

International collaboration advancing ecological understanding and sustainable management of small pelagic fish (SPF)

8 authors – 6 nations

(156 people from >30 nations in an ICES-PICES Working Group)



Navigating Changes in Small Pelagic Fish and Forage Communities: Climate, Ecosystems, and Sustainable Fisheries
May 4 – 8, 2026 | La Paz, Mexico

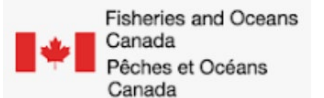


Food and Agriculture Organization of the United Nations

Endorsed by



United Nations Decade of Ocean Science for Sustainable Development

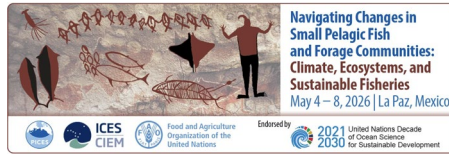


Presentation Outline

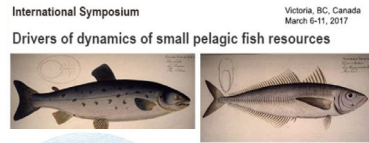
- 1) A brief historical perspective on four to five decades of (formal) international collaboration on SPF;
- 2) The formation and goals of the most recent, international working group (ICES – PICES WGSPF – WG43);
- 3) Provide examples of our group accomplishments including recent products / research (also from my backyard) and challenges;
- 4) Present our recommendations for future collaboration and research – where are we headed?



(An incomplete) Timeline of International Collaboration on SPF



Symposium - Navigating changes in small pelagic fish and forage communities: Climate, ecosystems and sustainable fisheries, La Paz, Mexico



Symposium - Small pelagic fish: New frontiers in science and sustainable management, Lisbon, Portugal

Symposium - Drivers and dynamics of small pelagic fish resources, Victoria, Canada

Lenfest Ocean Program Report – Little Fish Big Impact

Symposium - FACTS Forage fish interactions, Nantes, France

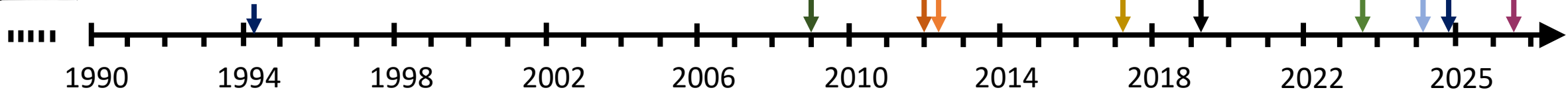
Synthesis Book - Climate Change and Small Pelagic Fish

GLOBEC Small Pelagic Fish and Climate Change (SPACC) Program, La Paz, Mexico

WGSPF / WG53 2nd Phase

WGSPF / WG43 1st Phase Synthesis

ICES PICES WGSPF / WG43



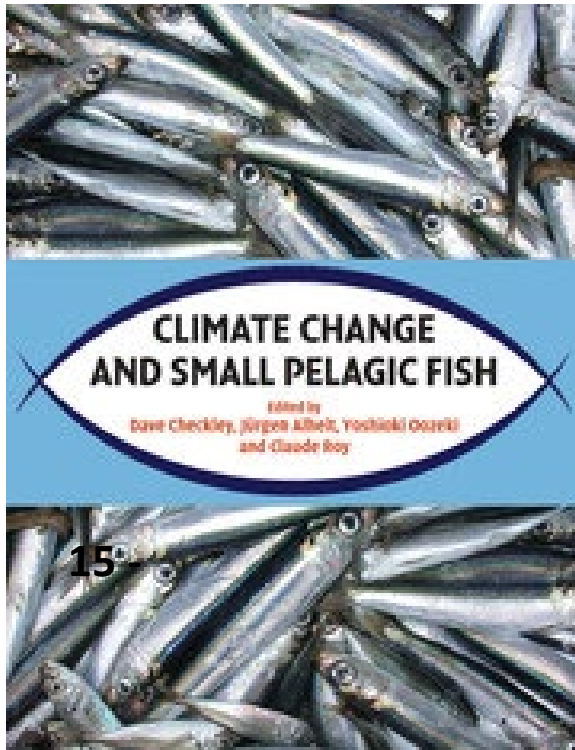
Reuben Lasker's "stable ocean hypothesis" (Lasker, 1975, 1978)

1963 International Larval Fish Symposium

Otolith microstructure analysis (Methot 1981, 1983)

Daily Egg Production Method (Lasker 1985)

Habitats, **Variability from scales in marine sediments**, Decadal-scale variability, **Biophysical models**, Trophic dynamics, **Impacts of fishing and climate change**, Current trends in assessment and management, **Human dimensions of the fisheries under global change**



David Checkley, Jr., **Jürgen Alheit**, Alec MacCall, Patricia Ayon, Tim Baumgartner, Miguel Bernal, Janet C. Coetzee, Robert Emmett, Renato Guevara-Carrasco, Larry Hutchings, Leire Ibaibarriaga, Hideaki Nakata, **Yoshiaki Oozeki**, Benjamin Planque, Jake Schweigert, Yorgos Stratoudakis, Carl van der Lingen, David Field, Vicente Ferreira, Hector Lozano-Montes, **Renato Salvateci**, Andy Soutar, Vicente Ferreira, **Dimitri Gutierrez**, Hector Lozano-Montes, Claude Roy, Souad Kifani, Christophe Lett, Kenneth A. Rose, Bernard A. Megrey, **Arnaud Bertrand**, Antonio Bode, **Richard Brodeur**, Luis Cubillos, Pepe Espinoza, Kevin Friedland, **Susana Garrido**, Xabier Irigoien, Todd Miller, Christian Möllmann, **Rubén Rodríguez-Sánchez**, Hiroshige Tanaka, Axel Temming, **Lynne Shannon**, **Marta Coll**, Sergio Neira, Philippe Cury, Jean-Paul Roux, Manuel Barange, Maria Cristina Cergole, Georgi M. Daskalov, **Carryn de Moor**, José De Oliveira, Mark Dickey-Collas, Dave J. Gaughan, Kevin Hill, Larry Jacobson, Fritz Köster, Jacques Massé, Miguel Niquen, Hiroshi Nishida, Isabel Palomera, Suzana Saccardo, Alberto Santojanni, Rodolfo Serra, **Stylianos Somarakis**, Yorgos Stratoudakis, **Andres Uriarte**, Akihiko Yatsu, Rosemary Ommer, **Astrid C. Jarre**, R. Ian Perry, Kevern Cochrane, Coleen Moloney, Pierre Fréon, **Francisco Werner**, Francisco P. Chavez

Working Group on Small Pelagic Fish (WGSPF / WG43 – Phase 1)

‘Terms of Reference’

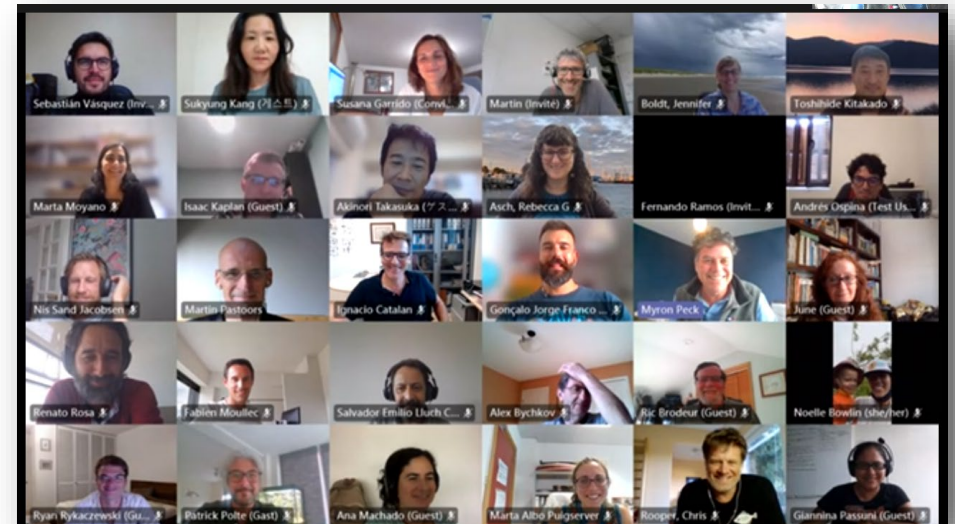
1. **Review progress on understanding how various drivers impact the population dynamics of SPF** in different ecosystems and whether and how potential drivers shift with changes in ecosystem state;
2. **Create a networking environment for international and multidisciplinary collaboration** to foster the establishment of similar study frameworks and comparative analyses of SPF across different social-ecological systems;
3. **Identify, prioritize, and coordinate research most needed to advance our knowledge and capacity to predict the population dynamics of SPF at both short and long time scales;**
4. **Provide recommendations for strategies of marine ecosystem monitoring and fisheries management of SPF for sustainable ecosystem-based fisheries management;**
5. **Organize a joint ICES/PICES symposium on SPF (was in Lisbon – but also here... WG53).**

... currently, 156 members

1st WG43 / WGSPF Meeting
March 2020 ICES Headquarters
Copenhagen, Denmark

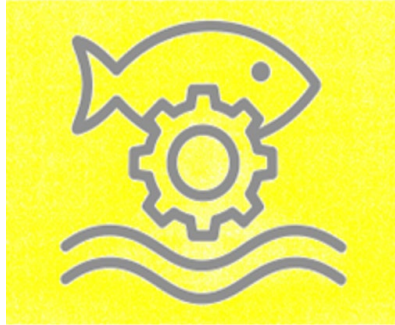


Covid – only online meetings... ugh.



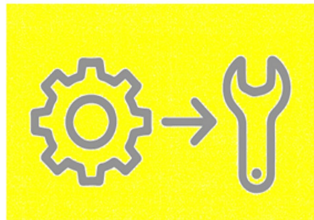
Established “Task Forces” & “Activity Groups”

Four Example Review Papers



Task Force on Ecological Process Knowledge

- 1: Critical review, evaluation & testing of classic hypotheses
- 2: Life cycle closure - bottlenecks & gaps in knowledge
- 3: Drivers of spatial distribution & phenology
- 4: Food-web dynamics
- 5: Internal & external drivers of growth, reproduction & survival



Task Force on Translating Process Knowledge

- 6: Survey design & monitoring
- 7: Improving short-term forecasts &/or long-term projections
- 8: Management improvement



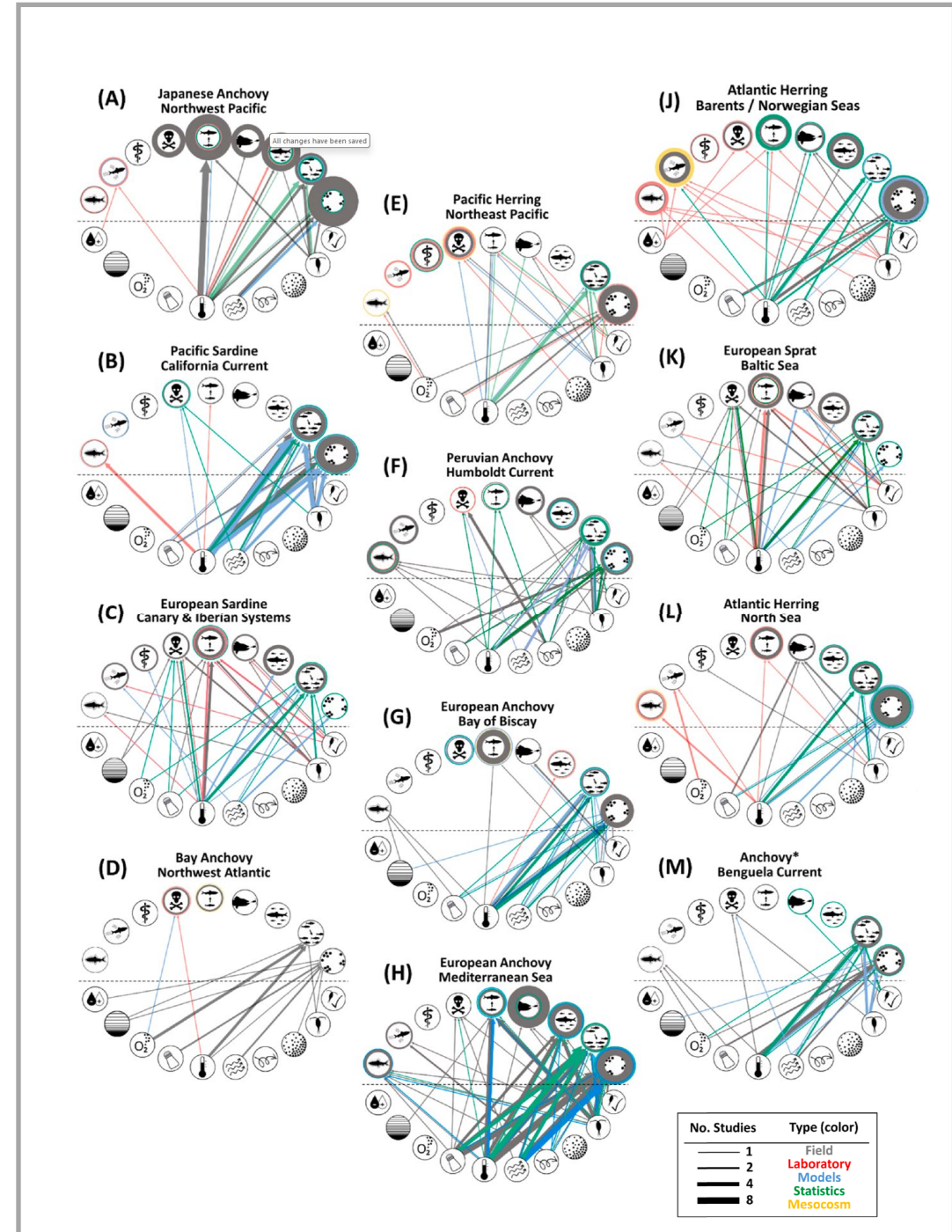
Task Force on Social-Ecological Approaches

- 9: Vulnerability & opportunities of dependent human communities
- 10: Quantifying trade-offs in goods & services
- 11: Bioeconomic modeling

Small Pelagic Fish in the New Millennium: A bottom-up view of global research effort

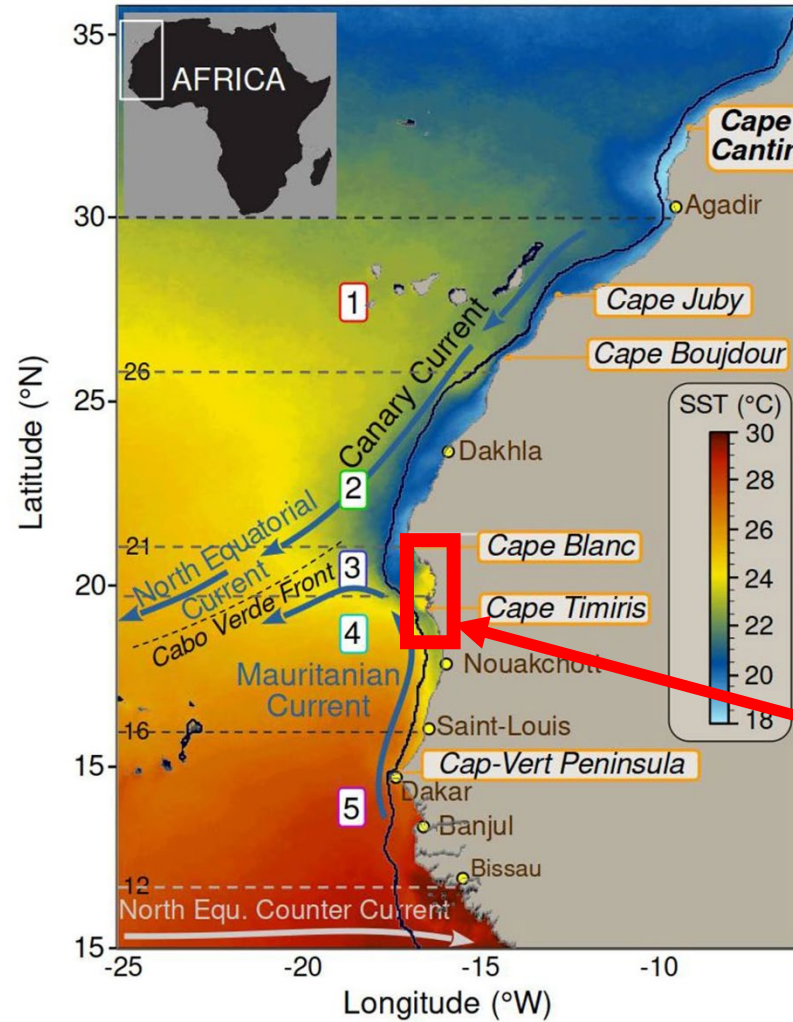
(9 authors – 9 nations)

- Compared **>900 studies** across **17 different biogeographic ocean regions** separated into types (field, laboratory, mesocosms, long-term statistical analyses and spatially-explicit modelling) and in relation to 10 bottom-up categories.
- **Lack of knowledge on young juveniles** and, in general, on the impacts of hypoxia and heatwaves on SPF;
- **Utility of paleo studies** in exploring population drivers;
- Continued need to develop **spatially-explicit, full life-cycle models**;
- importance of exploring how **density-dependent processes** impact vital rates (growth, survival, reproduction);
- Clear **benefits of international collaboration** for knowledge transfer and building unifying hypotheses on how bottom-up factors and processes regulate SPF populations.



Backyard distraction 1...

Page 22 - “Relatively little research has been conducted on stocks of SPF in Mauritanian-Senegalese subregion with most historical research published in regional journals or within technical reports... Interestingly, some of the seminal research on recruitment mechanisms of SPF stem (in part) from this subregion such as Cury and Roy’s (1989) “optimal environmental window”.



Climate change impacts on small pelagic fish distribution in Northwest Africa: trends, shifts, and risk for food security

Abdoulaye Sarre^{1,9}, Hervé Demarcq^{2,9}, Noel Keenlyside³, Jens-Otto Krakstad⁴, Salaheddine El Ayoubi⁵, Ahmed Mohamed Jeyid⁶, Saliou Faye¹, Adama Mbaye¹, Momodou Sidibeh⁷ & Patrice Brehmer^{1,8,9}

2024 scientific reports

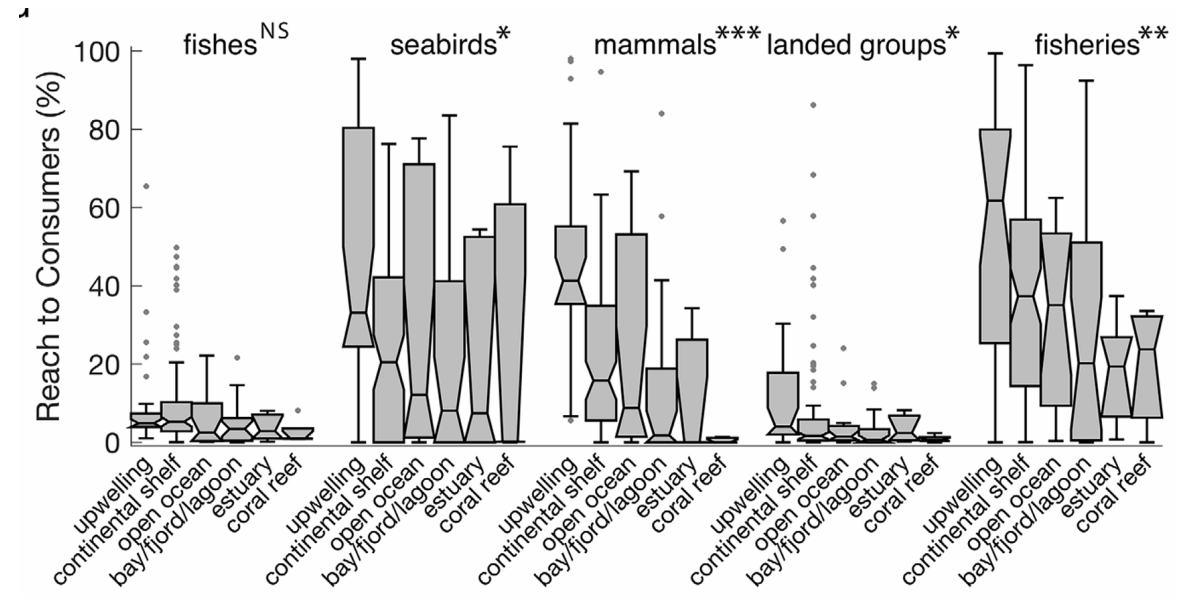
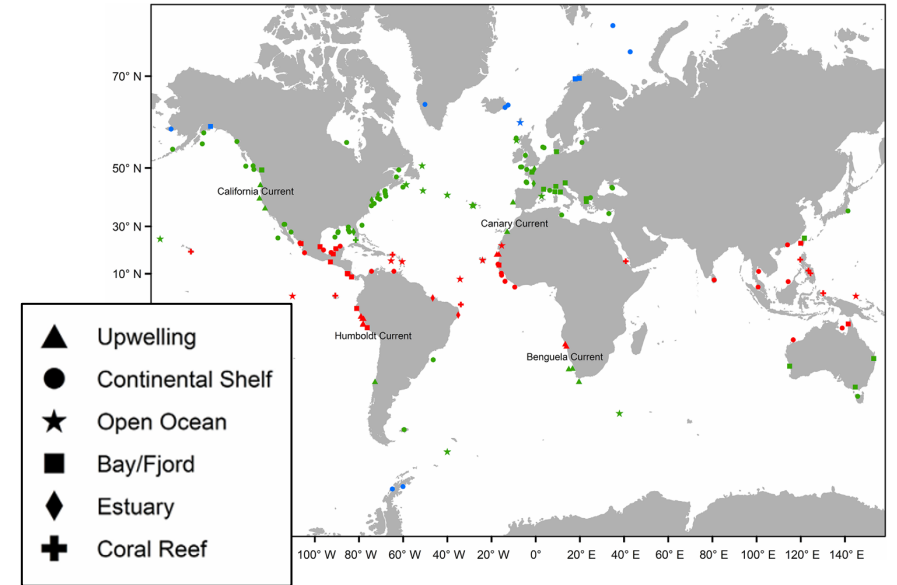


East Atlantic Flyway with top pressures identified in the East Atlantic Flyway Assessment Report

The role of small pelagic fish in diverse ecosystems: knowledge gleaned from food-web models

(12 authors – 7 countries)

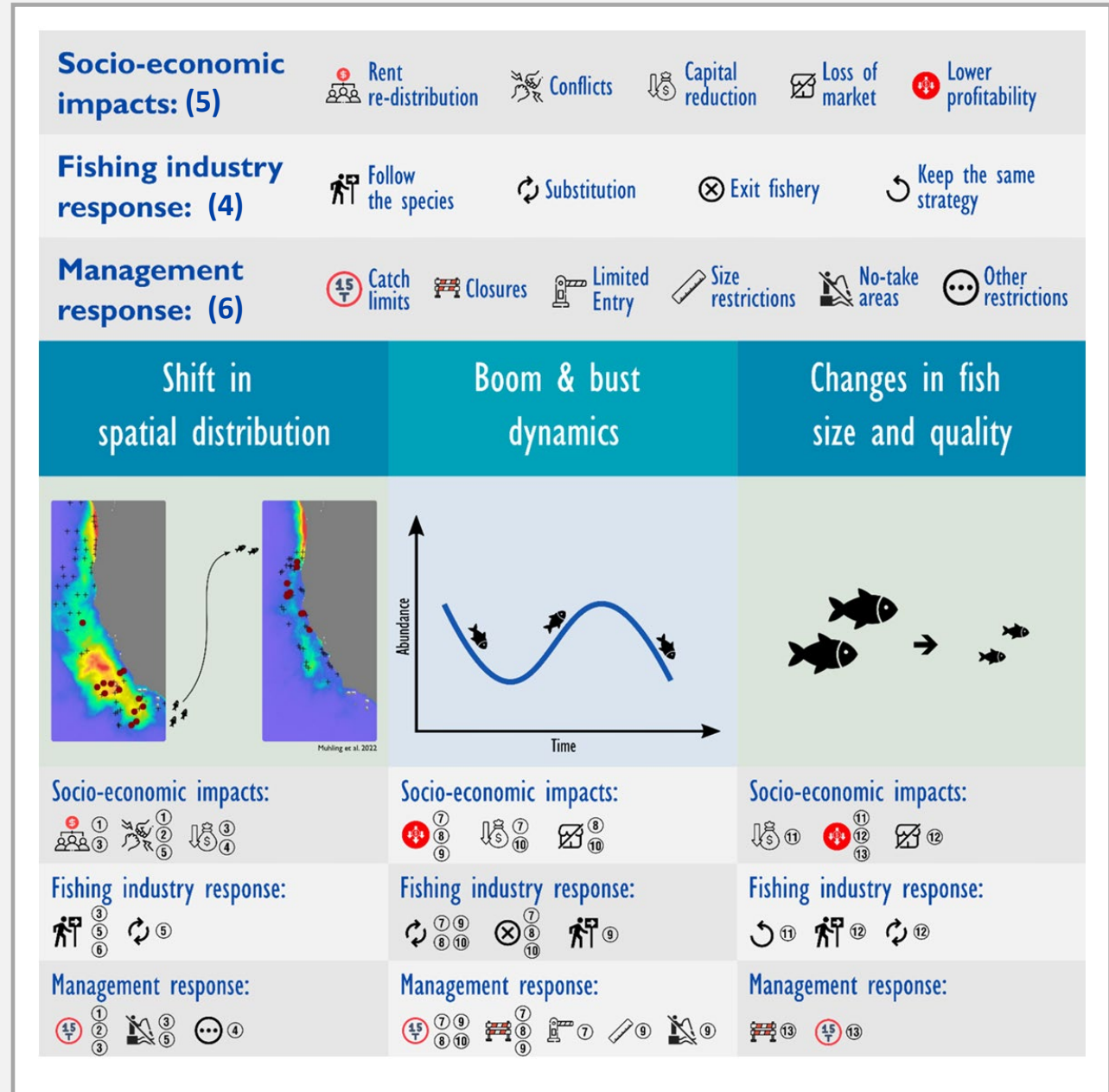
- Demand on ecosystem production, contribution to predators and fisheries, and sensitivities to changes in SPF were calculated from **199 models**.
- Globally, **SPF represented 43% of total fish production** and were supported by 8% of total primary production.
- SPF represented 18% of total fisheries catches (**53% of catches in upwelling models**).
- SPF supported 22% of seabird production, 15% of mammal production, and 34% of total fisheries catch (**33%, 41% and 62% in upwelling models**).
- Demonstrates the importance of **accounting** for direct and indirect support by **SPF to predators** and fisheries in management decisions.



Socio-economic impacts and responses of the fishing industry and fishery managers to changes in small pelagic fish distribution and abundance

(25 authors – 13 countries)

- (1) Transboundary issues in the North East Atlantic: The “Mackerel war”
- (2) Shifting SPF distribution outside Japanese EEZ
- (3) Restructuring of the South African sardine fisheries due to eastward expansion of biomass
- (4) Round Sardinella fisheries in NW Africa
- (5) Changes in the distribution of Pacific sardine in Northwestern Mexico
- (6) Hypoxic events and Gulf of Mexico menhaden fishery
- (7) Collapse of Pacific sardine on US West Coast in 1940’s
- (8) Collapse of anchovy fishery in the Bay of Biscay
- (9) Declining trend of Atlantic Iberian sardine
- (10) Booms and busts in the S. African sardine population
- (11) Decline of average size of anchovy in Tyrrhenian Sea
- (12) Decline of average size of anchovy in Bay of Biscay
- (13) Catching small-sized anchoveta in Peru due to compression of habitat and fishing grounds

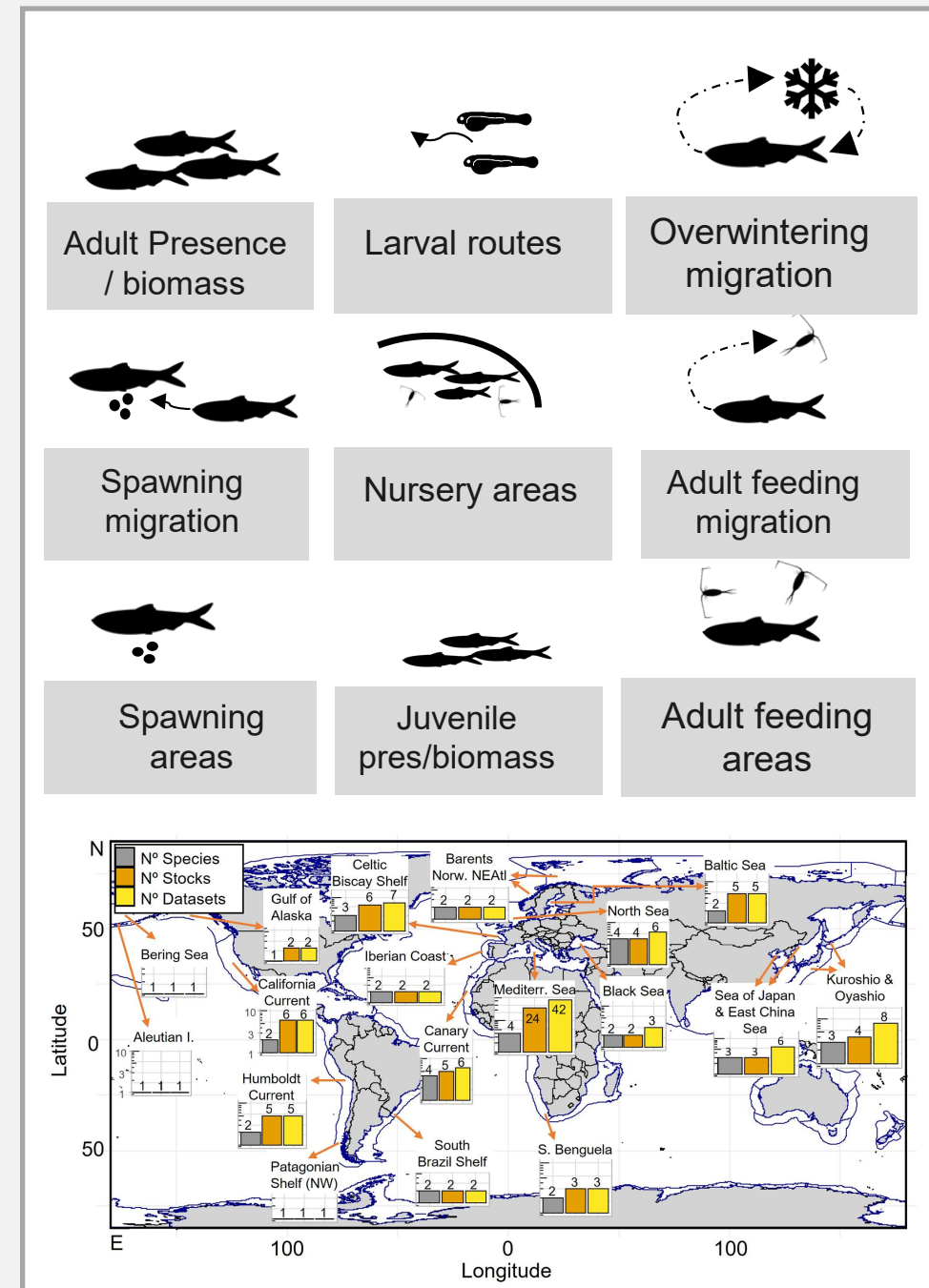


Worldwide appraisal of knowledge gaps in the space usage of SPF

- stock uncertainties and research priorities

(17 co-authors – 12 countries)

- Compiled information from 111 datasets (77 stocks) on 17 assessed / commercially relevant species across 19 Large Marine Ecosystems and 38 coastal ecoregions.
- Only ~40% of the stocks in this study covered the known or presumed stock distribution for at least one life-cycle variable.
- Apart from some Eastern Boundary Upwelling Systems and long-managed stocks, **important gaps exist** due to information quality, stock identity ambiguity, or spatial data biases.
- Key information on SPF spatial variability could be extracted from existing surveys, but there were various limitations due to **data access and spatiotemporal coverage**.
- Recommended six priority research/monitoring actions (e.g.):
 - **Manage** stocks coherently with their **ecological distribution**, as revealed by population markers such as molecular tools,
 - Leverage surveys of **data-rich stocks to inform monitoring of data poor** stocks in similar habitats.
 - Analyze spatial patterns with respect to **age or size structure** to distinguish the effects of environmental factors and fishing



Synthesis and Recommendations (2020 to 2024)



ORIGINAL ARTICLE **OPEN ACCESS**

Advancing Ecological Understanding and Sustainable Management of Small Pelagic Fish

23 authors - 11 nations

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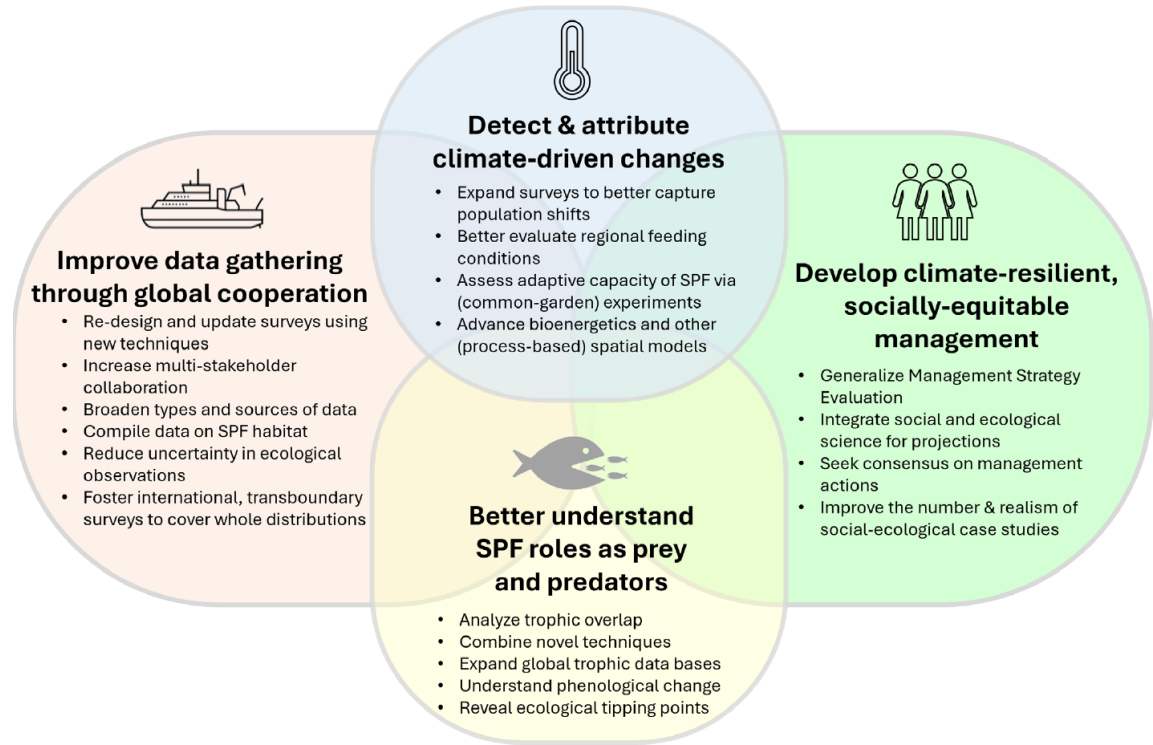
Received: 3 February 2025 | Revised: 11 March 2026 | Accepted: 29 March 2026

ABSTRACT

Small pelagic fish (SPF) are critical to the trophodynamic structure and function of marine systems and support some of the most valuable and socially important fisheries worldwide. Their “boom and bust” population dynamics, shifts in distribution, and importance as forage resources for other fish stocks place unique challenges to assessing and managing SPF. In response to these challenges, an international working group was formed in 2019 to foster collaboration aimed at closing key knowledge gaps in the ecology and sustainable management of SPF. Here, that group reviews progress made over the last ~10 years and identifies priorities for the next stage of coordinated international collaboration. Key research needs include: (i) enhancing monitoring programs to capture shifts in SPF distribution and incorporating new technologies, from molecular tools and digital imaging to biophysical and ecological modelling, (ii) improving data sharing to better understand life-history bottlenecks and cross-regional population dynamics, (iii) advancing process-based studies on oceanic and trophodynamic interactions to clarify the ecological roles of SPF as both predators and prey, and (iv) conducting bioeconomic and risk analyses to assess the vulnerability of fishing-dependent human communities to environmental and fish population fluctuations. A key pathway forward involves integrating mechanistic ecological knowledge, ecosystem and bioeconomic modelling, and social-ecological frameworks into real-time, adaptive, and equitable management approaches. This integration will be essential for developing resilient, ecosystem-based

<https://doi.org/10.1111/faf.70086>

published 3 weeks ago



La Paz, February 2024

Some recommendation from our most recent article...

In the short-term (1–5 years)

1. Investigate robustness of assessment models and management advice to bias and uncertainty in survey observations and ecological processes to improve fishery resilience as marine economies and ecosystems change due to global drivers.
2. Investigate bottom-up forcing of SPF dynamics through planktonic prey interactions by integrating the fields of fisheries oceanography, physiology, and population dynamics and by using innovative technologies (e.g., eDNA, fatty acid tracer analyses, autonomous observation platforms, AI, etc.) as they develop.

In the longer-term (5+ years)

3. Redouble efforts to increase coverage and resolution of socioeconomic and natural history datasets to improve mechanistic understanding of the roles SPF play in socioecological systems and achieve closure of their life history.
4. Establish responsive, effective management frameworks to quickly and nimbly observe, assess, and respond to changes in SPF dynamics to ensure equitable and sustainable harvests.



Some Other Products... Special Volumes



Small pelagic fish: new research frontiers

published July 30, 2024.

In total, **18 original research papers (Lisbon)**

For this symposium: W1, W2, W5, W6, W7, S3, S4, S5, S6 (August 1st)

Contact: myron.peck@nioz.nl



Small Pelagic Fishes: New Frontiers in Science and Sustainable Management, August 1, 2024.

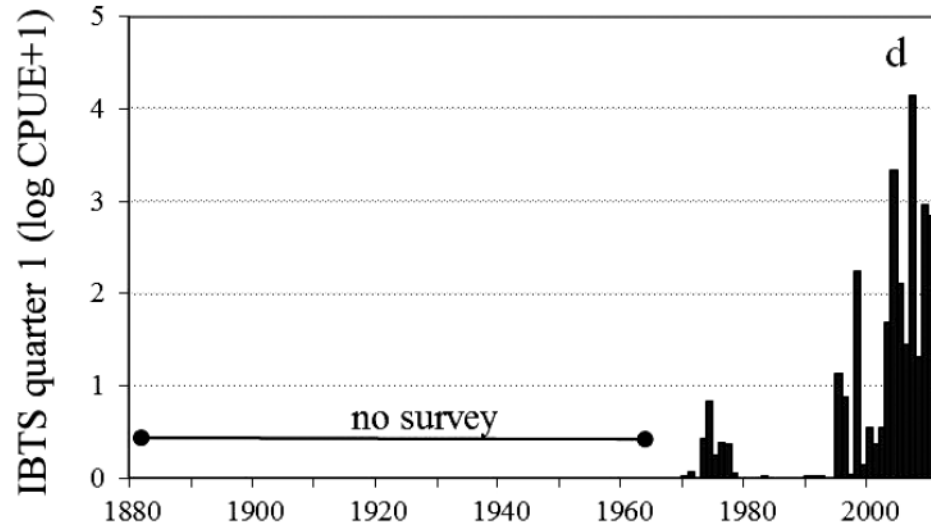
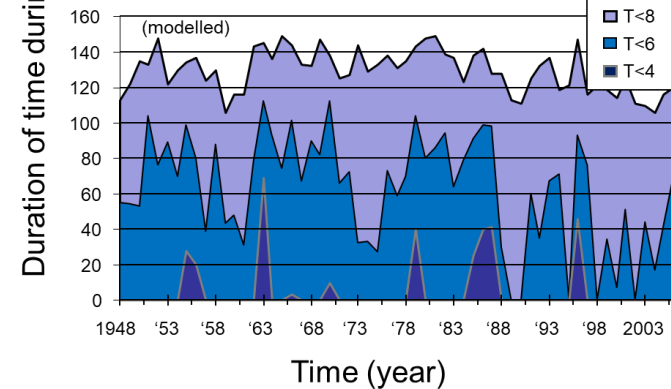
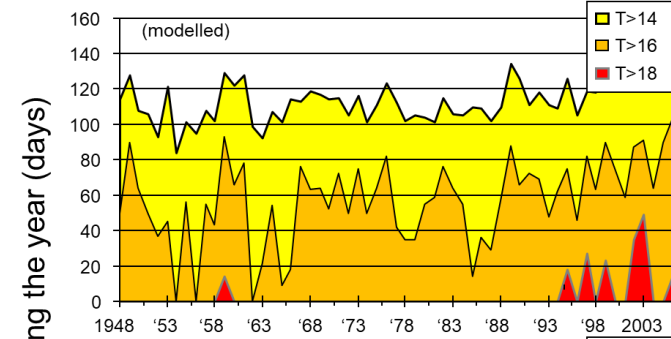
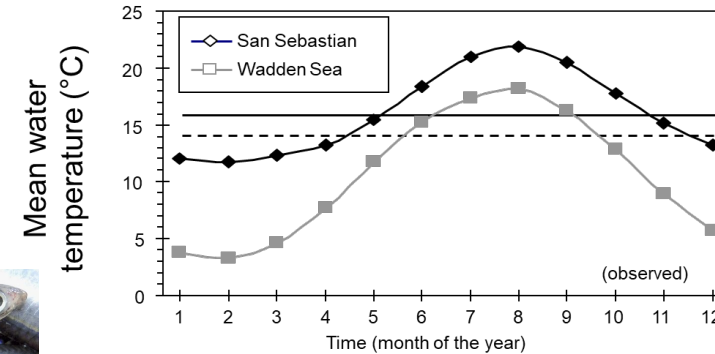
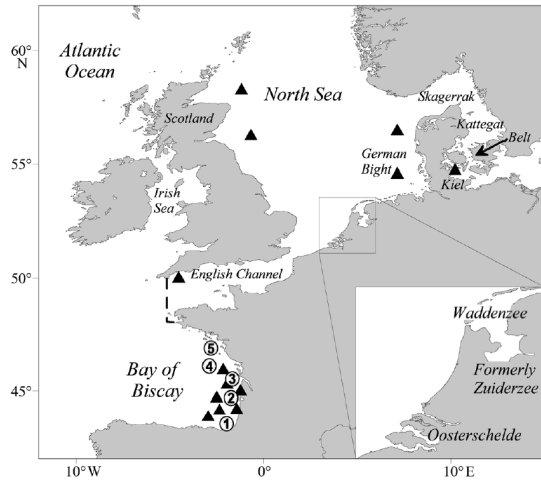
In total, **10 original research papers (Lisbon)**

For this symposium W3, W4, W8, S1, S2, S7, S8, S9 (August 1st)

Contact: chris.rooper@dfo-mpo.gc.ca

Climate Change and “Shifts” in SPF

Increase in **European anchovy** in the North Sea at the end of the 1990s was due to increased productivity of relict (southern North Sea) populations and not distribution shift. Evidence from three separate analyses: **genetics, transport modelling, survey time series analyses.**



Climate Change and "Shifts" in SPF

Increase in European anchovy in the North Sea at the end of the 1990s was due to increased productivity of relict (southern North Sea) populations and not distribution shifts. Three separate analyses: genetics, transport modelling, survey data.



Published July 30⁸



Vol. 444: 1–13, 2012
doi: 10.3354/meps09451

MARINE ECOLOGY PROGRESS SERIES
Mar Ecol Prog Ser

FEATURE ARTICLE

Anchovy population expansion

Pierre Petitgas^{1,*}, Jürgen Alheit², Myron A. Peckol³,
Martin Huret⁴, Jeroen van der Kooij⁶, Thomas
Iratxe Zarraindibia⁸, Mark L.

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²Institute of Hydrobiology and Fisheries Science, University of Hamburg, Olshausenstr. 26, 22609 Hamburg, Germany
³IMARES (Institute of Marine Resources and Fisheries Science), PO Box 68, 1790 AB IJLH, Wageningen, The Netherlands
⁴IFREMER, rue de l'Île d'Yeu, 44300 Nantes, France
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⁷AZTI-Tecnalia, Herrera kaia z/g, 20110 Pasaia, Gipuzkoa, Spain
⁸University of Basque Country, B⁹ Sarriena z/g, 48940 Leioa, Bilbao, Spain

ABSTRACT: The abundance and spatial occupation of European anchovy *Engraulis encrasicolus* have increased in the North Sea since the mid-1990s. We use a cross-disciplinary approach combining genetics, transport modelling, survey time series analyses and physical oceanographic modelling to investigate 3 hypotheses on the reasons for this change. Evidence from connectivity studies suggests that the population of North Sea anchovy is separate from that in the Bay of Biscay. The recruitment pulses observed in survey data fit a life cycle which includes spawning in summer and larval development in late summer/autumn. This supports the concept of a population originating from local spawning in the mid-1990s.



Vol. 741: 217–236, 2024
<https://doi.org/10.3354/meps14603>

MARINE ECOLOGY PROGRESS SERIES
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Contribution to the Theme Section 'Small pelagic fish: new research frontiers'

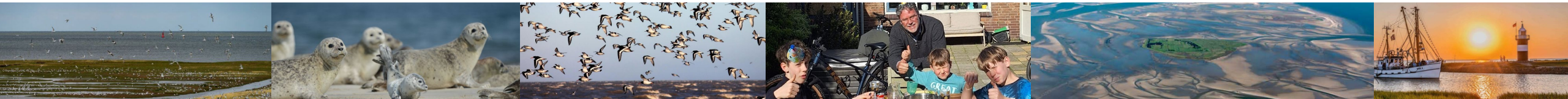
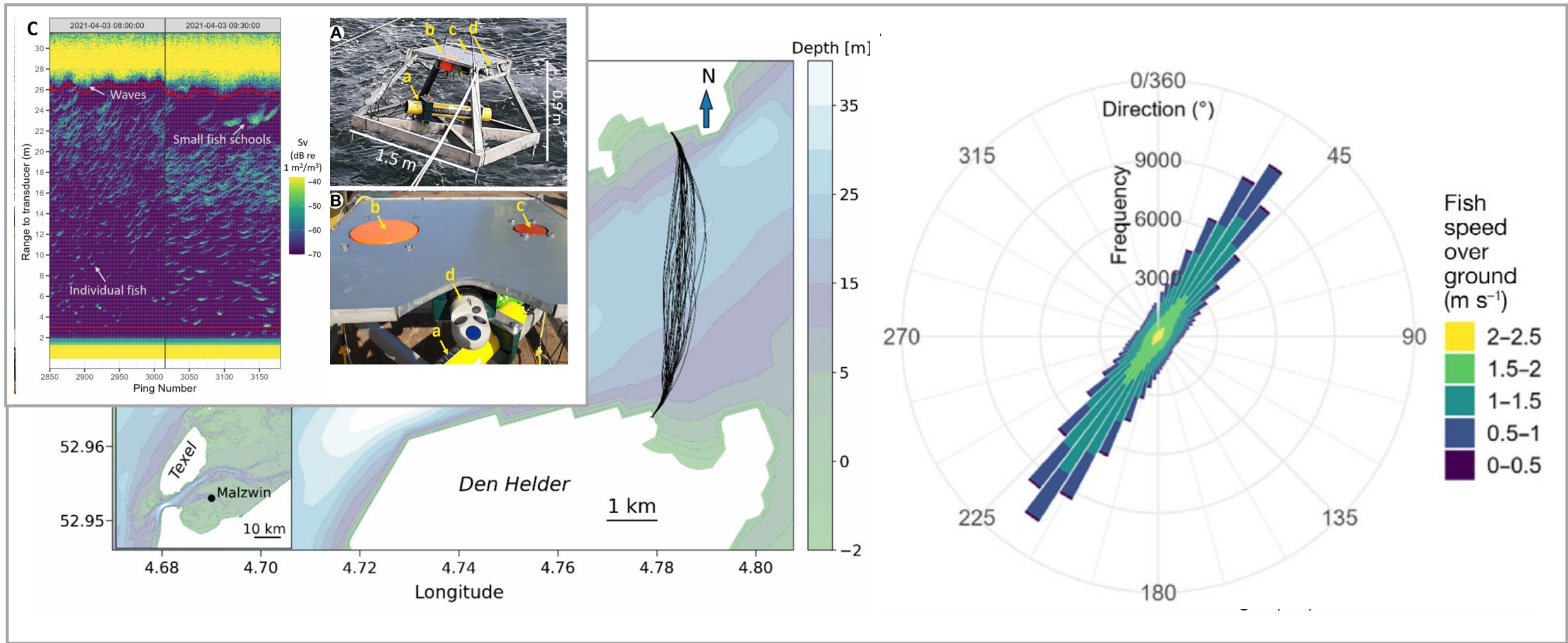
Northward range expansion of Bay of Biscay anchovy into the English Channel

8 authors – 4 countries

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⁶Present address: National Research Council (CNR), Institute for Biological Resources and Marine Biotechnologies (IRBIM), Largo Fiera della Pesca, 2, 60125 Ancona, Italy

ABSTRACT: European anchovy *Engraulis encrasicolus* is a widely distributed, warm-water species which has been postulated to be a climate change 'winner'. For decades, the northern-most stock resided in the Bay of Biscay, where it typically spawned during late spring, mostly in the south. An apparent regime shift in the mid-1990s saw the sudden appearance and subsequent increase of anchovy further north. This northward range expansion was found to be driven by remnant spawning in the North Sea. During the autumn of 2019 and 2020, for the first time, post-larval anchovy was found in the English Channel, far from their nearest known spawning grounds. Identifying the mechanisms driving this expansion is important for management purposes and to understand the limits of their distribution. Microsatellite- and mtDNA-based analyses of post-larval anchovy originated from the Bay of Biscay and southern North Sea specimens. By combining genetic and transport modelling, we examined the processes that due to population increase, increasing larval transport and an observed poleward shift in spawning time, led to the observed poleward expansion of the species into the English Channel.

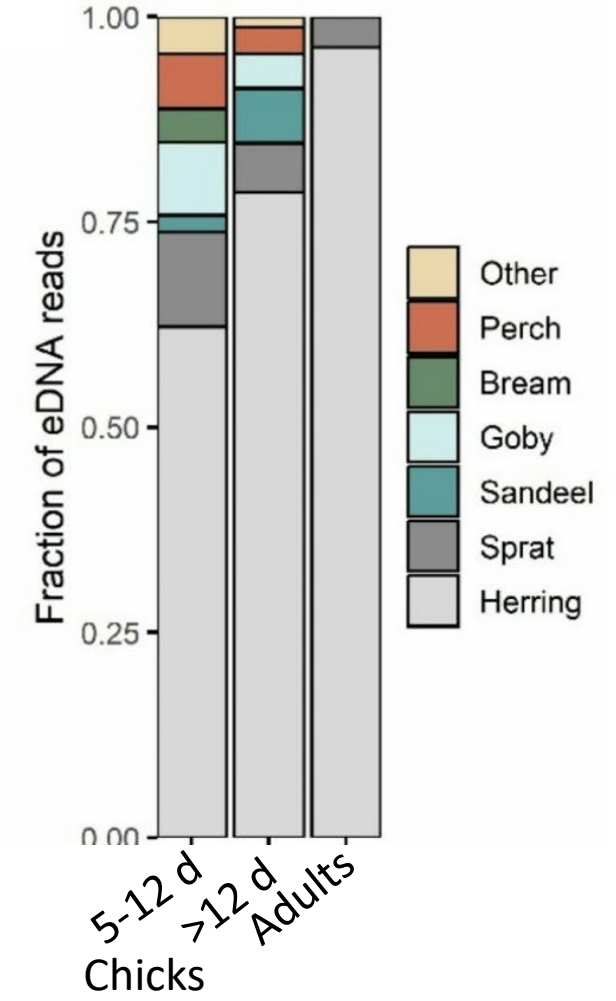
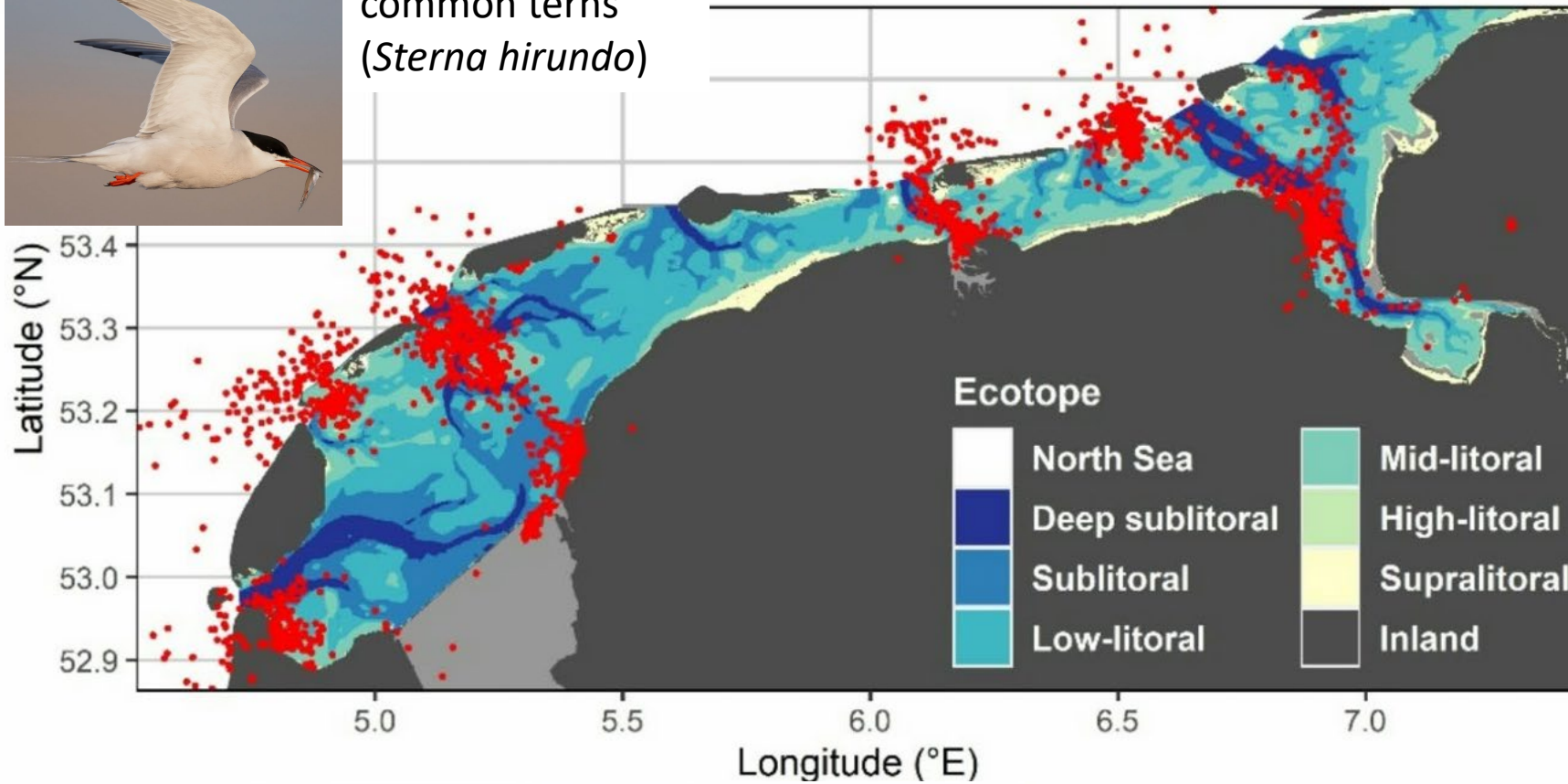
Acoustic Monitoring of Juvenile & Adult SPF in Shallow the Wadden Se (UNESCO World Heritage Site)



Monitoring Movements and Diet of SPF Predators in the Wadden Sea (UNESCO World Heritage Site)



common terns (*Sterna hirundo*)



Maathuis et al. Mar Biol. 2025



Some Products from your backyard?... Special Volumes



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published July 30, 2024.

In total, **18 original research papers (Lisbon)**

For this symposium: W1, W2, W5, W6, W7, S3, S4, S5, S6 (August 1st)

Contact: myron.peck@nioz.nl



Small Pelagic Fishes: New Frontiers in Science and Sustainable Management, August 1, 2024.

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La Paz...



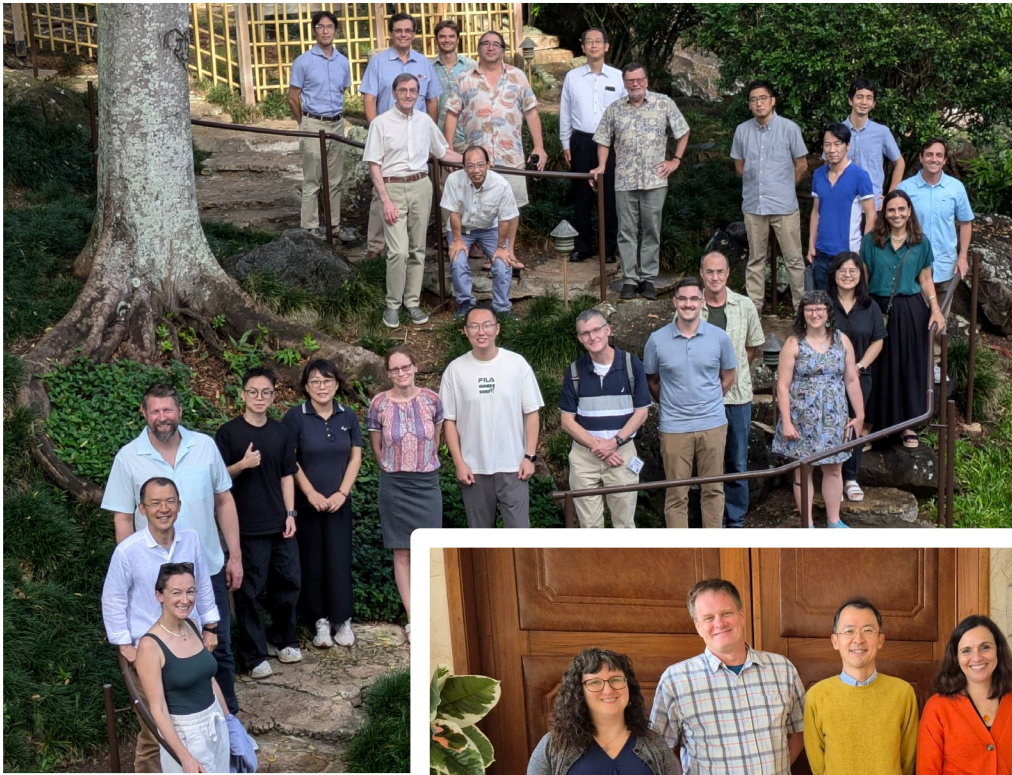
Photos by Myron Peck



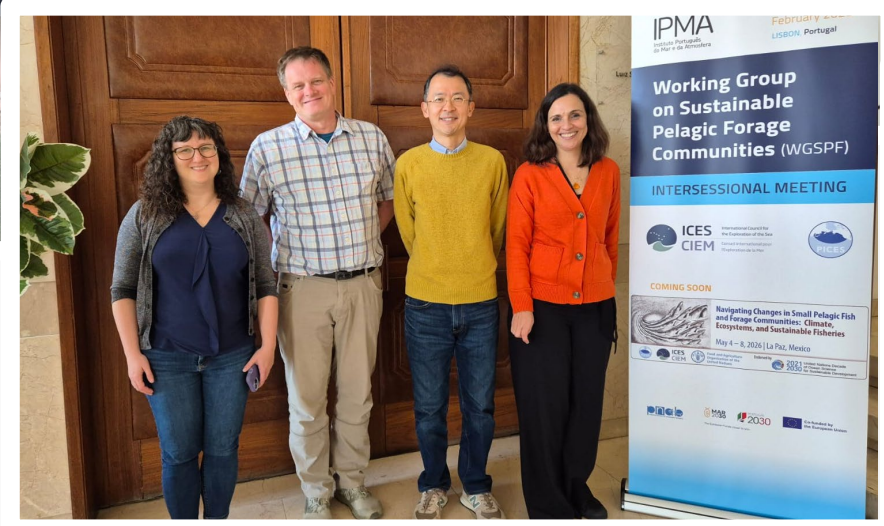
...one of the perfect places to discuss and plan research collaboration on small pelagic fish.

ICES – PICES WGSPF – WG53

Honolulu, October 2024



Lisbon, February 2025



Yokohama, October 2025

Thank you for listening!

We hope that you have an inspiring and fun conference! Questions or comments (6 other co-chairs are in audience...)

