycnal salinity in the California Current System

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Finescale structure and seasonal fluctuations of the isopycnal salinity of the California Current System from 2007 to 2013 were examined using temperature and salinity profiles obtained from a series of underwater glider surveys. The seasonal mean distributions of the spectral power of the isopycnal salinity gradient averaged over submesoscale (12–30 km) and mesoscale (30–60 km) ranges along three survey lines off Monterey Bay, Point Conception, and Dana Point were obtained from 298 transects. The mesoscale and submesoscale variance increased as coastal upwelling caused the isopycnal salinity gradient to steepen. Areas of elevated variance were clearly observed around the salinity front during the summer then spread offshore through the fall and winter. The high finescale variances were observed typically above 25.8 kg m^{-3} and decreased with depth to a minimum at around 25.3 kg m^{-3}. The mean spectral slope of the isopycnal salinity gradient with respect to wavenumber was 0.19±0.27 over the horizontal scale of 12–60 km, and 31% to 35% of the spectra had significantly positive slopes. In contrast, the spectral slope over 12–30 km was mostly flat, with mean values of –0.025±0.32. An increase in submesoscale variability accompanying the steepening of the spectral slope was often observed in inshore areas; *e.g.*, off Monterey Bay in winter, where a sharp front developed between the California Current and the California Under Current, and the lower layers of the Southern California Bight, where vigorous interaction between a synoptic current and bottom topography is to be expected.

S4: Advances in understanding Pacific shelf-offshore transitional areas

April 25, 14:05 (S4-12419) Invited

Cross-shelf transports of water and nutrients in the East China Sea and their impacts on the primary production

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Based on a three dimensional low-trophic ecosystem model, we revaluated budgets of nutrients and biogenic particles (phytoplankton and detritus) in the East China Sea (ECS), a shelf sea affected by a large river (Changjiang River) and a western boundary current (Kuroshio). After a careful comparison of model results with available observation data, we calculated the monthly inventories of the nutrients and biogenic particles in the ECS and the fluxes of the nutrients and biogenic particles through the lateral and vertical interfaces of the ECS. Our calculation shows the necessity of evaluating not only the horizontal fluxes of nutrients and biogenic particles through lateral boundaries but also the exchange fluxes of nutrients and biogenic particles between the upper and lower layers. Our calculation also reveals that the export of biogenic particles is more from the ECS to the Japan Sea through the Tsushima Strait than from the ECS to the Kuroshio region through the shelf slope and the export pathway of biogenic particles from the ECS to the Kuroshio region is through the middle layer (from ~60 m to ~160 m) of the shelf slope in the ECS. Furthermore, we separated the nutrients into the ECS by sources of Kuroshio, Taiwan Strait, rivers, and atmosphere and evaluated their contribution to the inventory of nutrients as well as the primary production over the ECS using a tracking technique. A concept of production efficiency is finally applied to understand the contribution of nutrients from different sources over the shelf of ECS.

April 25, 14:30 (S4-12433)

Buoyancy shutdown process for the development of the baroclinic jet structure of the Soya Warm Current during summer

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The Soya Warm Current (SWC), which is the coastal current along the northeastern part of Hokkaido, Japan, has a notable baroclinic jet structure during summer. This study addresses the formation mechanism of the baroclinic jet by analyzing a realistic numerical model and conducting its sensitivity experiment. The key process is the interaction between the seasonal thermocline and the bottom Ekman layer on the slope off the northeastern coast of Hokkaido; the bottom Ekman transport causes subduction of the warm seasonal-thermocline water below the cold lower-layer water, so the bottom mixed layer develops with a remarkable cross-isobath density gradient. Consequently, the buoyancy transport vanishes as a result of the thermal-wind balance in the mixed layer. The SWC area is divided into two regions during summer: upstream, the adjustment toward the buoyancy shutdown is in progress; and downstream, the buoyancy shutdown occurs. The buoyancy shutdown theory assesses the bottom-mixed-layer thickness to be 50 m, which is consistent with observations and our numerical results. The seasonal thermocline from June to September is strong enough to establish the dominance of the buoyancy shutdown process over the frictional spindown.

April 25, 14:50 (S4-12482)

Nutrient front across the Kuroshio

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The Kuroshio transports large amount of heat and salt to the north and forms temperature and salinity fronts with coastal waters. Th color of the Kuroshio water (dark ultramarine) and coastal water (blue or blue green) is also different each other representing their phytoplankton concentration, *i.e.*, low phytoplankton biomass in the Kuroshio and high in the coastal water. However, the nutrient front is not distinctive in the surface layer because of the detection limit of conventional method for nutrient analysis (*e.g.*, 30-50 nM for NO_3) is not enough high to distinguish the difference. Newly developed absorption photometry with LWCC (long waveguided capillary cell) for nutrient analysis (detection limit for NO_3 and PO_4 is 3 nM, respectively) makes it possible to examine the geographical difference in nutrient concentration across the Kuroshio axis. We applied the LWCC method during summer and autumn cruises of RV *Hakuho-Maru* in the Kuroshio region. In autumn, nitrate concentration in the Kuroshio axis and the south were 10-20 nM in the surface mixed layer, which was lower than coastal water (50-200 nM). In summer, the concentrations were similar each other (3-10 nM) in spite of higher chl.-*a* concentration in the coastal region. In coastal region, dense and high nutrient water upwelled, and the nutrient front was more distinct in subsurface layer. In the presentation, we will discuss on the origin of nutrient supplied in the surface layer and the mechanisms forming chlorophyll front from small difference in nutrient concentration.

April 25, 15:10 (S4-12385)

Numerical experiments based on a coupled physical–biochemical ocean model to study the Kuroshio-induced nutrient supply on the shelf-slope region south of Japan

Hiroshi **Kuroda**[1,2], Akinori Takasuka[2], Yuichi Hirota[2], Taketoshi Kodama[3], Tadafumi Ichikawa[4], Daisuke Takahashi[1], Kazuhiro Aoki[2] and Takashi Setou[2]

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We developed a triply nested 1/50° ocean model coupled with a NPZD-type lower trophic level ecosystem model and used it to conduct numerical experiments to identify the major processes that supply nutrients on the shelf-slope region north of the Kuroshio. Tosa Bay, an open-type bay facing the Kuroshio, was selected for our experiment. Comparisons of numerical simulations using different grid sizes revealed that a grid size of no larger than 1/50° was essential to reproduce a time-independent density structure related to the Kuroshio jet that uplifted nitrate from subsurface waters into the euphotic zone north of the Kuroshio front. The monthly mean budget of nitrate within the euphotic zone on the shelf showed that primary production was nearly balanced by physical advection and biochemical supply of nitrate via mechanisms such as remineralization of detritus. Eddy advection of nitrate based on Reynolds decomposition, attributable primarily to submesoscale variations, had both positive and negative values within the bay, the indication being that eddy advection functioned regionally to supply or remove nitrate. Lagrangian particle-tracking experiments were performed to examine the major pathways of the nitrate used for primary production in Tosa Bay during the summer, when subsurface maxima of primary production typically appeared. The experiments revealed that when the Kuroshio took a stable nearshore path, nitrate was frequently uplifted around the Kuroshio front and horizontally transported along the front and into the bay via the counterclockwise circulation within the bay; it was sometimes further uplifted onto the shelf.

April 25, 15:55 (S4-12421) Invited

Wind and nutrient controls on phytoplankton biomass in the coastal, offshore, and transitional areas of the California Current System

Michael G. **Jacox**, Steven J. Bograd and Elliott L. Hazen

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In Eastern Boundary Current systems, wind-driven upwelling drives nutrient-rich water to the ocean surface, making these regions among the most productive on Earth. Bottom-up regulation of productivity by changing wind and/or nutrient conditions can dramatically impact ecosystem functioning, though the mechanisms are not well understood beyond broad scale relationships. Here we use output from a physical ocean model in conjunction with remotely sensed chlorophyll data to quantify the dependence of phytoplankton biomass off the US west coast on wind forcing and nutrient availability. We show that the influences of wind and nutrients interact strongly and nonlinearly, and taken together they provide a much more complete view of bottom-up controls on productivity than either does on its own. Furthermore, the relationships between surface winds, subsurface nutrients, and phytoplankton biomass, which differ between nearshore and transitional areas of the California Current System, provide a framework that can be used to describe optimal environmental conditions for phytoplankton and to explain observed ecosystem responses during extreme events in the northeast Pacific.

April 25, 16:20 (S4-12425)

Cross-shelf variation in California Current Water mass structure

Steven J. **Bograd**[1,2], Isaac D. Schroeder[1,2], Michael G. Jacox[1,2] and Elliott L. Hazen[1,2]

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Historical hydrographic data (1950-2016) from the California Cooperative Oceanic Fisheries Investigations (CalCOFI) program were used to quantify the water mass history and its cross-shore structure off southern California. Recent observations have shown declining dissolved oxygen concentrations within the lower pycnocline, concurrent with strong increases in nitrate and phosphate that have spatial patterns matching those of dissolved oxygen. Silicic acid also shows an increasing trend in the offshore portion of the region, but has strong and opposing trends in the upper (increasing) and lower-pycnocline (decreasing). The varying rates of change in the inorganic nutrients yield a more complex pattern of variability in the nutrient ratios, resulting in large decreases in the N:P and Si:N ratios at depths that provide source waters for upwelling. Here we extend these observations back to the 1950s, using optimum multiparameter analysis to diagnose source waters and quantify cross-shore water mass structure from the coastal zone to the transitional areas within the southern California Current System over decadal time scales. The observed variability in regional biogeochemistry reflects variations in the advection of modified source waters, and may have important ecosystem impacts including a reduction of viable pelagic habitat and community reorganization.

April 25, 16:40 (S4-12420)

Variations in subsurface oxygen concentration in the Pacific Canadian transition zone

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Transition zone waters in the Pacific Canadian zone, below the surface mixed layer, experienced declining oxygen concentration from 1980 to 2009; however, the opposite trend was observed in previous and subsequent years. From 2006 to 2009 the oxygen concentration in bottom waters west of Vancouver Island dropped well into hypoxia. Although the variability shares many features with transition zone waters to the south, there are also distinctive differences. In addition, far offshore subsurface waters, as represented by Ocean Station P at 50N, 145W, reveal a steady decline in oxygen since 1950, modulated by an 18.6-year cycle. Detailed statistical analysis of oxygen concentration along Line P shows distinctive offshore and transition zone regions, with the boundary near Station P16, located about 500 km west of the continental shelf. Potential causes of the decadal variability in the Pacific Canadian transition zone are investigated using observations and results from a ROMS-NPZD model of the region. Results indicate that a combination of processes play a significant role in oxygen variability. These are: (1) changes in mixing rates with more oxygenated offshore waters, and (2) biological processes altered by decadal changes in local and remote winds, and (3) variable northward advection.

April 25, 17:00 (S4-12422)

Interannual variability of biogeochemical conditions along the British Columbia continental shelf and slope

Angelica **Peña**, Isaac Fine and Diane Masson

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The British Columbia shelf is at the northern end of the California Current System and is influenced by summer coastal upwelling, mesoscale eddies, and freshwater inputs. Previous studies have shown significant interannual to decadal variability in oceanographic conditions related to ENSO (El Niño Southern Oscillation) events. In this study, the interannual variability of this region is examined using a regional coupled circulation-biogeochemical (ROMS) model. In particular, we use the model to evaluate inshore-offshore nutrient fluxes, primary production and the biologically-driven carbon pump and to identify the mechanisms driving these changes. These variations are discussed within the context of climate change.

April 25, 17:20 (S4-12442)

A Lagrangian view of spring blooms and river-ocean dynamics

Shinichiro **Kida**[1] and Takamitsu Ito[2]

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We will introduce a new Lagrangian NPZD model, where the movement and transfers of nutrient parcels are solved by tracking a nitrogen parcel. The Lagrangian framework is useful for understanding the biogeochemical cycle in the ocean since it naturally follows the movement of materials through the turbulent ocean environment. The basic one-dimensional mechanism behind spring phytoplankton blooms is investigated using this model and we find that the onset of spring blooms depends on the cumulative euphotic age, which is the total time that inorganic nutrient is exposed to light before the photosynthetic conversion to phytoplankton biomass. The model shows that nutrient parcels accumulate enough light exposure through multiple entries to the sun-lit zone near the surface or the residence time near the surface. This is regardless of the underlying mechanism, such as critical depth hypothesis or critical turbulence hypothesis. The difference between the two modes lies in how cumulative euphotic age is accumulated and this can be distinguished by examining the cumulative euphotic age spectrum. A river-ocean coupled model is further presented, where the dynamical interaction between the riverine and oceanic water mass during extreme discharges is simulated. How the front between the two water mass behaves and may affect the biogeochemical cycle will be discussed.

S5: Biodiversity changes in Pacific transitional areas

April 25, 11:10 (S5-12440)

Identifying biogeographical transition zones and nekton assemblages in the northern Humboldt Current System

Giancarlo **Moron**, Andres Chipollini and Miguel Romero

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A biogeographical transition zone is a boundary between biogeographical regions, representing an area of biotic overlap, which is promoted by historical and ecological changes that allow the mixture of taxa belonging to different biotic components. These zones are influenced by environmental conditions and other ecological factors, and, in some cases, can be high species-rich areas. Most of these studies come from terrestrial ecosystems and few ones have been reported in the marine environment. Using taxa composition data from 25 scientific surveys, we identified nekton assemblages and spatial diversity patterns in the northern Humboldt Current System. Then, we related these assemblages with four environmental variables: temperature, salinity, chlorophyll concentration and distance to the shelf break. To identify biogeographical transition zones between the three most important superficial water masses in this ecosystem, we used alpha diversity gradients, taxa diversity turnover (beta diversity) and taxa affinities for each water mass. We found that the area on the shelf break had the highest alpha and beta diversity, and therefore it can be considered as a biogeographical transition zone between the neritic area, dominated by coastal cold waters, and the oceanic area, dominated by oceanic waters. On the other side, the richest taxa assemblage was dominated by warm equatorial waters and the least rich one was the oceanic assemblage, possibly influenced by the covered area during scientific surveys. Finally, we discussed possible influences of fishing on our results and climate change impacts on these assemblages and transition zones.

April 25, 11:30 (S5-12451)

Spatial-temporary distribution of biodiversity on the northern border of the Peruvian maritime domain (2014-2015)

Ruslan **Pastor**, Fabiola Zavalaga, Patricia Carbajal and Albertina Kameya
(*presented by Carmen Yamashiro*)

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Species communities are defined as a set of multidimensional axes that structure the space they occupy. Biotic variables as diversity, richness, biomass, abundance and abiotic variables as temperature, oxygen, salinity and depth represent some of these axes. During the austral autumn of 2014 and 2015, the arrival of Kelvin waves that temporarily altered the marine environment was recorded. Bentodemersal community samples were collected, between 03°S and 06°S, onboard RV Humboldt and José Olaya, in order to characterize the biodiversity of this community in northern Peru, where equatorial and Humboldt currents come together. Average species richness and abundance were estimated by latitudinal degree, station and depth, using a three-way design with crossed factors. A total of 136 and 188 taxa were registered, being families Sciaenidae, Serranidae and Paralichthyidae the most diverse. In both years, spatial distribution pattern of richness significantly varied in the study area, showing more diverse and patchy communities in 2014, and a less diverse and more uniformly distributed community in 2015. Distribution pattern of abundance helped delimit two important geographic areas (3-4°S y 5-6°S). The presence and concentration of the species *Platymera gaudichaudii, Merluccius gayi peruanus, Ctenosciaena peruviana, Hippoglossina macrops, Prionotus stephanophrys, Bellator gymnostethus* and *Hemanthias peruanus*, significantly influenced the structure of these communities.

April 25, 11:50 (S5-12452)

The Coastal El Niño 2017 and its effect on the space-time distribution of some fishes and invertebrates off the coast of Peru

Ruslan A. **Pastor**, Octavio Morón, Flor Paredes and Albertina Kameya
(*presented by Carmen Yamashiro*)

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Some fishes and invertebrates species have the high to moderate sensitivity to environmental variability, mainly in events such as El Niño, which it's showed accordance to the intensity and types of water masses that move towards the southern zone (Surface Equatorial Waters - AES, Surface Tropical Waters - ATS) or they approaches the coast (Subtropical Surface Waters-ASS), Depending on this dynamic, changes occur in the distribution of species, fluctuations in abundance, disorganization of schools and alteration in their physiological condition. The Coastal El Niño 2017, which impacted in Ecuador and the Peruvian coast, was caused by a weakening of the South Pacific Anticyclone that runs from south to north across the ocean basin of the South Pacific and the projection of AES during the austral summer 2017, which determined the increase daily increased of anomalies of the sea surface temperature (SST) with maximum values between +2°C and +10°C on the north coast, while on the central coast it varied between +2°C and +5.5°C, and on the southern coast, between -1°C and +1°C. As a result of these environmental changes, the typical species from the northern zone of Peru moved towards south (*Albula vulpes*, *Caranx* sp., *Eucinostomus* sp., *Sphoeroides* sp., *Symphurus* sp., *Umbrina xanti*) and others, approached The coast (*Coryphaena equiselis*, *Coryphaena hippurus*, *Cheilopogon heterurus*, *Hirundichthys rondeletii*, *Katsuwonus pelamis*, *Sarda chiliensis*, *Thunnus albacares* and *Xiphias gladius*), causing fluctuations in the abundance of fishes and invertebrates landings, influencing Peruvian artisanal and industrial fishing.

April 25, 12:10 (S5-12431)

Habitat suitability index of Pacific sardine (*Sardinops sagax*) in the Mexican Pacific Ocean under climate change scenarios

David **Petatán-Ramírez**[1], Miguel Ángel Ojeda Ruiz Dela Peña[1], Laura Sánchez-Velasco[2], David Rivas-Camargo[3], Cristian Salvadeo[1], Héctor Reyes-Bonilla[1], Gabriela Cruz-Piñon[1], and Hem Morzaria-Luna[4]

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The aim of this work is to model potential distribution of Pacific sardine (*Sardinops sagax*) in Northern Mexican Pacific at present time and in the future under IPCC climate change scenarios to identify potential changes in geographic distribution of this species. Species distribution models (SDM) were developed using local point ocurrences gathered from primary literature and open-access databases (Ocean Biogeographic Information System, OBIS and Global Biodiversity Information Facility, GBIF). Also, environmental variables (sea surface temperature, chlorophyll a, dissolve oxygen and salinity) were obtained from World Ocean Atlas and remote sensing, since 1985 until 2015, at 9x9 km spatial resolution. Those variables were used to build monthly climatology. Local species occurrences and environmental dataset were included in MaxEnt algorithm to generate present and future SDM. The results showed that Pacific sardine geographic range in northern Mexican Pacific would expand in more than 50% during negative ENSO stages and the opposite, during positive ENSO stages. Finally, averaging the expected temperature elevations of the three scenarios for the horizons 2050 and 2100 we predict a significant decrease in the geographic distribution of the sardine in tropical region (gulf of California), while in temperate zones the species may show an important increase in Baja California and California coasts.

April 25, 12:30 (S5-12397)

Species range shifts, long term variability of temperature on coastal systems, and insights into the future

Julio **Lorda**[1,2], Monica Almeida[2], Rodrigo Beas-Luna[3], Danielle Boudreau[2], Michelle Cordrey[2], Kristen Goodrich[2], Justin McCullough[2] and Jeff Crooks[2]

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Recent climactic events have resulted in dramatic range shifts of many coastal species, which may allow us to envision potential future distributions of species and perhaps the movement of bio-geographical transition zones due to climate change. Following the 2014-2016 North Pacific warm anomaly (the Blob) and the 2015-2016 El Niño we observed the northward shift of several invertebrate and fish species' ranges in the Southern California Bight. Sub-tropical zones, such as the Southern California Bight, are likely to continue to gain tropical species, and monitoring programs will allow us to continue to record the tropicalization of the Californias. Coastal Lagoons and Bays are complex and variable, where spatially close systems can vary significantly in some important environmental characteristics such as temperature. We examined the long-term temperature variability in our study region to explain observed species range shifts and to predict future potential range expansions. The data suggest we should expect to see variability (timing and/or severity) in the effects from climate change even across similar ecosystems close in proximity.

Plenary, Invited and Contributed Talks

April 26

Plenary

April 26, 09:00 (S6 Plenary)

Climate change, the challenge of fisheries management and the need of a change of paradigm: Ecosystem reference levels for sustainable fisheries

Francisco **Arreguín-Sánchez**, Pablo DelMonte-Luna, Manuel J. Zetina-Rejón, T. Mónica Ruiz-Barreiro, Mirtha O. Albáñez-Lucero and Arturo Tripp-Valdez

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Climate change, CC, is not only an environmental driver; in coastal zones it represents a stressor that affect ecosystems and their services. For the sustainable use of fish stocks under CC effects, management must be suitable to the uncertainty characterizing non-stable systems. For marine living resources, ecosystem organization and function evolves, as response to CC; and management must also dynamical evolve. This is the concept of adaptability. This is a change of paradigm and a challenge for management. Currently, CC effects are recognized, but management and governance continue being based on stocks or fisheries attributes; for example, the Biological Reference Points. Ecosystem attributes should also be considered for management, as Ecosystem Reference Levels, ERL, including evolving dynamics. An alternative strategy base on ERLs is suggested to face this challenge, using as examples trophic models for coastal regions of Mexico. The noxicline, an index of entropy gained by the system because the loss of biomass; the resilience, the auto-organization capacity of the system; and balanced harvest, reflecting a harvest conducted within the natural usage pattern of ecosystem production; are used as ERL. Such ecosystem attributes permit the identification of limit and target ERL at the fish stock level, offering an additional set of criteria for management. These ERL can be used under environmental changing or ecosystem evolving conditions. Potential implementation of ERLs is discussed in terms of sustainability of fishing and the ecosystem, including operational viability and institutional governance. Other potential ERL are also delineated considering biodiversity, vulnerability, and ecosystem performance.

April 26, 09:25 (S6 Plenary)

Coastal Aquatic Ecosystems Under Stress: PICES experiences

Thomas W. **Therriault**

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Coastal marine systems tend to be highly productive but also are under stress due to a number of human-mediated activities (*e.g.* pollution, effects of fishing, non-indigenous species introductions, and habitat degradation/loss). These human activities can result in both immediate and direct ecosystem impacts (*e.g.*, decline/loss in species) and longer-term, indirect ones (*e.g.* habitat degradation, decreased productivity). Further, these impacts are not limited to the coastal zone as changes in land use (*e.g.*, artificial river channelization, hydropower structures) and in the coastal zone (*e.g.* eutrophication) can disrupt and alter nutrient/energy flows and alter species distributions at larger scales. These alterations can lead to the manifestation of other ecosystem stressors such as jellyfish blooms, hypoxia events, harmful algal bloom (HAB) outbreaks or impacts of aquatic invasive species. Surveys of the PICES community identified the relative importance of a suite of ecosystem stressors that differed in relative importance and magnitude of impact around the North Pacific. However, to inform ecosystem-based management, the application of a generalized framework can be used to identify the relative contribution of various ecosystem stressors on different ecological or socioeconomic endpoints (*i.e.*, fisheries/aquaculture, important/cultural species, *etc.*) and identify potential indicators to track ecosystem and coastal community responses at different spatial and temporal scales. Further, risk assessments can be used to identify and prioritize these ecosystem stressors, especially in the context of multiple stressors and ecosystem resilience, a key element of the PICES FUTURE program.

April 26, 9:50 (General Plenary)

Multi-scale impacts of climate on Pacific Transitional Areas

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Pacific transitional areas (PTAs) are defined by regions of convergence and divergence of major oceanic current systems and are characterized by strong variance in physical parameters (e.g. sea surface temperature, currents, mesoscale processes, nutrient upwelling and transport) that are known to drive marine ecosystem dynamics. Quantifying the deterministic (e.g. predictable) multi-scale response of PTAs to large- and regional-scale climate forcing, and comparing it to the unpredictable variability associated with internal ocean-atmosphere processes, is an important step for understanding how PTAs may respond to external forcing associated with anthropogenic global climate change. Using a combination of high-resolution ocean model hindcasts and empirical linear inverse models, we break down the ocean variability in PTAs into a predictable component driven by large-scale (e.g. coherent across PTAs) and regional-scale (e.g. non-coherent) climate forcing, and an unpredictable component arising from internal variability of the ocean dynamics and atmospheric noise. The deterministic relationship identified between the variability in PTAs and the dominant processes of Pacific climate variability (e.g. El Niño, North and South Pacific Decadal Oscillations, Meridional Modes) allows us to develop a mechanistic framework to explore the influence of climate change. We use this framework in conjunction with climate model projections for 2100 to examine potential changes in PTAs variance associated with anthropogenic forcing.

S1: Effects of climate variability and change on the physics, biology, and fisheries in Pacific transitional areas

April 26, 10:50 (S1-12490)

Changes in the oxycline depth and their impacts on fish distribution

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The Northern Humboldt Current System (NHCS) is impacted by a shallow and intense oxygen minimum zone that structure vertically the marine ecosystem, in particular fish distribution. Understanding the dynamic of marine ecosystems and functions require simultaneous information on biotic and abiotic components at a variety of different spatiotemporal scales, which is difficult with classic methods. Underwater acoustics have an unrealised potential for multicomponent observations that can overcome previous limitations. In the NHCS, using acoustic methods were identified at a high spatial resolution the oxycline depth, thats is a proxy of physical processes, and macrozooplankton and fish biomass. Here using a high resolution acoustic data, we study the spatio-temporal variability of the oxycline depth and their impact on marine ecosystem components (macrozooplakton and fish distribution). We used acoustic data collected by IMARPE from 2001 to 2016. As light of our results, we observed high spatial variability during spring season than summer. This high seasonal variability has an impact on macroozooplankton distribution. And by the relation predator-prey, fish adapted their spatial distribution according the macrozooplankton distribution.

April 26, 11:10 (S1-12501)

Acoustic and bio-ecological observations of mesopelagic fishes (*Vinciguerria lucetia* and myctophids) in Peruvian Humboldt Current

Rodolfo **Cornejo**, Ramiro Castillo, Miguel Ñiquen, Ana Alegre, Luis LaCruz and Jhon Robles

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Taxonomy, spatial distribution, biomass and aggregative behavior of mesopelagic fish are described with emphasis on *Vinciguerria lucetia* and myctophids in relation to oceanographic features off Peru. This oceanic fish fauna presented a high diversity with 13 families, 24 genera and 30 species, dominated by the lightfish (*Vinciguerria lucetia*) myctophids (*Diogenichthys laternatus* and *Lampanyctus idostigma*) and smooth-tongued fish (*Leuroglossus urotranus*), representing respectively 60.4%, 12.8% and 3.7% of total catch collected during scientific research cruises target mesopelagic species. The distribution patterns and spatial-temporal concentration mesopelagic fish during the cycle of daily vertical migration can be explained by oceanographic features such as fronts, upwelling, Oxygen Minimum Zone (OMZ) and surface and subsurface waters mass. In the study area it was found that this oceanographic scenario is used by this fish group such as migratory routes for transport of eggs and larvae and to access foraging, nesting and breeding areas. Acoustic observations and fishing station indicated that mesopelagic fish regularly perform daily vertical migrations, forming sound scattering layers of different morphology, spatial occupation (ISO) and acoustic intensity (Sa) during the day in deep water in the OMZ (250-500 m), and surface waters at night. Also, atypical aggregative behavior of *Vinciguerria lucetia* was registered in surface waters during the day, which would be influenced by distribution and concentration of zooplankton species (prey biomass). Ecological implications of dominant species Peruvian anchovy and vinciguerria were discussed.

April 26, 11:30 (S1-12502)

Distribution of jumbo flying squid (*Dosidicus gigas*) and the environmental conditions in Peruvian waters

Carmen **Yamashiro**, Jorge Csirke, Luis Mariátegui, Juan Arguelles, Ramiro Castillo, Luis Vásquez, Daniel Grados and Renato Guevara-Carrasco

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The general distribution of jumbo flying squid (*Dosidicus gigas*) off Peru is closely related to the marine currents and water masses dynamics that influence the areas of high productivity in the edges of the Peruvian coastal upwelling system. Data from research cruises and the fishery of *D. gigas* are analyzed and related to horizontal and vertical distribution of sea surface temperatures and salinities along the Peruvian coast. *D. gigas* is widely distributed in Peruvian waters, although major concentrations between 4º-9ºS and 13º-17ºS up to 100 nm off-shore were observed. The highest densities were associated with zones of mixed Subtropical Surface Waters and Cold Coastal Water masses and in relation to the distribution of lantern fish *Vinciguerria lucetia*, a mesopelagic species on which it predates. Variability in recruitment and abundance of *D. gigas*, seems to be inversely related to the amplitude in the variability in oceanographic conditions off the Peruvian coast. During moderate variations of the environment, this species maintains high abundance indexes, while under extreme variations the observed concentrations or abundance indexes were low. An unstable environment affects negatively the survival of paralarvae, and drives the migration of spawning adults to other areas in their search for higher availability of prey species, affecting negatively the availability of *D. gigas* for the fishery.

April 26, 11:50 (S1-12401)

Biological and fishing aspects of the jumbo flying squid (*Dosidicus gigas*) in the main fishing areas of the Peruvian sea between July 2015 to June 2017

Luis **Mariátegui**, Ericka Espinoza, María Sanjinez, Carmen Yamashiro, Juan Arguelles, Octavio Morón and Wencheng Lau-Medrano
(*presented by Carmen Yamashiro*)

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Fishery and biological aspects of jumbo flying squid (*Dosidicus gigas*) from July 2015 to June 2017 along the coast of Peru were analyzed. This information was obtained by scientific observers placed on board artisanal jigging vessels and main landing places of Peru. The main fishing areas were centered to the north (4°S-9°S) and south (16°S-19°S), to distances less than 100 nm from the coast. During the strong El Niño 2015-2016 (Apr 2015-Jun 2016), the northern fleet showed a clear latitudinal migration from The North to South, especially between January and June 2016, reaching to 15°S (Pisco) and distances greater than 100 nm from the coast. After that, it returned to northern fishing areas, without showing spatial changes during El Niño 2016-2017 (December 2016-May 2017). The highest catches per unit of effort (CPUE) were estimated in the South (17°-18°S) and near the coast, where values greater than 250 kg/hour/fisherman stood out; while in the North CPUE values were less than 100 kg/hour/fisherman. For the period analyzed, according to the body size structure (mantle length), two size groups were observed, showing an increasing trend from North to South. The first, of individuals with median sizes of 69.1-85.4 cm, observed between August 2015 and April 2016; and the second of 53.9-72.4 cm, observed between May 2016 and May 2017.

Key words: *Dosidicus gigas*, jumbo flying squid, small-scale fisheries

April 26, 12:10 (S1-12519)

Impact of climatic variability on the distribution of dominant species in coastal and oceanic regions off Peru

Miguel **Ñiquen**[1], Jorge Csirke[1], Luis Vásquez[1] and Francois Colace[2]

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This study examines the interaction between two dominant species that are distributed in adjacent areas in Peruvian waters: the anchoveta (*Engraulis ringens*) in the coastal zone and the vinciguerria (*Vinciguerria lucetia*) in the oceanic zone. Both species have similar biological characteristics but occupy very different contiguous habitats, the anchoveta is a coastal pelagic species while the vinciguerria is oceanic mesopelagic. The main objective of this study is to show the different responses of these species to the same climate signal that is mainly related to the expansions or contractions in the coverage of the Surface subtropical waters (SSW) and the distancing and closeness to the coast of the thermal front associated with cold and warmer periods off Peru. It has been observed that during cold events the anchoveta extends its latitudinal and longitudinal distribution throughout the Peruvian waters, while the presence of vinciguerria diminishes markedly; but on the other hand, during extreme warm events (El Niño) the distribution of the anchoveta retreats towards the coast and from the north-center to the south while the vinciguerria expands its distribution towards the coastal zone, especially in the south where the continental shelf is narrowest. Based on recent observations, it is believed that one potential impact of the expected global warming and climatic variability would be the possible expansion of species associated with *Vinciguerria lucetia* and greater prospects for the future development of a fishery for this species.

April 26, 12:30 (S1-12494)

Spatio-temporal variability of the early life stages of anchovy (*Engraulis ringens*) and Panama lightfish (*Vinciguerria lucetia*) in the Northern Humboldt Current System (1964-2016)

Patricia **Ayón** and Katia Aronés

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Studies about the spatio-temporal distribution patterns of fish early life stages in the Northern Humboldt Current System (NHCS) are scarce, despite this system present a high variability in water mass distribution, upwelling zones among others.

The present study compares the time series of spatio-temporal changes of early life stages of two NHCS species, the Peruvian anchovy and the Panama lightfish, between 1964 and 2016. The first species is a key fishery resource, while the second not, but both together are important pieces to understand the dynamics of the transition area between cold coastal waters (CCW) and Surface Subtropical Waters (SSW) off Peru.

The analysis shows the distribution of Peruvian anchovy eggs and larvae are directly related with CCW, while the eggs and larvae of Panama lightfish, with SSW. Anchovy presented a wider distribution outside the shelf in cold years (*e.g.* La Niña) and is extended along the Peruvian coast, meanwhile in warm years (El Niño events) its distribution is very coastal and discontinuous off Peru, so that the overlap area between both species is normally limited, but sometimes increases, when a strong mixing between CCW and SSW occurs.

April 26, 14:00 (S1-P-12522)

Peruvian North as a transition area during coastal El Niño 2017 and its impact on the marine environment: A review oceanographic, meteorological and artisanal fishery

David **Correa**, Javier Castro, Paquita Ramírez, Javier Castañeda and Jaime Dela Cruz

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The Peruvian sea is under theinfluence of atmospheric dynamics, producing a significant coupling between sea, air and land at several spatio-temporal scales. This coupling support the dynamics of the coastal upwelling characterized by the cold, low salinity and rich nutrients subsurface watersadvection to the surface. Between January to May of 2017 "El Niño Costero 2017" change significantly the interaction between the ocean and the atmosphere with land impacts.

Oceanographic and meteorological information of wind speed (ASCAT scaterometer), surface temperature (AVHRR-NOAA radiometer and records in situ of San Jose (Chiclayo, Peru)) is analyzed for to determine the abnormal behavior and physical processes of wind and sea temperature that joined in the northern coast.

The "coastal El Niño 2017" was characterized by a sustained weakening of the wind (with velocities <3.0 m/s) off the Peruvian coast, producing increase in sea surface temperature SST (around 29°C) whith anomalies higher than +7.0°C. The high SST turn produced high atmospheric evaporation and precipitation off the north coast of Peru and in Ecuador.

Local fisheries on Lambayeque (Peru), registering an increase in the disembarks of *Mugil cephalus* "lisa" and the decrease in the disembarks of *Cynoscion analis* "cachema" and *Paralabrax humeralis* "cabrilla", all of them important resources for the artisanal fishery in front of Lambayeque.

This local event appear different in the genesis from the El Niño extraordinario 1997-1998 however, the impact was similar.

April 26, 14:20 (S1-12382)

Reproduction of Jack mackerel *Trachurus murphyi* in Peru

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This work shows a series of data from 1967 to 2017 of reproductive indexes, such as gonadosomatic index (GSI) that indicates that the main reproductive period of Jack mackerel *Trachurus murphyi* was in November. On the basis of these data, we also analyzed the annual and interannual variation of the reproductive cycle. It was evidenced that, for more than four decades, *T. murphy* has regularly spawned every year in the Peruvian sea. This species has a greater variability in Peru and the spawning peak period has bigger amplitude with respect to spawning that occurs off the coast of Chile. Although there is no time series based on microscopic studies that allow estimate the spawning fraction of *T. murphyi*, the characteristic of have a longer spawning period with higher IGS values low could be interpreted as a reproductive strategy induced by the high environmental variability in the Peruvian sea, and that would lead *T. murphyi* to produce less intense spawning but of longer duration that would increase the probability that their early stages of life find conditions of survival in not favorable marine conditions. In other hand, maturity length was estimated in 26,5 cm Total Length (TL) and this length has no significant changes along the period of study, on the contrary as what has been reported in Chile, where size at maturity has decreased gradually from 1964.

April 26, 14:40 (S1-12517)

Dynamics of the artisanal fishery of the flying fish roe in southern Peru

Luis **Usca Cornejo**, Ana Medina, Willy Marín, Octavio Morón and Renato Guevara-Carrasco
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Variability of water masses dynamics in the Peru Current system (northern Humboldt) is one of the drivers of the abundance and availability of marine living resources. This variability is magnified in space-time scale by the ENSO events (El Niño and La Niña) in this part of the Southeast Pacific, what is evident in availability of fishing resources such as flying fish (Cheilopogon heterurus and Hirundichthys rondeletii), captured by the artisanal fishery during their spawning period. These small pelagic fish are an important source of employment in southern Peru for artisanal fishermen who collect the roe ("ovas"). These species are typical of Surface Subtropical Waters and have a seasonal reproductive strategy associated with macroalgae meadows distributed on the southern coast. The understanding of the relationships between species of coastal and oceanic systems is still very limited.

We describe the dynamics of the artisanal fishery of flying fish roe (around 2000 tons/year) and its relation to the Oceanic Front (encounter of Cold Coastal Waters and Surface Subtropical Waters) variability in the south of Peru, as a contribution to the establishment of scientific basis for their fishery management.

April 26, 15:00 (S1-12472)

Spatio-temporal distribution modeling and abundance index of perico (*Coryphaena hippurus*) in the Pacific Ocean off Peru

Josymar **Torrejón–Magallanes**, Wencheng Lau–Medrano, Daniel Grados, Gladys Castillo and Ana Medina

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Perico, also known as dolphinfish, mahi mahi or dorado, is an epipelagic higly migratory species, mainly oceanic, distributed worldwide in tropical and subtropical waters. In Peru, the fishery of perico is carried out by the longline artisanal fleet and currently their landings represents more than 50% (~50 000 tons) of the total landing of perico around the world. The aim of this study are modelling abundance/availability trends and the spatio-temporal distribution of perico in the Pacific Ocean off Peru during the 2009–2017 period as a function of spatial (longitud, latitude), temporal (year, month) and environmental variables (sea surface temperatura, salinity and chorophyll). For model building we considered the spatial/temporal autocorrelation and used two approaches: The delta Generalized Additive Models (delta-GAM) and the spatial-temporal zero inflated Bayeasian model (ZIB). A detailed discussion is made using the main variables that trigger spatial and temporal changes in distribution and abundance/availability trend. Spatio-temporal analysis gives us clues about habitat preferences of perico (hotspots) in the transitional areas of Peru (coastal and oceanic), likewise abundance/availability trend would help to develop conservation management.

April 26, 15:20 (S1-12512)

Billfish fisheries and environmental variability in Peru during 1997-2016

Wilbert **Marin**, Luis Vásquez, Amado Solano and Maritza S. Saldarriaga
(*preseneted by Miguel Ñiquen*)

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The artisanal fishery in Peru it is distributed all over the coast, from Puerto Pizarro to Morro Sama, nevertheless the capture of billfish is associated to seasonality of Surface Subtropical Waters (18-27°C, >35.1 PSU). During spring and summer, the highest availability of billfishes occurs when they are captured as by catch with gill nets and long lines targeting eastern pacific bonito, smooth hammerhead, common dolphinfish and shark fisheries. Moreover, the presence of this species in the catches increases during warm events as El Niño and decreases during La Niña. In this study, the fishing zones and billfishes catch data registered by the field observers of the Instituto del Mar del Peru (IMARPE) from 1996 to 2016 was analyzed and compared with Sea Surface Temperature (SST) from MODIS. The results showed that around 100 boats per year capture billfish, and the highest catches occurred in 2014 and 2015 with 250 tons in average. Furthermore, the billfish species are conformed by the marlins (*Istiompax indica, Kajikia audax*), sailfish (*Istiophorus platypterus*) and swordfish (*Xiphias gladius*), and presented a high spatial-temporal distribution variability. This distribution presented mayor concentrations during warm events, when the oceanic front is localized near the coast. In particular the mayor captures of *Kajikia audax* was associated with temperatures between 18-25°C, while *Xiphias gladius* catches were found at temperatures between 17 and 22°C.

S4: Advances in understanding Pacific shelf-offshore transitional areas

April 26, 10:50 (S4-12417)

Frontal activity and characteristics in an area of seasonal coastal upwelling near Punta Lavapié, Humboldt Current System

Vera **Oerder**[1], Joaquim Bento[2], Carmen Morales[1], Samuel Hormazabal[1,2] and Oscar Pizarro[1]

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Fisheries in the South-eastern Pacific (SEP) are one of the most productive in the world. In this region, high levels of biological production are strongly related to wind-driven coastal upwelling and meso- to submesoscale activity. Coastal upwelling creates a strong cross-shore thermal gradient separating coastal nutrient-rich areas from offshore oligotrophic areas. Frontal zones also act as a natural barrier for the plankton distribution and also represent areas of biomass accumulation and intense biological activity. Our goal is to identify and characterize the spatio-temporal variability of the frontal zone in a restricted area (37°S–36.5°S). First, we describe a new front-detection algorithm to survey the thermal front using daily 1km resolution Sea Surface Temperature satellite data (MUR_GHRSST) between 2003 and 2016. Our front-detection algorithm identifies the main cross-shore front in a region dominated by the presence of multiple thermal fronts created by mesoscale activity. Front detected were analyzed with the methodology described by Cayula and Cornillon (1991), 94% of them were statistically relevant. These results evidenced an increase in the number of daily maps with an upwelling front and in the magnitude of this front when comparing the first with the second period of years in the time series. This increase can be related to an intensification of the upwelling-favorable wind conditions recently observed by Schneider et al. (2017). The distance from the front to the coast is largely influenced by the mesoscale activity and does not present any clear trend.

April 26, 11:10 (S4-12526)

The impact of El Niño events on the fine-scale dynamics off Peru coasts: In-situ measurements and regional model analysis

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The shelf circulation, coastal upwelling and ecosystem off Peru can be strongly affected by El Niño events. The general view is that during El Niño the thermocline and the nutricline deepen, leading to a significant warming in the coastal region and a disruption of the nearshore upwelling of nutrient-replete waters. The coastal circulation is also modified with an intensification of the poleward flow on the shelf. Nevertheless, each event can be different from the other leading to different consequences on the coastal ecosystem.

Although the 2015-2016 El Niño event presented a strong anomaly in the central Pacific, it had a moderate impact in the coastal region off Peru. Using *in situ* measurements (from glider deployments and oceanographic cruises), satellite data, and regional model simulations, we describe the environmental conditions (hydrology, productivity and oxygen concentration) on the shelf during the event. In particular, we investigate the processes responsible for the sustained productivity that occurred on the inner shelf. Using high-resolution regional ocean model simulations, we also show how the submesoscale activity on the shelf can be modulated during El Niño.

April 26, 11:30 (S4-12525)

Ecological characterization of the pelagic habitat in the Peruvian Upwelling Ecosystem: Insights from the dynamics of the coastal shelf-open ocean transitional areas

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The distribution of the main fish species in the Peruvian upwelling ecosystem has been extensively described, especially for pelagic fishes, classifying the species as coastal/neritic or oceanic. Some species, however, may have a more coastal or oceanic distribution depending on the environmental conditions. Extreme events like El Niño can originate the invasion of oceanic species into the normal coastal habitat, with important social and economic impacts. In this work we analyze the spatio-temporal variability of the extent of occupancy for the main pelagic species off Peru (anchovy, sardine, jack mackerel, chub mackerel, Pacific bonito, dolphin fish, and mesopelagic fish) and dynamically classify the extension of the coastal and oceanic habitat as function of the modeled habitat suitability for all the considered species. This classification uses metrics relative to the stability of the habitat suitability (mean habitat quality, interannual stability, seasonal stability, strength of the seasonality and impact of extreme events) to ecologically characterize the coastal and oceanic habitats and describe the environmental conditions in the transition area. We describe the distribution of these ecological areas in relation to the ocean fronts (temperature, chlorophyll) and shelf break to better understand the relationships between the environment and the fish community structure in determining the coastal shelf-open ocean transitional ecological areas.

April 26, 11:50 (S4-12470)

Connections between the Peruvian coastal upwelling and open ocean biogeochemistry with the plankton variability

Michelle I. **Graco**[1,2], Avy Bernales[1], Wilson Carhuapoma[1,2], Diana Alvites[2], Luc Beaufort[3], David Correa[1], Roberto Quesquén[1], Jesus Ledesma[1], Tony Anculle[1], Georgina Flores[1], Moron Octavio[1] and Dimitri Gutiérrez[1,2]

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The Peruvian Coastal Upwelling System is considered a hot spot for the scientific community, because the high productivity, the presence of an extensive and intensive Oxygen Minimum Zone (ZMO), low pH conditions and one of the strongest interannual signals of variability such as El Niño. The biogeochemistry in the coastal upwelling area and in the adjacent open ocean appear significantly modified by the OMZ variability and the coupling between the local and remote forcing. This high variability is expected to impact the phytoplankton community and in turn generate selectivity in the abundance and distribution of calcifying and non-calcifying planktonic groups. In order to get a better insight of the connection between the physical and biogeochemical processes across the onshore-offshore transition, we performed between 2013 and 2017 seasonal cruises including different El Niño events in the central area of Peru (Callao, 12°S). Some findings include changes in the chlorophyll-*a* associated with changes in the dominance between micro and nanoplancton. Under low pH <7.9, shallow OMZ and nutrient-rich within the upwelling cells, diatoms are dominant but towards the oceanic part , the increased stratification and pH is associated with a nanoplancton community with calcifying organisms that increase its abundance and diversity. This spatial distribution is significantly modified at seasonal resolution and also during El Niño indicating profound ecological changes related with the productivity.

April 26, 12:10 (S4-12520)

Interannual variability of the chlorophyll-*a* transitional zone in the Peruvian Upwelling System: Local and remote forcings

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The Peruvian Upwelling System is one of the most productive coastal system in the world. Interannually, it is impacted by the warm (El Niño, EN) and cold (La Niña, LN) phases of El Niño Southern Oscillation (ENSO). During EN and LN a productivity decrease and a slightly more increase is observed, respectively. Frequently, *in situ* data of chlorophyll-*a* (Chl), a proxy of productivity does not represent well the interannual variation of alongshore productivity in time and space, unlike satellite data. The goal of the present study is to describe the interannual variation of the productivity using two indexes from satellite data: (i) distance to the coast of the Chl transitional zone (front) defined as the 1 $mg.m^{-3}$ isoline which limits the upwelling area, and (ii) Chl mean within this transitional zone. Chl satellite data from SeaWIFS (Sept. 1997- Dec. 2010) and MODIS (Jul. 2002-present) were used. A statistical correction was applied to MODIS in order to merge SeaWIFS (1997-2010) and MODIS (2011-present) data due to the Chl overestimation of the latter. During EN in average the Chl decreased and an onshore displacement of the Chl front was observed, however positive anomalies were found nearshore. During LN, a slight increase of chlorophyll and an offshore Chl front were observed. These impacts were observed alongshore the Peruvian coast for ENSO phases, however during "El Niño Costero" in the summer 2017, intense negative anomalies were observed in the Central-Northern part (5°S-11°S) off the Peruvian coast, while at 12°S intense positive anomalies were found.

Keywords: Peruvian Upwelling System, Chlorophyll-*a*, satellite data, ENSO, El Niño Costero

April 26, 12:30 (S4-12459)

Impact of oceanographic variability in the nano- and microphytoplankton dynamics off the central coast of Peru – 12°S (2013-2016)

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The Northern Humboldt Current Ecosystem comprises important coastal upwelling centers as Callao (12° SL), whose high oceanographic variability determines a particular onshore-offshore gradient in distribution, composition and abundance of microphytoplankton (>20 µm) and nanophytoplankton (phytoflagellates and coccolithophorids, 2–20 µm). From 2013 to 2016, spatial (zonal and vertical distribution) and temporal (seasonal and interannual) variability of these groups were evaluated related to environmental factors such as sea surface temperature, nutrients, salinity, depth of 15° C isotherm (a proxy for thermocline depth), contribution of organic carbon per phytoplanktonic group (mg $C.m^{-3}$) and an upwelling persistence index. During La Niña 2013, high microphytoplankton cell densities coincided with low nitrates values due biological uptake 8 nm, whilst a great decrease since April 2014 (El Niño event) was caused by thermocline deepening, change in winds regime and Surface Subtropical Waters (SSW) approach to the coast. Diatom blooms of *Skeletonema* spp and *Leptocylindrus danicus* at 8 nm were frequent in summer and spring. Phytoflagellates and coccolitophorids were more abundant at 30 nm during warm conditions in 2014 and 2015. Dinoflagellates as *Prorocentrum minimum* were favored by cold conditions in 2013 at 30 nm as well. There was a greater contribution of phytoflagellates at 50 nm, excluding summer-autumn 2013, 2014 and winter 2015. By performing a sample-oriented stepwise discriminant analysis (SDA), shifts in community assembly were assessed. With the groups obtained, classification and ordination analysis (Canonical Correspondence Analysis) were done to identify structure of communities and ecological niche preferences. Spearman's bivariate correlations coefficients were obtained.

April 26, 14:00 (S4-12454)

Answer of zooplankton indicator species to oceanographic variability in the transition zone off the central coast of Peru (2013-2017)

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Within zooplankton, studies of some copepods species and holoplanktonic mollusks are of special interest because they have been recognized as indicators species of oceanographic condition (water mass distribution) and in the context of climate change and marine acidification. The present study has been carried out in the central zone of Peru, Callao (12 ° S) between 2013 and 2017 in a transect of 50 mn of coastline and describes the changes in the temporal space distribution of the zooplankton indicator species associated with oceanographic conditions in the transition zone between the cold water conditions rich in nutrients and low pH characteristics of the coastal upwelling and the warmer and higher pH waters of the open ocean. It is observed that the highest abundances (>640 000 Ind/100m^3) of species associated with Cold Coastal Water were recorded in 2013 indicating an active upwelling, while indicator species of Subtropical Surface Waters and Surface Equatorial Waters were recorded in the years 2015 and 2016 corresponding to warm years, increasing their densities to values >1000 Ind/100m^3 and their distribution closer to the coast indicating an upwelling replation. Main factors such as temperature, salinity and pH, and wind intensity are determinate as controller of the dynamics of these indicator species.

Key words: biological indicators, copepods, holoplankton mollusks, water mass

April 26, 14:20 (S4-12479)

Zooplankton biomass in the Northern Humboldt Current System and its variability associated with areas of transition

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The Northern Humboldt Current System (NHCS) presents complex oceanographic and topographic features, which influences the dynamics of upwelling fronts as well as species distribution. Pelagic species such as the anchovy (*Engraulis ringens*), the jack mackerel (*Trachurus murphyi*) and the mackerel (*Scomber japonicus*) are mainly zooplanktivorous. Zooplankton dynamics and patterns of distribution according to the geographic features and the water masses are thus key drivers for fish. In this context the objective of this work is to determine the spatio-temporal patterns of zooplankton biomass distribution.

Zooplankton biomass was estimated for an area comprised between 08° and 14°S from 2002 to 2012. We estimated the total zooplankton biomass by integrating two methodologies. First, mesozooplankton biomass was estimated from net sampling using a regression between its biovolume (mL.m^{-2}) and wet weight (g.m^{-2}). This regression was calibrated for 145 samples from four surveys. Second macrozooplankton biomass was estimated using a bi-frequency acoustic method from 13 acoustic surveys. Spatial pattern of zooplankton distribution was studied using a geostatistics model with external drift. Total zooplankton biomass ranged between 31 g.m^{-2} (2011) and 121 g.m-2 (2012), with the highest biomasses occurring in spring. Zooplankton biomass was significantly higher offshore than over the shelf associated with Subtropical Surface Waters (SSW) and upwelling waters, respectively.

April 26, 14:40 (S4-12521)

Surface temperature and chlorophyll-a satellite, in coastal transition zones: Effect on the anchovy fishery (*Engraulis ringens*) of northern Chile

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Northern Chile (18.3°S-25°S) is part of the Humboldt currents system, known for its high biological production, which supports important fish populations, whose commercial impact reaches one of the biggest in the hydrosphere. This region is characterized by permanent coastal upwelling process, which generates a coastal band with lower temperatures and high concentrations of chlorophyll-*a*. The displacement of upwelling waters towards the oceanic region generates a zone of transition (ZT), when reach warmer waters dominated by Subtropical Surface Water in the oceanic domain. This ZT has not been defined or studied in depth, that is why in this paper the spatial variability of ZT based on the analysis of sea surface temperature and Chlorophyll-*a* satellite data is analyzed. The aim was determined the effect of spatial dynamics of ZT over the spatial distribution of the anchoveta catches for the period 2010-2016. The satellite information was obtained from the MODIS-Aqua remote sensor of 4×4 km pixel. All the global images were sub-sampled to obtain the desired area and the capture data were obtained from the Instituto de fomento Pesquero of Chile. The results show that the principal changes in the thermal structure are of a longitudinal nature, observing a strong coast-ocean gradient. Both variables reflect an annual change in the position in the ZT, associated with a greater pumping of the coastal upwelling, causing a greater coastal-ocean displacement of the anchoveta populations, evidenced in the effective sets of the fishing fleet of the region.

April 26, 15:00 (S4-12403)

The Peruvian anchovy and oceanographic fronts: Description of association and using as a proxy of presence

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The Peruvian anchoveta is, ecologically and commercially, the most important specie for the Humboldt Current System. Its distribution ranges from latitude 2° S to the south and from 0 to 150 nautical miles; likewise, it is well known its association with coastal waters, in the transition zones between cold and warm subtropical waters, as well as in mixing waters. On the other hand, a number of works around the world have registered the association between geologic ridges and oceanographic fronts (particularly, SST and Chl-a fronts) with hotspots of high biodiversity and the presence of small pelagic as well, due to these zones promote high abundances of phyto and zooplankton; however, there are no references of this associations within the Peruvian Upwelling System. The present work analyzes catch and survey data from 2003 in order to explain the relation of Peruvian anchoveta and zones of intense gradients of SST and Chl-a, so they can be used as a presence proxy. Besides, it is presented the R package 'grec' (developed by the author), as a tool for calculating gradients (fronts) from satellite data matrices.

April 26, 15:20 (S4-12513)

Imprints of physical, chemical and biological conditions in sedimentary proxies across the Peruvian shelf

Ioanna **Bouloubassi**, Mercedes Mendez, Sandrine Caquineau, Michelle Graco, Federico Velazco, Ernesto Fernandez, Ursula Mendoza, Juana Solis, Luis Quipuzcoa and David Correa

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Because of the shortness of instrumental records, proxy-reconstruction of past climate and environments from natural archives covering longer time windows are crucial for documenting and understanding climate variability/change, for perceiving forcing factors, and for assessing dynamical responses and feedbacks of the physical-biological environment. The SE Pacific hosts one of the major Eastern Boundary Upwelling system, the Peru coastal upwelling. There, high resolution reconstructions from sediment cores have shown that the system has undergone important variations and shifts during the last centuries/millennia, both in its physical & chemical properties (SST, Oxygenation) and biological production (*e.g.* Gutierrez *et al.*, 2011; Salvatteci *et al.*, 2014, Briceno *et al.*, 2016). These are thought to be linked with regional, Pacific-wide modes of variability (IPO, ENSO) as well as with global scale climate change, modulated by mesoscale processes.

Here we present a multi-proxy study along two cross-shore transects (Callao-12°S and Pisco-14°S) that represent important transitional areas. We examine a series of organic, inorganic and sedimentological proxies (indicative of SST, OMZ intensity, phytoplankton production, aeolian/fluvial inputs, redox conditions) recorded in surficial sediments and confront them with water-column physical and biological data obtained during monitoring cruises in the study area. In this way, we aim at better assessing the imprint of present day functioning of the system and how relevant parameters/processes are recorded in sediments, constraining their use as natural archive of past climate variability and environmental responses in the Peru coastal upwelling.

S6: Transition zones in coastal habitats

April 26, 10:55 (S6-12346) Invited

Potential impacts of coastal mariculture on marine ecosystems and sustainable approaches

Zengjie **Jiang**, Jianguang Fang, Jinghui Fang and Yaping Gao

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It is generally admitted that the global capture fisheries production continues to be in the trend of declination due to the world's oceans are being overexploited. With global food security becoming an increasing concern, mariculture is becoming recognized as the possible solution to meet the growing seafood demand worldwide. In this context, maricultural production has grown rapidly in recent decades. However, the rapid development of mariculture have aroused increasing concern about the adverse effects on the ecosystems such as water quality deterioration, organic enrichment, habitat modification, changes in biodiversity, chemical contamination, spread of diseases and parasites, etc. Greater focus is needed on a more environmentally sustainable approach to mariculture. In recent years, the idea of Integrated Multi-Trophic Aquaculture (IMTA) has been often considered a mitigation approach against the excess nutrients/organic matter generated by intensive aquaculture activities in marine waters. Several kinds of coastal marine IMTA systems have been commercially successful at industrial scales in China, while experimental projects are now scaling up towards commercialization in Canada, Norway and some other countries. The implementation of IMTA is attractive conceptually, but in reality there are a number of considerations to be paid attention, particularly at commercial scales. The challenges facing the development and expansion of IMTA are also discussed herein.

April 26, 11:20 (S6-12446) Invited

A review of the use of models to simulate environmental interactions of marine finfish aquaculture in BC and their potential application to other coastal zone management challenges

Jon **Chamberlain**

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In British Columbia, Canada, the last 40 years has seen the expansion of marine finfish aquaculture facilities around the coast. As this new industry became established, a broad range of concerns and issues has been, and continue to be, raised regarding potential environmental impacts and sustainability. As part of a suite of approaches to consider and address these concerns, a number of modelling approaches and tools have been developed which seek to simulate the physico-chemical and biological processes underlying the potential pathway of effect. This talk will discuss the development and use of some of these models and consider how these 'aquaculture models' could have application to a broad range of coastal zone management challenges.

April 26, 11:45 (S6-12500)

Marine aquaculture vulnerability in the northern limit of the Peruvian upwelling system

Arturo **Aguirre-Velarde**[1], Américo Sanchez[1], François Colas[2], Vincent Echevin[2], Dante Espinoza-Morriberón[1], Jonathan Flye-Sainte-Marie[3], Gérard Thouzeau[3] and Fred Jean[3]

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Sechura Bay (5.6°) is the most important area for marine bivalve aquaculture on the Peruvian-Chilean coasts. Located in the northern limit of the Humboldt Current system influence, marine farms are exposed to a particular ocean dynamics. This work is an analysis effort on environmental context during the development, current crisis and future scenarios for bivalves cultivation in this transitional zone that irregularly alternate cold upwelling conditions and warm disturbances. After the El Niño 97-98 event, environmental conditions have been "favourable" for the development of aquaculture in Sechura Bay; no strong warm disturbances were observed during a period of 12 years in the region (El Niño Coastal Index, ENCI). This period allowed a bivalve production that exceeded 40000 MT.Year^{-1}. However, historically, these favourable environmental windows are rarely time-extended. An increased frequency of moderate warm conditions (ENCI >1.1) from 2012 seems to be related to the massive bivalve mortality events in the Sechura bay. In 2017, during the extraordinary coastal warm event, a total loss of cultures was registered with serious damages for local economy. Although the productive opportunity in Sechura Bay cannot be ignored, there exist environmental risks that constitute a challenge for aquaculture sustainability in this area. Positive trends in seawater temperature and chlorophyll suppose conditions that could increase aquaculture vulnerability in Sechura. In addition, increased coastal hypoxia, ocean acidification, sulphide events and contamination also constitute potential threats. In this sense, increasing our environmental prediction capabilities is necessary for the planning of aquaculture in this region.

April 26, 12:05 (S6-12356) Invited

Valuing the loss of ecological benefits of wetland reclamation in Jiaozhou Bay based on choice experiments

Jingmei **Li**, Hewei Liu and Jingzhu Dan

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This paper aims to evaluate the loss of ecological benefits, caused by wetland reclamation, based on choice experiment method in Jiaozhou bay. Through reviewing literature and consulting experts, we divide the wetland restoration attributes into four parts: wetland area, vegetation cover rate, water quality and biodiversity in the wetland. By sampling 293 residents in Jiaozhou bay at random, we also evaluate the willingness to pay to restore each attribute to the baseline level which is RMB 321.78 per year. Then we can figure out that the loss of ecological benefits caused by wetland reclamation in Jiaozhou Bay is RMB 767 million per year. The result further shows that the change of wetland area is the top concern of local residents, while the improvement of water quality is the second concern. Therefore, the government should make a proper restoration policy in which enlarging the wetland area should be the key point.

Key words: Reclamation; Choice experiments; Willingness to pay; Loss of Ecological services

April 26, 12:30 (S6-12338) CANCELLED

Preliminary analysis of the Jimo coastal ecosystem with the Ecopath model

Meng **Su**

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The Jimo coast encompasses an area of 2,157 km^2, the ecosystem is valuable both socially and economically with regional fisheries substantially contributing to the value. A mass-balanced trophic model consisting of 15 functional ecological groups was developed for the coastal ecosystem using the Ecopath model in Ecopath with Ecosim (EwE) software (version 6.4.3). The results of the model simulations indicated that the trophic levels of the functional groups varied between 1.0 and 3.76, the total production of the system was estimated to be 5,112.733 t km^{-2} yr^{-1} with a total energy transfer efficiency of 17.6%. The proportion of the total flow originating from detritus was estimated to be 48%, whereas that from primary producers was 52%, indicating that the grazing food chain dominated the energy flow. The fin cycling index and the mean path length of the energy flow were 4.92% and 2.57%, respectively, which indicated that the ecosystem exhibits relatively low maturity and stability. The mixed trophic impact (MTI) procedure suggested that the ecological groups at lower trophic levels dominated the feeding dynamics in the Jimo coastal ecosystem. Overfishing is thought to be the primary reason for the degeneration of the Jimo coastal ecosystem, resulting in a decline in the abundance of pelagic and demersal fish species and a subsequent shift to the predominance of lower-trophic-level functional groups. Finally, we offered some recommendations for improving current fishery management practices.

April 26, 14:00 (S6-12412)

Understanding social vulnerability and resource dependence in Alaska fishing communities

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Community social vulnerability and resource dependence are increasingly evaluated through quantitative social indices, typically developed using secondary data sources. These indices can inform which human communities will be most impacted by changes in resource management, resource abundance, and the environment. This study presents a summary of recent research conducted on Alaska fishing communities to better understand their involvement in commercial, recreational, and subsistence fisheries, vulnerability to climate change, resource dependence, and community social vulnerability. In addition to exploring social vulnerability and resource dependence using secondary data, the quantitative indices are compared with ethnographic data collected from 13 communities using a capital assets framework to groundtruth the indices, in which qualitative ranks of vulnerability were compared against quantitative indices. These comparisons are useful to explore what types of community vulnerability and resilience are adequately measured through the use of secondary data and which aspects, such as social, political, or ecological factors, are not. This work is informative to understand the ways in which humans interact with their environment and the potential responses by local residents in the face of environmental change.

April 26, 14:20 (S6-12426)

Fisheries in Bahia Magdalena-Almejas: Evolution and the need to explore new policies and management paradigms

Miguel Ángel **Ojeda Ruiz**[1], Gustavo Hinojosa Arango[2], Elvia Aida Marin Monroy[1], Alfredo Flores Irigollen[1], Juan José Cota Nieto[3], Ricardo Alberto Cavieses Núñez[1] and Octavio Aburto Oropeza[4]

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Bahía Magdalena-Almejas (BMA) is one of the most important fishery zones in Northwestern Mexico. It produces between 55 and 60% of the total annual catch of the State of Baja California Sur (BCS), mainly by the catches of industrial fisheries such as sardines, tuna, and shrimp. However, as many places in the world, the regions is experimenting an overexploitation of resources due to the absence of a long-term vision of sustainability, a multi-fishery management strategy, and a lack of planning and regulation strategies for local fisheries. Although the majority of the population in the region depends almost completely on activities related to small-scale fisheries (SSF), the economic and social aspects of these activities have been poorly documented. Using different governmental databases and interviews with fishers, we documented the conflicts between industrial and SSF fleets as a result of overlapping working areas inside the bay, and an increase in the relative importance of SSF over the past decade. Recently, independent fishermen and fishing cooperatives have obtained more permits that allow them to target different species throughout the year. The findings of this study confirm that SSF have played a major role in the economic development of BMA, but it is urgent that fishing policies be adapted to new challenges such as spatial management, a multi-fishery management scheme, intra-sectorial strategies, and social development programs should be improved.

April 26, 14:40 (S6-12515)

Physical variability associated to the formation of water stratification events and emergence of anoxia in Paracas Bay (14ºS) downstream the main Peruvian coastal upwelling cell

Lander **Merma**[1], Dimitri Gutiérrez[1,2], François Colas[3], Edgart Flores[1], Arturo Aguirre[2], David Correa[2], Sonia Sánchez[2] and Alberto Lorenzo[2]

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Paracas Bay is a shallow coastal environment of small dimensions where fishery and aquaculture activities but also critical environmental phenomena take place. This study aims to describe physical factors that lead to strong stratification events and to explain the influence of these on the emergence of anoxia in the bay. We analyzed high-frequency time series of observations of water temperature, local wind intensity, an upwelling index, and river discharge flow of between 2006 and 2015, as well as a database of water salinity, temperature and oxygen registered from non-periodically in-situ surveys between 2010 and 2015. Water stratification (difference of surface and bottom temperatures) is more intense and recurrent in summer when upwelling index values are minimal and river discharges are maximal. Because river mouth is 10 kilometers north of the bay, decreases in bay's salinity are controlled by a complex circulation, influenced by upwelling dynamics and local winds. Therefore, the formation of stratification events would be due to rapid increases in the surface temperature directly related with the intrusion of low surface salinity waters and indirectly to the intermittency of upwelling and local wind calms. Finally, frequent conditions of hypoxia were observed in the bottom, which are related to the low oxygen content of the incoming upwelling waters and the oxygen demand of local remineralization of organic matter. However, intense summer stratification events, that prevent the diffusion of oxygen to the bottom, promote the emergence and spread of anoxia possibly after sedimentation of large phytoplankton blooms.

April 26, 15:00 (S6-12437)

Sulfidic events in a bay of the Central Peruvian upwelling system

Edgart Flores[1], Michelle Graco[1,2], Lander Merma[1], Rut Diaz[3], Manuel Moreira[3], Arturo Aguirre[4], Michael E. Böttcher[5], Maritza S. Saldarriaga[1], Emmanoel V. Silva-Filho[3], Ana L. Albuquerque[3] and Ursula **Mendoza**[2,6]

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Eruptions of hydrogen sulfide, so-called 'sulfidic events', appear seasonally in the Paracas bay (13°S). This study aims to characterize the diffusive flux of dissolved sulfide across the sediment-water interface and the developing inorganic sulfur speciation in the surface sediments linked to the temporal changes of the oxygenation and temperature. An intense sulfidic event in Paracas bay was tracked by satellite image. A further 3-month time series was initiated, which registered a second short-term sulfidic event characterized by the intrusion of a bottom cold water (16.3 °C), triggered by a prominent upwelling cell. In fact, the sediment accumulation of total organic carbon (4.1%) under persisted hypoxic (<64 µM) and microxic (5 µM) conditions at the bottom water, promoted a pore-water sulfate reduction from 28 to 20 mM concomitant with a maximal sulfide production (5.6 mM). The sediment profile evidenced preservation of sulfide in iron sulfidic phases (acid volatile sulfide and chromium reducible sulfur) promoted by a diffusive flux of sulfide up to 4 $mmol.m^2.d^{-1}$. This condition was interrupted by a pulse of warm water (23 °C), possibly influenced by El Niño event, that was attenuated and prolonged until the end, where the oxygen concentration increase (17 to 50 µM) was reflected by a depletion of the diffusive fluxes of sulfide (0.8 to -0.3 $mmol/m^2/d$). The observed sulfidic events are supported by a high sulfide production within the bay which is particularly susceptible to the bottom water oxygen fluctuations, in connection with the impact of the upwelling and El Niño event.

April 26, 15:20 (S6-12534)

Analysis of the community structure of the mangrove fish in the American Continent

Juan A. **Payan-Alcacio**, Rodrigo Moncayo-Estrada, José Dela Cruz-Agüero and Gustavo Dela Cruz-Agüero

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Mangroves have similar environmental functions that fish exploit around the world (feeding, reproduction and refuge sites), given the properties by which these habitats share, we believe taxonomic and functional structure of each fish community should have similarities from one another. Through the analysis of scientific publications, we evaluate the genus composition of fish and its relationship with the biotic and environmental variables (average rainfall, type of substrate, mangrove species present and freshwater contributions). Relationships were identified using multivariate techniques (canonical correlations and hierarchical grouping). For the moment we´ve identify 334 species in 175 genus and 67 families in the Atlantic (15 locations) and 192 species in 107 genus and 49 families in Pacific (15 localities). Globally the most diversity families were *Cichlidae* and *Gobiidae* (10 genus c/u), in the Atlantic *Scianidae* (8) and in the Pacific *Ariidae* and *Carangidae* families (6 c/u). Results so far have identified similar groups as proposed by Spalding: Gulf of California region with antiestuarine mangrove conditions; Gulf of Mexico region given the richness of mangrove species and fish genus related to soft substrates; Brazilian region defined by the endemisms of the Amazon River; Region of Islands with fish genus related to reef substrates; and the Mexico-Panamic region. No similarity was found in the taxonomic community structure, the assemblages were rather related to local characteristics, however, it is expected that functional diversity analysis might be more sensitive to create a new regionalization proposal based on the performance of the species in the environment.

Poster Presentations
Abstracts

S1: Effects of climate variability and change on the physics, biology, and fisheries in Pacific transitional areas

S1-P-1

"El Niño" 2015-2016 in northeastern tropical-subtropical convergence: Implications on squid paralarvae distribution

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The interannual variability of the tropical-subtropical convergence is highly correlated with "El Niño" southern oscillation that gives changes in the water masses domain and thus in the cephalopod distribution and spawning areas. It assessed variations in abundance and distribution of ommastrephid paralarvae of the complex *Sthenoteuthis oualaniensis – Dosidicus gigas* given by El Niño 2015-2016 from the entrance of the Gulf of California to off Cabo Corrientes. Before the event (April 2012), the Gulf of California Water dominated the region, the surface mixed layer (SML) depth was ~20 m with temperature of ~22ºC. During the event (March 2016), the Surface Tropical Water advanced to northwest dominating the region. The SML had higher temperature (26ºC), and was deeper (~40 m depth) than April 2012. The paralarvae abundance was larger two orders of magnitude before the event (314 org/1000 m^3) than during the event (7 org/1000 m^3), which were almost present throughout the study area in the SML, with maximums in an anticyclonic eddy. During the event, the few paralarvae found were restricted to the upwelling area near Cabo Corrientes. Results suggest that the shifting of the water masses was the strongest factor that affects the spawning of these species with tropical-subtropical affinity, and therefore the paralarvae abundance and distribution.

Key words: Gulf of California, El Niño Southern Oscillation, *Dosidicus gigas*, SD complex

S1-P-2

Changes on the transport of North Pacific Current system based on CMIP5 projections to the end of the century

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The North Pacific Current (NPC) is the eastward flow originated from the confluence between Kuroshio and Oyashio Currents. Near the west coast of North America, the NPC bifurcates into a northward and a southward flow corresponding respectively to the Alaska (AC) and California Currents (CC). This divergence comprises a transitional zone between the subtropical and subpolar gyres of the North Pacific. According to observational data and numerical simulations, two distinct modes of variability are associated with NPC: a bifurcation and a breathing mode. The former is related to anti-correlated and the latter to in-phase variations between the gyres. The breathing mode is driven by changes in the strength of the NPC due to the wind forcing, being reported as the main responsible for the variance on AC and CC transports. Nevertheless, long-term trends have not been observed yet.

In the scope of the future climate changes, changes on the NPC system are expected due to the likely changed atmospheric conditions over this transitional zone. In light of this, the present work aims to evaluate the potential changes on NPC strength and position of divergence, which would alter its two main modes of variability, in order to verify potential trends that may occur throughout the century. For this, global results from HadGEM2-ES model for 1995-2005 and 2090-2100 will be compared considering the results from the CMIP5 historical and RCP4.5 experiments. The analyzes will be made mainly focusing on projected changes over AC and CC volume transports.

S1-P-3

Spatiotemporal variability of the oceanic fronts at the Kuroshio-Oyashio Confluence region and its relationship with ENSO

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The Kuroshio Oyashio Confluence (KOC) region that occurs east of Japan between the boundaries of the Subarctic Current and Kuroshio Extension is characterized by a system of oceanic fronts and jets formed by the encounter of the colder waters transported by the Oyashio Current with the warmer waters of the Kuroshio Current. As a result, the strong gradients of the oceanographic properties provide a complex circulation with meanders and eddies that plays an important role in the fishing and climate. The variability of fronts and eddies occurs over a range of temporal scales from seasonal to interdecadal, which may be associated with local or remote phenomena such as El Niño Southern Oscillation (ENSO). Therefore, the goal of this study is to characterize the spatiotemporal variability of the oceanic fronts from the KOC region (Subarctic Current, Isoguchi Jets, and Subarctic Frontal Zone), as well as to understand the possible responses of these fronts to the occurrence of ENSO events. OSTIA sea surface temperature (SST) daily products from 2007 to 2017 will be used for the characterization of spatiotemporal variability of SST, position, and strength of the fronts. Time series of monthly average SST anomalies from front's areas will be related to the Multivariate ENSO Index by the cross-correlation method. Within this analysis, it will be possible to obtain information about the correlation between their variabilities and the lag between the series, which would correspond to the time that the SST would take to respond to the climatic changes induced by ENSO.

S1-P-4

Biogenic silica as an indication of change in primary productivity in the last 5 thousand years

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The effect of global climate change is inevitable, therefore it is essential to conduct research about primary producers in the seas, both now and in the past, in order to understand the interaction of oceanographic and climatic conditions in greater scale. The main objective of this research is to estimate the content of biogenic opal in the margin of Magdalena to expand our knowledge in the reconstruction of primary paleoproductivity in the last 5 thousand years. We used 137 samples of a sediment core from the Magdalena margin (MAGD01), Baja California Sur, Mexico at a depth of 680 m, a region characterized by high primary productivity and an oxygen minimum zone. The 137 sediment samples were dried, homogenized and 20 mg of sediment were weighed for the quantification of the biogenic opal using the alkaline extraction technique, and blue spectrophotometric molybdenum. The content of biogenic opal average and standard deviation was 7.0±1.4% with a minimum of 3.9% and a maximum of 11.2%. The temporal record of the biogenic opal showed decrease in the period from 5 to 3.3 ka and 2.2 to 1.4 ka and increase from 3.3 to 2.2 ka and from 1.4 to 0.2 ka. The increase in biogenic opal and organic carbon (estimated from DSR3) suggests that marine productivity showed oceanographic and climatic oscillations analogous to El Niño and La Niña events in the ETNP.

S1-P-5

Decadal salinity changes on the isopycnal surfaces revealed by the Argo float array around the subarctic front in the North Pacific

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Decadal changes in salinity in the subsurface layers (26.6–27.6 σ_v) along the subarctic front can be captured by the Argo float array. The changes seemed to appear off the coast of Japan, propagate eastward, and reach the south of the Alaskan gyre, while the amplitude of the changes may be slightly decayed. The propagation speeds in the subsurface layers were similar to the geostrophic velocities (calculated with the reference level of 2000 dbar). The vertical shear of the geostrophic velocity mainly caused the phase differences of the salinity decadal changes at the south of the Alaskan gyre (around 47°N), where the layer-stripe pattern appeared in the vertical section in the decadal salinity changes. The nutrient and oxygen decadal changes along the subarctic front could be affected by similar propagation processes. The layer-strip pattern appeared in the decadal changes in preformed nitrate along 47°N (2014-2007), which was similar to the one in salinity, and at least in the 26.6 σ_v layer, the preformed nitrate changes around 47°N, 150°W was consistent with the ones around 38°N, 165°E which were captured time-series observations. This was an actual example which analysis taking into account physical processes potentially improve assessments of the changes in biological activity changes through the subsurface nutrient changes.

S1-P-6

Representation of multi-decadal changes in dissolved inorganic substances in the Estimated Ocean State for Climate Research (ESTOC)

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A 4-dimensional variational data synthesis system that was capable of estimating physical and biogeochemical variables for the global ocean was developed. The system was newly constructed with a pelagic lower trophic level ecosystem model and oceanic general circulation model and was used to integrate available ocean observations obtained from a wide range of observation tools. A set of optimized model parameters in the ecosystem model was obtained based on a Green's function approach with available in situ biogeochemical observations and satellite images. We carried out ocean state estimation experiment for the period of 1957-2011. We show multi-decadal changes in dissolved inorganic carbon (DIC) and in dissolved oxygen (DO) in this state estimation. The reproducibility of the estimated DIC and DO are by and large consistent with previous reports. We validated the basin scale changes in DIC along the World Ocean Circulation Experiment (WOCE) Hydrographic Program sections and we identified the multi-decadal changes in DIC under the diffusion and accumulation of absorbed anthropogenic CO2. The modeled multi-decadal trend of DO was similar to the situation shown from long term repeat observation. Obtained dataset on the basis of a dynamically self-consistent ocean state, the Estimated State of Global Ocean for Climate Research (ESTOC) is a promising tool for examining long-term changes in the ocean inorganic substances.

S1-P-7

Spatial and temporal variability of oxygen minimum zone in the North Pacific detected by biogeochemical Argo floats

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Oxygen minimum layer (OML) in the North Pacific is one of the widest scale in the global OMLs, where significant decrease trend of dissolved oxygen and area expansion have been detected from previous high accuracy observation by research vessels. According to previous observational studies, the mechanism of OML's variation might be caused by strengthened stratification in the surface layer, decreasing oxygen solubility and inflow of high-oxygen sea water from outside, and long-term variability associated with tide and atmospheric change. However, their mechanisms and the influences to other marine ecological system are still under investigation. Recent deployments of Argo float equipped with dissolved oxygen sensor make us increase available oxygen data in the North Pacific. Using these data, recent changes of spatial and temporal variability in OML are detected. Although the number and density of data are still not enough to clarify detailed long-term variability, recent decreasing trend of oxygen concentration and expansion of OML are represented in the western North Pacific region, the result of which is similar to the previous studies. While significant trend or variability in the central and eastern North Pacific regions are unclear, suggesting that the mechanism of variability on OML in the North Pacific is different in each area. Still more accurate data quality control and more large number of Argo float deployment related to the global BGC-Argo array are required, it will be expected to capture detailed distribution and mechanism of OML in the North Pacific.

S1-P-8

Decadal changes in the Colombian Pacific thermal frontal zones as revealed by satellite observations

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The Colombian Pacific basin supports one of the most important fisheries of the country. Oceanic features like thermal fronts are important in the characterization of the epipelagic environment, as they can concentrate plankton and support a food chain with large pelagic predators. Changes in the distribution of these fronts thus affect fisheries, impact commercial, artisanal, and subsistence fisheries. The study analyzed spatio-temporal dynamics of thermal fronts from January-February (one of the important pelagic fisheries fishing month) between 2003 and 2016. A single image edge detection (SIED) algorithm applied on daily 1km spatial resolution GHRSST Level 4 MUR Global Foundation Sea Surface Temperature Analysis (v4.1) to study the frontal dynamics. We identified two persistent frontal zones one along the edge of the continental shelf and another off shelf (oceanic) with SST fronts mostly of 4-5 day duration. The continental shelf frontal zones were mostly made of upwelling frontal structures. Study period observed persistent fronts with an average longitude of 66 km. There has been increasing fluctuation in the recent years in the spatial and temporal frontal zones with the formation of new persistent fronts and disappearance of historic persistent fronts. February had recurrent and persistent strong SST fronts. Northern Colombian pacific basin had higher frontal densities and persistent fronts compared to the South indicating possibility of high ground for large pelagic fisheries in the study months.

S1-P-9

Case study of upwelling at Baja California waters

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A case study was conducted to investigate the extent of upwelling in Baja California Peninsular waters and to identify the related oceanographic conditions during the years 2015 to 2016. A series of remote sensing measurements including surface Chlorophyll, sea surface temperature, sea surface height anomaly, wind speed, wind stress curl, and Ekman pumping were analyzed to study the oceanographic conditions that lead to the regional nutrient enrichment in the surface layer. With an upwelling index of 60 to 300 m^3/s per 100m of coastline, the Peninsular Upwelling Intensity fluctuates due to regional meteorological and topographical conditions. This study would contribute to the understanding of the regional upwelling of Baja California.

S1-P-10

Larval fish habitats in the shallow oxygen minimum zone in the Tropical Pacific off Mexico before and during "El Niño Godzilla 2015-2016"

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The objective of the present study is to detect the effects of "El Niño Godzilla 2015-2016" in larval fish habitats, from the southern Gulf of California to Cabo Corrientes, the northern limit of the shallow oxygen minimum zone of the Tropical Pacific. Based on the hydrographic data and stratified zooplankton samples collected in April 2012 and March 2016, recurrent larval fish habitats were detected, although with strong changes in their distribution and abundance of species, result of the hydrographic differences and variation of the domain of the water masses converging in the region. In April 2012, before the warm event, a habitat was detected in Tropical Surface Water, mainly about oxycline, dominated by *Vinciguerria lucetia* larvae; while during the warm event, in March 2016, this habitat was extended in depth, associated to the sinking of the surface mixed layer and oxycline. Another recurrent habitat was near Islas Marías, where the hypoxic water rose up to 40 m deep before the warm event, being dominated by larvae of *Bregmaceros bathymaster*; while during the warm event, this habitat was extended northward below the oxycline in Subtropical Subsurface Water. Likewise, others non-recurrent larval habitats were defined in each period, that could be associated with seasonal or mesoscale processes. The preliminary analysis of the results shows that the "El Niño 2015-2016" could strongly affect the pelagic ecosystem in general.

S1-P-11

Environmental conditions associated with swordfish Chilean coast

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Multivariate analyses were applied to explore the influence of environmental factors on swordfish (*Xiphias gladius*) size compositions and catches off Chile. A first analysis was applied to a fishing data base made up of biological and environmental records from 343 fishing sets performed between 2000 and 2002 by two longline vessels. Furthermore, a data base of fishing research cruises over the Cordillera de Nazca was analyzed; this set consisted of biological and environmental satellite information recorded for 43 fishing sets done in summer and winter 2003 and autumn and spring 2005. Principal component and hierarchical classification analyses were applied to seven environmental variables (Latitude, Longitude, Sea surface temperature, Chlorophyll a concentration, Sea surface height, Sea surface salinity, Bathymetry), all of which may affect the distribution of swordfish size compositions and catches. The analyses indicate four spatial groups representing specific latitudinal locations and typologies of environmental conditions associated with the swordfish size compositions and catches in the study area. Swordfish were caught within a range of SST that varied from 16 to 22°C, with larger catches given smaller SSTs, greater chlorophyll concentrations, and higher latitudes. A latitudinal gradient in size composition is affirmed, with juvenile specimens associated with warmer conditions, greater salinity, lower chlorophyll concentrations, and lower latitudes. The geographic distribution of the recruitment zone is associated with the Cordillera de Nazca marine area. More recent information shows that climate change would produce a remarkable change in the distribution of the resource from the north to the center-south of the country.

S1-P-12

Is there genetic fluctuation in northern population of *Engraulis ringens* over timescales? An approach with mitochondrial markers

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The anchovy *Engraulis ringens* inhabits highly variable marine system. Environmental fluctuations at different time scales, like ENSO events, could have effects in the contraction and expansion of the species' habitat, especially in the extreme northern of its distribution where population changes would be more evident. In this scenario, the estimation of genetic diversity under different environmental conditions could improve the understanding of the species response to natural disturbances. We evaluated the population genetic diversity of *E. ringens* collected in the north, central and south of Peru (species' northern distribution), during warm and cold months of 2015 and 2016, using two mitochondrial regions, cytochrome-b gene (Cytb) and a non-coding hypervariable region (HVR1). The genetic variability was higher in HVR1 (h=87.4%, π=0.46%) than Cytb (h=49.7%, π=0.08%). Narrow ranges of haplotype diversity for Cytb (37-52%) and HVR1 (82-93%), as well as nucleotide diversity for both mitochondrial markers (0.05-0.13% and 0.40-0.50%, respectively), suggest an apparent diversity stability between localities and time. No population structure was observed between localities (Fct=-0.00050, p=0.50538), months (Fct=-0.0046, p=0.8083) and years (Fct=-0.00468, p=0.96676). The apparent stability of the mitochondrial genetic diversity and the absence of structure could reflect a panmixia condition of the anchovy, possibly due to its constant displacement and consequent homogenization. However, these markers could not be enough sensitive to reflect slightly variations of the population genetic diversity occurring at different spatial scales (distance from coast) in short term, being necessary to include other molecular markers to contrast these first results.

S2: Challenges in managing highly migratory and transboundary resources in Pacific transitional areas

S2-P-1

Management of fisheries resources in the Convention Area of the North Pacific Fisheries Commission: Progress and challenges

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The North Pacific Fisheries Commission (NPFC) was formed in 2015 to bridge the gap in the management of fisheries resources and protection of marine ecosystems in the North Pacific. During the past two years of operations, NPFC has adopted nine legally binding conservation and management measures (CMM) which are now in force. Five of them are general for all fisheries, and address vessel registration in the Convention Area, IUU fishing, vessels with no nationality, transshipment, and boarding and inspection as part of the future monitoring, control and surveillance (MCS) system to implement sustainable management measures. The rest of the CMMs has a specific focus aimed at particular species/group of species including bottom fish, Pacific saury and chub mackerel.

Due to the newness of the Commission, species-specific CMMs are based on the 'precautionary' approach meaning that when sufficient data are not available, take precautionary management measures to protect the fisheries resources and ecosystems. These measures encourage NPFC Members to refrain from the expansion of fishing efforts in the Convention Area until the stock assessment has been conducted.

At this early stage of development, many of challenges that NPFC faces are related to data, scientific assessments, and MCS. NPFC needs to develop common standards for data collection, set up a database management system, and establish information security regulations. It needs to conduct stock assessments of key species and establish science-based CMMs. Although several CMMs were adopted aiming at identifying Members' authorized vessels and control of these vessels in the Convention Area, to make them effective, further MCS tools are needed to ensure compliance with the CMMs.

S3: Challenges in observing and modeling Pacific transitional areas

S3-P-1

Eastern Indian Ocean Upwelling Research Initiative (EIOURI)

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Upwelling systems and associated ocean variability in the eastern boundary and adjacent regions play an important role in biophysical interactions in marine ecosystems as well as in regional and basin scale climate variations. Seasonally regulated strong upwelling systems appear in the eastern Indian Ocean as well as the other basins. However, due to sparseness of in situ observations, much of details on variability in the upwelling systems in the Indian Ocean are still unveiled. To enhance our understanding on physical and biogeochemical/ecosystem variability associated with the upwelling systems in the eastern Indian Ocean, an international research initiative, named Eastern Indian Ocean Upwelling Research Initiative (EIOURI), is proposed as a core projects of IIOE-2 during 2015-2020. EIOURI includes an intensive observation campaign together with modeling and analyses of data from various sources. This research initiative mainly focuses on the coastal upwelling system off Sumatra-Java, but also includes open ocean and coastal upwelling systems in the Bay of Bengal, equatorial region, and area off northwestern coast of Australia as its target areas. Main topics of the initiative include; local and remote influences of oceanic processes on the upwelling systems, coastal and off-shore interactions, biogeochemical variability and their interactions with physical conditions, ecosystem variability associated with the upwelling variations. This presentation introduces science plan of EIOURI and discuss several specific key issues to be investigated during the initiative. Collaborations with research activities on the upwelling systems in the other basins, particularly those under EBUS, would be desirable.

S4: Advances in understanding Pacific shelf-offshore transitional areas

S4-P-1

Paralarvae of *Argonauta* spp. (Class: *Cephalopoda*) as indicators of ocean fronts in the NHCS

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The Peruvian coast, inside the Humboldt Current System (HCS), is characterized by a high variability in the dynamics of fronts produced by the interaction of different water masses. Many organisms are affected by these fronts, being one of them the cephalopods, which have economic importance in the fisheries of many countries (Hunsicker *et al*., 2010). However, little is known about the first stages of life "paralarvae" (Young & Harman, 1988) and that being part of the plankton have a behavior modulated by oceanographic conditions.

The objective of this research is to show the changes observed frequency, abundance and spatial distribution of *Argonauta* spp. paralarvae, associated with the interaction of these oceanic fronts.

We analyzed 821 samples of zooplankton collected with Hensen net of 300 microns of mesh opening, in the first 50 meters of depth from 5 research cruises made in the summers of 2013 to 2017 (February to April). Distribution maps were elaborated, relating the abundances with the distribution of these fronts, as well as an analysis of main components with the different oceanographic variables.

The abundance levels of the paralarvae fluctuated between 61 and 2 500 ind/ 1000m3, where the highest abundances were found precisely in the ocean fronts. The PCA analyzes indicate a direct relationship between the presence and abundance of the paralarvae with distance to the coast and SST. The relationships between oceanographic conditions and the abundance of paralarvae are discussed, as well as the use of this species as biological indicators of the ocean front.

Key words: paralarvae, Argonauta, fronts, NHCS

S4-P-2

Transport and recruitment of age-0 jack mackerel (*Trachurus japonicus*) from the East China Sea to coastal areas along the Kuroshio

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Jack mackerel (*Truchurus japonicus*) inhabiting coastal areas in temperate western North Pacific is an important fisheries resource in East Asian countries. Ichthyoplankton sampling surveys indicate that large spawning grounds are formed in the south of East China Sea (ECS) from February to March. However, transport and recruitment processes from the ECS to the coastal waters of Japan have yet to be quantified. In the present study, transport of age-0 jack mackerel by the Kuroshio and the recruitment to the southern coastal areas of Japan were investigated by analyzing fisheries landing records and numerical experiment and effect of ocean environments on the properties of catch variation. Mean seasonal fluctuation of the landing of age-0 jack mackerel compiled from 10-years records showed multiple peaks in the western part (Kagoshima, Miyazaki and Kochi prefectures), first in early spring and second in mid fall, and single peak in the eastern part (Mie, Shizuoka and Kanagawa prefectures). The timing of the peaks in the eastern part in Mie (first peak), Shizuoka (single), Kanagawa (single) prefectures were detected in mid fall, later than the timing expected for those from the ECS. Particle tracking experiment showed that most particles of the origin in the ECS were transported to the western part. These results suggest that larvae and juveniles from the ECS are mainly predominant source in the western part of the Pacific coastal waters of Japan. In contrast, local population reproduced in each area is also important, especially in the eastern part. In addition, there was significant correlation between temperature variation at semi-diurnal period and catch variation. In the presentation, egg density distribution and the transport paths are estimated, by comparing the catch records and the results of particle-tracking experiments incorporating temperature-dependent growth.

S4-P-3

Behavior of schools of anchoveta (*Engraulis ringens*) on the fronts of coastal and oceanic water masses between 2015 and 2017

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Acoustic and oceanographic data obtained from the "*Hydroacoustical Evaluation of Pelagic Resources*" surveys carried out between 2015 and 2017 by the Institute of the Sea of Peru were analyzed with the purpose of knowing differences in the distribution of anchovy schools in the water masses (Cold Coastal Water-CCW-, Surface Subtropical Water-SSW- and Mixing water between the CCW and SSW). Principal Component Analysis of the data on detection of schools by the *Echoview* program was carried out. The response of anchoveta had differences with respect to the masses of water, in volume, area, abundance and distance from the coast of the schools; although, in depth and height of the school they showed almost the same characteristics in the three types of water masses. The volume and area of the school were related to the abundance of the anchoveta. Abundance of anchovy was predominant in the mixing waters in 2015 and 2016 (cruises made before and after El Niño 2015-2016), and in 2017 in the CCW. The height of the schools was greater in the cruise 1502-04 because the predominance of adult specimens, under summer conditions and the beginning of the El Niño warming, but they were smaller in the cruise 1709-11 because the predominance of juvenile specimens-recruits under cold environmental conditions; however, in this last cruise the adult specimens were located deeper in some coastal areas. Regarding the distance from the coast, the most distant schools (SSW) are generally constituted by adults and are those located in the limits of the distribution with the greatest resistance to oceanographic variables.

S4-P-4

Spatial characterization offshore-inshore of Euphausiids in the Northern Humboldt Current System

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Spatial characterization offshore-inshore of the Euphausiids on the Northern Humboldt Current System (NHCS) was analyzed using zooplankton samples collected at 50 m depth by vertical haul with Hensen net and oceanographic data obtained during pelagic and demersal resources research vessels from 2011 to 2016.

Twenty species were identified with higher diversity out of the shelf. Three species were the most abundant and frequent: *Euphausia mucronata*, *Euphausia lamelligera* and *Nyctiphanes simplex*. *E, mucronata* is regarded as a key species in the NHCS.

E. mucronata was mainly distributed offshore with a high concentration near to the shelf break and juveniles were eventually on the shelf. By the other hand, *E. lamelligera* did not show any offshore-onshore pattern, while *N. simplex* was distributed on shelf.

These distribution patterns remained relatively constant and did not show seasonality for the period of study. However, the densities of these species changed. *E. lamelligera* and *N. simplex* increased their abundances when Subtropical Surface Water presented an intromission near to the coast due to warm conditions during 2015 and 2016 (coastal El Niño 2015/2016), while *E. mucronata* exhibited a decrease of its abundance.

S4-P-5

Persistence of a sub-surface fluorescence maximum within the Oxygen Minimum Zone in the Pacific off Mexico

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Global oceans are losing oxygen and the Oxygen Minimum Zones (OMZ) have expanded. The OMZ of Arabian Sea and Eastern tropical Pacific is known to shelter a sub-surface fluorescence maximum associated with a specific microbial community, affecting the ecosystem and biogeochemical cycles. In the Tropical Pacific off Central Mexico, the depth of the upper OMZ-core (<20 μmol/kg) has been mentioned as the main controlling factor of the Subsurface Fluorescence Maxima found in the OMZ (SFMO). However it is unknown if SFMO occurrence is affected by seasonal or interannual changes. Here 1161 fluorescence and oxygen profiles collected between 2003 and 2016, were used to describe statically the physical properties in which SFMO were found and to describe their spatial and temporal patterns. Results indicates that SFMO was found within the OMZ-core at depths between 40 -190 m. The average value of potential density was 1026 ± 0.16 kg/m^3, corresponding to Subtropical Subsurface Water mass which preserve its properties during the seasonal cycle. The highest frequencies of SFMO were found south off Cabo Corrientes associated to the shallowest OMZ-core depths (<75 m) that remains near or overlap (<50 m apart) with the euphotic zone. SFMO occurs along of the seasonal cycle and even under the influence of the strong 2015-2016 El Niño. These findings pointed out to the seasonal and interannual persistence of SFMO off Cabo Corrientes. This region potentially allows a close interaction between the deep photosynthetic communities and the microbial OMZ dynamics involving symbiotic relationships between bacterial groups.

S5: Biodiversity changes in Pacific transitional areas

S5-P-1

Spatio-temporal variability in the relative abundance of benthic foraminifera in La Paz lagoon, Gulf of California

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The La Paz City, Baja California Sur has increased its population by 130% in the last three decades. The increase in the demand for goods and services can cause environmental deterioration, due to dumping of anthropogenic waste into the La Paz lagoon. Therefore, benthic foraminifera will be affected in their relative abundance by increased anthropogenic activity. The objective of the present study is to determine the spatio-temporal variation in the relative abundance of the benthic foraminifera with the purpose of knowing the possible changes in the quality of the sedimentary environment in the lagoon. For this purpose, 2 sediment cores was collected, each with a length of 43 cm and sectioned every 1 cm. Benthic foraminifera were identified and quantified with a stereoscopic microscope. The 1LP core is characterized by silt and clays. The percentage of clays and the organic carbon content increase, from 10 cm, towards the most superficial part of the core. The 2LP core, it is characterized by clays and a lower percentage of silts. In the 1LP core (lagoon deeper zone) Ammonia, Elphidium, Quinqueloculina, Bolivina, Textularina and Peneroplis were identified. Ammonia and Elphidium, represent 80% of relative abundance, followed by Quinqueloculina and Bolivina (15 and 5%). In the 2LP core, in the southern zone of the lagoon, Ammonia and Elphidium had 100% relative abundance. The variability in abundances of benthic foraminifera, grain-size and organic carbon indicate a change in the quality of the sedimentary environment in recent years in the La Paz lagoon.

S5-P-2

Changes in marine zooplankton diversity during El Niño 2015-2016 in a convergence area in northern Peru

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The objective of this study was to determine the changes in the specific composition and diversity of marine zooplankton off the coast of Lambayeque (06°10'S - 07°10'S), northern Peru, and its relationship with the changes presented in the marine ecosystem in an area transition during event El Niño 2015-2016. For this purpose, samples collected with a Wp2 net at surface level were analyzed in a section perpendicular to the coastline, up to a maximum distance of 50 nm, between the San José cove and the Lobos de Afuera islands. The effects of the El Niño 2015-16 event are evident within the oceanographic variability that characterizes the Lambayeque Sea, which was reflected in the predominance of positive anomalies of the sea surface temperature throughout 2015 and the first half of the year 2016 as a consequence of the advance of the SSW and ESW beyond their normal seasonal limits interacting with the CCW that were very restricted near the coast. A total of 186 species distributed in 20 major groups were identified, being the most important according to their abundance, frequency and diversity, the group *copepoda*. The values of diversity and specific richness were more variable during the summer season, associated with water mixing (CCW+SSW+ESW). The community structure of zooplankton was correlated positively with temperature. The approach of warm water masses caused an increase in specific richness, changing the structure of zooplankton off the coast of Lambayeque.

S5-P-3

Distributional patterns of macroalgae from northern Peru

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The phytogeographic characterization of algae from temperate Pacific South America (5°-55°S) was done two decades ago, indicating that only 3.4% of the algal flora has tropical affinities. It seems that floristic exchange with northern Peru was not significant. Current estimates of macroalgal richness in Peru is ~225 species, from tropical and temperate waters. About half of these (105 taxa) are found along the transitional zone (TA), extending more than 400 km (3°-6°S). This pattern has not been deeply tested, as well as possible climatic (*e.g.* El Niño Southern Oscillation - ENSO) and anthropogenic influences. Our aim is to integrate available knowledge from relevant literature to diagnose and identify priority areas for future research. We recorded presence/absence of macroalgae from TA and non-TA zones located in both Ecuador and Peru. Affinities with tropical waters were found in only 37 species from Galapagos and continental Ecuador, whereas 22 species showed subantartic affinities. It is necessary to consider changes in distributions (*e.g. Eisenia cokeri*) and threats on algal diversity, such as accidental introduction of species (*e.g. Caulerpa filiformis* to southern Peru).

S5-P-4

Macrobenthic colonization of an artificial reef located in the west coast of Baja California, Mexico

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The development of epibenthic communities on hard substrates in the marine environment has been the subject of numerous investigations (Spagnolo *et al*. 2014). Community structure is controlled by the successful settlement of species which may then become dominant.

The composition of benthic communities settled on two types of experimental plates was studied by suspending 60 metal plates and 60 PVC plates in an artificial reef located in Rosarito, Baja California in March 2016. Plates were placed at two depths: 40 and 72 ft. and were recovered monthly during one year.

Eight Phyla colonized: *Arthropoda, Annelida, Mollusca, Echinodermata, Nemertea, Platyhelmintes, Porifera, Cnidaria*. A total of 16,593 organisms were collected in the metal plates representing 79 taxa and 11, 849 in PVC plates, 45 taxa.

Metal plates were colonized more rapidly; pioneer species were *Amphipoda Ischyroceridae*, *Perotripus* sp, *Isopoda, Tanaidacea,* and *Mollusca Buccinidae*. In PVC plates the phase of microalgae development previous to invertebrate settlement was longer, first colonizers were amphipods *Peritropus* sp, *Metopa dawsoni* and *Mollusca Naticidae*. Posteriorly colonial bryozoans, ascidians, and polychaetes arrived. Over time, plates exhibited a change in dominance from amphipods, isopods, tanaidaceans to syllids, nereids, gastropods.

Univariate and multivariate analyses were performed to identify how the benthic assemblages changed with time and type of plates. The present study showed differences in benthic settlement and species composition between the two types of experimental plates and also with depth.

S6: Transition zones in coastal habitats

S6-P-1

Seasonal cycle of the copepod community in an anti estuarine lagoon

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In zooplankton lagoon, dominate one or a few species (usually copepods) and exhibit low diversity. In general the copepods can provide between 50 and 90% of the volume of the zooplankton, while the contribution of the other groups that compose it varies depending on the variability of environmental conditions, the availability of food or other factor, related to human activities. In the lagoon of Guerrero Negro, B.C.S., the environmental stress is linked to its topography, which is characterized by a wide intertidal zone, where high variations in temperature, salinity, turbidity and dissolved oxygen are constant. Therefore this research analyzed the variability of the community of copepods in a 10 stations from September 2013 until August 2014. The copepods community, provide between 70 to 98% of the total abundance of zooplankton, like most of the coastal bodies, located on both coasts of the Baja California Peninsula. However, the singularity of this lagoon is express in the low diversity that characterized to the community of copepods (1 a16 species), coupled with to a marked dominance of a single species *Acartia tonsa* that in some months brings to the 98% of the abundance total. The low values of diversity and the remarkable dominance of this euritolerant species could be indicative of a region impacted by human activities. A possible alternative is that this low diversity relates to the capacity of response of the resident populations, which have a population growth that compensates for losses by mixture and transport out from the Bay. At difference to the species not residents, that ingress into the bay via tidal Exchange, and may suffer the dilution and therefore a negative net growth of their populations.

Key words: Copepod, seasonal variability, zooplankton, Guerrero Negro lagoon.

S6-P-2

Seasonal variability in the distribution of phytoplankton in Paracas Bay/Peru, as a response to environmental conditions

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During 2013-2015, a series of bio-oceanographic surveys was carried out in Paracas Bay (14°S). This coastal habitat represents transition between open ocean and continent. Changes in the distribution and structure of phytoplankton community and presence of noxious algal blooms were evaluated. The vertical stability of water column was analyzed on transects of temperature, salinity and potential density. According Simpson and Hunter (1974) stratification index was calculated.

Stratification of the water column as well as other variables presented a seasonal behavior. The maximum values were recorded in summer and were directly related to the seasonal heat flux in the surface layers of the bay, while in winter this stratification index was minimum. N/P ratios showed a seasonal variation with highest values in winter and lowest ones in summer. Silicates concentration were minimum mainly during in spring due to high biological fixation. In winter and spring it was evident the dominance of diatoms, with maximum abundances of "r" strategists. The diversity and equitability indexes were low (<3 bits.cel^{-1} and 0.31). During summer there was a greater contribution of oceanic species with high concentrations of the dinoflagellate *Prorocentrum minimum*; and a higher frequency of algal blooms (*Akashiwo sanguinea, Heterosigma akashiwo, Eutreptiella gymnastica* and *Gonyaulax polygramma*) in the coastal zone. Silicates and pH presented a significant correlation with diatom abundances in spring, whilst dinoflagellates were associated to warm and saline conditions in summer. Weak correlations were found for potentially toxic dinoflagellates with temperature and for the *Pseudo-nitzschia* group with silicates and phosphates.

S6-P-3

Genetic characterization of *Artemia franciscana* by isoenzymes

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Brine shrimp *Artemia franciscana* is registered in the American continent in hypersaline waters of chlorinated, carbonated and sulfated type. They range from lagoons at sea level (Thalassics type) to an altitude of almost 3,000 m (Athalassics type). These extreme physicochemical conditions, together with the isolation and geographic distance, lead to a reduction of gene flow and impose a strong selection that, from the evolutionary point of view, give rise to a rapid geographical differentiation of their populations. Considering the above, we studied the genetic structure of 13 American populations of *A. franciscana* (8 Thalassics and 5 Athalassics) by the analysis of 22 loci using the electrophoresis in starch gels. We obtained the main genetic estimators: and the F Wright statistics. The values of Fst and Nm were obtained by generation by pairs of populations to determine the direction and intensity of gene flow. The analysis indicates that the majority of the populations showed values of expected heterozygosis greater than that observed, reflecting a deficiency of heterozygosis and, therefore, an imbalance to the Hardy-Weinberg model. Fst values range from 0.058 (Nm=4.05 each generation) to Fst=0.787 (Nm=0.067). Although there is significant geographical isolation among *Artemia* populations, the lowest values of genetic identity are above 0.895, mainly due to migratory bird routes, as well as aquaculture activities. It also identifies gene flow between the athalassics populations and those of the thalassics type. This study contributes to the knowledge and conservation of the genetic diversity of populations of the same species living in extreme environments.

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