Activity 6: Forage communities beyond boundary currents

Leaders: TBD with Ryan Rykaczewski (USA) and Chris Rooper (Canada) as coordinators to nominate leads

Background

In contrast to our evolving knowledge of the dynamics of forage fish populations in boundary currents, the temporal variability of forage communities in the open ocean remains poorly described due to limited long-term datasets. Characterizing the sensitivity of these open-ocean forage communities to oceanographic processes is required to better predict how the ecosystems they support will respond to climate change and deep-sea mining activities. For example, the epipelagic and mesopelagic zones of ocean gyres contain what may be the largest fish biomass on Earth, with diverse micronektonic communities of fishes (particularly myctophids), cephalopods, euphausiids, and other invertebrates that form the backbone of open-ocean food webs. This forage community represents a critical trophic link between the plankton and highly migratory fishes, seabirds, and marine mammals of the open ocean. PICES Working Group 14 (PICES Sci. Rep. 30, 2005) and subsequent research efforts have provided syntheses of micronekton knowledge, documenting species composition, distribution patterns related to water masses, diversity of vertical migration patterns, and ecological relationships, but further research is needed.

Boundary current forage populations often exhibit "boom and bust" dynamics hypothesized to be associated with bottom-up processes ("regime shifts," changes in marine productivity) and top-down impacts (predation, fishing), but whether small pelagic communities of the open ocean exhibit similar characteristics remains largely unknown. A critical constraint is the virtual absence of fisheries-dependent data for these communities, as small pelagic fish research in boundary currents has greatly benefitted from insight offered by commercial fishing data. Additionally, the vast spatial scales and logistical challenges of sampling open-ocean environments have limited our ability to detect patterns analogous to the regime shifts and climate-driven fluctuations well documented in coastal systems. Use of emerging approaches (*e.g.*, genomics, acoustics, autonomous platforms, ecological models) and international collaboration may be particularly important in describing patterns of variability in open-ocean forage communities.

This Activity of joint WGSPF/WG53 seeks to identify the research and observations necessary to better understand temporal variability in the composition, biomass, and productivity of forage communities in the open ocean--beyond boundary currents--by exploring how insights from boundary-current research might inform questions and approaches for these understudied but globally important ecosystems.

Objectives of the activity for 2024–2028 [with links to WG's ToR]

- Use existing datasets to conduct comparative analyses of forage communities in open ocean systems, examining spatial and temporal variability and underlying drivers where data permit (related to *ToR 1*);
- Synthesize insights from established mesopelagic research communities to understand current knowledge of sensitivity to oceanographic conditions, while contributing SPF expertise to develop testable hypotheses regarding temporal variability and climate responses (related to *ToR 2*);
- Identify observational and modeling studies necessary to improve understanding of interannual to multi-decadal scale variability in forage communities, with focus on resolving responses to climate change and anthropogenic impacts including deep-sea mining (related to *ToR 3* and *ToR 5*);
- Assess current understanding of climate change impacts on open ocean forage communities, particularly in subtropical gyres where variability and climate sensitivity are poorly characterized (related to *ToR 5*);
- Contribute to 2026 ICES/PICES/FAO symposium by participating in relevant sessions and workshops to explore opportunities for integrating SPF approaches with beyond-boundary current forage research (related to *ToR 6*).

Description of tasks

- Engage with established mesopelagic research communities including Woods Hole Oceanographic Institution's Ocean Twilight Zone program, PTZ Symposium participants, EU projects SUMMER and MEESO, and other networks, building on the foundation of PICES Report 30;
- Review findings and recommendations from recent major initiatives (JETZON, SUMMER, MEESO) to understand current research priorities and avoid duplication of effort;
- Formulate descriptions of testable hypotheses about fundamental questions regarding the sensitivities of open-ocean forage communities to climate variability and change, including potential consequences for the management of higher predators and ecosystem stability;
- Identify observational and modeling requirements needed to test key hypotheses, with particular attention to overcoming the absence of fisheries-dependent data in open ocean systems;
- Participate in sessions and workshops at the SPF-2026 symposium to assess how SPF methodological approaches might complement existing mesopelagic research priorities.

Deliverables and anticipated timeline

To be discussed

Key collaborative networks and resources to engage with

- EU Projects: SUMMER and MEESO project participants and datasets, with focus on decadal variability findings;
- International networks: CLIOTOP stable isotope database, (JETZON (Joint Exploration of the Twilight Zone Ocean Network);
- Existing databases: UBC mesopelagic database, MESOTROPH database, CalCOFI Ichthyoplankton database, acoustic survey datasets;
- Emerging technologies: eDNA research groups, environmental genomics laboratories, molecular identification specialists, fisheries-quality acoustics on autonomous platforms;
- RFMO connections: Squid, saury, and emerging mesopelagic fisheries management;
- Deep-sea mining research: Environmental impact assessment groups, mining industry scientific programs;
- Deep-sea ecology community: Potential collaborators studying anthropogenic impacts on micronektonic forage base.

Potential scientists to engage:

Chris Rooper, Ryan Rykaczewski, Dave McGowan, Richard Brodeur, Beth Phillips, Patrick Ressler, Mike Levine, Russ Hopcroft, Alejandro Ariza, Anders Rostad, Rudy Kloser, Jeff Drazen, Anela Choy, Jen Johnson, Andone Lavery, Evgeny Pakhomov, Tracy Sutton, Frank Hernandez, Pillar Olivar, Motomitsu Takahashi, Réka Domokos, Qiuyun Ma, Luoliang Xu, Libin Dai, Kasuhiro Oshima and others.