The impact of oceanographic processes on ecosystems supporting fisheries production in boundary current regions

PICES 2025 Annual Meeting
Yokohama, Japan

Session 7
(* November, 2025)

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Kuroshio and its neighboring waters

Western Boundary Current

Poor prey availability

Oligotrophic (Guo 1990)
Unproductive (Ikeda & Motoda 1978)

⇔

Nursery grounds (Sassa et al. 2008; Kume et al. 2021)
High Fishery Production (Fisheries Agency 2020)

Kuroshio Paradox
(Saito 2019)

Why and how such small pelagic fishes spend such vulnerable early life stages in the unproductive waters?

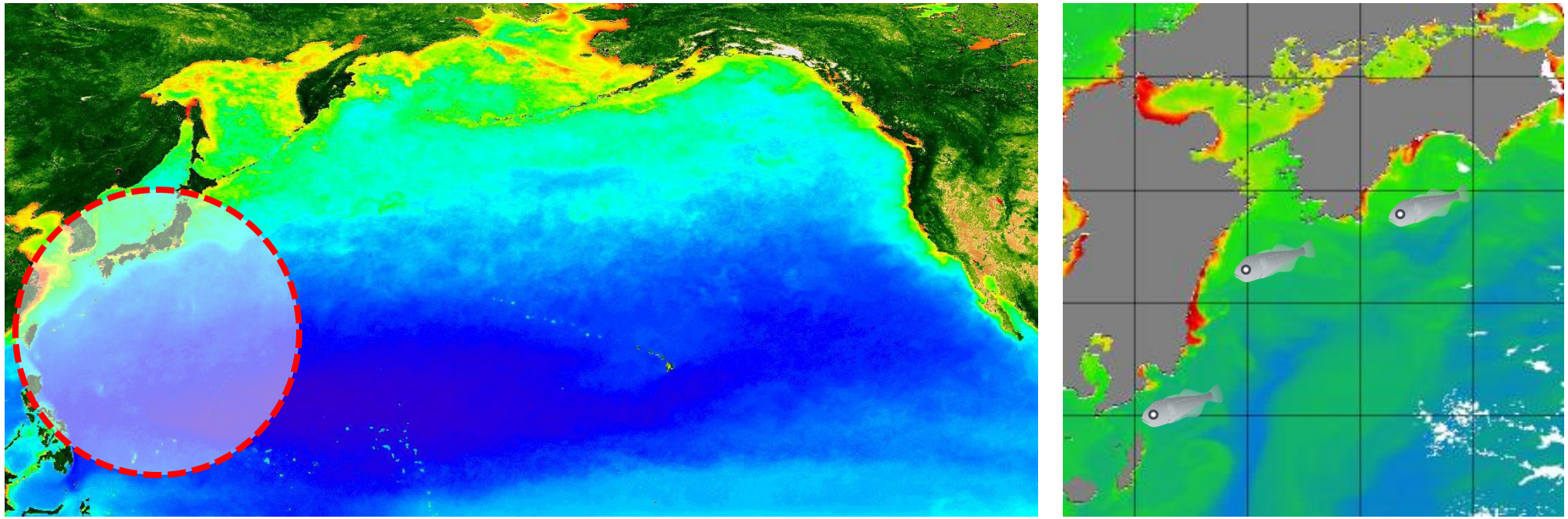

Fig. 1. Satellite image of ocean surface color (Left: from NOAA, Right: from MPFES).

Major theories to explain early survival and growth

Theories

- Critical Period Theory (Hjort 1914)
  Low survival during early life stages
- Match-Mismatch Theory (Cushing 1990)
  High survival synchronized with high plankton productivity in time and space
- Growth-Mortality Theory (Anderson 1988)
  Fast growth under high thermal regime to decline mortality
- Surf-Riding Theory (Pope et al. 1994)
  Following seasonal maxima of plankton productivity from south to north

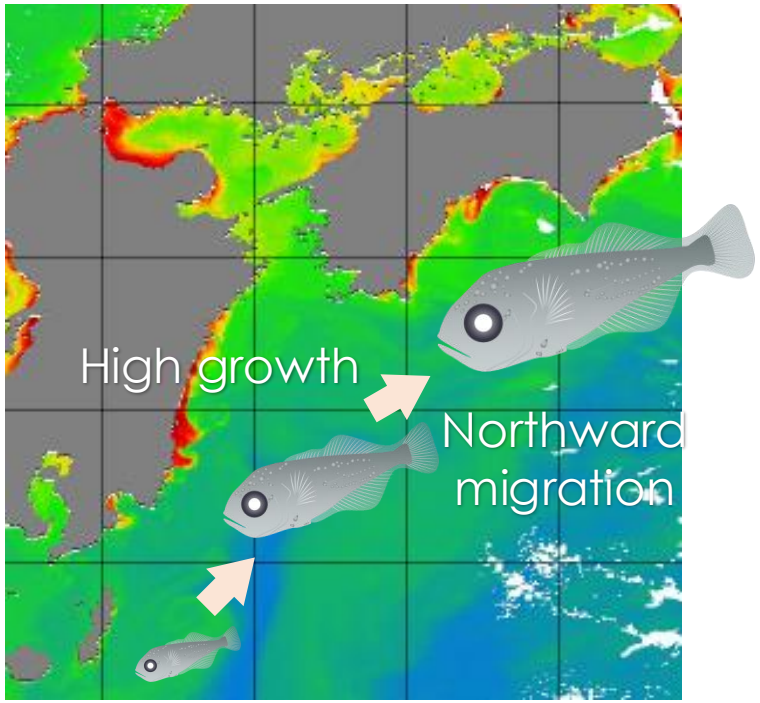

Fig. 2. Sea Surface Chl. a (from MPFES)

Evidences

- Starved fish larvae in the offshore of the Kuroshio (Nakata 1988)
- Good food availability for fish larvae in the continental shelf and the Kuroshio front (Nakata et al. 1995)

Strategies

- Achieve high growth under the high thermal regime and good prey availability
- Migrate northward transported by the Kuroshio to follow seasonal maxima of food availability

Such strategies are reasonable?

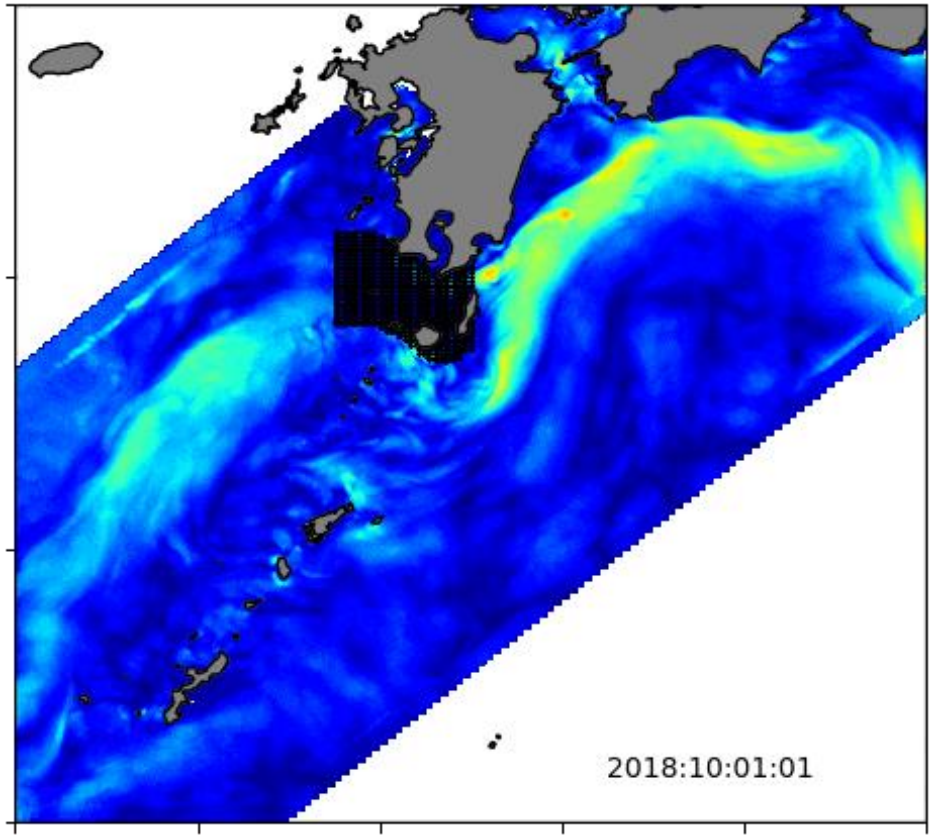

Fig. 3. Particle-tracking experiments
(modified from Kazuno et al. 2022)

- ✓ Variability of food availability associated with Kuroshio meandering is unpredictable
- ✓ Vicinity of the Kuroshio is risky to be entrapped in the oligotrophic waters for long period

Early survival and growth are not adaptive to variable environments?

Species alternation + Stock fluctuation

Small pelagic fishes represents large-scale and periodical stock fluctuations with species alternation

~ Regime Shift ~

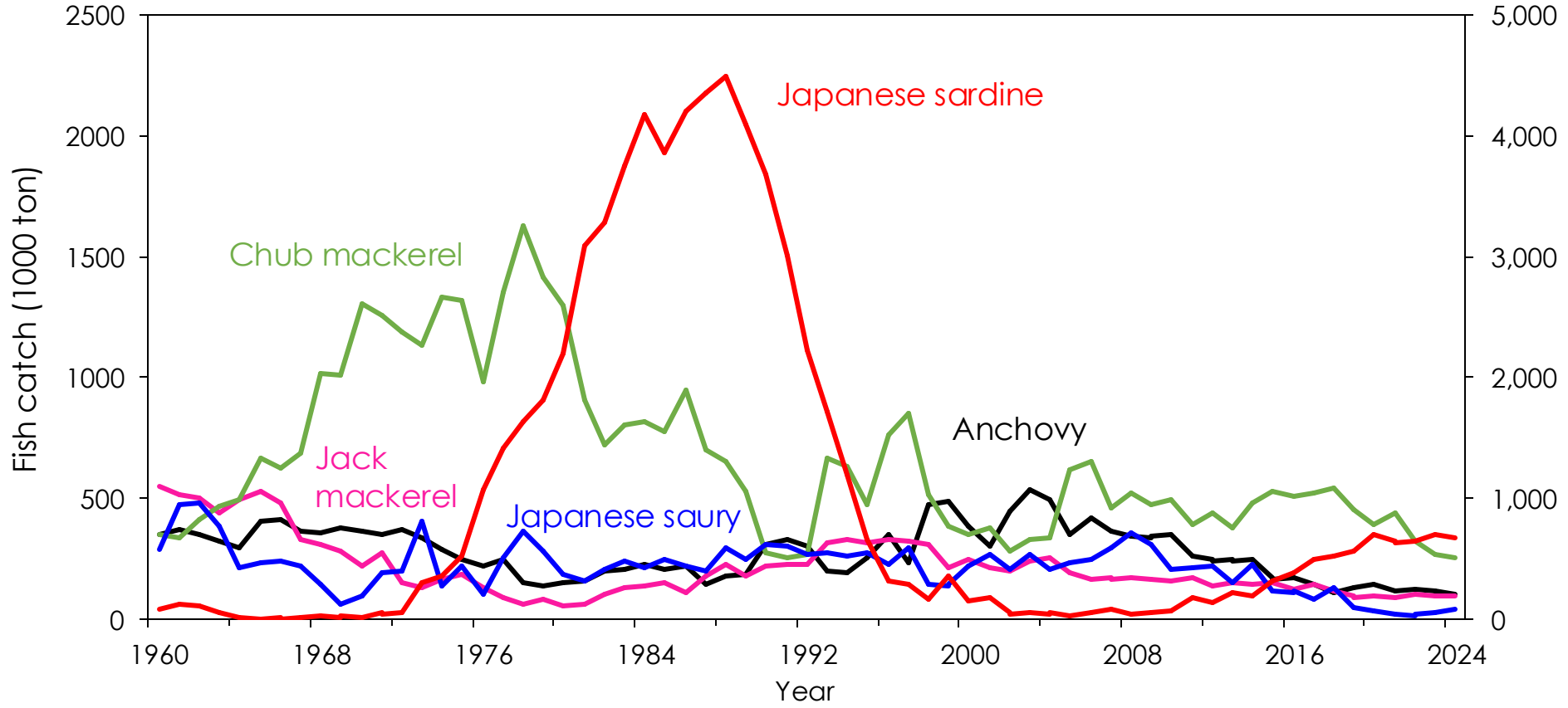

Fig. 4. Long-term variations in stocks of small pelagic fishes around Japanese waters (After Fishery Agency 2025)

How are small pelagic fishes affected by oceanographic and ecosystem processes?

What is detail mechanisms of "Regime Shifts"?

Agenda

16 talks (2 invited) and 13 posters

13 posters are available
Don't miss them!

1. Silvana Duran (Invited, ECOP)
   Submesoscale eddy induced nitrate upwelling and effect on biological production in the upstream Kuroshio current
2. Kosei Komatsu
   Impacts of the Kuroshio nutrient stream on the high productivity in the Kuroshio-Oyashio interfrontal zone
3. Ping Du
   The impact of summer Yangtze River runoff fluctuations on estuarine fronts dynamics and zooplankton communities from 2016 to 2023
4. Hikaru Homma
   Distribution of marine organisms associated with physical and biogeochemical environments observed off the Pacific coast of Tohoku, Japan
5. Tomohiro Komorita
   Spatial assessment of the impact of Kuroshio branch intrusion on the spring phytoplankton bloom in Kagoshima Bay using GCOM-C SGLI
6. Akinori Takasuka (Invited)
   Spawning responses of anchovy and sardine to environmental factors in different ecosystems: Comparative approaches from international collaboration projects
7. Mutsuo Ichinomiya
   Bloom formation by the colony-forming diatom *Thalassiosira diporocyclus* in the neighboring waters along the Kuroshio Current, North Pacific Subtropical Gyre, and its global distribution
8. Tomi Morimoto (ECOP)
   Ecological impact of aplanochytrid protists as a source of DHA for copepods in the marine environment
9. Nao Kominato (ECOP)
   Comparisons of fatty acid contents between zooplankton and fish larvae in the Kuroshio and neighboring waters
10. Honoka Ito (ECOP)
    Larval fishes encounter favorable prey availability? Testing Match-Mismatch hypothesis in major feeding grounds around the Kuroshio
11. Akinori Osawa (ECOP)
    Growth and feeding requirements of Japanese sardine *Sardinops melanostictus* larvae in the northern Satsunan area, southern Japan
12. Elena Ustinova
    Recent changes in oceanographic conditions in the Northwestern Pacific and their potential impacts on the migration and reproduction of sardine, mackerel and saury
13. Hui Liu
    Oceanographic influences on zooplankton dynamics with implications to fisheries in the northern Gulf of Mexico
14. Maria Lebedeva (ECOP)
    Assessing the impact of oceanographic field variability on the spatial distribution of chub mackerel in the northwestern Pacific fishing grounds
15. Chang-Shuo Ji (ECOP)
    Exploring the impact of typhoons on the feeding ecology of small to medium sized fish in the southwestern waters of Taiwan based on trawl catches
16. Soya Sakuma (ECOP)
    Exploring the impact of typhoons on the feeding ecology of small to medium sized fish in the southwestern waters of Taiwan based on trawl catches

Invited speaker

Gloria Silvana Duran Gomez
La Molina National University
Tokyo University of Marine Science and Technology

Research interests: Physical Oceanography

Biological production stimulated by nutrients supply with meso- to submeso-scale disturbance.

Major publications

GS Duran Gomez, T Nagai (2025)
Submesoscale Eddy induced nitrate upwelling and effect on biological production in the upstream Kuroshio Current. Sci Rep 15, 22618.

GS Duran Gomez, T Nagai (2022)
Elevated nutrient supply caused by the approaching Kuroshio to the southern coast of Japan. Frontiers in Marine Science, 555.

GS Duran Gomez, T Nagai, K. Yokawa (2020)
Mesoscale warm-core eddies drive interannual modulations of swordfish catch in the Kuroshio Extension System. Frontiers in Marine Science, 680.

Gloria Silvana Duran Gomez, Takeyoshi Nagai
Submesoscale Eddy induced Nitrate Upwelling and effect on biological production in the upstream Kuroshio Current.