



ICES-PICES Working Group on Sustainable Pelagic Forage Communities (WGSPF-WG53)



A brief history of the SPF groups
(with an emphasis on the recent efforts)



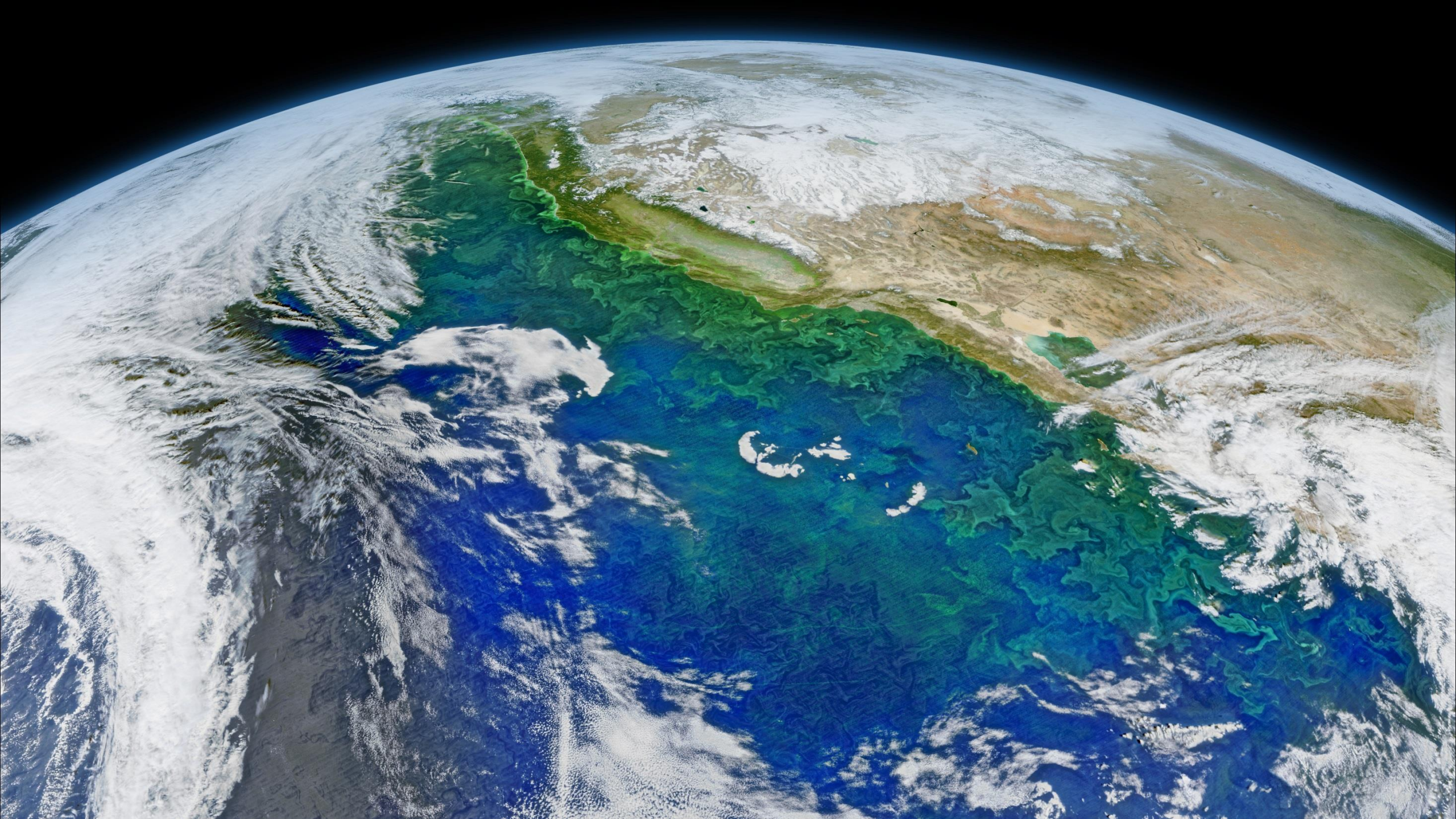
Welcome to Honolulu!

Motivations for collaborative discussions and investigations of SPF

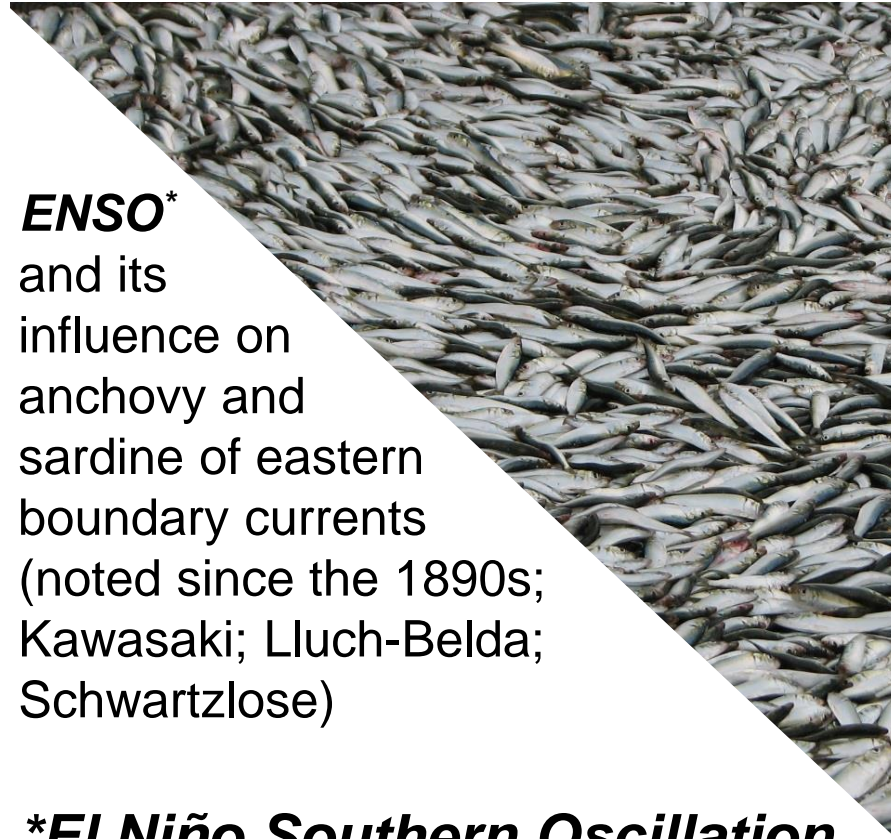
The facts that inspire collaboration on SPF haven't changed (much) over the decades....

- SPF account for about 20% - 30% (by weight) of the total landings of marine capture fisheries around the world.
- SPF support commercial industries and the well-being of communities, particularly in developing countries.
- These fishes are critical conduits for the transfer of energy and organic matter from plankton to higher-trophic-level organisms.
- SPF have facilitated rapid expansion of the global aquaculture industry.



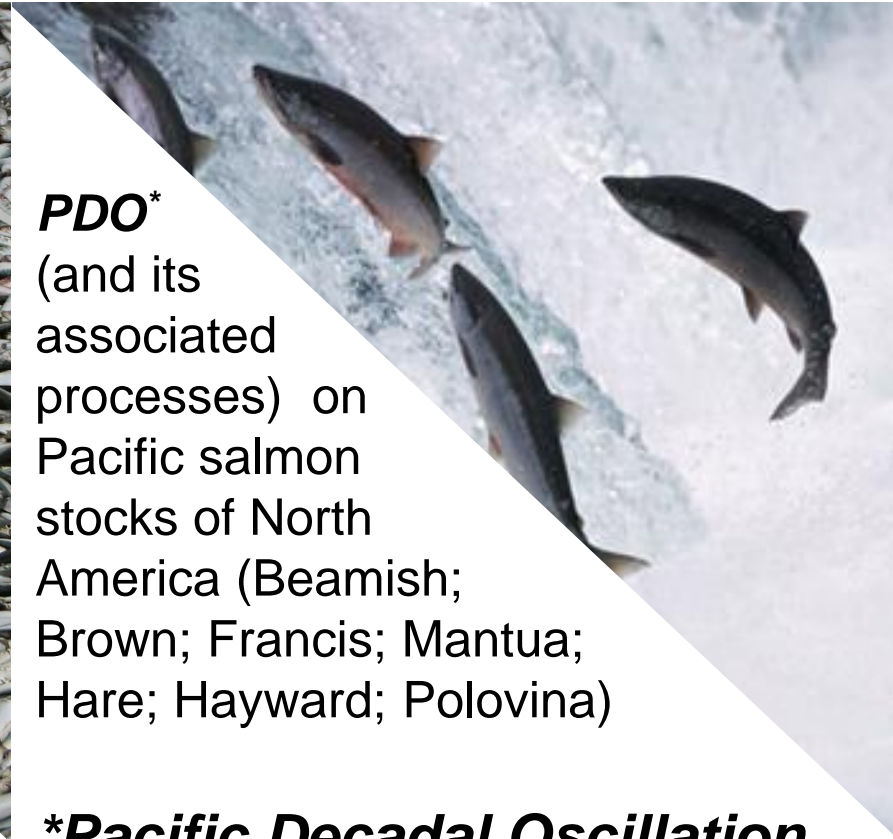


Fisheries investigations have helped advance our understanding of climate



ENSO*
and its
influence on
anchovy and
sardine of eastern
boundary currents
(noted since the 1890s;
Kawasaki; Lluch-Belda;
Schwartzlose)

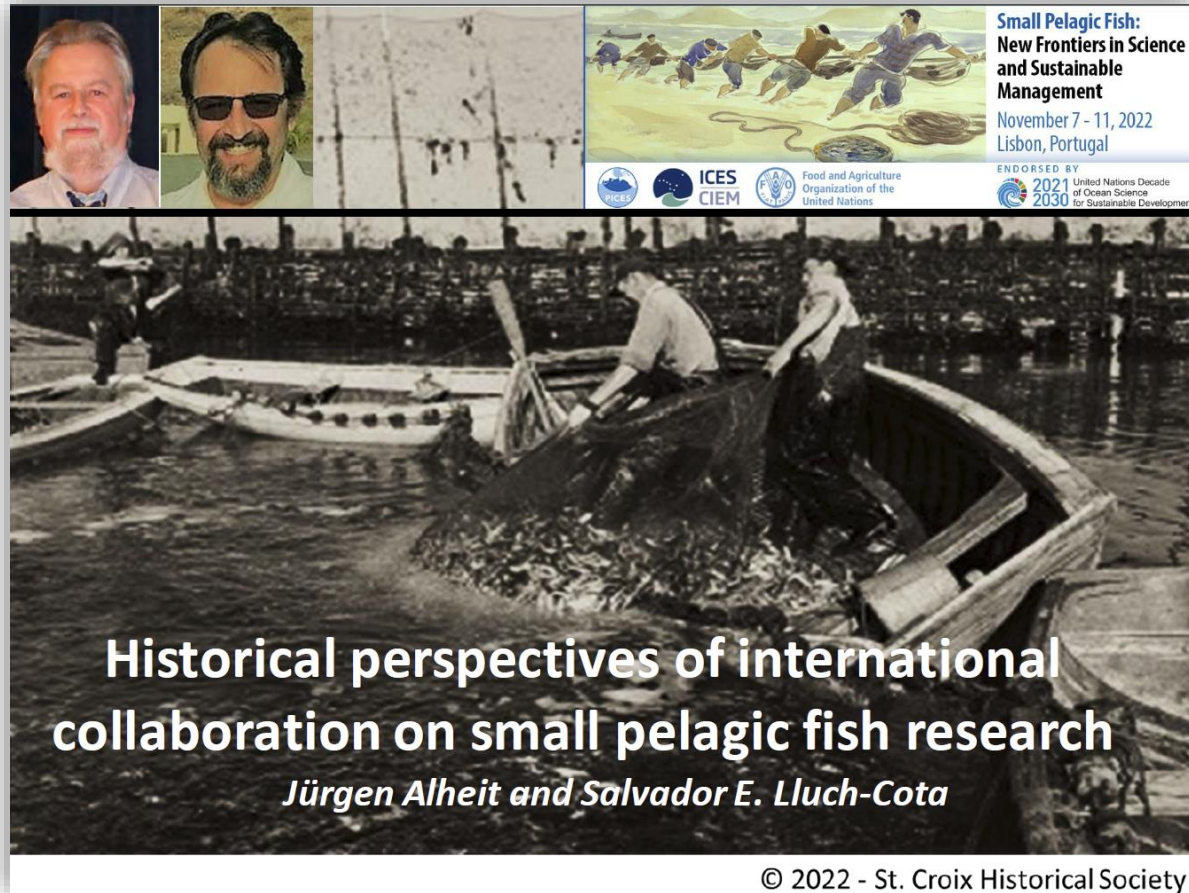
****El Niño Southern Oscillation***



PDO*
(and its
associated
processes) on
Pacific salmon
stocks of North
America (Beamish;
Brown; Francis; Mantua;
Hare; Hayward; Polovina)

****Pacific Decadal Oscillation***

The collaborative effort to investigate SPF dynamics has a rich history...



Salvador Lluch-Coda and Jürgen Alheit collaborated on an excellent presentation of a history of the collaborative nature of SPF research (from Pettersson & Hjort to Victoria & Lisbon).

See their slides linked [here](#), a plenary presentation at the 2022 international [symposium](#) on “Small Pelagic Fish: New Frontiers in Science for Sustainable Management.”

(My slides here are much less flavorful.)



An abbreviated (and biased) history...

- 1940s – *My NE Pacific bias*: Commitment to assess links between oceanographic conditions and SPF populations; resulting from recognition of astounding variability in Pacific sardine (California Cooperative Oceanic Fisheries Investigations).
- 1983 – International symposium titled “The Expert Consultation to Examine Changes in Abundance and Species Composition of Neritic Fish Resources” in San José, Costa Rica; organized by the Food and Agriculture Organization (FAO) and the Intergovernmental Oceanographic Commission (IOC).
- Suggestion of similar dynamics of the SPF populations (e.g., Kawasaki, 1983).
- 1988 – Workshops in La Paz to examine synchronous, massive population changes and
1990 characterization of the SPF “regime” problem (e.g., Lluch-Belda et al., 1989; and
1992 subsequent reports).

An abbreviated (and biased) history...

1993 – Formation of SCOR Working Group 98 on “Worldwide Large-scale Fluctuations of sardine and Anchovy Populations” with workshops in 1994 (La Paz) and 1997 (La Jolla); see Schwartzlose et al., 1999.

1994 – SPACC (GLOBEC)

2008

SPACC focused on comparing SPF populations 5 ecosystems:

California Current

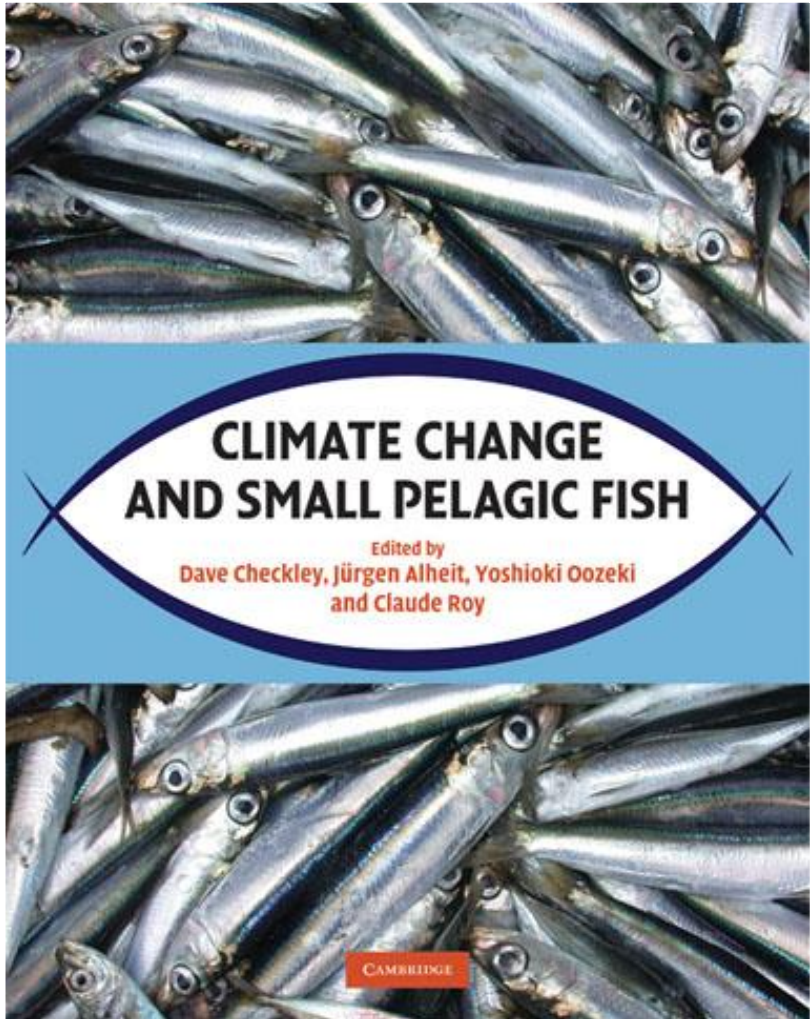
Humboldt Current

Benguela Current

Northeast Atlantic (European Atlantic and Canary Current)

Kuroshio-Oyashio

SPACC – Small Pelagic Fish and Climate Change



- GLOBEC Regional Program, launched in June 1994, with a workshop in La Paz, Mexico.
- Culminated with the SPACC Book published in 2009.

SPACC Book

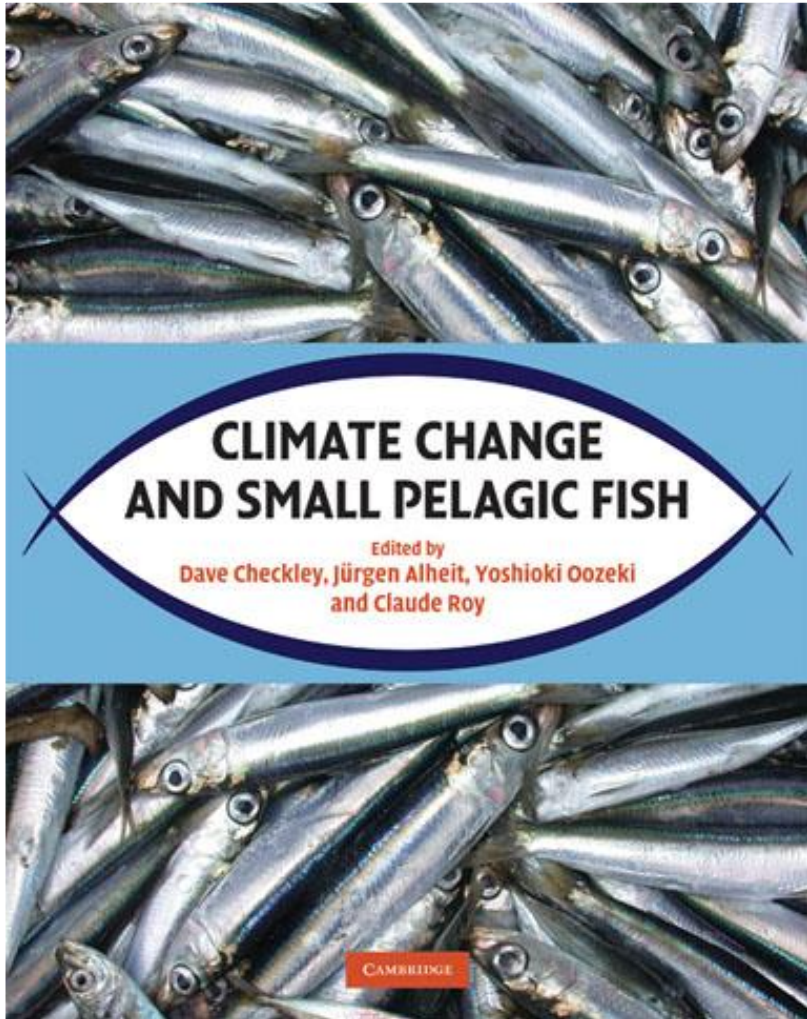
Edited by

Dave Checkley, Jürgen Alheit,

Yoshioki Oozeki, Claude Roy

Cambridge University Press, 2009

SPACC – Small Pelagic Fish and Climate Change



The core program for SPACC process research included:

- 1) daily somatic growth of larval and juvenile fish;
- 2) the daily production of zooplankton over the growth period;
- 3) circulation and vertical structure on population scale; and
- 4) numerical modeling to link the first three elements.

In the period since the conclusion of SPACC...

Efforts have continued in the last 15 years. Many advancements, however, had regional foci.

Some of the developments since 2008 included:

- lengthier time series and (in some cases) improved stock assessments.
- increased efforts to resolve spatial distributions of species.
- improved understanding of climate (both natural and anthropogenic).
- unprecedented oceanographic and climate extremes.
- relatively monotonic changes in top-predator biomasses.
- improved appreciation for other mid-trophic-level populations (e.g., mesopelagics, cephalopods).
- improved numerical modeling approaches and computational capabilities.
- more comprehensive approaches (e.g., multi-species; socio-economics).
- increased number of sedimentary analyses.
- new genetic approaches.
- perhaps some decay of past empirical relationships (e.g., synchrony, temperature).

Post-SPACC activities under ICES wings

GLOBEC INTERNATIONAL NEWSLETTER APRIL 2010

SPACC continues under ICES wings

Jürgen Alheit

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The GLOBEC Regional Programme, SPACC (Small Pelagic fishes And Climate Change), was launched in June 1994 with a workshop in La Paz, Mexico (Hunter and Alheit, 1995) and culminated with the SPACC book published in 2009 (Checkley *et al.*, 2009). International co-operation in the field of small pelagic fishes around the globe has a long tradition (Alheit and Bakun, 2009) and, already some years ago, it was discussed how to continue this highly successful co-operation. It was agreed that ICES would be an excellent platform to keep the SPACC work going. The ICES community was very interested in the subject of small pelagics and climate as, so far, ICES work on climate issues was mainly focused on “Cod and Climate Change”.

Preparatory work to link ICES and SPACC started with several workshops and theme sessions (Table 1). In order to give this international team work a more permanent character, a new ICES Working Group on “Small pelagic fishes, their environments and climate impact” (WGSPEC) was initiated at the ICES ASC in Berlin in 2009 which is chaired by J. Alheit. The new working group is based on the following criteria:

WGSPEC will organise the ICES Workshop on “Anchovy, sardine and climate variability in the North Sea and adjacent areas” (WKANSARNS) in Nantes, France, 22–25 June 2010, to be chaired by M. Dickey-Collas, P. Petitgas and J. Alheit.

The terms of reference are:

- a) synthesize the potential hypotheses for the multi-decadal fluctuations of anchovy and sardine abundance in the North Sea and adjacent areas,
- b) collate and analyse relevant data to test hypotheses explaining multi-decadal fluctuations,
- c) produce a working paper to be submitted for publication on the current understanding of the causes of the fluctuations of abundance relating to the hypotheses raised in a),
- d) recommend areas which require further investigation and highlight the gaps in our knowledge of the dynamics of anchovy and sardine in the North Sea for the purpose of stimulating and advising further research.

There are several ongoing projects investigating the dynamics

SPACC II Planning Meeting in La Paz, Mexico, 2010

GLOBEC INTERNATIONAL NEWSLETTER APRIL 2010

SPACC II Planning Meeting

24-26 February 2010, La Paz, Mexico

Carl D. van der Lingen¹, Salvador Lluch-Cota², David Checkley³,
Miguel Bernal⁴, Sharon Herzka⁵ and Akinori Takasuka⁶

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⁶Fisheries Research Agency, Yokohama, Japan

The aim of GLOBEC's Small Pelagic Fish and Climate Change (SPACC) programme was to understand and ultimately predict climate-induced changes in the production of small pelagic fish in marine ecosystems. SPACC's achievements have recently been synthesized in the book entitled *Climate Change and Small Pelagic Fish* and edited by Dave Checkley, Juergen Alheit, Yoshioki Oozeki and Claude Roy. The book includes a comparative description of worldwide fluctuations in small pelagic species over a variety of time scales; comparative analyses of biological and ecological characteristics of major stocks of small pelagic species; description of the improved understanding of



Figure 1. Actual and virtual (insert) participants at the SPACC II Planning Meeting, 24-26 February 2010, La Paz, Mexico, pictured at the workshop dinner at Salvador Lluch-Cota's house. From left to right: Salvador Lluch-Cota, Dave Checkley, Miguel Bernal, Carl van der Lingen, Jesús Bautista, Irma García-Corral, Sharon Herzka and Akinori Takasuka.

Post-SPACC activities

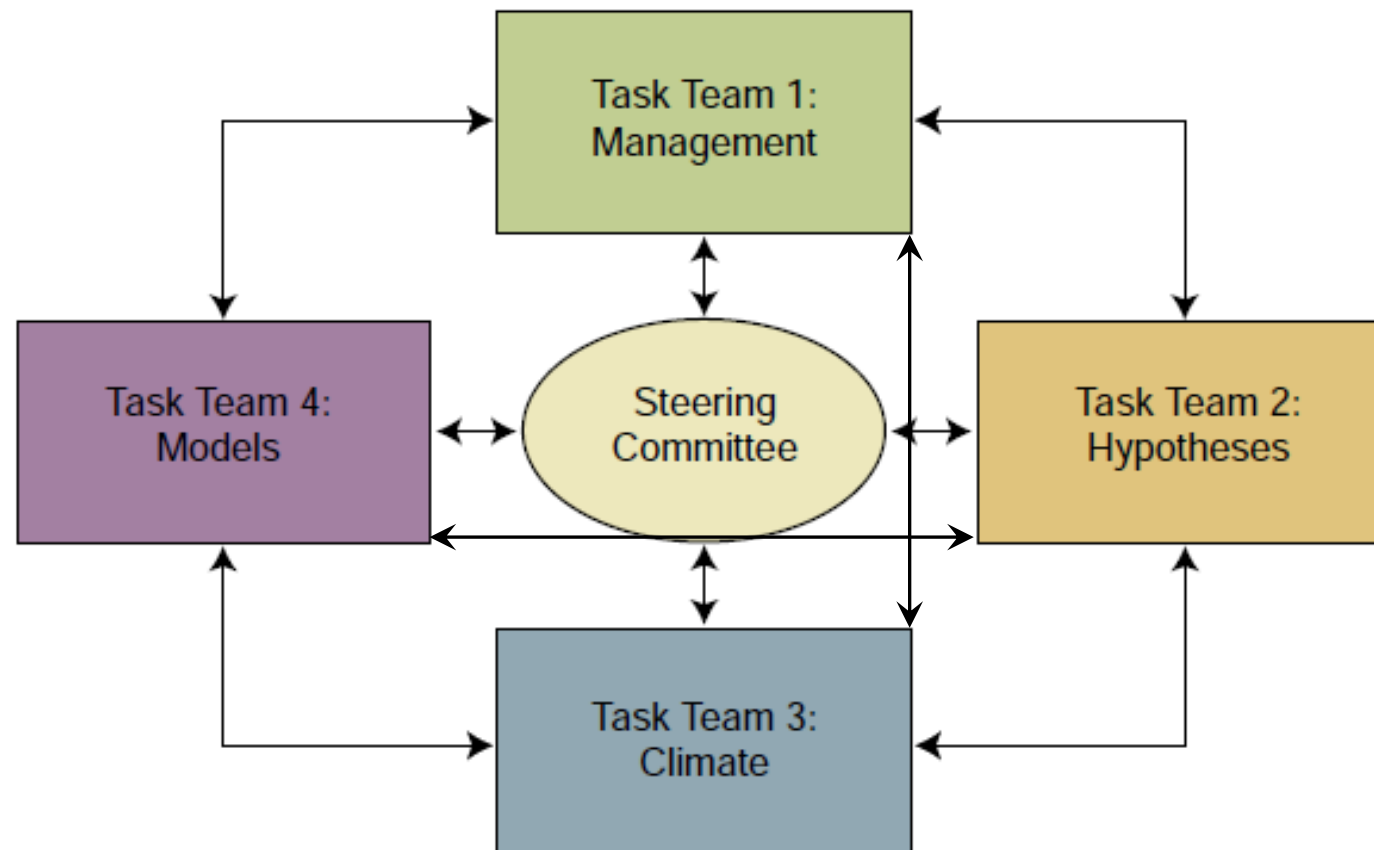


Figure 2. Proposed structure for SPACC II, emphasizing the integrated nature of the Steering Committee and the four Task Teams.

The idea proposed through the workshop (Carl D. van der Lingen, Salvador Lluich-Cota, David Checkley, Miguel Bernal, Sharon Herzka, Akinori Takasuka)

ICES-PICES Symposium

Forage fish interactions: Creating the tools for ecosystem based management of marine resources

12–14 November 2012, Nantes, France

Stefan Neuenfeldt (DK)

Myron Peck (DE)

Tim Essington (US)

Volume 71 (13 papers) in ICES JMS

Contributions from Canada, Europe, Japan and USA



ICES Journal of Marine Science



ICES Journal of Marine Science (2014), 71(1), 1–4. doi:10.1093/icesjms/fst174

Forage Fish Interactions: a symposium on “Creating the tools for ecosystem-based management of marine resources”

Myron A. Peck^{*1}, Stefan Neuenfeldt², Timothy E. Essington³, Verena M. Trenkel⁴, Akinori Takasuka⁵, Henrik Gislason², Mark Dickey-Collas^{6,7}, Ken H. Andersen², Lars Ravn-Jonsen⁸, Niels Vestergaard⁸, Sturla F. Kvamsdal⁹, Anna Gårdmark¹⁰, Jason Link¹¹, and Jake C. Rice¹²

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²Center for Ocean Life, Technical University of Denmark, Charlottenlund, Denmark

³University of Washington, Seattle, WA, USA

⁴IFREMER, Nantes, France

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⁶International Council for the Exploration of the Sea (ICES), Copenhagen, Denmark

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⁸University of Southern Denmark, Esbjerg, Denmark

⁹NHH Norwegian School of Economics, Bergen, Norway

¹⁰Swedish University of Agricultural Sciences, Öregrund, Sweden

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Peck, M. A., Neuenfeldt, S., Essington, T. E., Trenkel, V. M., Takasuka, A., Gislason, H., Dickey-Collas, M., Andersen, K. H., Ravn-Jonsen, L., Vestergaard, N., Kvamsdal, S., Gårdmark, A., Link, J., and Rice, J. Forage Fish Interactions: a symposium on “Creating the tools for ecosystem-based management of marine resources”. – ICES Journal of Marine Science, 71: 1–4.

Received 3 September 2013; accepted 17 September 2013.

Forage fish (FF) have a unique position within marine foodwebs and the development of sustainable harvest strategies for FF will be a critical step in advancing and implementing the broader, ecosystem-based management of marine systems. In all, 70 scientists from 16 nations gathered for a symposium on 12–14 November 2012 that was designed to address three key questions regarding the effective management of FF and their ecosystems: (i) how do environmental factors and predator–prey interactions drive the productivity and distribution of FF stocks across ecosystems worldwide, (ii) what are the economic and ecological costs and benefits of different FF management strategies, and (iii) do commonalities exist across ecosystems in terms of the effective management of FF exploitation?

Keywords: forage fish, introduction, symposium.

Introduction

Forage fish (FF) are small, often pelagic and schooling fish that are a main pathway for energy to flow from plankton to higher predators in marine ecosystems. Because they maintain this trophodynamic role throughout their life, their population fluctuations may produce notable ecological effects and, therefore, the sustainable management of forage fisheries is critical to maintaining ecosystem functioning. This special issue of the *ICES Journal of Marine Science* contains 12 articles stemming from the ICES-PICES Forage Fish Symposium. These papers largely reflect the major themes of the symposium which included: (i) key processes affecting FF

recruitment, (ii) important trophodynamic roles of FF, (iii) quantifying the bioeconomic costs and trade-offs of FF fisheries, and (iv) management of FF resources. In the following, we briefly summarize the presentations and discussions at the conference as well as some of the take home messages from this symposium and papers in this special volume.

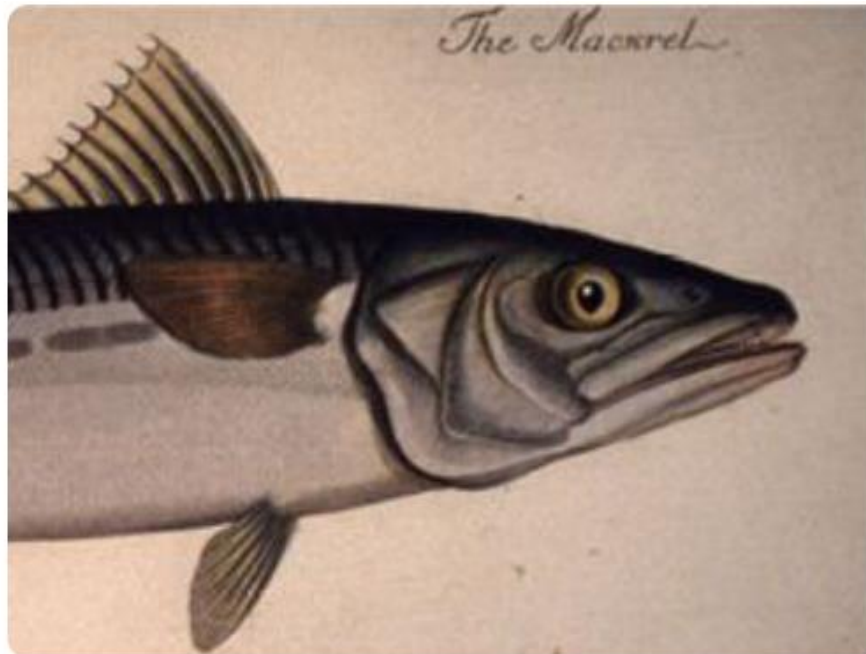
Climatic and biotic forcing on FF recruitment

One characteristic of FF populations is that they display large fluctuations in abundance associated with climate variability (Fréon *et al.*, 2005; Peck *et al.*, 2012; Litz *et al.*, 2014; Tian *et al.*, 2014). In some

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Rekindling of interests during the 2017 ICES/PICES International Symposium

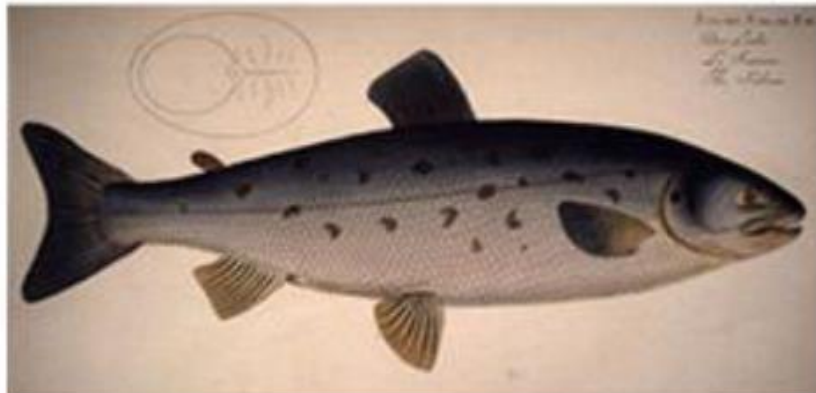
The goal of the 2017 symposium was to revitalize global international cooperation on investigations of SPF and to identify, discuss and develop a framework to address unanswered questions such as the impact of climate and/or fishing pressure on the resilience of small pelagic populations using a comparative approach.



International Symposium

Victoria, BC, Canada
March 6-11, 2017

Drivers of dynamics of small pelagic fish resources



**PICES/ICES International Symposium on
“Drivers of dynamics of small pelagic fish resources”**

by Jürgen Alheit and Yoshioki Oozeki



Populations of small pelagic fish (SPF) such as sardine, anchovy, herring, capelin and mackerel provide about 25% of the total annual yield of capture fisheries, and the well-being of many coastal communities around the world, particularly in developing countries, depends critically on these resources. Small pelagic population sizes exhibit extreme fluctuations in abundance and geographic distribution due to environmental and anthropogenic influences. In spite of many internationally coordinated research efforts, we still do not have sufficient knowledge about the drivers of SPF recruitment and in particular, the interactive effects of environmental and anthropogenic factors.

In 1983, the Fisheries and Agriculture Organization (FAO) and the Intergovernmental Oceanographic Commission (IOC) organized an International Symposium titled “The

unconnected regions of the global ocean. This is an issue that we are still attempting to understand, as the distances between the small pelagic stocks are great, atmospheric and ocean connections weak and unclear, and mechanisms unresolved.

There has been no global symposium on SPF for 30 years, and the exchange of information about SPF globally has declined since the end of the Small Pelagics and Climate Change (SPACC) project of GLOBEC in 2008. The goal of an International Symposium on “Drivers of dynamics of small pelagic fish resources”, organized by PICES and ICES from March 6–11, 2017, in Victoria, BC, Canada, was to revitalize global international cooperation on investigations of SPF, and to identify, discuss and develop a framework to address unresolved questions such as the impact of climate and/or fishing pressure on the resilience

Theme Sessions:

- (1) environmental control of spatio-temporal changes in population size, distribution and migration of small pelagic fish in the ecosystem context
- (2) external drivers of change in early life history, growth and recruitment processes
- (3) the role of small pelagic fish in food web dynamics between plankton and top predators
- (4) comparison of methods for assessment of small pelagic fish populations;
- (5) future challenges for ecosystem-based management of highly variable fish populations
- (6) small pelagic fish and humans—social, economic and institutional dimensions.

A number of special issues and review articles were stimulated by the 2017 symposium



Forage Fish Interactions: a symposium on "Creating the tools for ecosystem-based management of marine resources"

Myron A. Peck^{1*}, Stefan Neuenfeldt², Timothy E. Essington³, Verena M. Trenkel⁴, Akinori Takasuka⁵, Henrik Gislason², Mark Dickey-Collas^{6,7}, Ken H. Andersen², Lars Ravn-Jonsen⁸, Niels Vestergaard⁹, Sturla F. Kvamsdal⁹, Anna Gårdmark¹⁰, Jason Link¹¹, and Jake C. Rice¹²

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Forage fish (FF) have a unique position within marine foodwebs and the development of sustainable harvest strategies for FF will be a critical step in advancing and implementing the broader, ecosystem-based management of marine systems. In all, 70 scientists from 16 nations gathered for a symposium on 12-14 November 2012 that was designed to address three key questions regarding the effective management of FF and their ecosystems: (i) how do environmental factors and predator-prey interactions drive the productivity and distribution of FF stocks across ecosystems worldwide, (ii) what are the economic and ecological costs and benefits of different FF management strategies, and (iii) do commonalities exist across ecosystems in terms of the effective management of FF exploitation? The symposium was organized around six themes:

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MARINE ECOLOGY PROGRESS SERIES
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Contribution to the Theme Section 'Drivers of dynamics of small pelagic fish resources: biology, management and human factors'

OPEN ACCESS

INTRODUCTION

Drivers of dynamics of small pelagic fish resources: biology, management and human factors

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²Institute for Marine Ecosystem and Fisheries Science (IMEF), Center for Earth System Research and Sustainability (CESR), University of Hamburg, Große Elbstraße 133, 22767 Hamburg, Germany

ABSTRACT: Populations of small pelagic fish (SPF) such as sardine, anchovy, herring, capelin and mackerel provide ~25% of the global annual yield of capture fisheries, and the well-being of many human coastal communities around the world, particularly in developing countries, critically depends on these SPF resources. These fishes display large 'boom and bust' cycles with great ecological as well as socioeconomic consequences. Despite many internationally coordinated research efforts, sufficient knowledge about the drivers of SPF population dynamics and, particularly, the interactive effects of environmental and anthropogenic factors is lacking. The ecology and management of SPF were discussed in a symposium in Victoria, BC (Canada), attracting participants from 31 countries. This Theme Section consists of 22 research contributions providing fundamental insights into (1) the biology of SPF, (2) the drivers of SPF dynamics and (3) the socioeconomic impacts of SPF fisheries. Such insights are urgently needed for effective, ecosystem-based management of these highly variable fish populations. The symposium was an important catalyst for future, internationally coordinated research efforts to further advance our knowledge on the drivers of SPF population dynamics and the effective management of SPF fisheries.

KEY WORDS: Small pelagic fish · Recruitment · Growth · Food web dynamics · Management · Assessment · Socioeconomic aspects



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Drivers of dynamics of small pelagic fish resources: environmental control of long-term chan

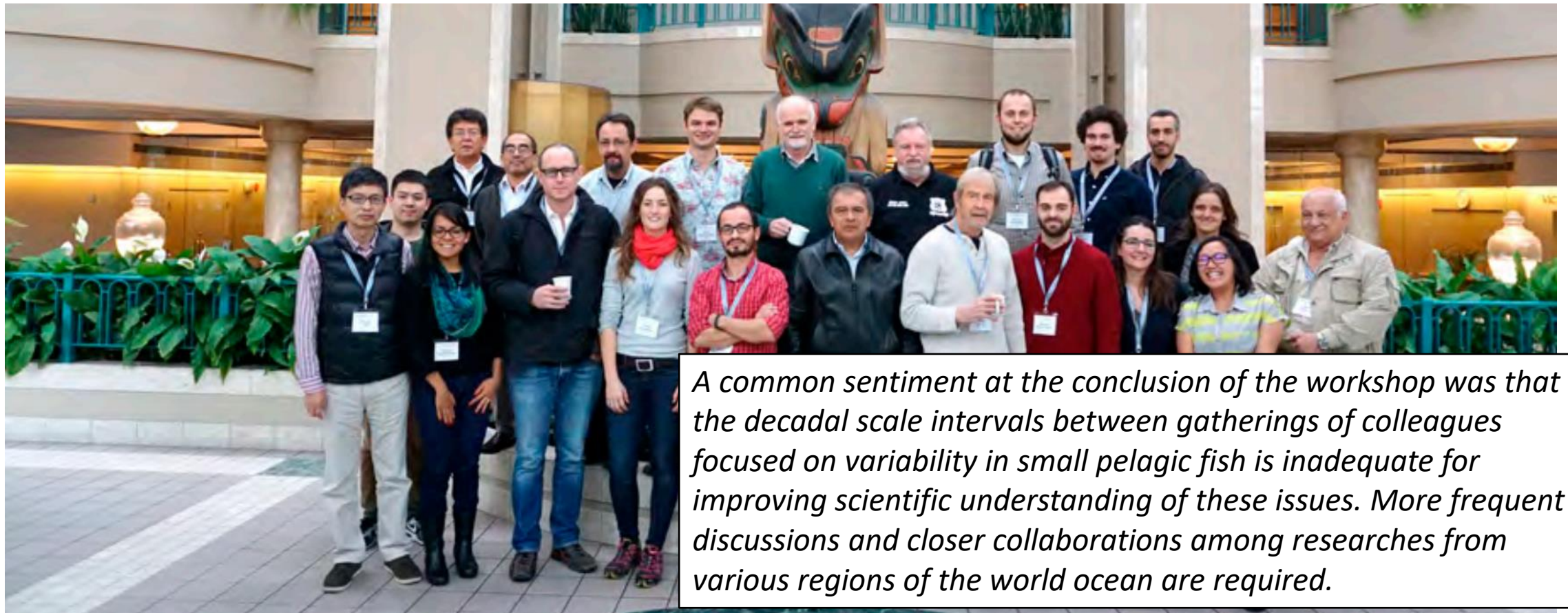
1. Background

Populations of small pelagic fish (SPF), also called forage fish, such as sardine, anchovy, herring, capelin and mackerel and other species provide about 25% of the total annual yield of capture fisheries globally. The well-being of many coastal communities around the world, particularly in developing countries, depends critically on these resources. Population sizes of SPF exhibit extreme fluctuations in abundance and geographic distribution due to the impact of environmental factors, which are often amplified by anthropogenic influences. Despite many internationally coordinated research efforts, we still do not have sufficient knowledge about the drivers of SPF recruitment and particularly the interactive effects of environmental and anthropogenic factors. The Fisheries and Agriculture Commission (FAO) and Intergovernmental Oceanographic Commission (IOC) organized in 1983 an international symposium titled "The Expert Consultation to Examine Changes in Abundance and Species Composition of Neritic Fish Resources" in San José, Costa Rica (FAO Fisheries Report 291, 1983, 3 Volumes). The symposium was a major success and inspired many research efforts on SPF for the next three decades. As there had been no global symposium on SPF since 1983, and the exchange of information about SPF globally had declined since the end of the GLOBEC project in 2008, a PICES/ICES international symposium on "Drivers of Dynamics of Small Pelagic Fish Resources" was organized from 6-11 March 2017 in Victoria, BC, Canada, as a follow-up event to the FAO/IOC Conference. The goal of the symposium was to revitalize international cooperation on investigations of SPF. The symposium was organized around six themes:

2. Highlights of papers ap

dynamics different from higher trophic levels, more volatile in their spatial distributions, than demersal and piscivore fish species, characteristic boundaries of Large Marine Ecosystems to both feeding areas and spawning areas. Particularly large temporal and multidecadal interannual to decadal and spatial variability between close to extinct populations of the same particular ecosystem which they inhabit historically and prior to the 20th century during the second half of the 20th century large eastern boundary upwelling ecosystem spring-bloom ecosystems from temporal responses indicate that they could be more variable than other fishes, although variability differs considerably between climate modes such as the El Niño Oscillation, Atlantic Multidecadal Oscillation has been shown to be a population fluctuations and migration sometimes stretching over centuries, when the species composition shifts, a puzzle we are still struggling to understand. The 15 contribution

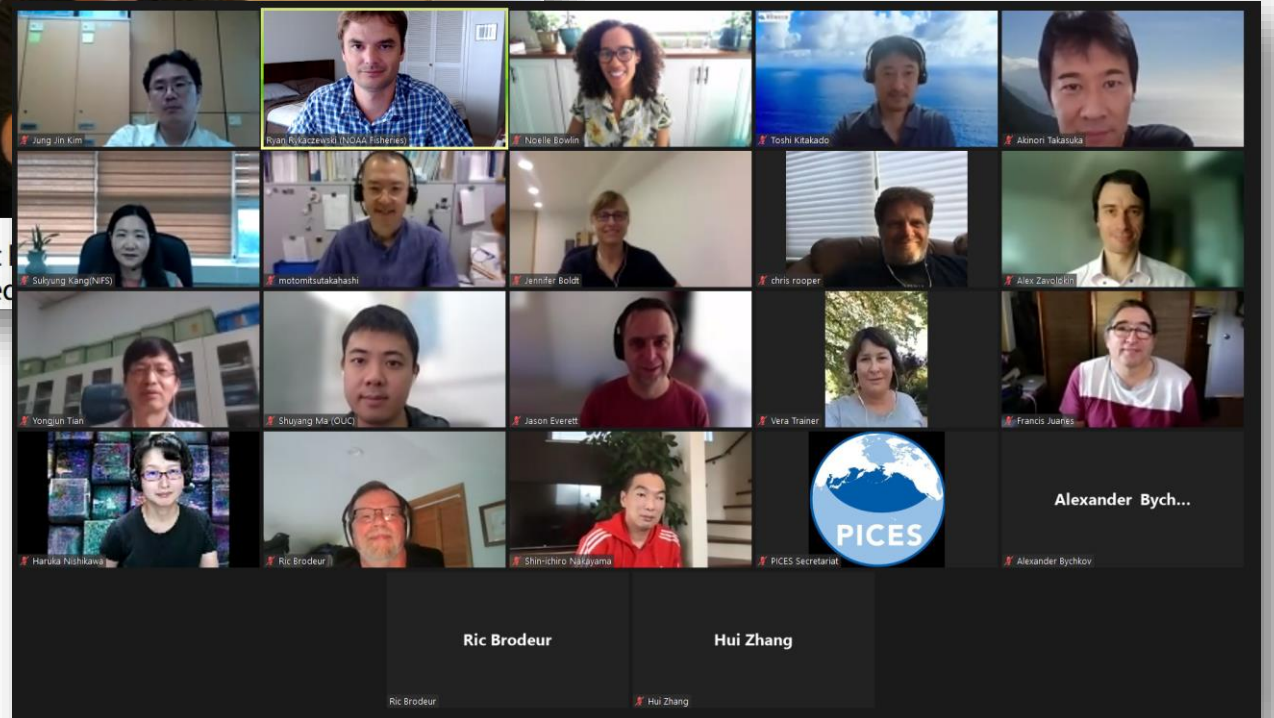
Workshop 1: Workshop on “Environmental control of spatio-temporal changes in population size, distribution and migration of small pelagic fish in an ecosystem context”





Group photo of several members of the Joint PICES/ICES Working Group on Small Pelagic Fish during their workshop in March 2020 in Copenhagen, Denmark. Many participants joined

Joint PICES/ICES Working Group on Small Pelagic Fish (WG 43; WGSPF) March 2020 in Copenhagen, Denmark



Subsequent meetings were remote.

Task Force on Ecological Process Knowledge

- Activity 1: Critical review, evaluation and testing of classic hypotheses
Myron Peck (The Netherlands), Akinori Takasuka (Japan)
- Activity 2: Life cycle closures - bottlenecks and gaps in knowledge
Noelle Bolwin (USA), Ignacio Catalan (Spain)
- Activity 3: Drivers of spatial distribution and phenology
Rebecca Asch (USA), Marta Moyano (Norway)
- Activity 4: Food-web dynamics
Richard (Ric) Brodeur (USA), Susana Garrido (Portugal)
- Activity 5: Internal and external drivers of growth, reproduction, and survival
Florian Berg (Norway), Martin Huret (France), Martin Lindegren (Denmark)

Task Force on Translating Process Knowledge

- Activity 6: Survey design and monitoring
Matthias Kloppmann (Germany), Chris Rooper (Canada)
- Activity 7: Improving short-term forecasts and/or long-term projections
Stefan Koenigstein (USA), Ryan Rykaczewski (USA)
- Activity 8: Improvements to management
Salvador Lluch-Cota (Mexico), Richard Nash (UK), Andres Uriarte (Spain)

Task Force on Social-Ecological Approaches

- Activity 9: Networks, vulnerability, and opportunities of dependent human communities
Myron Peck (The Netherlands)
- Activity 10: Quantifying trade-offs in goods and services
Cecilie Hansen (Norway), Isaac Kaplan (USA)
- Activity 11: Bioeconomic modeling
Myron Peck (The Netherlands)



Small Pelagic Fish: New Frontiers in Science and Sustainable Management

November 7 - 11, 2022
Lisbon, Portugal



Food and Agriculture
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2021
2030

United Nations Decade
of Ocean Science
for Sustainable Development

**2022 Symposium on “*Small Pelagic Fish: New Frontiers in
Science for Sustainable Management*”**

<http://www.pices.int/smallpelagics2022>

ICES/PICES/FAO International Symposium on SPF



International symposium “Small Pelagic Fish: New Frontiers in Science for Sustainable Management”

~~February 21-24, 2022, Lisbon, Portugal~~
November 7-11, 2022, Lisbon, Portugal

In the heart of Lisbon, the Calouste Gulbenkian Foundation is housed in a modernist architectural complex that includes a museum, an art library, a state-of-the-art auditorium and is surrounded by one of the most emblematic modern gardens of Portugal.

2017 (Victoria) Theme Sessions:

- [\(1\)](#) Environmental control of spatio-temporal changes in population size, distribution and migration of small pelagic fish in the ecosystem context
- [\(2\)](#) External drivers of change in early life history, growth and recruitment processes of small pelagic fish
- [\(3\)](#) The role of small pelagic fish in food web dynamics between plankton and top predators
- [\(4\)](#) Comparison of methods for assessment of small pelagic fish populations
- [\(5\)](#) Future challenges for ecosystem-based management of highly variable fish populations
- [\(6\)](#) Small pelagic fish and humans – social, economic and institutional dimensions

2022 (Lisbon) Theme Sessions:

- [\(1\)](#) Trophodynamic Processes
- [\(2\)](#) Life Cycle Closure: Advances in Process Understanding
- [\(3\)](#) Understanding Population- and Ecosystem-level Shifts: From Seasonal Timing to Tipping Points
- [\(4\)](#) Responses to Climate Variability and Change at Decadal to Centennial Time Scales
- [\(5\)](#) Progress in Pelagic Surveys: From Biomass Estimates to Monitoring Ecosystems
- [\(6\)](#) Reconciling Ecological Roles and Harvest Goals: Development and Testing Management Strategies to Safeguard Marine Ecosystem Services
- [\(7\)](#) Advancing Social-ecological Analyses and Sustainable Policies for Dependent Human Communities

Symposium in Lisbon Re-unites the Global Community Investigating Small Pelagic Fish in Marine and Inland systems

Myron Peck, Akinori Takasuka, Ignacio Catalan, Ryan Rykaczewski and Susana Garrido



Small Pelagic Fish: New Frontiers in Science and Sustainable Management

November 7 - 11, 2022

Lisbon, Portugal



Food and Agriculture
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One of the take-home messages from nearly every session was the need for more interaction among scientists from different disciplines. The combination of various techniques (e.g., spatially explicit ecosystem modeling, stock assessment, population dynamics, paleo measurements, genetics and genomics, economic analyses) and people across disciplines and sectors will improve our understanding of the causes and consequences of SPF fluctuations and the trade-offs in the sustainable and equitable management of these resources.

- 289 participants from 38 countries and 4 international organizations (PICES, ICES, FAO and NPFC).
- 47 participants being from developing countries.
- The symposium was nearly gender-balanced (47% female, 53% male), with a substantial portion (44%) of the attendees being early career researchers



The 334-seat auditorium had a nearly full house for the Small Pelagic Fish symposium's opening plenary session on 8 November, 2022.

<https://meetings.pices.int/publications/pices-press/PICES-Press-2023-Vol31No1.pdf#page=58>

